Minto Mine

Water Licence QZ14-031

Quartz Mining Licence QML-0001

2017 Annual Report

Prepared by:
Minto Explorations Ltd.
Minto Mine

March 2018

Table of Contents

List of Figures

List of Tables

List of Appendices

Appendix A – Minto Mine Underground Development Map

Appendix B – Minto Mine Spill Contingency Plan

Appendix C – Groundwater Quality Monitoring Program Laboratory Results

Appendix D – Seepage Monitoring Program Laboratory Results

Appendix E – 2017 Water Balance and Water Quality Model Summary for the Minto Mine

Appendix F – Minto and McGinty Creek 2017 Surface Hydrology Update

Appendix G – 2017 Physical Monitoring Plan

Appendix H – 2017 AMP Groundwater SRK Memo

Appendix I – MMER Effluent Monitoring and Environmental Effects Monitoring Water Quality 2017 Submissions

Appendix J – Minto Mine Phase 4 EEM Interpretive Report

Appendix K – Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment 2017 Update

Appendix L – Minto Creek Fish Monitoring Program Review and Recommendations

Appendix M – Copper Toxicity in Turbid Flow Report (Minnow)

Appendix N – Waste Rock Verification Program Results

Appendix O – ABA Report 2017 GMP Annual Report

Appendix P – Wildlife and Hazing Tracking Report

Appendix Q – 2017 Update Minto Mine Constructed Wetland Treatment Research Program

Appendix R - 2017 Annual Socio-Economic Monitoring Report

List of Acronyms

Acronym	Definition
ABA	Acid-Base Accounting
AMP	Adaptive Management Plan
AP	Acid Potential
CWTS	Constructed Wetland Treatment System
DSTSF	Dry Stack Tailings Storage Facility
EEM	Environmental Effects Monitoring
EMSRP	Environmental Monitoring, Surveillance and Reporting Plan
GCL	Geosynthetic Clay Liner
GPS	Global Positioning System
HDPE	High Density Polyethylene
LTF	Land Treatment Facility
MCDS	Minto Creek Detention Structure
Minto	Minto Explorations Ltd.
MMER	Metal Mining Effluent Regulations
MPTMF	Main Pit Tailings Management Facility
MVF	Mill Valley Fill
MVFE	Mill Valley Fill Extension
MWD	Main Waste Dump
NP	Neutralizing Potential
NPR	Neutralizing Potential Ratio
QA/QC	Quality Assurance and Quality Control

QML	Quartz Mining Licence QZ-0001
ROD	Reclamation Overburden Dump
SAT	Waste material destined for subaqueous long term storage
SECP	Sediment and Erosion Control Plan
SDD	South Diversion Ditch
SMP	Seepage Monitoring Plan
SOP	Standard Operating Procedure
SWD	Southwest Dump
TDD	Tailings Diversion Ditch
TDS	Total dissolved solids
TSS	Total suspended solids
UG	Underground
UTM	Universal Transverse Mercator
WGS 84	World Geodetic System 1984
WSP	Water Storage Pond
WUL	Water Use Licence QZ14-031
YWB	Yukon Water Board

List of Units

Unit	Definition
BCM	Bank cubic meter
BTU	British Thermal Unit
dmt	Dry metric tonnes
g/t	Gram per tonne
kg	kilogram
L	Litre
m	meter
m^2	Square meter
m^3	Cubic meter
mg/m^2	Milligrams per square meter
Mlb	Million pounds
Mt	Million tonnes
oz	ounce
V	Volt

1 Introduction

This Annual Report has been prepared by Minto Explorations Ltd. (Minto) for the 2017 calendar year, as required by Type A Water Use Licence (WUL) QZ14-031-01 and Quartz Mining Licence (QML) QML-0001. Specific requirements for the Annual Report, as outlined in the respective licences, are summarized in Table 1-1.

This report provides a summary of activities at Minto Mine for the reporting year, including production summaries, construction activities, environmental monitoring studies, physical stability monitoring, water management, and progressive reclamation.

An aerial photo taken in August 2017, with updated site infrastructure labeled, is presented in Figure 1-1. For comparison, the 2016 site layout is shown in Figure 1-2.

Table 1-1: Reporting Requirements as per WUL and QML (2017)

Licence	Section	Clause	Requirement	Annual Report Section
WUL QZ14-031				
WUL QZ14-031	16		Summary of the review of the *Spill Contingency Plan* including any changes needed.	2.5.4 App. B
WUL QZ14-031	18		Summary list of all spills for 201~~6~~7.	2.5.3
WUL QZ14-031	25		The Licensee shall submit Annual Reports to the Board no later than March 31 of the year following the reporting period. The reporting period is January 1 to December 31 of each year.	All
WUL QZ14-031	26	a	Summary of all data collected as per the EMSRP, including analysis and interpretation by a qualified party and a discussion of any variances from baseline conditions, from previous years' data, and from expected performance.	5-8, 11-14
		b	Summary of actions as per the Operations Adaptive Management Plan, including analysis and interpretation by a qualified party and a discussion of any variances from baseline conditions, from previous years' data, and from expected performance.	10 App H
		c	A record of any major maintenance carried out on any physical works.	2.2
		d	Detailed data on the volume of water used during the year including water withdrawal from each water source, water routed around and through the site as part of the water conveyance system, water diverted around the site, water routed for storage in the pits, water deposited with mine wastes in waste storage facilities, water routed to the Water Storage Pond, water routed to the treatment plant and water discharged to Minto Creek.	8

Licence	Section	Clause	Requirement	Annual Report Section
WUL QZ14-031		e	Detailed data on tailings deposition in each of the tailings management facilities, including volume and tonnage of tailings slurry deposited, cumulative volume of tailings solids stored in the pits, tailings solids surface elevation and pit water elevation.	2.3.4
		f	Details of updates to the Water Balance and Water Quality Model.	8.2.4 App. E
		g	Results and interpretations of the QA/QC Program.	5.1.2
		h	Any other reports that are required to be submitted as part of the Annual Report by this Licence.	See Below
WUL QZ14-031	70		The Licensee shall monitor, sample. and report on the maintenance and performance of the Mill Water Pond, in accordance with the procedures that are detailed in the Physical Monitoring Program, and include in the Annual Report	9
WUL QZ14-031	86		The Licensee shall include data relating to the Surface Water Surveillance Program in the Monthly and Annual Reports.	5.3
WUL QZ14-031	89		The results of these studies and programs in clauses 87 and 88 shall be submitted to the Board as part of the Annual Report along with and any additional studies or revisions to studies required under the MMER.	11
WUL QZ14-031	93		The results of the seepage program shall be compared to the source terms used in the Water Balance and Water Quality Model Report and summarized in the Annual Report.	7 App. E
WUL QZ14-031	95		The Licensee shall implement the updated Geochemical Monitoring Program, including the Waste Rock Verification Program, and the results from this program are to be included in the Annual Report.	13 App. O
WUL QZ14-031	97	h	Reporting of all data obtained using physical monitoring instrumentation as a part of the Physical Monitoring Program in Monthly and Annual Reports.	9
WUL QZ14-031	98		The Physical Monitoring Program shall be updated annually to reflect the installation of new instrumentation, replacement of damaged instrumentation, and changes in monitoring methods and procedures. The updated Physical Monitoring Program shall be provided as part of the Annual Report, along with a summary table outlining revisions to the plan from previous versions.	App. G
WUL QZ14-031	99	b	The Licensee shall submit these Geotechnical Engineer's Inspection and Data Reviews as part of the Annual Report.	9

Licence	Section	Clause	Requirement	Annual Report Section
WUL QZ14-031	100	f	For each operating year, the following information shall be provided as part of the Annual Report for the Physical Monitoring Program: i. interpretation of physical monitoring data, and summary of the stability, integrity and status of all the inspected structures, works, and installations inspected by the Professional Engineer; ii. a list of each of the Professional Engineer's recommendations for remedial action; iii. an explanation of how and when each recommendation was addressed, including supporting documentation, and iv. a list of outstanding recommendations (including previous inspection reports) and associated approach and timelines to address them.	9.2 9.2 Table 9-1 Table 9-1
WUL QZ14-031	102		The Licensee shall review and evaluate the Aquatic Environmental Monitoring Program design every three (3) years and submit the findings to the Board, along with any recommendations for further refinements, as part of the Annual Report, starting in 2016.	11.4
WUL QZ14-031	104		Results and interpretations of the QA/QC program shall be provided in the Annual Report.	5.1.2
WUL QZ14-031	108	a	The Licensee shall submit an updated Water Balance and Water Quality Model as part of the Annual Report. The updated models shall include without limitation all model assumptions.	App. E
		b	Updated site data collected as per the EMSRP including: i. water quality results and water levels from all groundwater monitoring wells; ii. the most current climatic, environmental and operational conditions and data; iii. surface water quality and quantity data; iv. seepage monitoring quality and quantity data, and v. geochemical source terms from tailings and waste rock.	6 12 5.3 7 App. E
		c	A comparison of the updated geochemistry for Phase V/VI tailings and waste rock with that of previously-produced tailings and waste rock, and a comparison of model source term chemistry with equivalent operation monitoring results.	13 App. O App. E
		d	Updated predictions for operations and Permanent Closure water quality, including discussion of any variances identified and associated implications on site water management.	App. E
WUL QZ14-031	109		Specifications for the Annual Report to include but not be limited to: i. activities undertaken in relation to the Adaptive Management Plan; ii. trend analysis and water levels in Minto and McGinty creeks; iii. proposed updates and revisions to the Adaptive Management Plan, and iv. any other revisions necessary to comply with the conditions of this Licence.	10 8.5 App. H Through out
WUL QZ14-031	114	a	Annual reporting on reclamation research activities.	16.3

Licence	Section	Clause	Requirement	Annual Report Section
QML-0001				
QML-0001	13.5		On or before March 31 of each year of the term of this License, the Licensee must submit an annual report, in writing, containing the information set out in Schedule D, covering the period of January 1 to December 31 of the prior year	This Report
QML-0001	D (Site Activities)	a	Summary of construction activities associated with the Undertaking	2.2
		b	Summary of mining activities	2.3
		c	Map showing the status of all structures, works, and installations associated with the Undertaking	Fig 1-1
		d	total amount of ore and waste removed from the underground workings and open pits for the year and for the life of the Undertaking	2.3
		e	Total amount and the average head grade of ore milled	2.3.6
		f	Total amount of concentrate produced and removed from the Undertaking	2.3.6
		g	Total amount of tailings deposited in each of the tailings facilities	2.3.4
		h	Total amount of waste rock removed from the mine and the amount deposited into each deposit location	2.3.3
		i	Total amount of waste rock stored in each waste rock storage facility;	2.3.3
		j	Details respecting any action taken as a result of the recommendations made by the engineer in relation to the inspection referred to in 13.2 of QML -0001	9.2
		k	Summary of any updates to estimates of ore reserves and the life of the mine, including reserve category, tonnage and grade	4
		l	Total amount and the average grade of each ore stockpiled	2.3.5
		m	remaining reserve life of the mine	4
QML-0001	D (As-built Drawings)	a	as-built drawings of the open pit and underground mines and of all engineered structures, works, and installations constructed or altered at the Undertaking during the year	2.2 App. A
		b	as-built drawing report of the 220 kW vertical stirred mill rougher/scavenger concentrate regrinding system the year following the installation	N/A
QML-0001	D (Environmental Monitoring)	a	Summary of the programs undertaken for environmental monitoring and surveillance as outlined in the *Environmental Monitoring, Surveillance and Reporting Plan* and the 2014 Wildlife Protection Plan, including an analysis of these data and any action taken or adaptive management strategies implemented to monitor or address any changes in environmental performance	5-9 11-14 10
		b	any update to the *Site Characterization Report* referred to in 13.1 of QML-0001	15
		c	summary of invasive plants that have been identified on site and measures taken to control or remove invasive plants	14.3

Licence	Section	Clause	Requirement	Annual Report Section
		d	summary of spills and accidents that occurred at the site and measures taken respond to any spills or accidents	2.5
		e	summary of the level of traffic, access control issues, wildlife incidents and other accidents, and any upgrade or maintenance work planned for the upcoming year	2.4
QML-0001		f	summary of any site improvements undertaken to address sediment and erosion control	14.2
QML-0001	D	a	summary of any underground stability incidents	2.3.2
	(Physical Monitoring)	b	summary of data collected to date as part of the Physical Monitoring Program	9
		c	details of results, including data collected, for the physical monitoring program	9
QML-0001	D (Reclamation and Closure)	a	any temporary closure or permanent closure that has occurred during the year	16
		b	summary of activities related to care and maintenance of the Undertaking, including any temporary closure activities if applicable	16
		c	summary of progressive and ongoing reclamation activities	16
		d	summary of proposed development and production and reclamation activities for the coming year	3 16.2
		e	summary of reclamation research and results	16.1
QML-0001	D (Socio-Economic Monitoring)	a	summary of action taken by the Licensee with respect to implementation of "Minto Socio-Economic Monitoring Program Framework" (the "Framework')	17 App. R
		b	a copy of the annual report prepared by Minto Explorations Ltd., identified in paragraph 6.1 of the Framework	App. R
		c	a summary of action taken by the Licensee with respect to implementing an approved socio-economic adjustment measures plan, as identified in the Framework	App. R

MINTO MINE

Water License
QZ14-031/QML-0001
2017 Annual Report

FIGURE 1-1

SITE CONFIGURATION AND EXISTING INFRASTRUCTURE

DECEMBER 2017

capstone
MINTO MINE

1:18,000 *when printed on 8x11 inch paper*

0 100 200 300 400 500
Meters

ALEXCO ENVIRONMENTAL GROUP

National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Cadastral data compiled by Natural Resources Canada. Reproduced underlicense from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Datum: NAD 83 Projection: UTM Zone 8N

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent

D:\Project\AllProjects\Minto\gis\mxd\Overview_Maps\05-Project Development\Letter Size\Year_0_Overview_Letter_20171115.mxd

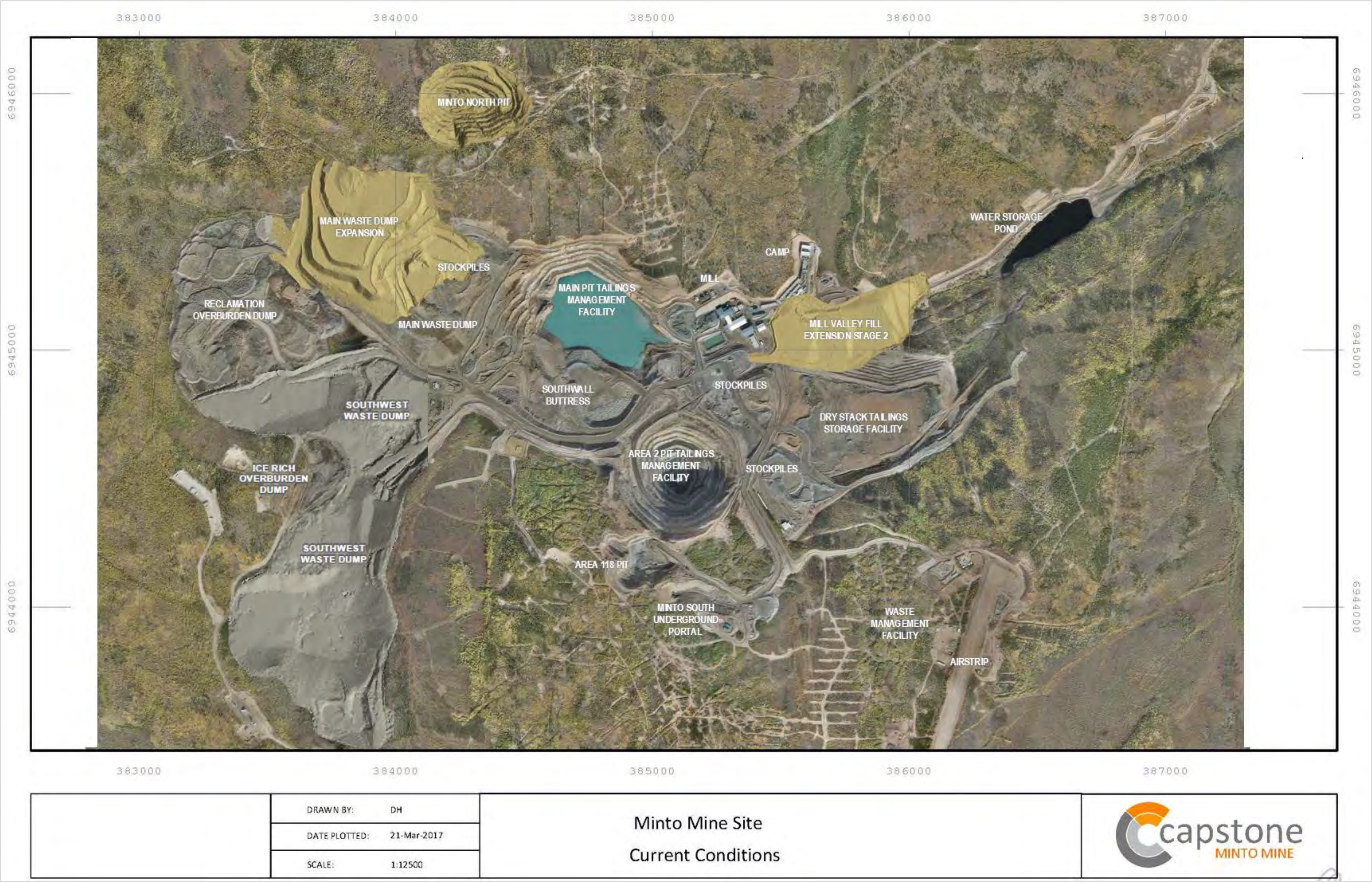


Figure 1-2: Site Layout (2016)

2 Site Activities

Operation of the Minto Mine continued in 2017, with the production of 36.0 million pounds (Mlb) of copper from the milling of 1.44 million tonnes (Mt) of ore.

Surface mining for the year totaled 3.80 million bank cubic meters (BCM). Surface mining took place in the Area 2 Stage 3 pit throughout the year.

Underground mining took place in the Area 2 and Minto East zones during 2017. Both zones are in the Minto South Underground.

Waste rock produced from mining activities was hauled to either the Main Pit Dump, Main Waste Dump Expansion, Main Pit Tailings Management Facility or Area 2 Tailings Management Facility as per the Waste Rock and Overburden Management Plan. Overburden produced from mining activities was hauled to the Area 118 Backfill Dump or closed facilities for progressive reclamation. Milling was a combination of run-of-mine ore from both surface and underground operations, as well as ore stockpiled from previous mining.

Tailings produced from the milling process were deposited into the Area 2 Pit Tailings Management Facility as per the licensed Tailings Management Plan.

2.1 Exploration

Although no exploration drilling occurred at Minto in 2017, a total of 5,468 meters were drilled in 46 holes targeting various ore lenses with the intent of upgrading resources to probable reserves and to provide geological confidence for the optimization of the mine design.

These totals include 410 meters of drilling in 5 underground targeting gaps in coverage on the fringe of the Area 2 lower ore lens. In addition, two surface holes, totaling 171m, were drilled at the eastern edge of the Area 2 Stage 3 pit primarily to confirm the depth of overburden. Both programs were conducted in February 2017.

Four holes, totaling 1,526m, were drilled in September 2017 targeting the Minto East ore lens. One of the holes was drilled to test ground conditions in advance of the planned Minto East ventilation raise, and 3 holes were drilled to test the ground conditions around the Minto East fault.

The final program was conducted in October-November and consisted of 35 holes, totaling 3,361m. This program targeted the Ridgetop deposit with the goal of improving drill coverage where any significant gaps existed.

2.2 Maintenance, Infrastructure and Construction Projects

There were no major maintenance activities conducted in 2017 on the physical works. One construction project was started in 2017, the Tailings Diversion Ditch (TDD) portal road re-alignment. The following is a summary of the project.

2.2.1 Tailings Diversion Ditch Portal Road Re-Alignment

As part of Phase V/VI development of the Area 2 Stage 3 Pit, a portion of the South Diversion Ditch was mined out. The water conveyance infrastructure was replaced by diverting routine flows to the Tailings Diversion Ditch (TDD) via an intake structure and pipeline. An overflow spillway into the Area 2 Stage 3 Pit was also required to divert event flows that exceed the pipeline capacity. The design details are discussed in a report prepared by SRK Consulting (SRK, 2017).

Construction of the Tailings Diversion Ditch Portal Road Re-Alignment began in July. The 4k cable and propane line were protected and buried. The area was grubbed of organic materials and construct grade waste material was utilized to establish the new portal haul road and airport access road. The water conveyance pipes were placed and covered. The intake channel was excavated, a geosynthetic clay liner was installed to limit seepage, with a non-woven geotextile placed overtop to provide a layer of protection. A layer of residuum provided an additional layer of protection and riprap was placed to provide protection against erosion. Water could be conveyed to the Tailings Diversion Ditch via the intake structure and pipeline prior to the freezing temperatures in October, however some additional work is required prior to freshet in 2018 before the project is considered complete.

2.3 Mining Activities

Section 2.3 discusses the mining activities for 2017 including open pit and underground mining, waste rock and tailings management, ore stockpiles, operating results, and concentrate shipments.

2.3.1 Open Pit Mining

In January 2017, mining of the Area 2 Stage 3 pit began with the removal and stockpiling of organic rich soil from within the pit footprint, followed by stripping of overburden and waste rock. The first ore release from the pit occurred in February. In July, the Area 2 Stage 3 pit design was revised based on current economic conditions, increasing the size of the pit. Mining activities in the expansion of Area 2 Stage 3 commenced in August, and ramped up to full production after the original Area 2 Stage 3 pit design was completed on September 12th, 2017. The first ore release from Area 2 Stage 3 Expansion occurred in November.

2017 total mined waste and ore quantities are summarized in Table 2-1, below.

Table 2-1: Open Pit Mined Quantities: Mining Waste Volume and Ore Volume (2017)

	Waste / Overburden (BCM)	Ore (BCM)	Ore (t)
Area 2 Stage 3	2,124,554	299,119	800,344
Area 2 Stage 3 Expansion	1,326,603	52,766	140,777
Total	**3,451,157**	**351,885**	**941,121**

2.3.2 Underground Mining

Mining activities in the Minto South Underground continued throughout 2017. Production continued from the Area 2 zone, with ore release totaling 328,000 tonnes.

A ramp was developed to the Minto East ore zone, from which three level accesses, accesses to ventilation and escapeway raises, and supporting infrastructure such as sumps and an electrical substation were completed. Development within the ore zone itself did not begin in 2017. 142,000 tonnes of waste rock were hauled to surface. See Appendix A for the underground development map.

2.3.3 Waste Rock Management

Waste rock dump development continued in 2017, as per the *Minto Mine Waste Rock and Overburden Management Plan*. Table 2-2 summarizes the waste materials and ultimate destinations, and the volumes deposited. Current waste rock inventory in the various waste rock and overburden dumps at the Minto Mine site are summarized in Table 2-3.

Table 2-2: Waste Rock Destination and Volumes – Unreconciled truck counts (2017)

Material Type	Destination	Volume (BCM)
Waste - Construction Grade	Roads/Ramps	106,000
Waste - Construction Grade	Tailings Diversion Ditch – Portal Road Re-Alignment	39,000
Waste	Main Pit Dump	950,000
Waste	Main Waste Dump	148,000
Waste Rock - SAT	Main Pit Buttress	26,000
Waste Rock - SAT	A2S2 In-Pit	56,000
Total		**1,325,000**

Table 2-3: Waste Dump Location and Storage Volumes (2017)

Dump Location	Quantity Stored as of December 31, 2017 (m^3)
Main Pit Buttress	4,230,000
Main Pit Dump	1,230,000
Southwest Dump	12,120,000
Mill Valley Fill Extension	1,440,000
Reclamation Overburden Dump	4,300,000
Main Waste Dump	8,360,000
Main Waste Dump Expansion	3,600,000
Mill Valley Fill Extension 2	1,360,000
Total Waste Dumped	36,640,000

2.3.4 Tailings Management

All tailings produced in 2017 were deposited in the Area 2 Pit Tailings Management Facility (A2PTMF). The following table lists the deposition schedule.

Table 2-4: Tailings Deposition Schedule in 2017

Tailings Management Facility	Date Range	Quantity Deposited (dry metric tonnes)
A2PTMF	January 1 – December 31	1,402,004
Total 2017 Tailings		**1,402,004**

A total of 1,402,004 dry metric tonnes (dmt) of tailings were discharged to the A2PTMF in 2017. Since November 2012, the Main Pit Tailings Management Facility (MPTMF) has received 3,347,000 tonnes of tailings. Since March 2015, the Area 2 Pit has received 3,756,000 tonnes of tailings.

Deposition to the A2PTMF is from a point at the northeast corner of the pit. A discharge line runs from the pit crest at the 806m elevation to a point on the highwall passed the overburden contact, at 787m: this ensures that the tailings stream runs down solid rock and does not cause erosion. As of year-end, the highest point of the tailings beach is at the 774.0m elevation and the water level in A2PTMF was 771.1m.

Deposition in the MPTMF is possible from two locations, near the middle of the pit via a floating tailings line and near the north wall of the pit. The highest point of the tailings beach is at 787.5m elevation. At year-end, the water level was measured at 784.5m.

The pipeline and pump which transfers supernatant water from A2PTMF to MPTMF, where the mill's process water intake is located, was repositioned in November due to Area 2 Stage 3 Expansion pit mining activities.

As in previous years, tailings were not observed to remain ponded on the ice surface of either tailings management facility during the winter months. The relatively high tailings temperature, combined with the erosive effect of the tailings stream, melts through the ice at the discharge point.

Minto's filter press plant, previously used to prepare tailings for deposition to the Dry Stack Tailings Storage Facility (DSTSF), has been deactivated and did not operate in 2017. While the filtration equipment is still in place, a substantial portion of the building's electrical supply has been re-routed to the Minto South Portal.

2.3.5 Ore Stockpiles

Several ore stockpiles exist on the property. Southeast of the mill complex, three adjacent stockpile pads exist:

1. Mill Pond Pad – Blended and crushed mill feed
2. East Stockpile –Sulfide and partially oxidized run-of-mine (ROM) ore stockpiles
3. South Stockpile –Partially oxidized run-of-mine (ROM) ore stockpiles

West of the Main Pit, adjacent to the Main Waste Dump, the Top of the World stockpile consisting of partially oxidized run-of-mine (ROM) ore is being actively depleted.

The stockpile areas are displayed in Figure 2-1.

Ore is segregated by copper grade and percentage of acid-soluble copper as shown in Table 2-5.

Table 2-5: Ore Stockpiles

Material Type	Copper Grade Range	Soluble Copper
Blue Sulfide Ore	0.50 – 1.00% Cu	<15.0%
Green Sulfide Ore	1.00 – 2.00% Cu	<15.0%
Yellow Sulfide Ore	>2.00% Cu	<15.0%
Partially Oxidized Ore (POX)	>1.50% Cu	>15.0%
Low-Grade Partially Oxidized Ore (LG POX)	0.80 – 1.50% Cu	>15.0%

The higher-grade ores are fed to the mill as they are mined to maintain the highest possible head grade while mining ore. The lower-grade and partially oxidized stockpiles are depleted gradually and are used to supplement mill feed during periods of waste stripping.

Table 2-6: Stockpile Inventory

	December 31, 2016			December 31, 2017		
	Mass (tonnes)	Cu (%)	Ag (g/t)	Mass (tonnes)	Cu (%)	Ag (g/t)
Red	33,235	5.54	24.27	-	-	-
Yellow	30,427	2.76	12.36	-	-	-
Green	71,477	1.44	6.28	-	-	-
Blue	245,851	0.73	2.76	1,707	0.78	3.93
POX	0	-	-	235,296	1.21	3.50
LG POX	56,809	0.91	2.24	199,582	0.66	1.74
Portal Ore Pad	29,259	1.58	7.81	9,434	2.36	12.78
Live Pile	22,230	2.07	8.63	21,583	1.71	6.09
Total Ore	**489,287**	**1.42**	**5.84**	**467,601**	**1.02**	**3.06**

DRAWN BY: RK

DATE PLOTTED: 03-AUG-17

Figure 2-1
Ore Stockpiles – 2017

capstone
MINTO MINE

2.3.6 Operating Results

Ore processing and metal production results for the 2017 calendar year are summarized in Table 2-7, below.

Table 2-7: Operating Results (2017)

Metal Production	Quantity
Copper (t)	16,331.71
Gold (kg)	787.86
Silver (kg)	5,263.88
Ore Milled	
Ore processed (t)	1,439,374
Copper grade (%)	1.37
Gold grade (g/t)	0.79
Silver grade (g/t)	4.76
Recoveries	
Copper (%)	82.6
Gold (%)	59.3
Silver (%)	77.6
Concentrates Produced	
Copper concentrate (dmt)	37,372.0
Copper (%)	43.7
Gold (g/t)	18.01
Silver (g/t)	142.16

2.3.7 Concentrate Shipments

Minto produced 41,299 wet metric tonnes of concentrate at 9.51% moisture content, which corresponds to 37,372 dmt. The average concentrate grades are listed in Table 2-7, above. 996 truckloads of concentrate were shipped from Minto in 2017: 534 via the winter ice bridge and 462 during the summer barge season.

2.4 Mine Access Road

2.4.1 Traffic

From December 27th, 2016 to April 9th, 2017, access across the Yukon River was over an ice bridge during which time, heavy trucks made 700 round trips, medium trucks made 148 round trips, and light vehicles made 386 round trips across the ice bridge. Between April 10th and June 17th, 2017 there was no land access to the mine site. On June 18th, 2017, the summer tug and barge operation started for the season. During the barge operating season, heavy trucks made 621 round trips, medium trucks made 299.5 round trips, and light vehicles made 556.5 round trips to the Minto Mine via the mine access road. The barge operating season ended November 7, 2017. Establishment of the 2018 ice bridge started in December 2017.

2.4.2 Access Control Issues

No access control issues were experienced in 2017.

2.4.3 Planned Access Road Maintenance for 2018

Beyond routine maintenance work, no major projects or upgrades are planned for 2018 regarding the access road.

2.5 Accidents and Incidents

2.5.1 Incidents

In 2017, Minto Mine experienced three lost time accidents, seven medical aids and seven serious incidents reported to the Yukon Workers Compensation Health and Safety Board for the reporting period. In order to respond to incidents on site, Minto maintains a current Emergency Response Plan supported by a complement of emergency response personnel trained and certified in advanced first aid, firefighting and mine rescue along with equipment required for all response types. In addition, reporting and investigation of incidents is standard practice at the site.

2.5.2 Wildlife Incidents

The Conservation Officer was made aware of two events at Minto in 2017. The first incident was an aggressive black bear initially encountered on the access road on June 25th, 2017, then again by two hikers walking after work on July 23rd, 2017. A temporary ban on recreational outdoor activities was put in place on July 24th, 2017 due to the presence of the aggressive bear. The bear eventually left the area and was not seen again, resulting in the recreation ban being lifted. The second communication with the Conservation Officer was due to a porcupine being run over and killed by a haul truck on the mine site on September 28th, 2017. The porcupine was disposed of in the onsite incinerator, a method supported by the Conservation Officer.

2.5.3 Reportable Spills

There was one reportable spill that occurred at Minto Mine during 2017. The volume and causes of the spill are summarized below in Table 2-8.

Table 2-8: Reportable Spills (2017)

Date	Amount	Substance	Cause
8-Jul-17	50 kg	Potassium Hydroxide	A pallet containing potassium hydroxide flakes had multiple broken bags that had spilled contaminant onto the ground. During the investigation, it was determined that the pallets had been stored there for up to 4 years, however, it was difficult to determine at what time the packaging had become uncovered and degraded to the point that the material spilled to the ground.

The spill in Table 2-8 was reported as per the *Spills Regulations* of the Yukon Environment Act. The follow up spill report was submitted within 10-days of the occurrence. Additionally, non-reportable spills were tracked internally as per the WUL. Spills on site were cleaned up with a variety of methods including, but not limited to, absorbent spills pads, soil excavation, soil treatment in the LTF, and disposal in the Main Pit dump.

2.5.4 Spill Contingency Plan Review

An update to the Minto Mine Spill Contingency Plan is required annually as part of the Annual Report and the updated 2018 Minto Mine Spill Contingency Plan is provided in Appendix B.

3 Proposed Mining for 2018

Section 3 discusses the proposed mining for 2018 at the Minto Mine, including open pit and underground mining.

3.1 Proposed Open Pit Mining for 2018

The Area 2 Stage 3 Expansion is expected to be completed in April 2018.

A program of infill drilling was completed in Q4-2017 at the Ridgetop North pit. These results will be used to create an updated block model and to better define the boundaries between partially oxidized and sulfide ore. These changes, along with current market conditions and an updated slope stability analysis, will be incorporated into a pit optimization for the Ridgetop North pit. The pit optimization work is expected to be completed in March 2018, with mining activities commencing shortly after if economics determine that it is feasible.

The mine plan will be revisited whenever key inputs such as copper price, exchange rate, or fuel price change significantly.

3.2 Proposed Underground Mining for 2018

Mining of the Area 2 zone will continue, with completion expected in Q1. Production will begin in the Minto East zone, continuing throughout the year. Development toward the next ore zone, Copper Keel, will begin in Q1 and continue throughout the year; first ore is expected in Q4.

The new Minto East exhaust raise will be commissioned, reversing the airflow direction in the main ramp and improving ventilation efficiency.

4 Mineral Resources and Reserves

Minto Mine's updated mineral resources and reserves are provided in Tables 4-1 and 4-2 respectively, below. The most recent update is from December 31, 2016. There were no updates in 2017.

Table 4-1: Updated Mineral Resources for Minto Mine (most recent Dec. 31, 2016)

Classification	Tonnes (kt)	Copper (%)	Silver (g/t)	Gold (g/t)	Contained Copper (kt)	Contained Silver (koz)	Contained Gold (koz)
Minto South Deposit (MSD) (Open Pit and Underground)							
Measured	3,466	1.09	3	0.41	38	374	45.2
Indicated	17,723	1.08	3	0.37	192	1,893	212
Total Measured + Indicated	21,189	1.09	3	0.38	230	2,268	257.2
Inferred	12,445	0.8	2	0.22	100	969	89.3
Ridgetop (Open Pit)							
Measured	1,531	0.98	2	0.25	15	105	12.3
Indicated	3,534	0.87	3	0.3	31	326	34.1
Total Measured + Indicated	5,065	0.9	3	0.28	46	431	46.4
Inferred	318	0.75	2	0.13	2	16	1.3
Minto North (Open Pit)							
Measured	221	0.94	3	0.21	2	20	1.5
Indicated	257	1	6	0.61	3	46	5
Total Measured + Indicated	477	0.97	4	0.42	5	67	6.5
Inferred	28	0.7	3	0.32	0	3	0.3
Minto East (Underground)							
Measured	-	-	-	-	-	-	-
Indicated	919	2.35	7	1.01	22	204	29.8
Total Measured + Indicated	919	2.35	7	1.01	22	204	29.8
Inferred	124	1.48	5	0.6	2	20	2.5
Minto East 2 (Underground)							
Measured	-	-	-	-	-	-	-
Indicated	2,778	1.72	7	0.8	48	629	71.8
Total Measured + Indicated	2,778	1.72	7	0.8	48	629	71.8
Inferred	1,889	1.38	4	0.5	26	247	30.1
Minto North 2 (formerly Inferno North)							
Measured	-	-	-	-	-	-	-
Indicated	-	-	-	-	-	-	-
Total Measured + Indicated	-	-	-	-	-	-	-

Classification	Tonnes (kt)	Copper (%)	Silver (g/t)	Gold (g/t)	Contained Copper (kt)	Contained Silver (koz)	Contained Gold (koz)
Inferred	1,419	1.42	5	0.51	20	214	23.3
Stockpiles							
Measured	489	1.42	5	0.41	7	92	6.4
Total Mineral Resources							
Total Measured	5,707	1.09	3	0.36	62	592	65.5
Total Indicated	25,211	1.17	4	0.44	295	3,098	352.7
Total Measured + Indicated Resources	**30,918**	**1.15**	**4**	**0.42**	**357**	**3,690**	**418.2**
Total Inferred Resources	**16,223**	**0.93**	**3**	**0.28**	**150**	**1,470**	**146.8**

Table 4-2: Updated Mineral Reserves for Minto Mine (most recent Dec. 31, 2016)

Classification	Tonnes (kt)	Copper (%)	Silver (g/t)	Gold (g/t)	Contained Copper (kt)	Contained Silver (koz)	Contained Gold (koz)
Minto North Open Pit							
Proven	-	-	-	-	-	-	-
Probable	-	-	-	-	-	-	-
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**
MSD - Area 2 Open Pit							
Proven	-	-	-	-	-	-	-
Probable	807	1.21	1	0.41	10	26	10.6
Total	**807**	**1.21**	**1**	**0.41**	**10**	**26**	**10.6**
Minto East Underground							
Proven	-	-	-	-	-	-	-
Probable	625	2.07	6	0.89	13	120	17.9
Total	**625**	**2.07**	**6**	**0.89**	**13**	**120**	**17.9**
MSD - Area 2/118 Underground							
Proven	-	-	-	-	-	-	-
Probable	381	2.06	8	0.87	8	103	10.7
Total	**381**	**2.06**	**8**	**0.87**	**8**	**103**	**10.7**
MSD - Copper Keel Underground							
Proven	-	-	-	-	-	-	-
Probable	1,616	1.73	6	0.63	28	315	32.5
Total	**1,616**	**1.73**	**6**	**0.63**	**28**	**315**	**32.5**

Classification	**Tonnes (kt)**	**Copper (%)**	**Silver (g/t)**	**Gold (g/t)**	**Contained Copper (kt)**	**Contained Silver (koz)**	**Contained Gold (koz)**
MSD -Wildfire Underground							
Proven	-	-	-	-	-	-	-
Probable	-	-	-	-	-	-	-
Total	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Stockpiles							
Proven	489	1.42	6	0.41	7	92	6.4
Total	**489**	**1.42**	**6**	**0.41**	**7**	**92**	**6.4**
Total Mineral Reserves							
Proven	489	1.42	6	0.41	7	92	6.4
Probable	3,429	1.71	5	0.65	59	563	71.7
Total Mineral Reserves	**3,919**	**1.67**	**5**	**0.62**	**65**	**655**	**78.2**

5 Surface Water Quality Monitoring

Environmental monitoring programs are outlined in the *Environmental Monitoring, Surveillance and Reporting Plan* (EMSRP2016-02) and the results for the surface water quality monitoring conducted in 2017 are provided in this section. Where possible, the 2017 results have been compared to historical results to identify trends and compare 2017 values with previous values.

5.1 Surface Water Quality Program

Details of the Surface Water Surveillance Program, including sampling station locations and monitoring frequency, are outlined in the EMSRP2016-02 and the results are presented in this section for water quality stations outlined in the WUL. Water quality result statistics including the mean, minimum and maximum are presented in summary tables. For the purposes of calculating the mean, minimum and maximum concentrations, values less than the detection limit were taken to be half of the detection limit.

The WUL effluent quality standards were compared to the water quality result statistic summaries at stations W16, W16A, W17, W50 and WTP/RO. The WUL water quality objectives were compared to the water quality result statistic summary at station W2, and at W50 when W35 and W15 are frozen.

As water quality stations may be adjusted from year-to-year because of environmental changes or modifications to infrastructure, an update to the water quality station locations listed in the WUL is provided in Table 5-1 below. All surveillance monitoring sites in use in 2017 are confirmed with a Global Positioning System (GPS) unit to determine current UTM coordinates. Coordinates presented in Table 5-1 are associated with the World Geodetic System 1984 (WGS 84) coordinate system.

Table 5-1: Water Quality Site Descriptions and UTM Coordinates

Station	Description	UTM Coordinates – Zone 8	
		Easting	Northing
W1	Lower Reach of Minto Creek	392445	6948251
W2	Minto Creek, upstream of the Minto Creek/Yukon River confluence where the access road crosses Minto Creek	392584	6948402
W3	Minto Creek, at the federal MMER compliance point	387000	6945778
W4	Yukon River, upstream of the confluence with Minto Creek	394070	6948203
W5	Yukon River, downstream of the confluence with Minto Creek	392583	6949119
W6	Tributary on the North side of Minto Creek	387583	6946392
W7	Mouth of the tributary on the south side of Minto Creek, approximately 0.8 km downstream of W3	387546	6946034
W8	Western collection sump from the DSTSF	385629	6945076
W8A	Eastern collection sump from the DSTSF	385716	6945012
W10	Headwaters of Minto Creek (south-west fork at headwaters)	383855	6943364
W12	Main Pit and Main Pit Tailings Management Facility	384544	6945137
W12A	Discharge from Main pit	*	*
W14	Tailings thickener overflow	385223	6945089
W15	Upper Minto Creek storm water collection sump, downstream of the overburden dump, just upstream of Main Pit	384181	6944708
W16	Water Storage Pond	386402	6945559
W16A	Discharge from the Water Storage Pond	386679	6945664
W17	Water Storage Pond dam seepage	386679	6945664
W30	Headwaters Minto Creek (north-west fork)	383693	6945026
W33	Up-gradient of South Diversion Ditch	385351	6944072
W35	South Diversion Ditch	385223	6944427
W36	Minto Creek detention structure (MCDS) – Decommissioned in 2015	385892	6945191
W37	100 m downstream of MCDS (W36 collection sump) and upstream of Water Storage Pond – Decommissioned in 2015	386180	6945294
W45	Area 2 Pit and Area 2 Pit Tailings Management Facility	384912	6944068
W46	Minto Creek, downstream of W7 and W6 tributaries	387873	6946301
W47	Area 118 Pit water	384775	6944153
W50	Minto Creek, approximately 50 m downstream of the toe of the Water Storage Pond Dam and downstream of the inflow of the treated water	386747	6945682
MC-1	Minto Creek upstream of Canyon	390967	6947528
WTP	Treated water from water treatment plant when RO not operating	385126	6945154
RO	Treated water from RO	385126	6945154
W51	Area 2 Stage 3 Pit	385160	6944240
W52	Ridgetop North Pit and Ridgetop North Pit Tailings Management Facility	*	*

Station	Description	UTM Coordinates – Zone 8	
		Easting	Northing
W53	Ridgetop South Pit	*	*
W54	Main Dam seepage	*	*
W55	Tailings Diversion Ditch	386209	6945007
W62	MVFES2 Collection Sump	386079	6945335
C4	Tributary on the south side of Minto Creek, downstream of W3	388407	6946571
C10	Tributary on the south side of Minto Creek, downstream of W3	391868	6947914
MN	Minto North pit water	384342	6946090
MN-0.2	Upper west arm of McGinty Creek (Reference Station)	382267	6947299
MN-0.5	West arm of McGinty Creek just upstream of the confluence with the east arm	385251	6951262
MN-1.5	Upper east arm of McGinty Creek downstream of the Minto North deposit	384473	6947055
MN-2.5	East arm of McGinty Creek just upstream of confluence with the west arm	385493	6950788
MN-4.5	Lower mainstream McGinty Creek near confluence with Yukon River	386231	6952851
UG 1	Minto South underground mine dewatering	384916	6944098
UG 2	Wildfire underground mine dewatering	*	*
UG 3	Copper Keel underground mine dewatering	*	*
UG 4	Minto East underground mine dewatering	*	*

*Water quality sites not developed

5.1.1 Water Quality Monitoring Conformance

2017 conformance with the external water sampling requirements is summarized in Table 5-2, below. Flow monitoring at water quality surveillance sites is highly variable because of site and seasonal conditions and is not presented in Table 5-2, however, full details were provided in the Monthly Reports submitted to the YWB. Additionally, the specifics of non-conformance in relation to external and internal water sampling requirements are included in the Monthly Reports. Quality Assurance and Quality Control (QA/QC) sampling is not included in sampling events described in Table 5-2, but is provided in section 5.1.2.

Table 5-2: Water Quality Sampling Monitoring Conformance Summary (2017)

Site Name	2017 WQ sampling events	2017 Reason(s) for non-conformance events
W1	N/A	N/A
W2	37	Site was frozen during the first and fourth quarter. Sampled as per schedule for remainder of 2017.
W3	56	Sampled as per schedule.
W4	3	Sampled as per schedule except for Q3 due to human error.
W5	2	Inaccessible due to ice conditions in the first quarter. Sampled as per schedule for second and fourth quarter of 2017, but was missed in Q3 due to human error.
W6	6	Site frozen for 6 months of the year. Sampled as per schedule for remainder of 2017.
W7	8	Site frozen for 4 months of the year. Sampled as per schedule for remainder of 2017.
W8	0	Site dry for all of 2017.
W8a	45	Weekly samples not collected once in March, all of May and once in June due to site being frozen. Sampled as per schedule otherwise.
W10	11	Site frozen for March. Sampled as per schedule otherwise
W12	12	Sampled as per schedule.
W12A	0	No discharge from W12A in 2017.
W14	12	Sampled as per schedule.
W15	18	Site frozen for March. Sampled as per schedule otherwise.
W16	37	One weekly sample missed in June. Sampled as per schedule for remainder of 2017.
W16a	12	Sampled as per schedule.
W17	53	Sampled as per schedule.
W30	8	Site was frozen for first three months of 2017. Sampled as per schedule otherwise.
W33	7	Site frozen for 5 months of the year. Sampled as per schedule otherwise.
W35	13	Site frozen for 5 months of 2017. Sampled as per schedule otherwise.
W36	0	Decommissioned in 2015.
W37	0	Decommissioned in 2015.
W45	10	Site was not sampled for two months due to pump being removed and unsafe access. Sampled as per schedule for remainder of 2017.
W46	8	Site frozen for four months. Sampled as per schedule for remainder of 2017.
W47	0	Decommissioned and backfilled in January 2017.
W50	12	Site dry while not discharging. Sampled as per schedule during discharge in 2017.
MC-1	32	Site frozen for 4 months. Sampled as per schedule for remainder of 2017.
WTP	9	Sampled as per schedule.
RO		
W51	2	Site sampled in September and October 2017. Was inaccessible the remainder of the year.
W52	0	Site not established.
W53	0	Site not established.
W54	0	Site not established.
W55	4	Flow present in April to July. Site dry for remainder of 2017.

Site Name	2017 WQ sampling events	2017 Reason(s) for non-conformance events
W62	14	Sampled as per schedule.
C4	7	Site frozen for 5 months. Sampled as per schedule for remainder of 2017.
C10	5	Site frozen for 7 months. Sampled as per schedule for remainder of 2017.
MN	1	Sampled once during 2017. Access unsafe for remainder of 2017.
MN-0.2	6	Site frozen for 6 months. Sampled as per schedule for remainder of 2017.
MN-0.5	7	Site frozen for 5 months. Sampled as per schedule for remainder of 2017.
MN-1.5	6	Site frozen for 6 months. Sampled as per schedule for remainder of 2017.
MN-2.5	7	Site frozen for 5 months. Sampled as per schedule for remainder of 2017.
MN-4.5	7	Site frozen for 5 months. Sampled as per schedule for remainder of 2017.
UG1	12	Sampled as per schedule.

5.1.2 Quality Assurance and Quality Control Program

As required by Clause 104 of the WUL, Minto is required to submit the results and interpretations of the Quality Assurance and Quality Control Program (QA/QC Program). The QA/QC program is directed through the EMSRP. Implementation of the Minto QA/QC Program occurred since November 2012.

The primary objective of the QA/QC Program is to ensure that data collected, analyzed and evaluated through the environmental monitoring programs at Minto are representative of the environmental conditions present at the time of sample collection.

The QA/QC Program has been developed using recognized QA/QC protocols. Specific procedures for data collection at the Minto Mine are detailed in Standard Operating Procedures (SOPs). SOPs are internal documents to the Minto Mine that may be modified or improved as required.

The main components of the QA/QC Program presented in the following sections include QA/QC with regards to water quality monitoring, external and on-site laboratory reporting, and environmental programs monitoring. QA/QC results and interpretations are presented in each Monthly Report.

5.1.2.1 Water Quality QA/QC

Procedures for water quality monitoring at the Minto Mine are described in the EMSRP and further detailed in the Minto Mine Surface Water Quality Monitoring Standard Operating Procedure. The SOP is reviewed at the start of each field season and signed off by Minto Environment department staff to help ensure consistency in sampling procedures.

In 2017, 728 water quality samples (surface and groundwater) were collected for the water quality monitoring programs. QC samples represented 22.1% of the total number of samples collected in 2017, and included 85 field duplicates, 6 field blanks, 6 trip blanks, and 64 field splits. The Minto Mine Surface Water Quality Monitoring Standard Operating Procedure describes a 1:10 quality control to routine sampling ratio and this ratio was achieved in 2017.

5.1.2.2 External Laboratory QA/QC

The 2017 external laboratory water quality analysis were performed by ALS Environmental in Burnaby, BC. As described in the EMSRP, all results provided by the external laboratory were accompanied by a Quality Control Report. If procedural deviations or exceedances in standard holding time occurred, the details of such nonconformities were included in each report. Additionally, each report contained QC batch numbers enhancing sample result traceability.

5.1.2.3 On-site Laboratory QA/QC

Procedures for analyzing water samples at the on-site laboratory are detailed in a variety of SOPs such as, but not limited to: The Laboratory QA/QC Guidelines SOP; Preparation of Dissolved and Total Metals (Cu, Al, Cd) SOP; Preparation of Dissolved and Total Selenium SOP; and Total Dissolved Solids SOP. All on-site laboratory equipment was calibrated per the manufacturer’s specifications in 2017.

On-site laboratory analysis of water quality samples occurred at W2, W3, W8A, W16, W16A, W17 and W50 as per the WUL Schedule 1 – Part 2 monitoring requirements, as environmental conditions allowed. No internal samples were provided to the internal laboratory from W8 as the site remained dry throughout 2017. Additionally, the on-site laboratory analyzed water from sites W15, W35, RO, and WTP intake daily during discharge conditions to inform day-to-day discharge-related decisions. Samples from W12 were also analyzed.

The 2017 QC procedures performed by the on-site laboratory included spiked blanks and calibration checks. If two or more QC failures occurred, the 2017 QC procedures involved re-analyzing the entire batch of samples. Additionally, one replicate sample is analyzed for each batch analysis. In the event the replicate sample results do not match; the entire batch is reanalyzed.

On-site and external laboratory water quality results for water quality sites W2, W3, W8A, W16, W16A and W50 are presented in each Monthly Report submitted to the Water Board. In monthly reports, it was noted that discrepancies in results from the external and on-site laboratories occurred and were likely a result of different methods and/or equipment utilized in analyzing water samples, different processing times between sampling and processing the samples, and the associated use of non-preserved versus preserved samples.

5.2 Compliance

5.2.1 Discharge Compliance – WQ Effluent Standards

5.2.1.1 W16A – EQS Compliance Point

For the station W16A, copper, aluminum, cadmium and selenium concentrations, with corresponding standards (WUL Clause 9) are displayed in Table 5-3. This is shown graphically in Figure 5-1 and Figure 5-2. The TSS value that exceeded the EQS (5/14/2013) was re-run on the same day and had a value of 17 mg/L, this was prior to the station becoming a compliance point.

Table 5-3: W16A Water Quality Results Summary (2007-2017)

W16A	Effluent Quality Standards (WUL Clause 9)	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters		**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	6.0-9.0	7.99	6.86	8.32	8.17	7.87	8.33
TSS (mg/L)	15	5.12	<1.0	**55.1**	2.25	<3.0	5.4
Nutrients (mg/L)							
Ammonia Nitrogen	0.75	0.1055	0.0169	0.430	0.0461	0.0071	0.146
Nitrite Nitrogen	0.18	0.02414	<0.0050	0.0920	0.0493	0.0111	0.0808
Nitrate Nitrogen	27.3	3.372	0.549	6.30	2.18	1.75	2.77
Dissolved Metals (mg/L)							
Aluminum	0.3	0.01139	<0.0030	0.0732	0.0091	0.0045	0.0149
Arsenic	0.015	0.000346	0.00023	0.00059	0.00035	0.00024	0.00049
Cadmium	0.00015*	0.00001396	<0.0000050	0.000089	0.0000127	0.0000056	0.0000273
Chromium	0.003	0.000371	<0.00010	<0.0010	0.000136	<0.00010	0.00022
Copper	0.039	0.02118	0.00793	0.0349	0.0276	0.0237	0.0326
Iron	3.3	0.0653	0.0105	0.301	0.084	0.053	0.139
Lead	0.012	0.0001369	<0.000050	0.00159	0.0002544	<0.000050	0.00173
Molybdenum	0.219	0.00463	0.001	0.0098	0.00250	0.00221	0.00277
Nickel	0.33	0.00077	<0.0010	<0.0050	0.00085	0.00050	0.00111
Selenium	0.006	0.001267	0.00019	0.0021	0.000665	0.000568	0.000777
Zinc	0.09	0.00216	<0.0010	0.0059	0.00108	<0.0010	0.0023

Bold values indicate exceedances of the WUL standards
***Based on measured hardness**

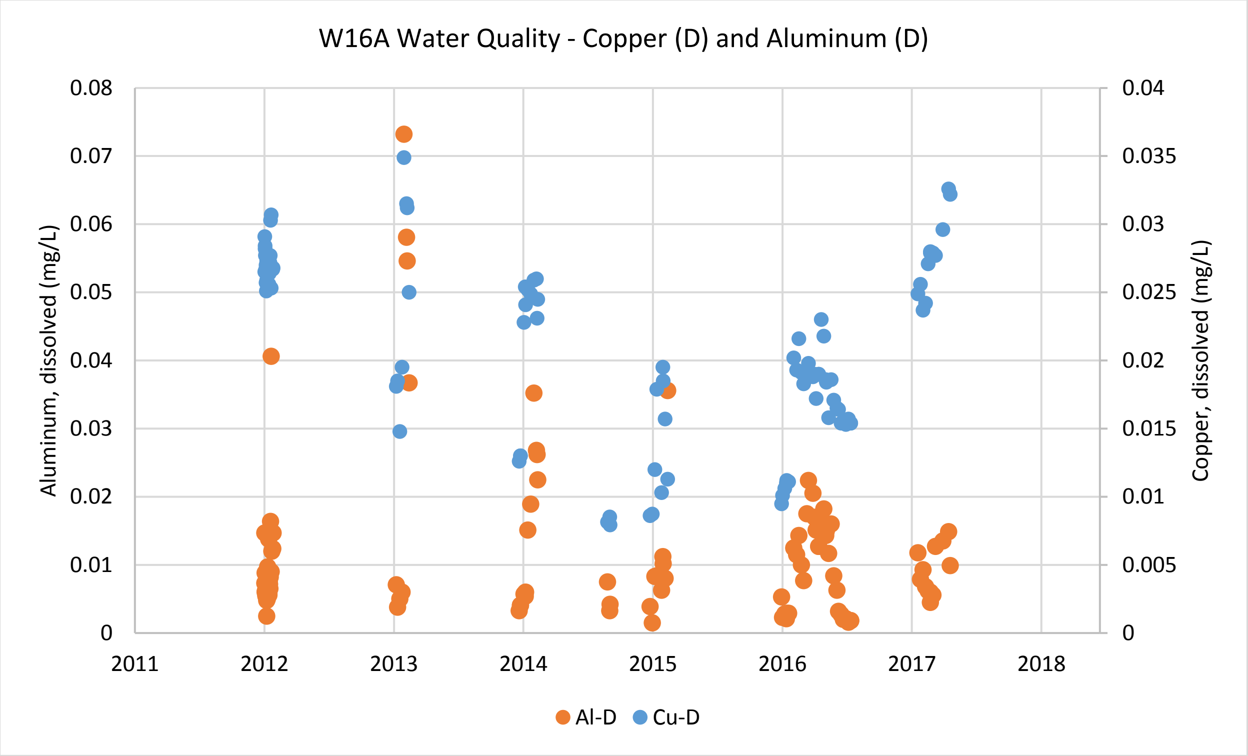
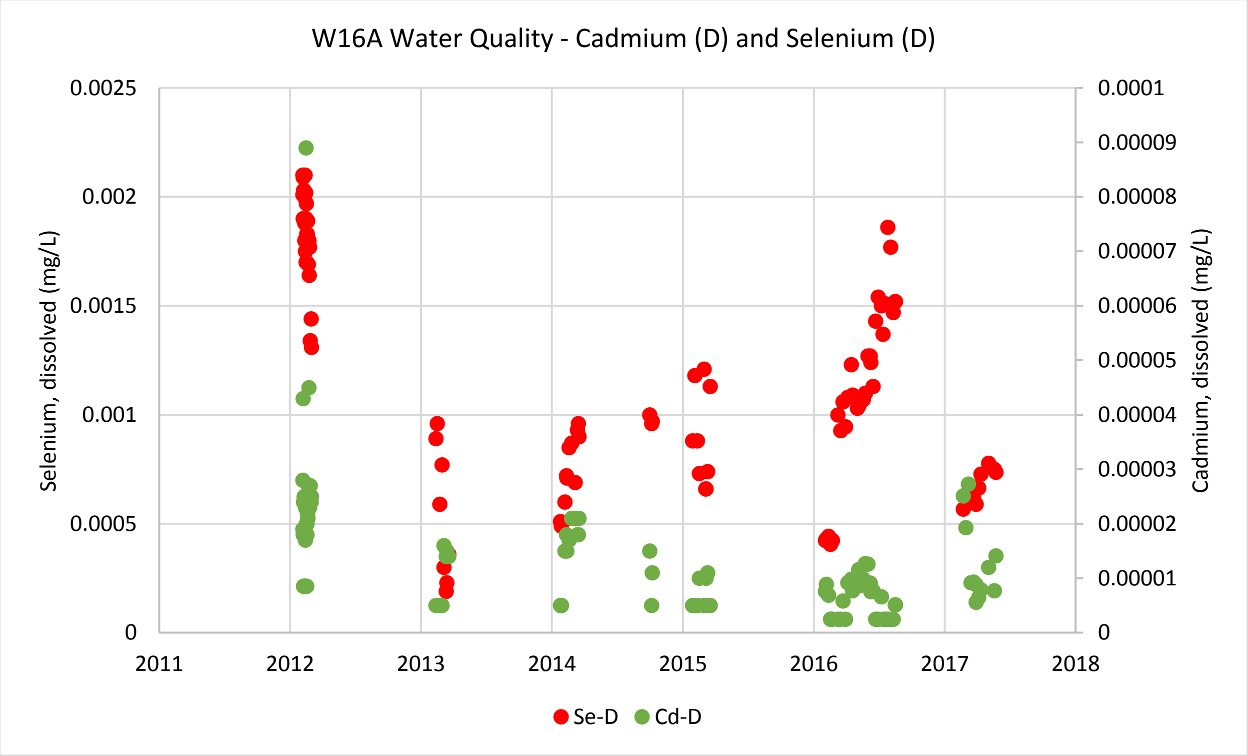


Figure 5-1: W16A Copper and Aluminum Concentrations (2012-2017)



*Note that the cadmium standard is based on a hardness of 63 mg/L which is a conservative estimate of hardness at the WQO station.

Figure 5-2: W16A Cadmium and Selenium Concentrations (2012-2017)

5.2.1.2 W50 – EQS Compliance Point

The Effluent Quality Standards (EQS) (Clause 9 of the WUL) were applied and met at W50 from the period of May 2nd to August 1st 2017 when water was encountered. The water quality statistics for 2017 where W50 was the EQS compliance point are summarized below in Table 5-4. The summary from 2009 to 2016 has some exceeded parameters, those were triggered prior to 2015, with different standards. The summary for dissolved aluminum, copper, cadmium and selenium are also presented graphically in Figure 5-3 and 5-4 below.

Table 5-4: W50 Water Quality Results Summary (2009-2017)

W50	Effluent Quality Standard (WUL Clause 9)	2009 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters		Mean	Min	Max	Mean	Min	Max
pH	6.0-9.0	8.03	6.82	8.4	8.16	7.99	8.29
TSS (mg/L)	15	5.14	0.5	**42**	2.92	1.5	6.6
Nutrients (mg/L)							
Ammonia Nitrogen	0.75	0.08750	0.0025	**1**	0.0400	0.0145	0.156
Nitrite Nitrogen	0.18	0.02405	0.0025	0.158	0.0412	0.0214	0.0717
Nitrate Nitrogen	27.3	3.8888	0.010	16.2	2.20	1.77	3.27
Dissolved Metals (mg/L)							
Aluminum	0.3	0.01605	0.0013	0.12	0.0078	0.0049	0.0125
Arsenic	0.015	0.000373	0.00012	0.0031	0.00036	0.00025	0.00050
Cadmium	0.00015*	0.00001530	0.0000025	**0.00028**	0.00000841	0.0000025	0.0000239
Chromium	0.003	0.000467	0.00005	0.0017	0.000124	0.00005	0.00018
Copper	0.039	0.01529	0.0005	**0.075**	0.0249	0.0185	0.0281
Iron	3.3	0.05009	0.0025	0.3	0.067	0.048	0.095
Lead	0.012	0.0001317	0.000025	0.0008	0.0001499	0.000025	0.000593
Molybdenum	0.219	0.00609	0.0005	0.019	0.00262	0.00220	0.00336
Nickel	0.33	0.000894	0.00025	0.003	0.00080	0.00054	0.00110
Selenium	0.006	0.001200	0.00005	0.0049	0.000668	0.000567	0.000905
Zinc	0.09	0.00280	0.0005	0.018	0.00085	0.0005	0.0023

Bold values indicate exceedances of the current WUL standards
***Based on measured hardness**

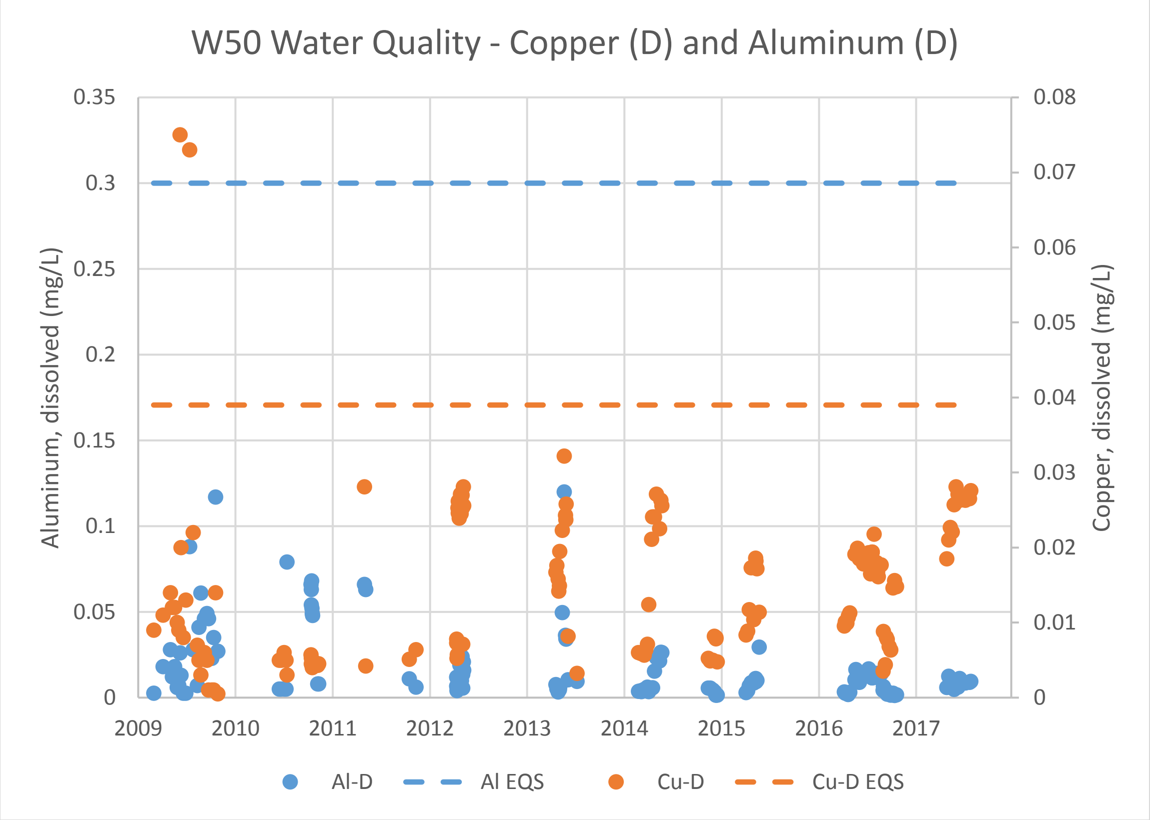
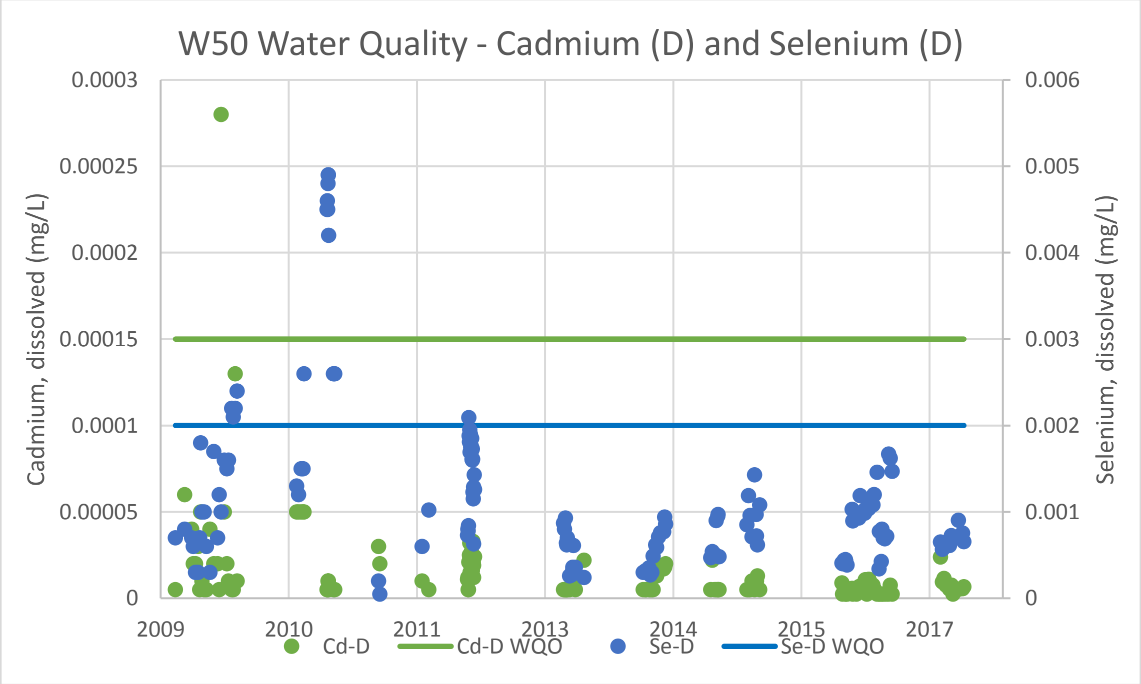


Figure 5-3: W50 Copper and Aluminum Concentrations (2009-2017)



***Note that the cadmium standard is based on a hardness of 63 mg/L which is a conservative estimate of hardness at the WQO station.**

Figure 5-4: W50 Cadmium and Selenium Concentrations (2009-2017)

5.2.1.3 W17 – EQS Compliance Point

During 2017, there was no water discharged from W17 to the Minto Creek, therefore EQS were not applied to this station.

5.2.2 Discharge Compliance – Bioassays

Monthly and quarterly bioassays are conducted at several surface water quality sites, as per WUL requirements. These tests are to ensure the water is not toxic for aquatic organisms.

In August 2017, WUL bioassay sampling was scheduled with the external lab for August 8th, but unexpected low flows in Minto Creek discharge caused mine discharge to be stopped and Minto missed the opportunity to sample for LC50 tests within the 5 days of discharge at W16A, W50 and W3, this incident was discussed in the August Monthly Report. The remaining tests were conducted per the WUL requirements; and all tests passed in 2017 for all sample sites. Lab results were submitted with the monthly reports.

Bioassay compliance testing, as per the WUL requirements, were conducted at W3 during 2017. An LC50 bioassay was conducted at W3, 3 days after discharge stopped in August. All toxicity tests conducted in 2017 for W3 passed. Lab results were submitted with the respective monthly reports.

At W2 station, bioassay sampling was not completed in the first quarter of 2017, as the water quality station became ice-free with very low flows in the second week of April 2017, and hence did not allow for the monthly samples or the quarterly 30-day CT test to be conducted in Q1. In Q3, the W2 CT 30-day samples were collected and sent to the lab for testing; however, the lab cancelled the analysis after the second week due to a control failure. The test was re-started and cancelled again on the second week, the external lab was not ready to receive the samples, finally the Q3 CT 30-day test was completed mid-October. The Q4 CT 30-day analysis could not be completed due to no visible flow after October 31st, 2017. These incidents were discussed in the respective WUL monthly reports reflect the uncertainty around gamete availability and quality on a quarterly basis.

5.2.3 Water Quality Objectives Compliance – Minto Creek

5.2.3.1 W2 – WQO Compliance Point

As of April 11th, W15 and W35 were no longer frozen and W2 became the WQO station until W15 and W35 froze again on October 3rd, 2017. Following the date in October, W50 became the WQO station.

The Water Quality Objectives (WQO) (Clause 11 of the WUL) were met at the W2 during the period between April 11th and October 3rd, 2017. The water quality statistics during the period where W2 was the WQO compliance point are summarized below in Table 5-6. The maximum copper concentration was collected on April 30th 2017, the DOC for that sample was 32.3mg/L, and therefore did not exceed the WQO.

Table 5-5: W2 Water Quality Results Summary (2017)

W2	Water Quality Objective (WUL Clause 11)	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters		**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	6.0-9.0	8.11	7.03	8.46	8.17	7.86	8.42
TSS (mg/L)		52.5	<1.0	2600	40.3	<3.0	529
Nutrients (mg/L)							
Ammonia Nitrogen	0.25	0.04	<.001	**0.8300**	0.0118	<0.0050	0.0726
Nitrite Nitrogen	0.06	0.0118	<0.0010	**0.36**	0.0014	<0.0010	0.0047
Nitrate Nitrogen	9.1	1.5854	<0.0050	**9.4**	0.1122	<0.0050	0.365
Dissolved Metals (mg/L)							
Aluminum	0.1	0.0196	0.0028	**0.201**	0.0137	0.0029	0.0604
Arsenic	0.005	0.00053	<0.0002	0.0018	0.00049	0.00035	0.00077
Cadmium	0.00015*	0.0000393	<0.0000050	0.00104	0.0000079	<0.0000050	0.0000217
Chromium	0.001	**0.00116**	**0.00012**	**0.0031**	0.00023	<0.00010	0.00051
Copper	0.013 ([DOC] ≤ 10mg/L) 0.02 ([DOC] > 10mg/L)	0.00318	0.001	**0.0227**	0.00435	0.00145	0.0173
Iron	1.1	0.17	0.019	0.9050	0.098	0.028	0.338
Lead	0.004	0.000192	<0.000050	0.0009	0.000058	<0.000050	0.00023
Molybdenum	0.073	0.002835	0.00018	0.015	0.001216	0.000452	0.00175
Nickel	0.11	0.00122	<0.0005	0.004	0.00113	0.00070	0.0017
Selenium	0.002	0.000658	<0.00010	**0.0026**	0.000148	0.000074	0.00029
Zinc	0.03	0.006	<0.0010	0.0200	0.0016	<0.0010	0.0058

***Based on measured hardness**

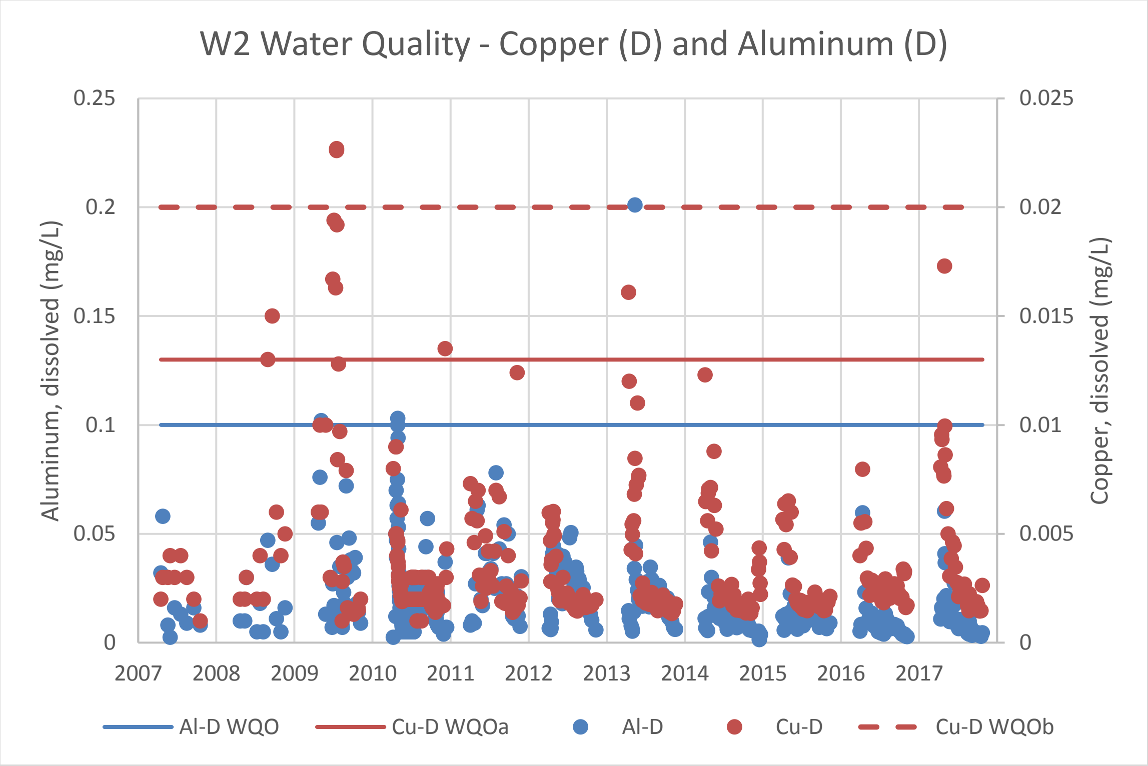


Figure 5-5: W2 Copper and Aluminum Concentrations (2007-2017)

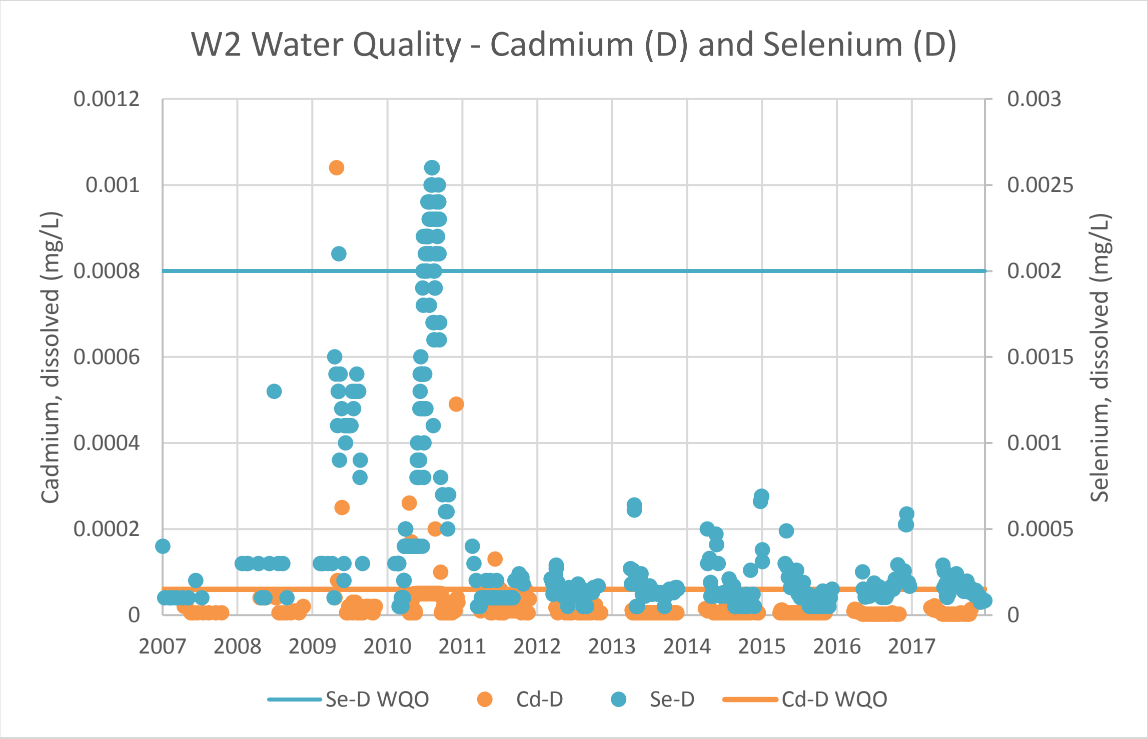


Figure 5-6: W2 Cadmium and Selenium Concentrations (2007-2017)

5.2.3.2 W50 – WQO Compliance Point

From January 1st until April 11th, W15 and W35 were frozen and W50 was the WQO station. Following April 11th until October 3rd, W2 was then the WQO station. After which, W15 and W35 froze and W50 once again became the WQO station. During the period that W50 was the WQO compliance point, no water samples were collected from the station as it was dry.

5.2.3.3 Discharge Compliance – RO

On April 16th 2017, there was a 7 m^3 unplanned discharge from the RO directly to the Minto Creek. This event was discussed and resolved in the Monthly Report and subsequently with regulators, RO results for this incident are presented below in Table 5-5. The results are from the discharge collected April 16th, 2017.

Table 5-6: RO Water Quality Results from April 16, 2017

RO	Water Quality Objectives (WUL Clause 11)	Date
Parameters		**4/16/2017**
pH-L	6.0-9.0	7.44
TSS		<3.0
Nutrients (mg/L)		
Ammonia	0.25	0.193
N-NO2	0.06	0.129
N-NO3	9.1	1.78
Dissolved Metals (mg/L)		
Al-D	0.1	<0.0010
As-D	0.005	<0.00010
Cd-D	0.00017348*	<0.0000050
Cr-D	0.001	<0.00010
Cu-D	[DOC] @W2 > 10 mg/L = 0.02; [DOC] @W2 < 10 mg/L = 0.013	0.00051
Fe-D	1.1	<0.010
Pb-D	0.004	<0.000050
Mo-D	0.073	0.000165
Ni-D	0.11	<0.00050
Se-D	0.002	0.000183
Zn-D	0.03	0.0042

*value calculated from formula: $e^{(0.736(\ln(\text{hardness})4.943))}$

5.3 Surface Water Quality Surveillance Stations

5.3.1 W2 – Minto Creek at Lower Road Crossing Water Quality

The water quality statistics for W2 from 2007 to 2017 are presented in Section 5.2.3.1 above.

5.3.2 W3 – Minto Creek, at the Federal (MMER) Compliance Point

The water quality statistics for W3 from 2007 to 2017 are summarized below in Table 5-8. A total of 54 routine samples were collected from station W3 during the 2017 monitoring period. The results for dissolved copper, dissolved aluminum, dissolved cadmium, and dissolved selenium for W3 from 2007 to 2017 are also presented in Figure 5-7 and Figure 5-8 below. Three outlier data points dating from 2009 and early 2010 were removed from the W3 Cadmium and Selenium graph to better show the dataset on the graph (5/27/2009, 12/15/2009 and 1/11/2010).

Table 5-5: W3 Water Quality Results Summary (2007-2017)

W3	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.09	7.4	8.6	8.2	7.92	8.5
TSS (mg/L)	7.4	<1.0	985	3.9	<3.0	17.7
Nutrients (mg/L)						
Ammonia Nitrogen	0.0558	-0.01	0.6200	0.0167	<0.0050	0.143
Nitrite Nitrogen	0.0442	<0.0010	4.13	0.0032	<0.0010	0.0511
Nitrate Nitrogen	2.874	<0.020	18.7	0.431	0.105	1.91
Dissolved Metals (mg/L)						
Aluminum	0.0207	0.0013	0.373	0.0038	0.001	0.0238
Arsenic	0.000346	0.00015	0.0014	0.00025	0.00012	0.00035
Cadmium	0.000847	<0.0000050	0.565	7.7E-06	<0.0000050	2.67E-05
Chromium	0.00106	<0.00010	<0.0040	0.00011	<0.00010	0.00025
Copper	0.0054	<0.001	0.067	0.00494	0.00167	0.022
Iron	0.0449	<0.005	0.7500	0.031	0.01	0.068
Lead	0.00027	0.000009	0.0603	0.000051	<0.000050	0.000135
Molybdenum	0.00568	0.00066	0.103	0.00418	0.00257	0.00529
Nickel	0.001141	<0.00050	0.006	0.00093	0.00059	0.00132
Selenium	0.00103	<0.00010	0.0348	0.000334	<0.000050	0.000679
Zinc	0.00607	0.00067	0.1430	0.0013	<0.0010	0.0054

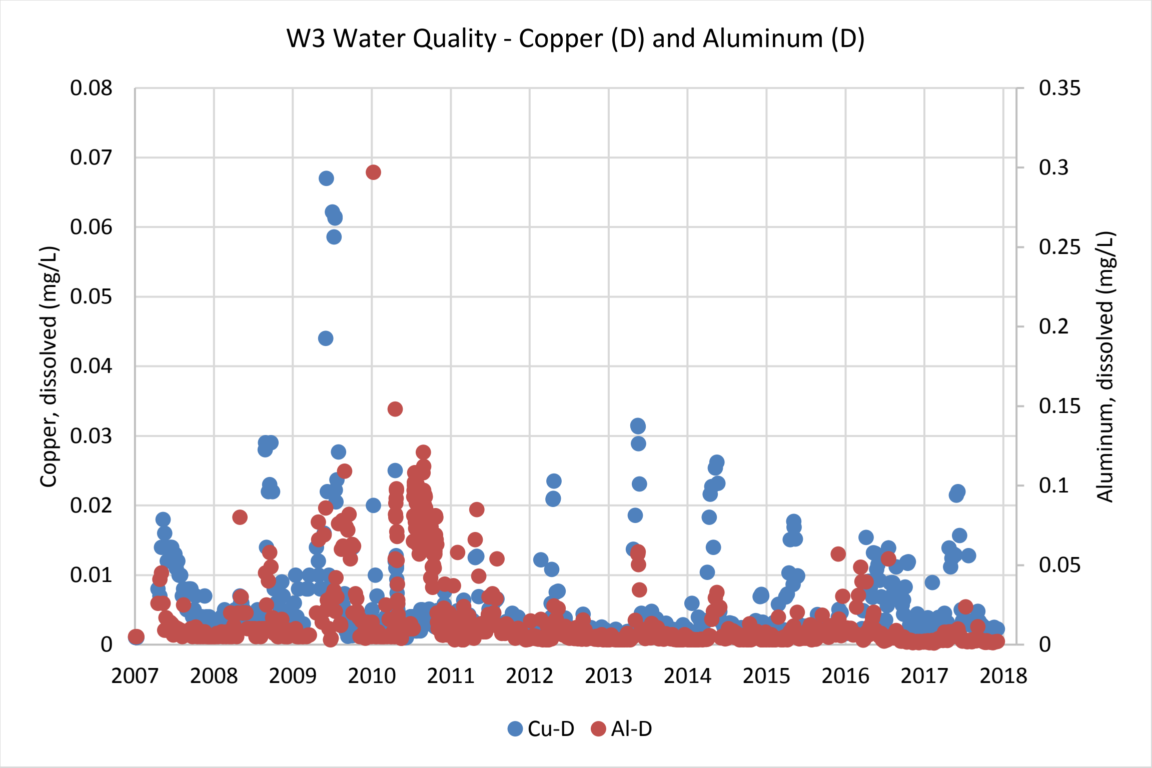


Figure 5-7: W3 Copper and Aluminum Concentrations (2007-2017)

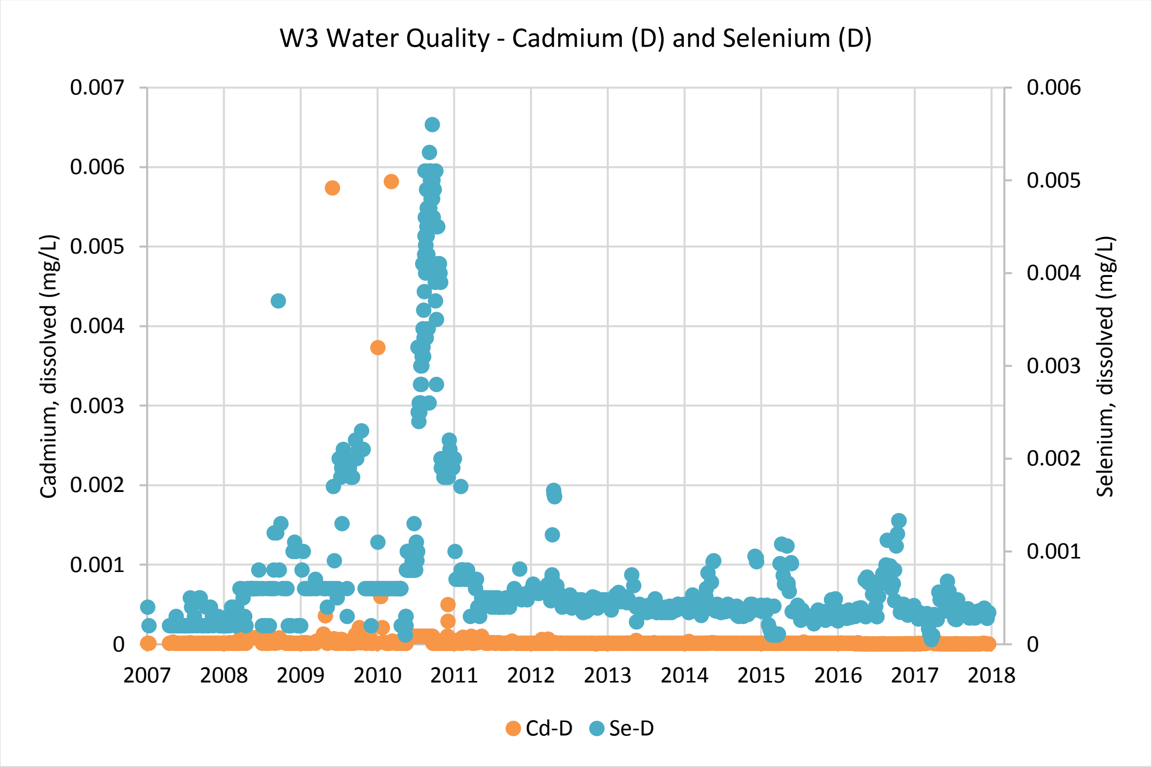


Figure 5-8: W3 Cadmium and Selenium Concentrations (2007-2017)

5.3.3 W4 – Yukon River, Upstream of the confluence with Minto Creek

The water quality statistics for W4 from 2011 to 2017 are summarized below in Table 5-9. A total of three routine samples were collected from station W4 during the 2017 monitoring period. The Q3 sample was missed due to human error, resulting in changes to our management system to prevent recurrence.

Table 5-6: W4 Water Quality Results Summary (2011-2017)

W4	2011 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.93	5.48	8.26	7.9	7.52	8.06
TSS (mg/L)	20.5	<1.0	270	55.1	<3.0	211
Nutrients (mg/L)						
Ammonia Nitrogen	0.0369	<0.0050	2.4000	0.0075	<0.0050	0.0148
Nitrite Nitrogen	0.0062	<0.0010	<0.050	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0751	0.0099	0.849	0.058	0.0257	0.15
Dissolved Metals (mg/L)						
Aluminum	0.0136	0.0017	0.167	0.0249	0.0025	0.088
Arsenic	0.00045	<0.00010	0.00105	0.00053	0.00041	0.00086
Cadmium	1.72E-05	<0.0000050	0.0014	7.1E-06	<0.0000050	1.33E-05
Chromium	0.00099	<0.00010	<0.0020	0.00017	<0.00010	0.00034
Copper	0.00106	<0.00020	0.004	0.00308	0.00055	0.00819
Iron	0.036	<0.0050	0.3070	0.064	0.011	0.219
Lead	0.000199	<0.000050	<0.00040	0.000058	<0.000050	0.000081
Molybdenum	0.00109	<0.0010	0.0021	0.000942	0.000684	0.00116
Nickel	0.00101	<0.00050	0.002	0.00081	<0.00050	0.00173
Selenium	0.000141	<0.00010	0.00044	0.00014	0.000113	0.000165
Zinc	0.0051	<0.0010	0.0278	0.001	<0.0010	0.0012

5.3.4 W5 – Yukon River, Downstream of the Confluence with Minto Creek

The water quality statistics for W5 from 2011 to 2017 are summarized below in Table 5-10. A total of two routine samples were collected from station W5 during the 2017 monitoring period. The Q1 sample was inaccessible due to freezing conditions, and the Q3 sample was missed due to human error, resulting in changes to our management system to prevent recurrence.

Table 5-7: W5 Water Quality Results Summary (2011-2017)

W5	2011 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.96	7.58	8.25	7.88	7.69	8.06
TSS (mg/L)	36.5	<1.0	340	78	<3.0	153
Nutrients (mg/L)						
Ammonia Nitrogen	0.0248	<0.0050	0.3820	0.014	<0.0050	0.0229
Nitrite Nitrogen	0.0063	<0.0010	<0.050	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0595	0.0091	<0.4	0.0573	0.0225	0.0921
Dissolved Metals (mg/L)						
Aluminum	0.0141	<0.0030	0.0588	0.0344	0.005	0.0637
Arsenic	0.0005	0.00036	0.00086	0.00058	0.00043	0.00072
Cadmium	1.09E-05	<0.0000050	0.000031	9.2E-06	<0.0000050	1.33E-05
Chromium	0.00098	<0.00010	<0.001	0.0002	<0.00010	0.00031
Copper	0.00132	0.00047	0.00694	0.00244	0.00062	0.00426
Iron	0.0887	0.009	0.7120	0.113	0.023	0.203
Lead	0.000197	<0.000050	<0.0002	0.000066	<0.000050	0.000083
Molybdenum	0.001151	0.000984	0.0018	0.001019	0.000868	0.00117
Nickel	0.00102	<0.00050	0.002	0.00112	<0.00050	0.00174
Selenium	0.00015	<0.00010	0.00029	0.000128	0.000125	0.000132
Zinc	0.0052	<0.0010	0.0355	0.0014	<0.0010	0.0017

5.3.5 W6 – Tributary on the North side of Minto Creek

The water quality statistics for W6 from 2007 to 2017 are summarized below in Table 5-11. A total of six routine samples were collected from station W6 during the 2017 monitoring period.

Table 5-8: W6 Water Quality Results Summary (2007-2017)

W6	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.00	7.34	8.40	8.06	7.82	8.22
TSS (mg/L)	80.4	<1.0	1160	60.5	<3.0	294
Nutrients (mg/L)						
Ammonia Nitrogen	0.0488	<0.0050	<0.5	0.011	<0.0050	0.0311
Nitrite Nitrogen	0.0077	<0.0010	0.07	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.3333	<0.0050	8.09	0.0081	<0.0050	0.0165
Dissolved Metals (mg/L)						
Aluminum	0.0134	<0.0030	0.097	0.0101	0.0047	0.0194
Arsenic	0.00045	0.0002	<0.001	0.00051	0.00046	0.00054
Cadmium	0.0000383	<0.0000050	0.0002	0.0000052	<0.0000050	0.0000064
Chromium	0.00118	0.00018	<0.002	0.00022	0.00017	0.00028
Copper	0.00267	0.0008	0.043	0.00154	0.00092	0.00244
Iron	0.0672	0.01	0.2000	0.11	0.07	0.162
Lead	0.000188	<0.000050	0.0005	0.00005	<0.000050	<0.000050
Molybdenum	0.001391	0.000247	0.015	0.000428	0.000364	0.000479
Nickel	0.00117	<0.0010	<0.003	0.00150	0.00128	0.00184
Selenium	0.000396	0.000057	0.002	0.000088	0.000061	0.000123
Zinc	0.0066	<0.0010	0.0490	0.0011	<0.0010	0.0015

5.3.6 W7 – North Flowing Tributary to Minto Creek

The water quality statistics for W7 from 2007 to 2017 are summarized below in Table 5-12. A total of eight routine samples were collected from station W7 during the 2017 monitoring period.

Table 5-9: W7 Water Quality Results Summary (2007-2017)

W7	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.97	5.51	8.41	8.11	7.96	8.28
TSS (mg/L)	33.7	<1.0	400	14.3	<3.0	50.7
Nutrients (mg/L)						
Ammonia Nitrogen	0.0354	<0.0050	0.3400	0.0151	0.007	0.0443
Nitrite Nitrogen	0.0162	<0.0010	0.14	0.0011	<0.0010	0.0017
Nitrate Nitrogen	0.1112	0.0063	0.324	0.0934	0.005	0.155
Dissolved Metals (mg/L)						
Aluminum	0.0193	<0.0030	0.096	0.01	0.0041	0.0279
Arsenic	0.00045	<0.0002	0.001	0.00046	0.00039	0.00055
Cadmium	0.0000304	<0.0000050	<0.0001	0.0000073	<0.0000050	0.0000208
Chromium	0.0011	0.00013	0.002	0.00025	0.00017	0.00038
Copper	0.00202	0.00063	0.0154	0.00184	0.00087	0.00568
Iron	0.1967	0.0102	1.0600	0.1	0.02	0.185
Lead	0.000194	<0.000050	0.0017	0.00005	<0.000050	<0.000050
Molybdenum	0.001285	0.00013	0.002	0.001328	0.000846	0.00161
Nickel	0.00124	<0.0005	0.004	0.00113	0.00083	0.00175
Selenium	0.000335	0.000092	0.0022	0.000152	0.000119	0.000174
Zinc	0.0054	<0.0010	0.0100	0.0042	<0.0010	0.0302

5.3.7 W8 – Western Collection Sump from DSTSF

W8 sump was dry throughout 2017 and was destroyed in mid-December during normal operations, buried under waste material. Water quality statistics for W8 from 2009 to 2013 are presented in Table 5-13 below. Trend analyses for seepage parameters results are presented in the Seepage section 7.1.

Table 5-10: Water Quality Result Summary (2009-2013)

Station Name	2009 - 2013 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	7.98	7.49	8.4
TSS (mg/L)	45	<2	660
Nutrients (mg/L)			
Ammonia Nitrogen	0.541	0.005	4.2
Nitrite Nitrogen	0.841	<0.005	4.5
Nitrate Nitrogen	43.87	<0.01	116
Dissolved Metals (mg/L)			
Aluminum	0.0135	<0.0030	0.144
Arsenic	0.00063	0.0002	0.0085
Cadmium	0.000145	<0.00001	0.00211
Chromium	0.0012	<0.0004	0.0053
Copper	0.1216	0.008	0.352
Iron	0.109	0.014	0.826
Lead	0.0002	<0.0001	0.0007
Molybdenum	0.01369	0.0004	0.064
Nickel	0.0023	<0.001	0.009
Selenium	0.00698	<0.0001	0.0193
Zinc	0.306	<0.001	9.49

5.3.8 W8A – Eastern Collection Sump from DSTSF

W8A was collected on a weekly basis per WUL requirements, a total of 46 samples were collected during the 2017 monitoring period; the sump was briefly frozen in March 2017 and dry in May 2017 for a 5-week period. Water quality statistics from 2009 to 2017 are summarized below in Table 5-14. Furthermore, trend analyses for seepage parameters results are presented in the Seepage section 7.1.

Table 5-11: Water Quality Result Summary (2009-2017)

Station Name	2009 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.00	5.04	8.6	7.85	7.31	8.36
TSS (mg/L)	45.9	<1.0	6540	37.7	4.0	106
Nutrients (mg/L)						
Ammonia Nitrogen	0.1148	0.007	1.6	0.2541	0.0362	0.477
Nitrite Nitrogen	0.0728	<0.0010	0.61	0.2138	0.0125	1.18
Nitrate Nitrogen	10.0570	<0.0050	72	3.957	0.126	7.20
Dissolved Metals (mg/L)						
Aluminum	0.01223	0.00262	0.157	0.0129	0.0044	0.143
Arsenic	0.000539	<0.00010	0.0066	0.00066	0.00038	0.00145
Cadmium	0.000179	<0.000010	0.0013	0.000205	7.91E-05	0.000518
Chromium	0.00100	0.0001	0.002	0.00063	0.00027	0.00151
Copper	0.10888	<0.00020	0.272	0.0705	0.0278	0.126
Iron	0.1502	<0.0050	0.648	0.926	0.147	7.00
Lead	0.000188	0.000013	0.0005	0.000079	<0.000050	0.00102
Molybdenum	0.01051	<0.0010	0.049	0.01084	0.00410	0.0172
Nickel	0.001454	0.000677	0.006	0.00173	0.00099	0.00289
Selenium	0.00639	<0.00010	0.018	0.00563	0.00101	0.0104
Zinc	0.6483	<0.001	5.17	0.2247	0.0927	0.559

5.3.9 W10 – Minto Creek Headwaters (South-West Fork)

The water quality statistics for W10 from 2007 to 2017 are summarized below in Table 5-15. A total of eleven routine samples were collected from station W10 during the 2017 monitoring period.

Table 5-12: W10 Water Quality Results Summary (2007-2017)

W10	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.43	6.00	8.57	7.54	6.95	8.01
TSS (mg/L)	15.3	<1.0	366	82.1	<3.0	390
Nutrients (mg/L)						
Ammonia Nitrogen	0.1314	<0.0050	1.3000	0.6399	0.0067	3.25
Nitrite Nitrogen	0.0163	<0.0010	0.148	0.02	<0.0010	0.0723
Nitrate Nitrogen	0.3669	<0.0050	6.59	5.1412	<0.0050	19.8
Dissolved Metals (mg/L)						
Aluminum	0.1231	<0.0030	0.418	0.0562	0.0025	0.235
Arsenic	0.00049	<0.00010	0.00248	0.00062	<0.00010	0.00268
Cadmium	0.0000432	<0.0000050	0.0007	0.0000065	<0.0000050	0.0000136
Chromium	0.00097	<0.00010	<0.002	0.00043	<0.00010	0.00241
Copper	0.033	<0.00020	0.138	0.01609	0.00067	0.0876
Iron	2.6593	<0.0050	41.7000	10.143	0.013	76.5
Lead	0.000203	<0.000050	0.0022	0.00005	<0.000050	<0.000050
Molybdenum	0.000843	0.00003	0.0015	0.000511	0.000084	0.00123
Nickel	0.00156	<0.00050	0.00395	0.00149	<0.00050	0.00573
Selenium	0.000265	<0.000050	<0.001	0.00017	<0.000050	0.000735
Zinc	0.0077	<0.0010	0.0620	0.0029	<0.0010	0.0101

5.3.10 W12 – Water in the Main Pit

The water quality statistics for W12 from 2007 to 2017 are summarized below in Table 5-16. A total of twelve routine samples were collected from station W12 during the 2017 monitoring period.

Table 5-13: W12 Water Quality Results Summary (2007-2017)

W12	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.07	6.20	10.60	7.81	5.37	8.14
TSS (mg/L)	18.5	<1.0	251	10.8	<3.0	36.2
Nutrients (mg/L)						
Ammonia Nitrogen	2.3176	<0.0050	24.0000	4.28	<0.015	6.94
Nitrite Nitrogen	0.7844	<0.0050	8.78	3.6067	<0.0010	6.71
Nitrate Nitrogen	20.728	<0.01	141	17.1737	<0.0050	28.9
Dissolved Metals (mg/L)						
Aluminum	0.0226	0.0016	0.124	0.0062	0.0036	0.0124
Arsenic	0.00069	<0.00010	0.003	0.00044	0.00039	0.00054
Cadmium	0.0000484	<0.0000050	0.0005	0.0001342	0.0000142	0.000205
Chromium	0.00092	<0.00010	0.0025	0.00018	<0.00010	<0.00020
Copper	0.05656	0.00046	0.476	0.0412	0.0117	0.074
Iron	0.0411	<0.0050	0.3860	0.022	<0.010	0.047
Lead	0.0002	<0.000050	0.0005	0.000106	<0.000050	0.00021
Molybdenum	0.04448	<0.0010	0.0972	0.0775	0.0645	0.0847
Nickel	0.00158	<0.0005	0.0038	0.00353	0.00262	0.0046
Selenium	0.00723	<0.00010	0.0207	0.0127	0.010800	0.0153
Zinc	0.0056	0.001	0.0310	0.0061	0.0022	<0.0090

5.3.11 W12A – Discharge in the Main Pit

There was no discharge from the Main Pit in 2017 and no discharge from the Main Pit in previous years.

5.3.12 W14 – Tailings Thickener Overflow

The water quality statistics for W14 from 2007 to 2017 are summarized below in Table 5-17. A total of twelve routine samples were collected from station W14 during the 2017 monitoring period.

Table 5-14: W14 Water Quality Results Summary (2007-2017)

W14	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.99	7.29	8.69	8.07	7.79	8.19
TSS (mg/L)	122.7	<5	1120	60.3	18	155
Nutrients (mg/L)						
Ammonia Nitrogen	3.19	<0.05	13.0000	4.93	2.9	9.69
Nitrite Nitrogen	0.9966	0.0183	4.3	4.03	1.89	6.19
Nitrate Nitrogen	35.8	12.3	86.7	28.9	18.9	46.7
Dissolved Metals (mg/L)						
Aluminum	0.1231	0.0078	1.91	0.0281	0.0102	0.0377
Arsenic	0.00061	<0.0002	0.0052	0.00036	0.00021	0.00056
Cadmium	0.0000444	<0.0000050	0.0003	0.0000701	<0.000010	<0.00015
Chromium	0.00091	<0.00010	0.0036	0.00017	<0.00010	<0.00020
Copper	0.01461	0.0002	0.723	0.00597	0.00066	0.02
Iron	0.0906	<0.0050	4.8000	0.017	<0.010	<0.020
Lead	0.000207	<0.000050	0.0011	0.000083	<0.000050	<0.00010
Molybdenum	0.0969	0.0458	0.181	0.1216	0.048	0.17
Nickel	0.00141	<0.0005	0.0082	0.00241	0.00160	0.00364
Selenium	0.03288	0.00166	0.229	0.0189	0.014100	0.023
Zinc	0.0051	<0.0010	0.0280	0.0017	<0.0010	<0.0020

5.3.13 W15 – Upper Minto Creek Stormwater Collection Point

The water quality statistics for W15 from 2007 to 2017 are summarized below in Table 5-18. A total of eighteen routine samples were collected from station W15 during the 2017 monitoring period. The results for dissolved copper, dissolved aluminum, dissolved cadmium, and dissolved selenium for W15 from 2007 to 2017 are also presented in Figure 5-9 and Figure 5-10 below.

Table 5-15: W15 Water Quality Results Summary (2007-2017)

W15	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.93	6.11	8.48	8.16	7.84	8.45
TSS (mg/L)	17.3	<1.0	370	19.6	<3.0	291
Nutrients (mg/L)						
Ammonia Nitrogen	0.1193	<0.0050	5.3000	0.1436	0.0095	1.03
Nitrite Nitrogen	0.0983	<0.0050	3.78	0.1301	0.0055	0.548
Nitrate Nitrogen	12.096	<0.01	265	13.83	4.24	58.8
Dissolved Metals (mg/L)						
Aluminum	0.0528	0.0019	2.65	0.0202	0.004	0.0712
Arsenic	0.000536	<0.00010	0.0022	0.00043	0.00026	0.00068
Cadmium	0.0000432	<0.0000050	0.00234	0.000015	<0.0000050	0.000068
Chromium	0.00105	<0.00010	0.0053	0.00019	<0.00010	0.00032
Copper	0.0236	<0.00020	0.415	0.0248	0.00719	0.0401
Iron	0.4015	<0.0050	6.4800	0.122	0.01	0.28
Lead	0.000208	3.1E-05	0.0027	0.000052	<0.000050	<0.00010
Molybdenum	0.00406	0.0001	0.113	0.00328	0.00194	0.0126
Nickel	0.001309	<0.00050	0.008	0.00099	<0.00050	0.0017
Selenium	0.00269	<0.00010	0.0504	0.00389	0.001230	0.0132
Zinc	0.00573	<0.0010	0.0410	0.0041	<0.0010	0.0231

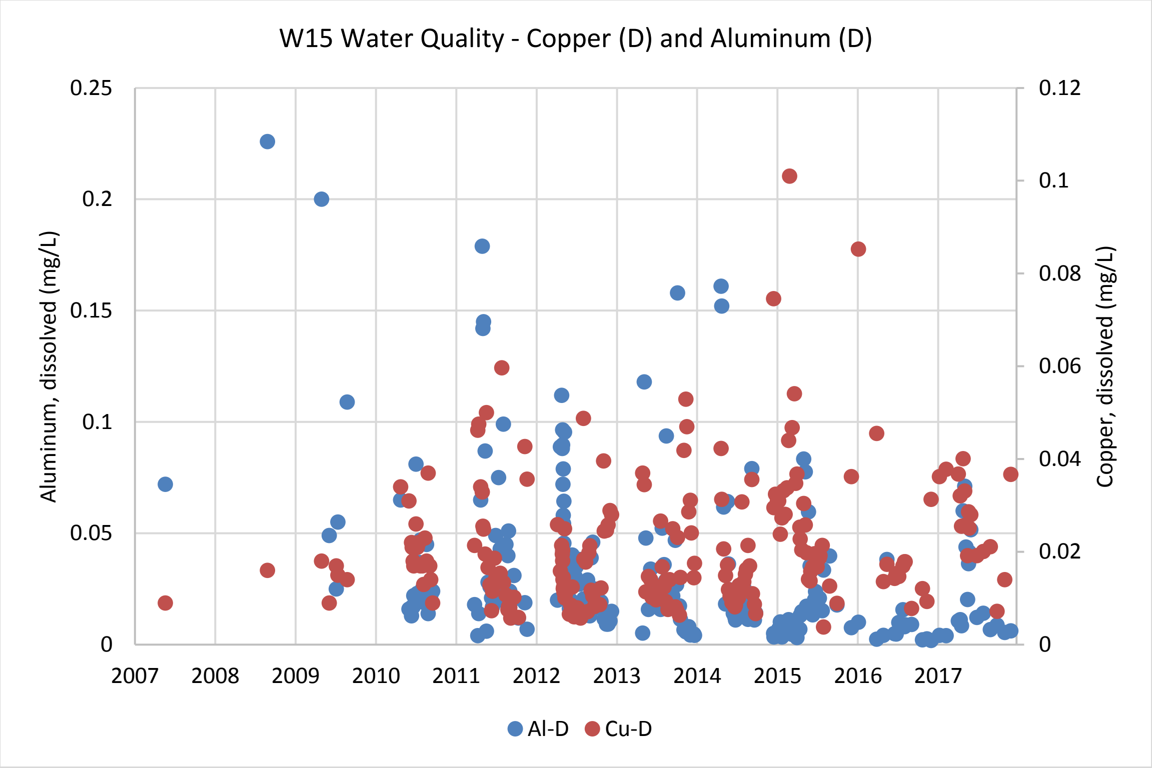


Figure 5-9: W15 Copper and Aluminum Concentrations (2007-2017)

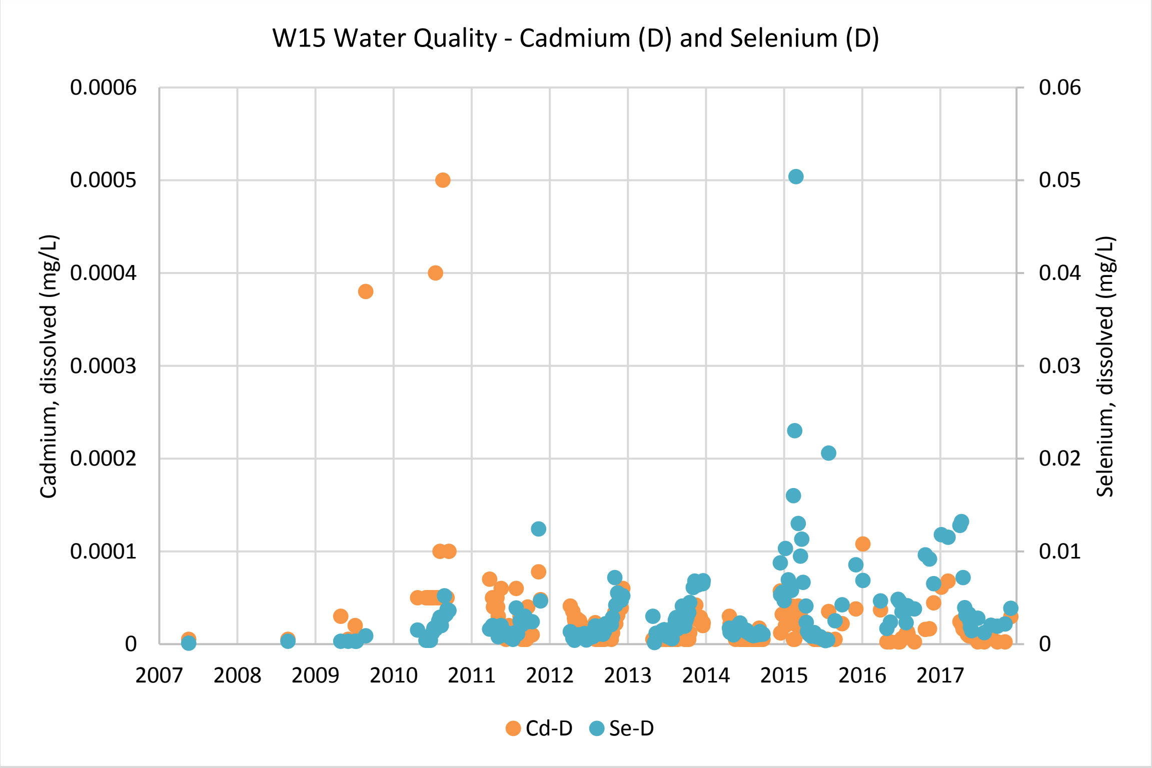


Figure 5-10: W15 Cadmium and Selenium Concentrations (2007-2017)

5.3.14 W16 – Water Storage Pond

The water quality statistics for W16 from 2007 to 2017 are summarized below in Table 5-19. A total of 37 routine samples were collected from station W16 during the 2017 monitoring period. The results for dissolved copper, dissolved aluminum, dissolved cadmium, and dissolved selenium for W16 from 2007 to 2017 are also presented in Figure 5-11 and Figure 5-12 below. An outlier in cadmium concentration for W16 collected on 5/5/2009 was removed for presenting the dataset in Figure 5-12.

Table 5-16: W16 Water Quality Results Summary (2007-2017)

W16	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.99	6.74	8.81	8.14	7.55	8.41
TSS (mg/L)	7.6	<1.0	181	9.6	<3.0	63.5
Nutrients (mg/L)						
Ammonia Nitrogen	0.1441	<0.0050	2.0000	0.0622	<0.0050	0.163
Nitrite Nitrogen	0.1041	0.0012	8.62	0.037	<0.0010	0.118
Nitrate Nitrogen	3.571	0.01	35	2.25	0.252	4.86
Dissolved Metals (mg/L)						
Aluminum	0.01759	0.0013	0.234	0.0095	0.0019	0.0341
Arsenic	0.000413	<0.00010	0.0015	0.00036	<0.00010	0.00048
Cadmium	0.0000416	<0.0000050	0.00557	0.0000133	<0.0000050	0.0000485
Chromium	0.00104	<0.00010	0.0172	0.00012	<0.00010	0.00022
Copper	0.02384	0.00158	0.123	0.02465	0.00643	0.047
Iron	0.1201	0.0066	1.3600	0.071	<0.010	0.141
Lead	0.000207	0.00002	<0.0010	0.000051	<0.000050	0.000096
Molybdenum	0.00586	0.00074	0.0271	0.002782	0.000653	0.00511
Nickel	0.001275	<0.00050	0.009	0.00080	<0.00050	0.00127
Selenium	0.001205	<0.00010	0.0064	0.000748	0.000145	0.0015
Zinc	0.00654	<0.0010	0.0828	0.002	<0.0010	0.0105

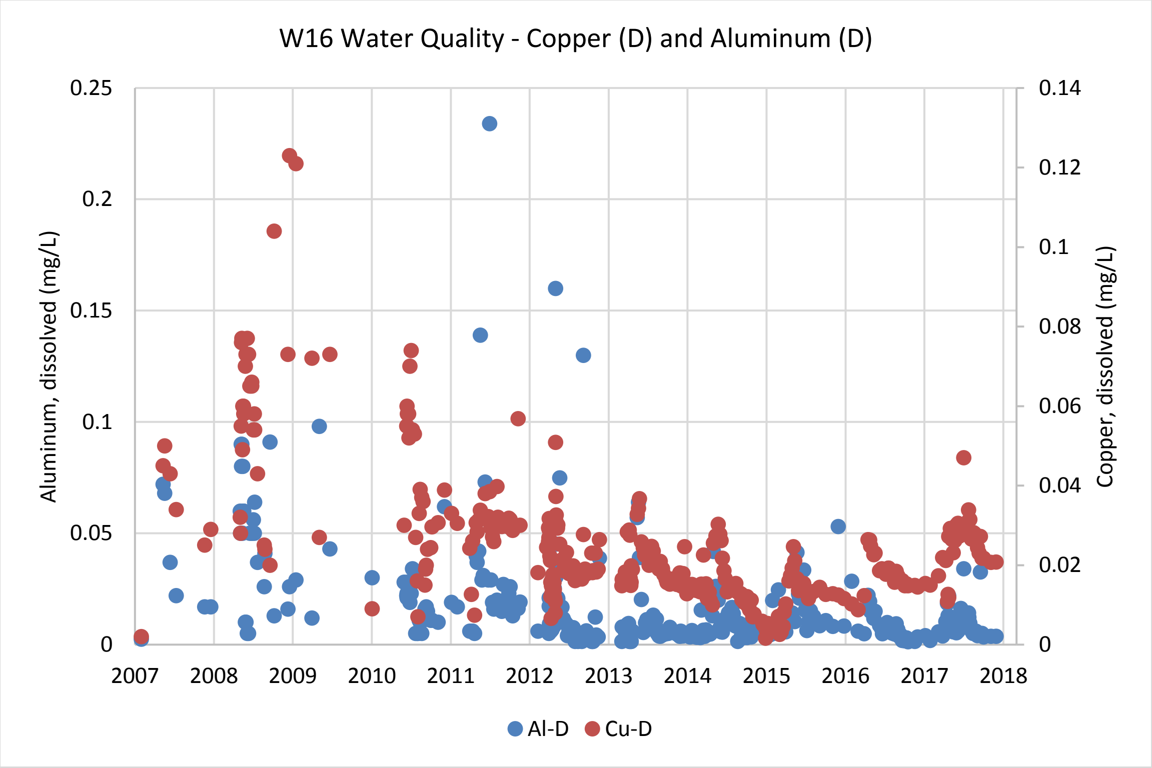


Figure 5-11: W16 Copper and Aluminum Concentrations (2007-2017)

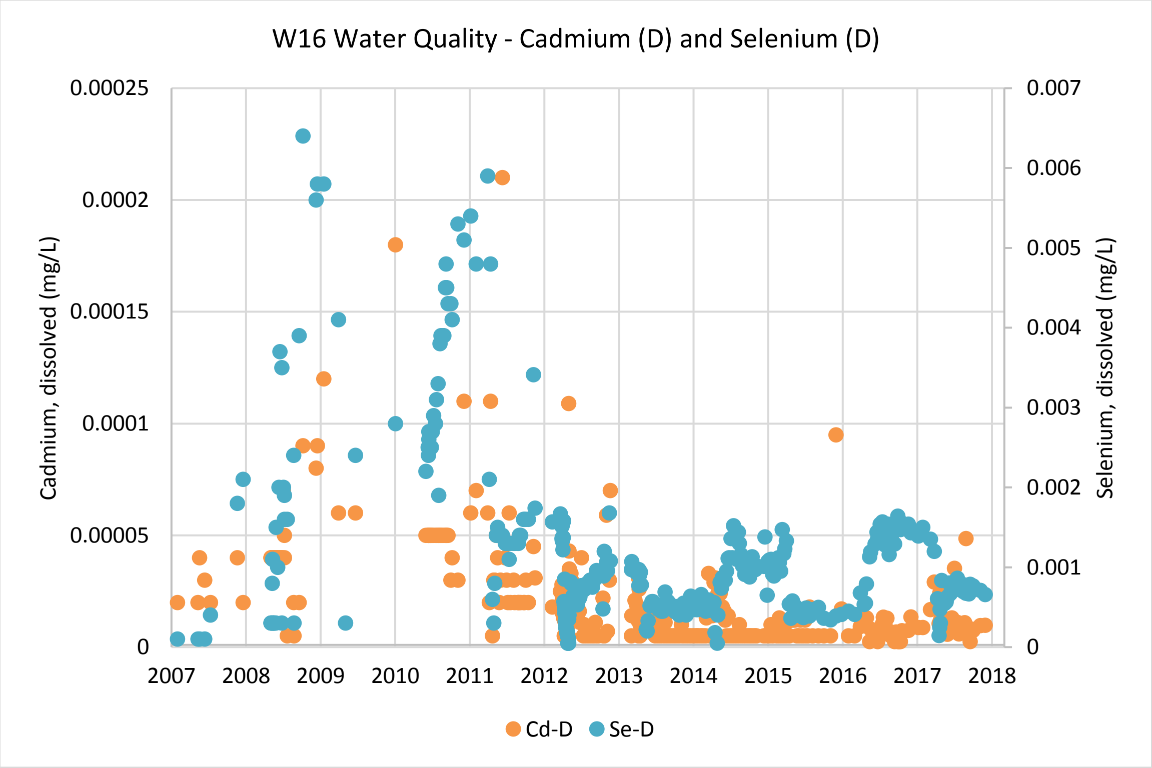


Figure 5-12: W16 Cadmium and Selenium Concentrations (2007-2017)

5.3.15 W17 – Water Storage Pond Dam Seepage

The summary results for this station are presented in the seepage section 7.4 along with trend analyses for dissolved copper, aluminum, cadmium and selenium concentrations throughout the years. A total of 54 samples were collected at this station during the 2017 monitoring period.

5.3.16 W30 – Headwaters Minto Creek (northwest fork)

The water quality statistics for W30 from 2009 to 2017 are summarized below in Table 5-20. A total of eight routine samples were collected from station W30 during the 2017 monitoring period.

Table 5-17: W30 Water Quality Results Summary (2009-2017)

W30	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.76	6.15	8.43	8.22	8.02	8.32
TSS (mg/L)	18.3	<1.0	1110	7.3	<3.0	16
Nutrients (mg/L)						
Ammonia Nitrogen	0.1182	<0.005	0.8500	0.1035	0.0201	0.599
Nitrite Nitrogen	0.0325	<0.0010	0.579	0.0148	0.0014	0.0564
Nitrate Nitrogen	3.737	<0.01	78.6	0.625	0.163	2.17
Dissolved Metals (mg/L)						
Aluminum	0.0604	<0.001	0.217	0.0054	0.0014	0.0098
Arsenic	0.00111	0.00024	0.054	0.00074	0.00044	0.00132
Cadmium	0.0015038	<0.0000050	0.143	0.0000066	<0.0000050	0.0000154
Chromium	0.00112	<0.00010	0.0149	0.0001	<0.00010	<0.00010
Copper	0.0345	0.0067	0.179	0.01657	0.00835	0.0248
Iron	0.2196	<0.001	0.7830	0.067	0.012	0.146
Lead	0.0002	<0.000050	0.001	0.00005	<0.000050	<0.000050
Molybdenum	0.00211	<0.0002	0.0098	0.00241	0.00137	0.00408
Nickel	0.00126	<0.00050	0.024	0.00054	<0.00050	0.00093
Selenium	0.00551	0.0004	0.343	0.001678	0.000665	0.00515
Zinc	0.0057	<0.0010	0.0164	0.0015	<0.0010	<0.0050

5.3.17 W33 – Above Tailings Diversion Ditches

The water quality statistics for W33 from 2009 to 2017 are summarized below in Table 5-21. A total of seven routine samples were collected from station W33 during the 2017 monitoring period. W33 was buried during construction at the end of December.

Table 5-18: W33 Water Quality Results Summary (2009-2017)

W33	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.64	5.98	8.25	7.78	7.52	8.06
TSS (mg/L)	10.3	<1.0	218	6	<3.0	23
Nutrients (mg/L)						
Ammonia Nitrogen	0.0578	<0.0050	<0.5	0.0118	0.0087	0.0167
Nitrite Nitrogen	0.0163	<0.0010	0.251	0.0102	<0.0010	0.0544
Nitrate Nitrogen	2.86	<0.01	60.4	7.979	0.442	40.7
Dissolved Metals (mg/L)						
Aluminum	0.0472	<0.0030	0.31	0.0315	0.016	0.0501
Arsenic	0.00036	<0.00010	<0.001	0.00039	0.0003	0.00043
Cadmium	0.0000312	<0.0000050	<0.0001	0.0000066	<0.0000050	0.0000127
Chromium	0.00114	0.00039	0.0022	0.00041	0.00027	0.00051
Copper	0.01348	<0.00020	0.106	0.01542	0.00761	0.0348
Iron	0.1561	<0.0050	0.9560	0.127	0.079	0.205
Lead	0.000194	<0.000050	0.0007	0.00005	<0.000050	<0.000050
Molybdenum	0.000977	0.0002	0.003	0.000584	0.000348	0.000725
Nickel	0.00149	<0.0010	0.003	0.00149	0.00104	0.00192
Selenium	0.000414	<0.00010	0.006	0.000189	0.000120	0.000429
Zinc	0.0058	<0.0010	<0.01	0.0013	<0.0010	0.0025

5.3.18 W35 – Storm Water Collection Point – South Diversion Ditch

The water quality statistics for W35 from 2012 to 2017 are summarized below in Table 5-22. A total of thirteen routine samples were collected from station W35 during the 2017 monitoring period. The results for dissolved copper, dissolved aluminum, dissolved cadmium, and dissolved selenium for W35 from 2012 to 2017 are also presented in Figure 5-13 and Figure 5-14 below. In September 2017, the SDD was removed due to changes in the construction of the A2S3 expansion. New conveyance infrastructure was installed to reroute water from W35 to the TDD or A2 Pit depending on water quality.

Table 5-19: W35 Water Quality Results Summary (2012-2017)

W35	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.90	6.77	8.26	7.91	7.56	8.14
TSS (mg/L)	24.1	<1.0	465	12.9	<3.0	63.2
Nutrients (mg/L)						
Ammonia Nitrogen	0.0506	0.0059	0.3030	0.0273	0.0105	0.098
Nitrite Nitrogen	0.0367	0.0025	0.335	0.017	0.0017	0.0851
Nitrate Nitrogen	5.32	<0.020	28.7	5.878	0.709	25.1
Dissolved Metals (mg/L)						
Aluminum	0.0273	0.0061	0.104	0.0255	0.0107	0.0411
Arsenic	0.00034	0.00023	0.0005	0.00039	0.00029	0.00056
Cadmium	0.0000124	<0.0000050	5E-05	0.0000121	<0.0000050	0.0000288
Chromium	0.00086	0.00021	<0.0010	0.00033	0.00018	0.00061
Copper	0.0332	0.017	0.0551	0.0427	0.0194	0.0836
Iron	0.0894	0.0144	0.3230	0.084	0.025	0.15
Lead	0.000171	<0.000050	<0.00020	0.00005	<0.000050	<0.000050
Molybdenum	0.001425	0.000783	0.0055	0.000896	0.000485	0.00183
Nickel	0.00117	0.00064	0.0016	0.00135	0.00090	0.00173
Selenium	0.000245	<0.00010	0.0005	0.00018	0.000105	0.000466
Zinc	0.0046	<0.0010	0.0068	0.0014	<0.0010	0.0028

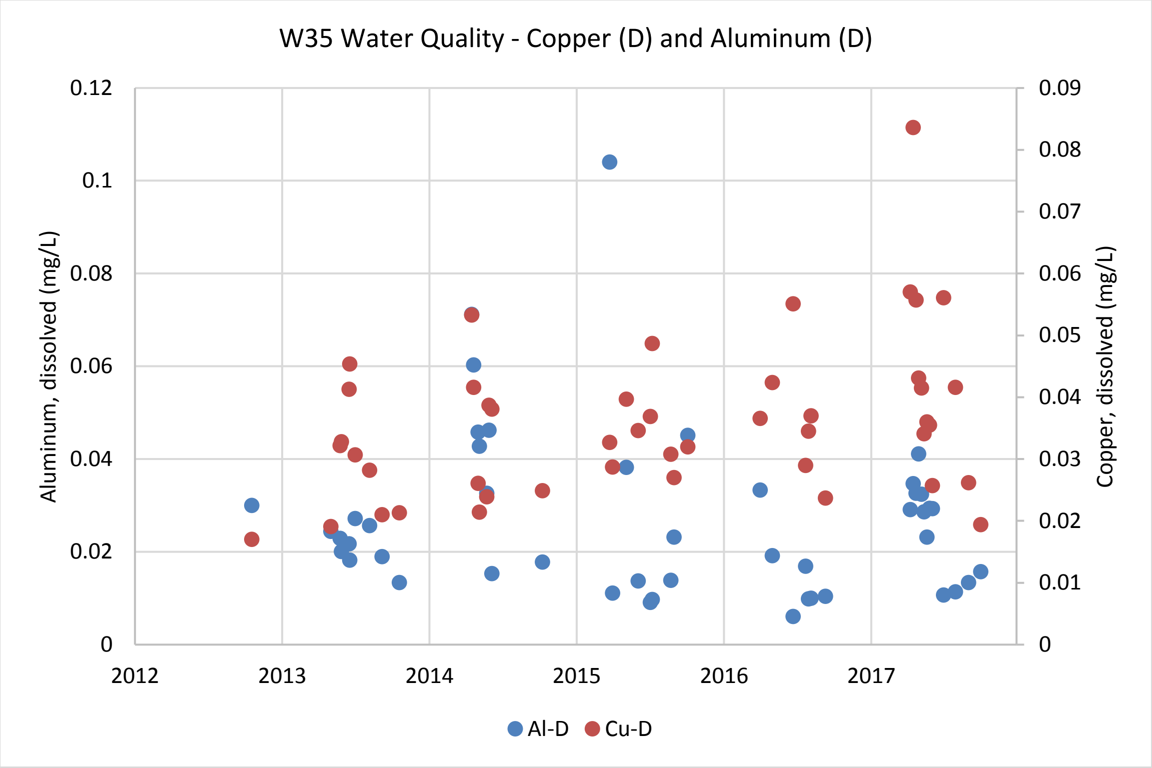


Figure 5-13: W35 Copper and Aluminum Concentrations (2012-2017)

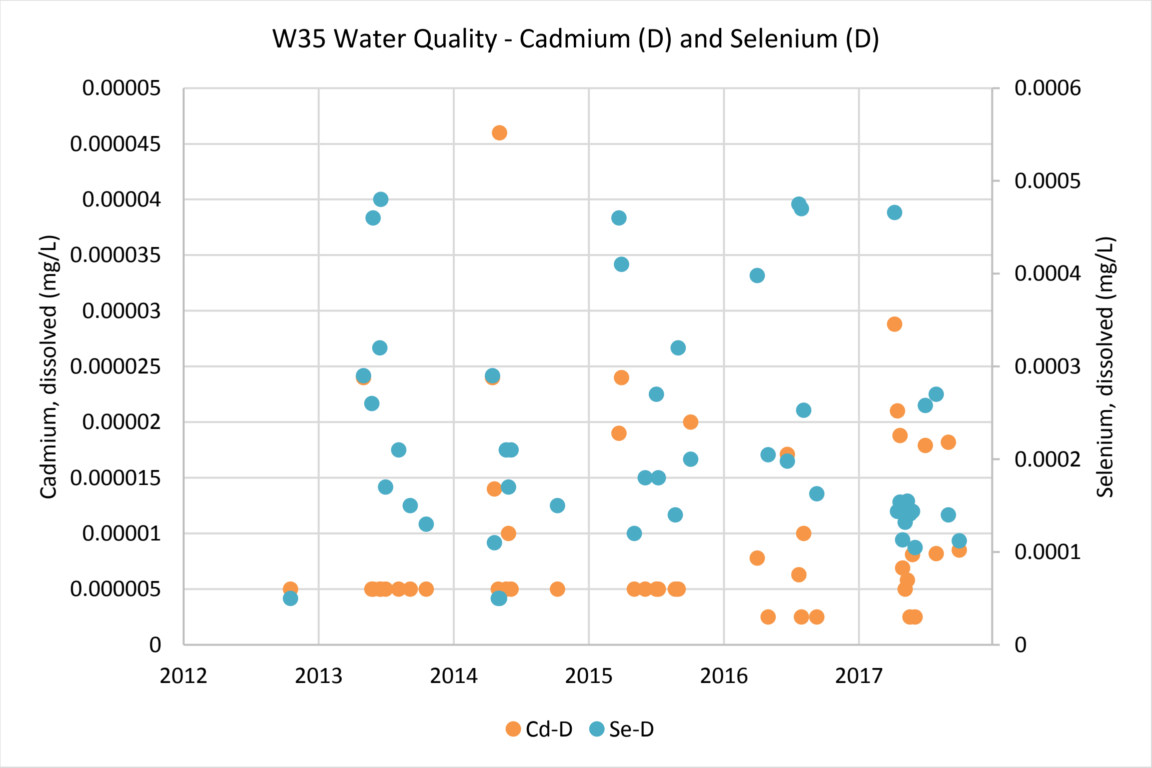


Figure 5-14: W35 Cadmium and Selenium Concentrations (2012-2017)

5.3.19 W36 – Minto Creek Detention Structure Pond

W36 was decommissioned during the construction of the Mill Valley Fill Extension Phase 2 (MVFE2) in 2015. As such, no samples were taken in 2017.

5.3.20 W37 – 100 m downstream of MCDS (W37 Collection Sump) and upstream of Water Storage Pond

W37 was decommissioned during the construction of the Mill Valley Fill Extension Phase 2 (MVFE2) in 2015 and replaced by W62. As such, no samples were taken in 2017.

5.3.21 W45– Area 2 Pit

The water quality statistics for W45 from 2012 to 2017 are summarized below in Table 5-23. A total of ten routine samples were collected from station W45 during the 2017 monitoring period. Access was not permitted for two months when the pump was removed, due to safety reasons.

Table 5-20: W45 Water Quality Results Summary (2012-2017)

W45	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.06	7.86	8.27	7.90	7.76	8.03
TSS (mg/L)	27.8	<1.0	291	51.6	12.3	139
Nutrients (mg/L)						
Ammonia Nitrogen	5.739	0.072	37.0000	5.81	3.33	9.02
Nitrite Nitrogen	1.7216	0.0223	7.6	4.308	0.433	11.4
Nitrate Nitrogen	23.31	1.65	77.2	22.97	9.6	35.5
Dissolved Metals (mg/L)						
Aluminum	0.0202	0.0032	0.337	0.012	0.0083	0.0148
Arsenic	0.00102	0.00032	0.0023	0.00042	0.00034	0.00056
Cadmium	0.0001138	<0.0000050	0.0005	0.000104	0.000028	0.00018
Chromium	0.0008	<0.00010	<0.0010	0.0002	<0.00020	<0.00020
Copper	0.06354	0.00025	0.276	0.00685	0.001	0.0208
Iron	0.068	<0.0050	0.7260	0.058	<0.020	0.172
Lead	0.000183	<0.000050	0.0007	0.0001	<0.00010	0.00014
Molybdenum	0.0516	0.0033	0.117	0.101	0.0851	0.121
Nickel	0.00184	<0.0010	0.0047	0.00590	0.00440	0.0082
Selenium	0.00906	0.00048	0.0298	0.016	0.014000	0.0181
Zinc	0.0109	<0.0010	0.0673	0.0022	<0.0020	0.003

5.3.22 W46 – Minto Creek, Downstream of W7 and W6

The water quality statistics for W46 from 2012 to 2017 are summarized below in Table 5-24. A total of eight routine samples were collected from station W46 during the 2017 monitoring period.

Table 5-21: W46 Water Quality Results Summary (2012-2017)

W46	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.08	7.49	8.33	8.14	8.01	8.35
TSS (mg/L)	21.7	<1.0	175	182.6	<3.0	693
Nutrients (mg/L)						
Ammonia Nitrogen	0.0292	0.0062	0.1600	0.0273	0.0081	0.069
Nitrite Nitrogen	0.005	<0.0010	0.0242	0.0015	<0.0010	0.0023
Nitrate Nitrogen	0.3835	<0.020	3.28	0.1333	0.013	0.245
Dissolved Metals (mg/L)						
Aluminum	0.0098	<0.0030	0.0449	0.0086	0.0043	0.0136
Arsenic	0.00046	0.0003	0.0008	0.0005	0.00039	0.00061
Cadmium	0.0000099	<0.0000050	2E-05	0.0000084	<0.0000050	0.0000217
Chromium	0.00083	0.00011	<0.0010	0.00018	0.00011	0.00022
Copper	0.00268	0.00089	0.0108	0.0029	0.0014	0.00483
Iron	0.1753	0.0183	0.6460	0.153	0.059	0.34
Lead	0.000169	<0.000050	0.0002	0.00005	<0.000050	<0.000050
Molybdenum	0.0021	<0.0010	0.007	0.0018	0.00157	0.00208
Nickel	0.00112	0.00068	0.0021	0.00111	0.00095	0.00135
Selenium	0.000232	<0.00010	0.0009	0.000183	0.000115	0.000216
Zinc	0.0046	<0.0010	0.0150	0.0021	<0.0010	<0.0050

5.3.23 W47 – Area 118 Pit Water

W47 was decommissioned and backfilled during the construction of the Area 2 Stage 3 pit in January 2017. As such, no samples were taken in 2017.

5.3.24 W50 – Minto Creek, 50m Downstream of the Toe of the Water Storage Pond Dam

The water quality statistics for W50 are presented in Section 5.2.1.2 above.

5.3.25 W51 – Area 2 Stage 3 Pit

The water quality statistics for W51 from 2017 are summarized below in Table 5-26. W51 was developed in 2017 with the mining activities in the Area 2 Stage 3 pit. A total of two routine samples were collected from station W51 during the 2017 monitoring period. No other samples were collected because the sump was inaccessible for safety reasons.

Table 5-22: W51 Water Quality Results Summary (2017)

W51	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.27	8.12	8.41
TSS (mg/L)	36.9	3.1	70.7
Nutrients (mg/L)			
Ammonia Nitrogen	1.284	0.627	1.94
Nitrite Nitrogen	0.341	0.126	0.555
Nitrate Nitrogen	7.96	4.13	11.8
Dissolved Metals (mg/L)			
Aluminum	0.0034	0.0024	0.0045
Arsenic	0.00084	0.00083	0.00084
Cadmium	0.000038	<0.000025	<0.000050
Chromium	0.0001	<0.00010	<0.00010
Copper	0.0626	0.0354	0.0898
Iron	0.01	<0.010	<0.010
Lead	0.00005	<0.000050	<0.000050
Molybdenum	0.0301	0.0269	0.0333
Nickel	0.00050	<0.00050	<0.00050
Selenium	0.00296	0.002730	0.00319
Zinc	0.0014	<0.0010	0.0017

5.3.26 W52 – Ridgetop North Pit

The Ridgetop North Pit was not developed in 2017; therefore, water quality results are not available.

5.3.27 W53 – Ridgetop South Pit

The Ridgetop South Pit was not developed in 2017; therefore, water quality results are not available.

5.3.28 W54 – Main Pit Dam Seepage

The Main Pit Dam was not developed in 2017; therefore, water quality results are not available.

5.3.29 W55 – Tailings Diversion Ditch

The water quality statistics for W55 from 2016 and 2017 are summarized below in Table 5-27. Four routine sample were collected from station W55 during the 2017 monitoring period.

Table 5-23: W55 Water Quality Results Summary (2016-2017)

W55	2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.63	7.52	7.74	7.91	7.71	8.10
TSS (mg/L)	4.2	<3.0	5.3	18.3	4.4	43.3
Nutrients (mg/L)						
Ammonia Nitrogen	0.0155	0.0131	0.0178	0.0207	0.0134	0.039
Nitrite Nitrogen	0.0015	<0.0010	0.0021	0.0033	<0.0010	0.006
Nitrate Nitrogen	0.0126	0.0065	0.0187	0.089	<0.0050	0.221
Dissolved Metals (mg/L)						
Aluminum	0.0612	0.0585	0.064	0.0525	0.0265	0.0691
Arsenic	0.0006	0.0006	0.00061	0.00082	0.00068	0.00114
Cadmium	0.0000175	0.0000132	0.0000219	0.0000181	0.0000056	0.0000339
Chromium	0.00034	0.00033	0.00034	0.00038	0.00029	0.00047
Copper	0.0743	0.0567	0.092	0.0768	0.0149	0.14
Iron	0.128	0.128	0.128	0.181	0.114	0.338
Lead	0.000065	<0.000050	0.00008	0.000063	<0.000050	0.000104
Molybdenum	0.001047	0.000784	0.00131	0.001426	0.000633	0.00297
Nickel	0.00205	0.00192	0.00219	0.00180	0.00140	0.00219
Selenium	0.000202	0.000185	0.000219	0.000418	0.000158	0.000675
Zinc	0.0013	0.0011	0.0014	0.0015	<0.0010	0.002

5.3.30 W62 – Mill Valley Fill Extension Phase 2 Collection Sump

The water quality statistics for W62 from 2016 and 2017 are summarized below in Table 5-28. A total of thirteen routine samples were collected from station W62 during the 2017 monitoring period.

Table 5-24: W62 Water Quality Results Summary (2016-2017)

W62	2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.18	7.90	8.37	8.31	8.21	8.42
TSS (mg/L)	12.1	<3.0	58	4.4	<3.0	11.3
Nutrients (mg/L)						
Ammonia Nitrogen	0.0354	<0.0050	0.23	0.0148	<0.0050	0.0563
Nitrite Nitrogen	0.0298	<0.0010	0.119	0.0353	<0.0050	0.0546
Nitrate Nitrogen	7.6491	0.0084	11.3	6.04	4.17	7.35
Dissolved Metals (mg/L)						
Aluminum	0.005	0.0022	0.0144	0.0055	0.0022	0.0308
Arsenic	0.00036	0.00011	0.00044	0.00038	0.00034	0.00042
Cadmium	0.0000207	<0.0000050	0.0000383	0.0000173	0.0000117	0.0000312
Chromium	0.00028	<0.00010	<0.0010	0.00017	<0.00010	0.00023
Copper	0.04048	0.00195	0.0629	0.0518	0.0422	0.0633
Iron	0.0436	0.0113	0.072	0.03	0.014	0.057
Lead	0.000073	<0.000050	<0.00020	0.000054	<0.000050	0.000092
Molybdenum	0.006067	0.00042	0.00822	0.00648	0.00525	0.00811
Nickel	0.00109	0.00082	0.00161	0.00102	0.00088	0.00124
Selenium	0.003461	0.000095	0.00485	0.003	0.001980	0.00393
Zinc	0.2251	0.0018	0.799	0.0967	0.032	0.193

5.3.31 MC-1 – Minto Creek Upstream of Canyon near Km 8 on Mine Access Road

The water quality statistics for MC-1 from 2009 to 2017 are summarized below in Table 5-29. A total of 32 routine samples were collected from station MC-1 during the 2017 monitoring period.

Table 5-25: MC-1 Water Quality Results Summary (2009-2017)

MC1	**2009 - 2016 Summary Statistics**			**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.14	5.27	8.54	8.23	7.84	8.43
TSS (mg/L)	54	<1.0	727	50.7	<3.0	793
Nutrients (mg/L)						
Ammonia Nitrogen	0.0328	<0.0050	0.36	0.0132	<0.0050	0.0838
Nitrite Nitrogen	0.0073	<0.0010	<0.05	0.0013	<0.0010	0.0056
Nitrate Nitrogen	0.4529	<0.0050	7.3	0.1262	<0.0050	0.444
Dissolved Metals (mg/L)						
Aluminum	0.0162	<0.0010	0.07	0.012	0.0029	0.0412
Arsenic	0.00058	<0.00010	0.00125	0.00053	0.00034	0.00076
Cadmium	0.000023	<0.0000050	0.0002	0.0000074	<0.0000050	0.0000221
Chromium	0.001	<0.00010	0.0021	0.00021	0.0001	0.00039
Copper	0.00275	<0.00020	0.00992	0.00363	0.00121	0.0106
Iron	0.231	<0.010	1.11	0.103	0.027	0.322
Lead	0.000186	<0.000050	<0.00050	0.000051	<0.000050	0.000077
Molybdenum	0.001773	<0.000050	0.008	0.001471	0.000615	0.00198
Nickel	0.00127	<0.00050	0.004	0.00108	0.00064	0.00173
Selenium	0.000314	<0.000050	0.0022	0.000177	0.000091	0.000715
Zinc	0.0053	<0.0010	0.0334	0.0015	<0.0010	0.0064

5.3.32 WTP and RO – Treated Water

An explanation of operations and water quality statistics for WTP and RO are presented in Section 5.2.3.3 above.

5.3.33 C4 – Tributary on the south side of Minto Creek

The water quality statistics for C4 from 2012 to 2017 are summarized below in Table 5-31. A total of seven routine samples were collected from station C4 during the 2017 monitoring period.

Table 5-26: C4 Water Quality Results Summary (2012-2017)

C4	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.03	7.59	8.29	8.14	7.95	8.31
TSS (mg/L)	212.1	2.3	1260	4.3	<3.0	9
Nutrients (mg/L)						
Ammonia Nitrogen	0.0923	0.005	0.36	0.0132	0.0079	0.0225
Nitrite Nitrogen	0.0071	<0.0010	<0.050	0.0013	<0.0010	0.0019
Nitrate Nitrogen	0.1265	<0.0050	2.31	0.0375	<0.0050	0.0568
Dissolved Metals (mg/L)						
Aluminum	0.0251	0.0085	0.0622	0.0115	0.0048	0.0298
Arsenic	0.00141	0.00029	0.00559	0.00083	0.00064	0.00104
Cadmium	0.0000107	<0.0000050	0.000029	0.0000088	<0.0000050	0.0000337
Chromium	0.00087	0.00037	0.0013	0.00034	0.00022	0.00045
Copper	0.00184	0.00095	0.00952	0.00243	0.00087	0.0102
Iron	1.465	0.056	14.2	0.405	0.146	0.606
Lead	0.000161	<0.000050	0.00022	0.00005	<0.000050	<0.000050
Molybdenum	0.001214	0.000379	0.0068	0.000764	0.00062	0.000823
Nickel	0.00236	<0.0010	0.0061	0.00191	0.00151	0.00211
Selenium	0.000125	0.000076	0.00068	0.000108	0.000076	0.000164
Zinc	0.0041	<0.0010	<0.0050	0.0014	<0.0010	0.0031

5.3.34 C10 – Tributary on the south side of Minto Creek

The water quality statistics for C10 from 2012 to 2017 are summarized below in Table 5-32. A total of five routine samples were collected from station C10 during the 2017 monitoring period.

Table 5-27: C10 Water Quality Results Summary (2012-2017)

C10	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.13	7.73	8.37	8.25	8.16	8.39
TSS (mg/L)	335.1	<1.0	2210	19.7	<3.0	66
Nutrients (mg/L)						
Ammonia Nitrogen	0.0748	<0.0050	0.2	0.0118	0.005	0.0289
Nitrite Nitrogen	0.011	<0.0010	<0.050	0.0022	<0.0010	0.0066
Nitrate Nitrogen	0.1294	0.0178	0.417	0.1119	<0.0050	0.226
Dissolved Metals (mg/L)						
Aluminum	0.2893	0.0091	5.84	0.0084	0.0075	0.01
Arsenic	0.00132	0.0004	0.00551	0.00059	0.00048	0.00071
Cadmium	0.0000255	<0.0000050	0.000344	0.0000077	<0.0000050	0.0000187
Chromium	0.0013	0.00028	0.0093	0.00022	0.00017	0.0003
Copper	0.003	0.00091	0.0339	0.002	0.00142	0.00263
Iron	1.7	0.141	19.9	0.31	0.033	0.94
Lead	0.000538	<0.000050	0.00772	0.00005	<0.000050	<0.000050
Molybdenum	0.001059	0.000697	0.0019	0.001043	0.000384	0.00184
Nickel	0.00289	<0.0010	0.0215	0.00130	0.00096	0.00166
Selenium	0.000102	0.000066	0.00014	0.000117	0.000063	0.00021
Zinc	0.0071	<0.0010	0.0603	0.0013	<0.0010	0.0024

5.3.35 MN – Minto North Pit Water

The water quality statistics for MN from 2015 to 2017 are summarized below in Table 5-33. One routine sample was collected from station MN during the 2017 monitoring period, once safe access to the pit water could be established. The water was frozen at the end of the year.

Table 5-28: MN Water Quality Results Summary (2015-2017)

MN	2015 - 2016 Summary Statistics			2017 Summary Statistics
Parameters	**Mean**	**Min**	**Max**	**Result**
pH	7.84	7.56	8.16	8.05
TSS (mg/L)	62.2	<3.0	142	29.7
Nutrients (mg/L)				
Ammonia Nitrogen	13.8	1.45	51	0.612
Nitrite Nitrogen	5.391	0.345	14.7	0.105
Nitrate Nitrogen	149.6	14.2	342	25.9
Dissolved Metals (mg/L)				
Aluminum	0.0087	0.0025	0.0266	0.0031
Arsenic	0.00064	0.0002	0.00142	0.00043
Cadmium	0.0000609	<0.000010	0.000283	0.0000733
Chromium	0.00036	<0.00010	<0.0010	0.00047
Copper	0.1608	0.0119	0.562	0.0314
Iron	0.1045	<0.010	0.449	<0.010
Lead	0.0001	<0.000050	<0.00020	<0.000050
Molybdenum	0.0207	0.0077	0.0384	0.0228
Nickel	0.00136	<0.00050	0.0041	<0.00050
Selenium	0.01517	0.003850	0.0627	0.0199
Zinc	0.005	<0.0010	0.0159	0.0027

5.3.36 MN-0.2 – Upper West Arm of McGinty Creek

The water quality statistics for MN-0.2 from 2011 to 2017 are summarized below in Table 5-34. A total of six routine samples were collected from station MN-0.2 during the 2017 monitoring period.

Table 5-29: MN-0.2 Water Quality Results Summary (2011-2017)

MN-0.2	2011 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.32	6.55	7.69	7.55	7.19	7.85
TSS (mg/L)	20.4	<1.0	300	9	<3.0	50.7
Nutrients (mg/L)						
Ammonia Nitrogen	0.0239	<0.005	0.11	0.0106	0.0057	0.0187
Nitrite Nitrogen	0.0096	<0.0010	<0.050	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0389	<0.0020	0.23	0.0084	<0.0050	0.0176
Dissolved Metals (mg/L)						
Aluminum	0.0743	0.0337	0.199	0.0827	0.0492	0.152
Arsenic	0.000552	0.00025	0.00388	0.00061	0.0004	0.00081
Cadmium	0.0000134	<0.0000050	0.000053	0.000005	<0.0000050	5.4E-06
Chromium	0.0007	0.0002	0.0011	0.00056	0.00046	0.00068
Copper	0.00273	0.00142	0.00527	0.00221	0.00128	0.00465
Iron	0.614	0.084	10.3	0.682	0.363	0.995
Lead	0.0001158	0.000009	0.000271	0.00005	<0.000050	<0.000050
Molybdenum	0.000553	<0.00005	<0.0010	0.000219	0.000154	0.000243
Nickel	0.00165	0.00104	0.00272	0.00142	0.00109	0.00177
Selenium	0.000083	<0.000040	0.00012	0.000075	<0.000050	0.000096
Zinc	0.0036	0.0001	0.0131	0.0027	<0.0010	<0.0060

5.3.37 MN-0.5 – West Arm of McGinty Creek

The water quality statistics for MN-0.5 from 2010 to 2017 are summarized below in Table 5-35. A total of seven routine samples were collected from station MN-0.5 during the 2017 monitoring period.

Table 5-30: MN-0.5 Water Quality Results Summary (2010-2017)

MN-0.5	2010 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.86	7.10	8.25	8.05	7.74	8.27
TSS (mg/L)	73.7	<1.0	737	19.8	<3.0	64.7
Nutrients (mg/L)						
Ammonia Nitrogen	0.0297	<0.0050	0.33	0.0062	<0.0050	0.0115
Nitrite Nitrogen	0.0079	<0.0010	<0.050	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0872	<0.0050	1.69	0.0718	<0.0050	0.159
Dissolved Metals (mg/L)						
Aluminum	0.032	<0.0030	0.191	0.0848	0.0041	0.58
Arsenic	0.000444	0.00026	0.000713	0.00042	0.00026	0.00089
Cadmium	0.0000129	<0.0000050	0.000076	0.0000279	<0.0000050	0.000186
Chromium	0.00059	<0.0001	0.0016	0.00034	0.00012	0.00126
Copper	0.00186	0.00071	0.00441	0.00464	0.00095	0.0264
Iron	0.1698	0.0062	0.716	0.164	0.014	0.929
Lead	0.000113	0.000006	<0.00020	0.000168	<0.000050	0.000991
Molybdenum	0.000922	0.00011	0.00143	0.000997	0.000423	0.00125
Nickel	0.00116	0.00048	0.00205	0.00140	0.00063	0.00432
Selenium	0.000193	0.000050	0.00063	0.000187	0.000097	0.000249
Zinc	0.00329	0.00016	0.0121	0.0068	<0.0010	0.0459

5.3.38 MN-1.5 – Upper East Arm of McGinty Creek

The water quality statistics for MN-1.5 from 2010 to 2017 are summarized below in Table 5-36. A total of six routine samples were collected from station MN-1.5 during the 2017 monitoring period.

Table 5-31: MN-1.5 Water Quality Results Summary (2010-2017)

MN-1.5	2010 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.34	6.00	8.10	7.75	7.36	7.93
TSS (mg/L)	280.2	<1	8200	11.9	<3.0	56.7
Nutrients (mg/L)						
Ammonia Nitrogen	0.0579	<0.0050	0.66	0.0131	0.0068	0.0239
Nitrite Nitrogen	0.01	<0.0010	0.053	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0506	<0.0050	0.2	0.0171	<0.0050	0.0434
Dissolved Metals (mg/L)						
Aluminum	0.1101	0.0309	0.259	0.0534	0.0282	0.129
Arsenic	0.000501	0.00015	0.00113	0.00047	0.00032	0.00057
Cadmium	0.0000187	<0.0000050	0.000106	0.0000057	<0.0000050	1.03E-05
Chromium	0.00068	0.0002	<0.0010	0.00047	0.00036	0.00062
Copper	0.00619	0.00302	0.00983	0.00444	0.00278	0.00918
Iron	0.606	0.126	1.62	0.508	0.413	0.568
Lead	0.00011	0.000008	0.000527	0.00005	<0.000050	<0.000050
Molybdenum	0.000571	0.00008	<0.0010	0.000364	0.000218	0.000426
Nickel	0.00127	0.00078	0.00233	0.00111	0.00084	0.00139
Selenium	0.000087	<0.00004	0.00015	0.000072	0.000051	0.000122
Zinc	0.00375	0.0003	0.012	0.0011	<0.0010	0.0017

5.3.39 MN-2.5 – East Arm of McGinty Creek

The water quality statistics for MN-2.5 from 2010 to 2017 are summarized below in Table 5-37. A total of seven routine samples were collected from station MN-2.5 during the 2017 monitoring period.

Table 5-32: MN-2.5 Water Quality Results Summary (2010-2017)

MN-2.5	2010 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.85	7.10	8.50	8.07	7.80	8.17
TSS (mg/L)	38.4	<1.0	350	38.7	<3.0	226
Nutrients (mg/L)						
Ammonia Nitrogen	0.0322	<0.005	0.3	0.0096	<0.0050	0.0248
Nitrite Nitrogen	0.0076	<0.0010	<0.050	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0447	<0.0050	<0.20	0.025	<0.0050	0.0455
Dissolved Metals (mg/L)						
Aluminum	0.0241	0.0059	0.112	0.0105	0.005	0.028
Arsenic	0.000428	0.0002	0.00149	0.00032	0.00016	0.00044
Cadmium	0.000014	<0.0000050	0.000075	0.0000064	<0.0000050	0.00001
Chromium	0.00053	<0.0001	<0.0010	0.00022	0.00013	0.00032
Copper	0.00211	0.00071	0.00463	0.00179	0.00117	0.00341
Iron	0.22	0.0225	0.867	0.067	0.032	0.208
Lead	0.0001105	<0.000005	0.000822	0.00005	<0.000050	<0.000050
Molybdenum	0.00074	0.00011	0.00117	0.000671	0.000417	0.000865
Nickel	0.00127	0.00073	0.00376	0.00114	0.00085	0.00171
Selenium	0.000093	0.000040	0.00038	0.000076	<0.000050	0.000102
Zinc	0.00306	0.0004	0.0061	0.0012	<0.0010	0.0019

5.3.40 MN-4.5 – McGinty Creek near confluence with Yukon River

The water quality statistics for MN-4.5 from 2010 to 2017 are summarized below in Table 5-38. A total of seven routine samples were collected from station MN-4.5 during the 2017 monitoring period.

Table 5-33: MN-4.5 Water Quality Results Summary (2010-2017)

MN-4.5	2010 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.87	7.10	8.18	8.07	7.80	8.26
TSS (mg/L)	39.6	<1.0	570	31.5	<3.0	201
Nutrients (mg/L)						
Ammonia Nitrogen	0.026	<0.0050	0.27	0.0072	<0.0050	0.0167
Nitrite Nitrogen	0.008	<0.0010	<0.050	0.001	<0.0010	<0.0010
Nitrate Nitrogen	0.0823	<0.0050	0.323	0.1004	<0.0050	0.262
Dissolved Metals (mg/L)						
Aluminum	0.0281	0.0044	0.174	0.0134	0.0044	0.0363
Arsenic	0.000408	0.00025	0.00065	0.00035	0.00019	0.00046
Cadmium	0.0000139	<0.0000050	0.000135	0.0000075	<0.0000050	1.72E-05
Chromium	0.00052	<0.0001	<0.0010	0.00021	<0.00010	0.00032
Copper	0.00209	0.00113	0.00471	0.00201	0.00132	0.00333
Iron	0.1471	<0.010	0.562	0.05	0.011	0.179
Lead	0.000108	<0.000005	0.000467	0.00005	<0.000050	<0.000050
Molybdenum	0.000841	0.00017	0.00122	0.000892	0.000474	0.00102
Nickel	0.00117	0.00054	0.00188	0.00099	0.00062	0.00182
Selenium	0.000148	0.000060	0.00023	0.000193	0.000130	0.000366
Zinc	0.00308	0.0002	0.0144	0.0016	<0.0010	0.0037

5.3.41 UG1 – Minto South Underground Mine Dewatering

The water quality statistics for UG1 from 2015 to 2017 are summarized below in Table 5-39. A total of 12 routine samples were collected from station UG1 during the 2017 monitoring period.

Table 5-34: UG1 Water Quality Results Summary (2015-2017)

UG1	2015 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.89	7.70	8.14	7.89	7.79	8.06
TSS (mg/L)	96.3	3.8	477	151.4	21.5	545
Nutrients (mg/L)						
Ammonia Nitrogen	25.05	8.1	75	14.21	6.01	32.2
Nitrite Nitrogen	1.225	0.344	3.18	1.647	0.856	2.53
Nitrate Nitrogen	39.7	13.2	81.9	34	22.5	59.6
Dissolved Metals (mg/L)						
Aluminum	0.043	0.007	0.51	0.0114	0.0067	0.0261
Arsenic	0.0013	0.0006	0.0026	0.001	0.00056	0.00146
Cadmium	0.000107	<0.000010	0.00038	0.000225	0.000059	0.000398
Chromium	0.00056	<0.00020	<0.0010	0.00042	0.00012	0.00228
Copper	0.02778	0.00374	0.178	0.01432	0.0043	0.0254
Iron	0.0763	0.0052	1.16	0.02	<0.010	0.036
Lead	0.00017	<0.00010	0.00063	0.000092	<0.000050	<0.00010
Molybdenum	0.0186	0.0083	0.0394	0.0227	0.0157	0.0302
Nickel	0.00280	0.00110	0.007	0.00305	0.00200	0.0056
Selenium	0.00122	0.000220	0.00557	0.00105	0.000760	0.00193
Zinc	0.022	<0.0020	0.134	0.0105	0.006	0.0223

5.3.42 UG2 – Wildfire Underground Mine Dewatering

This station was not established in 2017.

5.3.43 UG3 – Copper Keel Underground Mine Dewatering

This station was not established in 2017.

5.3.44 UG4 – Minto East Underground Mine Dewatering

This station was not established in 2017.

6 Groundwater Monitoring Program

Groundwater monitoring program details are provided in section 2.2 of the Minto Mine Environmental Monitoring, Surveillance and Reporting Plan. The primary monitoring objective of the groundwater monitoring program is to identify potential impacts on groundwater from Minto Mine.

Mine facilities that are monitored for groundwater impacts include, but are not limited to the DSTSF, Mill area, Main Pit, Area 2 Pit, Minto North Pit, waste rock dumps, and the Water Storage Pond. Additionally, groundwater monitoring of hydrogeological conditions in areas of proposed future mine components including the Ridgetop North Pit and Ridgetop South Pit is also conducted. The Groundwater Monitoring Program is comprised of operational and baseline monitoring. Water quality samples for the program are collected according to standard procedures such as those summarized in the ASTM (2007*) Standard Guide for Sampling Ground-Water Monitoring Wells*. The main components of the groundwater monitoring program include groundwater quality, vibrating wire piezometers, and ground temperature cable monitoring.

In 2017, five new West-bay multi-port groundwater monitoring wells, and three new drive point wells were installed and developed. Groundwater samples were collected and the data analysis was conducted by an external lab.

Also in 2017, four Lysimeter installations were completed within each of the following facilities: Main Waste Dump, Southwest Dump, Dry Stack Tailings Storage Facility, and Mill Valley Fill. The Lysimeters record temperature and groundwater infiltration on a continual basis, with first results expected in spring of 2018. Additionally, water samples can be collected from the DSTSF Lysimeter.

6.1 Groundwater Quality Monitoring Conformance

Minto's 2017 conformance with groundwater sampling requirements is summarized in Table 6-1, below. Quality Assurance and Quality Control (QA/QC) sampling is not included in Table 6-1, but is described in Section 6-2.

Sampling of wells MW17-08, MW17-09, MW17-10, MW17-11, and MW17-12 was completed in Q3 and Q4 only since the wells were installed during July 2017. All other groundwater wells were sampled quarterly, as per the EMSRP and GW Plan 2016-02 requirements, which has been in effect since July 2016.

Table 6-1: Groundwater Quality Monitoring Conformance Summary (2017)

Mine Project Component	Monitoring Installation	Quality	Level	Monitoring Frequency	2017 Groundwater Compliance
Up-gradient of Mine Activities	MW17-08-01	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-08-02	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-08-03	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-08-04	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
Southwest Waste Dump	MW12-DP1	X	X	Quarterly	Sampled as per schedule. Well was destroyed in August 2017.
	MW12-DP2	X	X	Quarterly	Sampled as per schedule.
	MW12-DP3	X	X	Quarterly	Sampled as per schedule.
	MW17-09-01	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
Main Waste Dump	MW09-01-01	X	X	Quarterly	Sampled in Q1 and Q2. Since MW09-01 has been dry since October 2014 it was replaced by MW17-10.
	MW09-01-02	X	X	Quarterly	Sampled in Q1 and Q2. Since MW09-01 has been dry since October 2014 it was replaced by MW17-10.
	MW09-01-03	X	X	Quarterly	Sampled in Q1 and Q2. Since MW09-01 has been dry since October 2014 it was replaced by MW17-10.
	MW17-10-1	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-10-2	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-10-3	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-10-4	X	X	Quarterly	Q3 sample was missed due to human error. Well was established in July 2017.
Dry Stack Tailings Storage Facility and Mill Valley Fill Expansion	MW12-06-01		X	Quarterly	Sampled as per schedule.
	MW12-06-02	X	X	Quarterly	Sampled as per schedule.
	MW12-06-03		X	Quarterly	Sampled as per schedule.
	MW12-06-04	X	X	Quarterly	Sampled as per schedule.
	MW12-06-05		X	Quarterly	Sampled as per schedule.
	MW12-06-06	X	X	Quarterly	Sampled as per schedule.
Main Pit	MW12-07-01	X	X	Quarterly	Sampled as per schedule.
	MW12-07-02	X	X	Quarterly	Sampled as per schedule.
	MW12-07-03		X	Quarterly	Sampled as per schedule.

Mine Project Component	Monitoring Installation	Quality	Level	Monitoring Frequency	2017 Groundwater Compliance
Minto North Pit	MW09-03-01	X	X	Quarterly	Sampled as per schedule.
	MW09-03-02	X	X	Quarterly	Sampled as per schedule.
	MW09-03-03	X	X	Quarterly	Sampled as per schedule. Port was dry during 2017
	MW17-11-01	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-11-02	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-11-03	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-11-04	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-11-05	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
Water Storage Pond	MW12-05-01	X	X	Quarterly	Sampled as per schedule.
	MW12-05-02	X	X	Quarterly	Sampled as per schedule.
	MW12-05-03	X	X	Quarterly	Sampled as per schedule.
	MW12-05-04	X	X	Quarterly	Sampled as per schedule.
	MW12-05-05	X	X	Quarterly	Sampled as per schedule.
	MW12-05-06	X	X	Quarterly	Sampled as per schedule.
	MW12-05-07	X	X	Quarterly	Sampled as per schedule.
	MW17-12-01	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-02	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-03	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-04	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-05	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-06	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-07	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.
	MW17-12-08	X	X	Quarterly	Sampled as per schedule. Well was established in July 2017.

6.2 Groundwater Quality Control and Assurance

In 2017, 143 groundwater samples were taken at Minto. A total of 26 duplicate QC samples were taken from groundwater sampling sites, representing 18.2% of the total number of samples collected in 2017.

The EMSRP recommends field duplicate sampling be conducted at a frequency of one field duplicate sample per ten groundwater monitoring samples. The recommended rate of field duplicate sampling was achieved in 2017.

Minto currently employs compliance management system software to track programs and actions that meet licence requirements. To achieve the QA/QC objective of 1:10 samples, the compliance system was updated in 2016 and used successfully in 2017 to ensure that environmental staff completed the required field duplicates.

6.3 Groundwater Monitoring Stations

The EMSRP details the groundwater wells at the Minto Mine, including operative and inoperative wells. Figure 6-1 shows a location map of the operative wells, including new wells that were established in 2017. Stations that were collected more than three times in 2017 have results presented as follows: Mean, Minimum and Maximum values.

Wells MW09-01, MW11-02, MW11-03, MW12-DP1, MW12-DP2, and MW12-DP3 did not produce enough water during 2017 sampling events to sample, thus no results are presented.

Complete results for the 2017 Groundwater Monitoring Program groundwater wells are presented in Appendix C.

Figure 6-1: Minto Mine Groundwater Well Locations (2017)

6.3.1 MW09-01

Groundwater well MW09-01 was dry during 2017, thus no results are presented. Historically, this is consistent with sampling data from that well, as there have only been two sampled successfully drawn from MW09-01 since 2013. A new well was installed in summer 2017, MW17-10, to capture groundwater at the Main Waste Dump.

6.3.2 MW09-03

Groundwater well MW09-03 water quality results from 2017 are summarized in Table 6-2 and Table 6-3, and compared to historical data. MW09-03 produced results from sampling zones 01 and 02, while zone 03 produced no water during 2017. As such, only results for zones 01 and 02 are presented.

Table 6-2: MW09-03-01 Water Quality Results Summary (2009 - 2017)

MW09-03-01	2009 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.18	7.94	8.86	8.19	8.11	8.28
TDS (mg/L)	216.30	146	652	179.6	169	202
Sulfate-dissolved (mg/L)	25.07	0.53	117	20.4	19.4	21.9
Nutrients (mg/L)						
Ammonia Nitrogen	0.058	0.024	0.17	0.0435	0.0327	0.0853
Nitrate Nitrogen	0.10	0.0089	0.669	0.0112	<0.0050	0.0231
Nitrite Nitrogen	0.82	0.0742	9.27	0.2764	0.0654	0.944
Dissolved Metals (mg/L)						
Silver	0.0000185	<0.0000050	0.00005	0.000010	<0.000010	<0.000010
Aluminum	0.00494	0.0014	0.0105	0.0028	0.0021	0.0044
Arsenic	0.000312	0.000037	0.00097	0.00080	0.00020	0.00109
Cadmium	0.0000685	<0.0000050	0.000683	0.0000168	<0.0000050	0.0000890
Chromium	0.00075	<0.00010	0.001	0.00021	<0.00010	0.00111
Copper	0.00166	<0.00020	0.019	0.00047	<0.00020	0.00133
Lead	0.000202	0.000036	0.0011	0.000052	<0.000050	0.000070
Molybdenum	0.00981	0.0035	0.0806	0.00625	0.00441	0.0158
Nickel	0.00208	<0.0010	0.008	0.00105	0.00073	0.00130
Selenium	0.000493	<0.000050	0.008	0.000109	<0.000050	0.000418
Zinc	0.0105	<0.0050	0.0268	0.0203	0.0057	0.0593

Table 6-3: MW09-03-02 Water Quality Results Summary (2009-2017)

MW09-03-02	**2009 - 2016 Summary Statistics**			**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.98	7.59	8.2	8.17	8.03	8.32
TDS (mg/L)	482.25	172	716	203.2	177	225
Sulfate-dissolved (mg/L)	11.653	0.25	110	9.37	6.4	19.5
Nutrients (mg/L)						
Ammonia Nitrogen	0.171	0.0116	0.33	0.0140	<0.0050	0.0422
Nitrate Nitrogen	0.254	0.01	1.77	2.4335	<0.0050	3.72
Nitrite Nitrogen	0.156	0.0429	0.776	0.4412	0.0596	1.93
Dissolved Metals (mg/L)						
Silver	0.000020	<0.000010	0.00004	<0.000010	<0.000010	<0.000010
Aluminum	0.0051	0.0011	0.013	0.0022	<0.0010	0.0040
Arsenic	0.00055	<0.00010	0.0012	0.00024	<0.00010	0.00078
Cadmium	0.0000582	<0.0000050	0.00072	0.0000327	0.0000070	0.0000916
Chromium	0.00074	<0.00010	0.0013	0.00014	<0.00010	0.00026
Copper	0.00274	<0.00020	0.022	0.00215	<0.00020	0.00340
Lead	0.000160	<0.000050	0.0003	0.000050	<0.000050	<0.000050
Molybdenum	0.02118	0.0041	0.101	0.00605	0.00329	0.0118
Nickel	0.00126	<0.00050	0.004	0.00064	<0.00050	0.00107
Selenium	0.000698	0.000060	0.0067	0.000197	<0.000050	0.000254
Zinc	0.01273	<0.0050	0.0563	0.0257	0.0067	0.0727

6.3.3 MW11-02

MW11-02 was dry during the 2017 sampling events, thus water quality results are not presented.

6.3.4 MW11-03

MW11-03 was dry during the 2017 sampling events, thus water quality results are not presented.

6.3.5 MW11-04A

One full suite sample was collected in March 2017 and one partial suite (Total Organic Nutrients and Dissolved Metal) in May 2017. The results presented below in Table 6-4 are the outcomes of the 2017 sampling season.

Table 6-4: MW11-04A Water Quality Results Summary (2012 – 2017)

MW11-04A	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	11.20	10.3	11.7	11.11		
TDS (mg/L)	203	148	396	148.0		
Sulfate-dissolved (mg/L)	5.39	3.47	7.7	5.49		
Nutrients (mg/L)						
Ammonia Nitrogen	0.3445	0.0265	1.5	0.0246	0.0191	0.0302
Nitrate Nitrogen	1.30	1	1.64	1.10		
Nitrite Nitrogen	0.0145	0.0071	0.0234	0.0085		
Dissolved Metals (mg/L)						
Calcium	78.7	49.6	170	56.0	53.8	58.1
Cadmium	0.0000123	<0.0000050	0.000045	7.4E-06	6.3E-06	8.5E-06
Copper	0.0705	0.0119	0.137	0.0607	0.0362	0.0852
Iron	0.0092	<0.0050	0.0198	0.016	<0.010	0.021
Selenium	0.00235	0.00175	0.00334	0.00256	0.00250	0.00261

6.3.6 MW12-DP1

Drivepoint well MW12-DP1 was dry or frozen during the 2017 Q1 and Q2 sampling events. The well was destroyed during Q3 when the permafrost into which the well had been installed, degraded; compromising the ground integrity and the well. As such, water quality results are not presented.

6.3.7 MW12-DP2

Drivepoint well MW12-DP2 was dry or frozen during the 2017 sampling events, thus water quality results are not presented.

6.3.8 MW12-DP3

Drivepoint well MW12-DP3 was dry or frozen during the 2017 sampling events, thus water quality results are not presented.

6.3.9 MW12-05

Groundwater well MW12-05 water quality results from 2017 are summarized in Table 6-5 through Table 6-11, and compared to historical data. Zones 02, 04, and 06 were not sampled prior to 2016, thus instead of presenting historical data, 2016 is presented next to 2017 for those zones. All zones (01 through 07) were sampled during 2017.

Table 6-5: MW12-05-01 Water Quality Results Summary (2012 - 2017)

MW12-05-01	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.02	7.69	8.31	7.99	7.88	8.15
TDS (mg/L)	1339	706	1700	1775.0	1740	1820
Sulfate-dissolved (mg/L)	797	350	1090	1165.0	1120	1200
Nutrients (mg/L)						
Ammonia Nitrogen	0.1230	<0.0050	0.602	0.0298	0.0110	0.0447
Nitrate Nitrogen	0.041	<0.010	0.368	0.044	<0.025	<0.050
Nitrite Nitrogen	0.0910	0.0277	0.427	0.0435	0.0309	0.068
Dissolved Metals (mg/L)						
Silver	0.000018	<0.000010	<0.000020	0.000015	<0.000010	<0.000020
Aluminum	0.0072	0.0031	0.0182	0.0040	0.0032	0.0054
Arsenic	0.00098	0.00059	0.00216	0.00068	0.00060	0.00079
Cadmium	0.0000177	<0.0000050	0.00014	0.0000104	<0.0000050	0.0000165
Chromium	0.00083	0.00037	<0.0010	0.00032	0.00023	0.00045
Copper	0.00097	<0.00020	0.00836	0.00030	<0.00020	<0.00040
Lead	0.000162	<0.000050	<0.00020	0.000075	<0.000050	<0.00010
Molybdenum	0.001373	0.000227	0.012	0.000196	0.000125	0.00031
Nickel	0.00107	<0.00050	0.0043	0.00075	<0.00050	<0.0010
Selenium	0.000328	0.000083	0.00144	0.000790	0.000275	0.00225
Zinc	0.0056	<0.0010	0.0402	0.0023	<0.0020	<0.0030

Table 6-6: MW12-05-02 Water Quality Results Summary 2016 & 2017

MW12-05-02	**2016 Summary Statistics**			**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.18	7.9	8.43	8.14	8.06	8.22
TDS (mg/L)	1147	389	1750	1770	1700	1870
Sulfate-dissolved (mg/L)	622.8	41.2	1090	1120.0	1070	1160
Nutrients (mg/L)						
Ammonia Nitrogen	0.1512	0.0095	0.642	0.0249	0.0121	0.0367
Nitrate Nitrogen	0.0135	0.0025	0.025	0.044	<0.025	<0.050
Nitrite Nitrogen	0.1352	0.02	0.377	0.0323	0.0162	0.0531
Dissolved Metals (mg/L)						
Silver	0.000012	<0.000010	<0.000020	0.000015	<0.000010	<0.000020
Aluminum	0.0049	0.0036	0.0061	0.0045	0.0043	0.0048
Arsenic	0.00041	0.00023	0.00063	0.00027	<0.00020	0.00030
Cadmium	0.0000060	<0.0000050	<0.000010	0.0000075	<0.0000050	<0.000010
Chromium	0.00047	0.00025	0.00093	0.00031	0.00029	0.00033
Copper	0.00024	<0.00020	<0.00040	0.00035	<0.00020	0.00060
Lead	0.000060	<0.000050	<0.00010	0.000075	<0.000050	<0.00010
Molybdenum	0.000838	0.00041	0.00112	0.000245	0.000147	0.00039
Nickel	0.00060	<0.00050	<0.0010	0.00075	<0.00050	<0.0010
Selenium	0.000197	<0.000050	0.000610	0.000815	<0.00010	0.00275
Zinc	0.0111	0.0011	0.0261	0.0025	<0.0010	<0.0045

Table 6-7: MW12-05-03 Water Quality Results Summary (2012 - 2017)

MW12-05-03	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.06	7.72	8.22	8.08	7.92	8.31
TDS (mg/L)	1322	880	1570	1372	1270	1440
Sulfate-dissolved (mg/L)	726	456	828	815	749	883
Nutrients (mg/L)						
Ammonia Nitrogen	0.0426	<0.0050	0.11	0.0213	0.0122	0.0296
Nitrate Nitrogen	0.027	<0.010	0.068	0.044	<0.025	<0.050
Nitrite Nitrogen	0.0852	0.0252	0.372	0.0331	0.0193	0.049
Dissolved Metals (mg/L)						
Silver	0.000016	0.000005	<0.000020	0.000015	<0.000010	0.000021
Aluminum	0.0072	0.0011	0.0233	0.0030	0.0025	0.0034
Arsenic	0.000335	0.00017	0.00077	0.00024	0.00021	0.00029
Cadmium	0.0000322	<0.0000050	0.000324	0.0000072	<0.0000050	0.000014
Chromium	0.00068	<0.00010	<0.0010	0.00015	<0.00010	<0.00020
Copper	0.00052	<0.00020	0.00266	0.00164	<0.00020	0.00579
Lead	0.000183	<0.000050	0.000665	0.000062	<0.000050	<0.00010
Molybdenum	0.002213	0.000430	0.0121	0.000556	0.000229	0.000832
Nickel	0.00108	<0.00050	0.00328	0.00062	<0.00050	<0.0010
Selenium	0.000121	0.000057	0.000364	0.000209	<0.000050	0.000562
Zinc	0.0075	<0.0010	0.0312	0.0024	0.0015	<0.0040

Table 6-8: MW12-05-04 Water Quality Results Summary (2016 & 2017)

MW12-05-04	**2016 Summary Statistics**			**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.06	7.87	8.21	8.24	8.14	8.32
TDS (mg/L)	286	280	290	280.6	262	296
Sulfate-dissolved (mg/L)	39.6	32.5	47.3	28.4	25.2	34.6
Nutrients (mg/L)						
Ammonia Nitrogen	0.0349	0.0025	0.144	0.0231	0.0107	0.0352
Nitrate Nitrogen	0.0301	0.0025	0.0569	0.0050	<0.0050	<0.0050
Nitrite Nitrogen	0.1218	0.0309	0.32	0.0320	0.0124	0.0677
Dissolved Metals (mg/L)						
Silver	0.000010	<0.000010	<0.000010	0.000010	<0.000010	<0.000010
Aluminum	0.0027	0.0021	0.0033	0.0041	0.0034	0.0049
Arsenic	0.00014	<0.00010	0.00024	0.00013	<0.00010	0.00017
Cadmium	0.0000052	<0.0000050	0.0000063	0.0000050	<0.0000050	<0.0000050
Chromium	0.00011	<0.00010	0.00014	0.00018	<0.00010	0.00023
Copper	0.00025	<0.00020	0.00048	0.00021	<0.00020	0.00026
Lead	0.000050	<0.000050	<0.000050	0.000050	<0.000050	<0.000050
Molybdenum	0.00463	0.00411	0.00508	0.00273	0.00142	0.00406
Nickel	0.00050	<0.00050	<0.00050	0.00050	<0.00050	<0.00050
Selenium	0.000080	<0.000050	0.000127	0.000665	0.000056	0.00171
Zinc	0.0068	0.0011	0.0141	0.0019	<0.0010	<0.0035

Table 6-9: MW12-05-05 Water Quality Results Summary (2012 - 2017)

MW12-05-05	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.12	7.82	8.35	8.11	8.05	8.15
TDS (mg/L)	285.1	252	338	279.6	264	287
Sulfate-dissolved (mg/L)	45.2	33.3	62.4	46.8	43.5	49.0
Nutrients (mg/L)						
Ammonia Nitrogen	0.0193	<0.0050	0.054	0.0181	0.0082	0.0479
Nitrate Nitrogen	0.377	0.196	0.817	0.276	0.194	0.334
Nitrite Nitrogen	0.1310	0.03	0.398	0.0438	0.0355	0.0606
Dissolved Metals (mg/L)						
Silver	0.0000154	<0.0000050	<0.000020	0.000011	<0.000010	0.000017
Aluminum	0.00482	0.0023	0.0106	0.0027	0.0024	0.0034
Arsenic	0.000263	0.00012	0.00122	0.00023	<0.00010	0.00061
Cadmium	0.0000109	<0.0000050	0.00003	0.0000062	<0.0000050	0.0000081
Chromium	0.00061	<0.00010	<0.0010	0.00010	<0.00010	<0.00010
Copper	0.00099	0.00034	0.00360	0.00121	0.00082	0.00178
Lead	0.000136	<0.000050	<0.00020	0.000050	<0.000050	<0.000050
Molybdenum	0.00490	0.0035	0.0153	0.00375	0.00365	0.00393
Nickel	0.000955	0.00052	0.0019	0.00057	<0.00050	0.00065
Selenium	0.000115	0.000072	0.00017	0.000112	<0.000050	0.000173
Zinc	0.02175	0.0032	0.118	0.0183	0.0060	0.0457

Table 6-10: MW12-05-06 Water Quality Results Summary 2016 & 2017

MW12-05-06	2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.08	7.98	8.2	8.11	7.99	8.18
TDS (mg/L)	277	268	302	278.5	265	293
Sulfate-dissolved (mg/L)	43.1	41.9	45	47.0	44.4	49.5
Nutrients (mg/L)						
Ammonia Nitrogen	0.0025	0.0025	0.0025	0.0083	<0.0050	0.0181
Nitrate Nitrogen	0.341	0.271	0.433	0.357	0.229	0.463
Nitrite Nitrogen	0.0388	0.023	0.0663	0.0353	0.0297	0.0470
Dissolved Metals (mg/L)						
Silver	0.000010	<0.000010	<0.000010	0.000010	<0.000010	<0.000010
Aluminum	0.0023	0.0022	0.0024	0.0028	0.0021	0.0042
Arsenic	0.00013	0.00012	0.00013	0.00022	0.00011	0.00047
Cadmium	0.0000133	0.0000076	0.0000179	0.0000120	<0.0000050	0.0000158
Chromium	0.00010	<0.00010	<0.00010	0.00011	<0.00010	0.00015
Copper	0.00102	0.00087	0.00121	0.00154	0.00130	0.00197
Lead	0.000050	<0.000050	<0.000050	0.000050	<0.000050	<0.000050
Molybdenum	0.00350	0.00331	0.00373	0.00367	0.00347	0.00379
Nickel	0.00064	0.00055	0.00073	0.00062	0.00054	0.00067
Selenium	0.000136	0.000100	0.000176	0.000143	0.000070	0.000190
Zinc	0.0528	0.0073	0.115	0.0315	0.0118	0.0613

Table 6-11: MW12-05-07 Water Quality Results Summary (2012 - 2017)

MW12-05-07	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.20	7.76	8.45	8.15	7.98	8.26
TDS (mg/L)	294	252	362	286.2	270	306
Sulfate-dissolved (mg/L)	29.1	11.4	45.2	33.0	28.5	38.7
Nutrients (mg/L)						
Ammonia Nitrogen	0.1049	<0.0050	0.465	0.0196	0.0146	0.0248
Nitrate Nitrogen	0.0383	<0.0050	<0.20	0.0060	<0.0050	0.0090
Nitrite Nitrogen	0.2566	<0.0010	2.91	0.0105	0.0057	0.0177
Dissolved Metals (mg/L)						
Silver	0.0000150	<0.0000050	<0.000020	0.000010	<0.000010	<0.000010
Aluminum	0.00514	0.0022	0.0127	0.0028	0.0018	0.0038
Arsenic	0.000390	0.00022	0.000917	0.00032	0.00023	0.00044
Cadmium	0.0000083	<0.0000050	0.000019	0.0000050	<0.0000050	<0.0000050
Chromium	0.00062	<0.00010	<0.0010	0.00020	<0.00010	0.00036
Copper	0.000348	<0.00020	0.00158	0.00021	<0.00020	0.00025
Lead	0.000156	0.000039	0.00055	0.000050	<0.000050	<0.000050
Molybdenum	0.00247	0.00124	0.0038	0.00200	0.00109	0.00246
Nickel	0.00083	<0.00050	0.0015	0.00052	<0.00050	0.00057
Selenium	0.000255	<0.000050	0.000750	0.000652	0.000129	0.00168
Zinc	0.00450	<0.0010	0.0136	0.0016	<0.0010	0.0025

6.3.10 MW12-06

Groundwater well MW12-06 water quality results from 2017 are summarized in Table 6-12 through Table 6-17, and compared to historical data. Zones 02, 04, and 06 were sampled and analyzed during 2017 under the Groundwater Monitoring Plan, while Zones 01, 03, and 05 were also sampled in response to the Adaptive Management Plan.

Table 6-12: MW12-06-01 Water Quality Results Summary (2016 & 2017)

MW12-06-01	2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.94	7.93	7.95	7.97	7.60	8.33
TDS (mg/L)	409.5	401	418	423	387	499
Sulfate-dissolved (mg/L)	3.3	2.3	4.3	3.16	1.14	<5.0
Nutrients (mg/L)						
Ammonia Nitrogen	0.5046	0.0542	0.955	0.1824	0.0067	0.612
Nitrate Nitrogen	0.536	0.252	0.820	0.0827	0.0139	0.251
Nitrite Nitrogen	2.131	0.952	3.31	0.2955	0.0379	0.936
Dissolved Metals (mg/L)						
Silver	0.000010	<0.000010	<0.000010	0.000010	<0.000010	<0.000010
Aluminum	0.0158	0.0148	0.0169	0.0164	0.0150	0.0182
Arsenic	0.00700	0.00640	0.00759	0.00663	0.00571	0.00828
Cadmium	0.0000067	<0.0000050	0.0000085	0.0000079	<0.0000050	0.0000112
Chromium	0.00326	0.00318	0.00333	0.00347	0.00312	0.00402
Copper	0.00036	0.00034	0.00038	0.00146	0.00057	0.00337
Lead	0.000053	<0.000050	0.000056	0.000063	<0.000050	0.000085
Molybdenum	0.001293	0.000867	0.00172	0.001007	0.000954	0.00104
Nickel	0.00055	<0.00050	0.00060	0.00056	<0.00050	0.00073
Selenium	0.001108	0.000327	0.00189	0.001273	0.000170	0.00374
Zinc	0.0036	0.0027	0.0044	0.0042	0.0025	0.0066

Table 6-13: MW12-06-02 Water Quality Results Summary (2012 - 2017)

MW12-06-02	**2012 - 2016 Summary Statistics**			**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.02	7.65	8.2	7.99	7.66	8.20
TDS (mg/L)	647.8	612	693	644.2	637	649
Sulfate-dissolved (mg/L)	205.1	177	227	215.5	211	224
Nutrients (mg/L)						
Ammonia Nitrogen	0.0380	0.0074	0.075	0.0434	0.0261	0.0528
Nitrate Nitrogen	0.218	0.025	1.83	0.0727	0.035	0.106
Nitrite Nitrogen	0.8325	0.0882	7.21	0.266	0.126	0.413
Dissolved Metals (mg/L)						
Silver	0.000016	0.000008	<0.000020	0.000010	<0.000010	0.000011
Aluminum	0.00383	<0.0010	0.0102	0.0018	0.0011	0.0037
Arsenic	0.00456	0.00227	0.00664	0.00381	0.00362	0.00403
Cadmium	0.0000139	<0.0000050	0.000047	0.0000055	<0.0000050	0.0000076
Chromium	0.00061	<0.00010	<0.0010	0.00011	<0.00010	0.00017
Copper	0.000348	<0.00020	0.00115	0.00424	<0.00020	0.0202
Lead	0.000136	0.000029	<0.00020	0.000050	<0.000050	<0.000050
Molybdenum	0.00807	0.0051	0.0164	0.00746	0.00695	0.00791
Nickel	0.000854	<0.00050	0.00121	0.00087	<0.00050	0.00235
Selenium	0.000168	<0.000050	0.000740	0.000304	<0.000050	0.000721
Zinc	0.00607	0.0028	0.0111	0.0037	0.0016	0.0058

Table 6-14: MW12-06-03 Water Quality Results Summary (2016 & 2017)

MW12-06-03	2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.02	7.77	8.20	8.01	7.74	8.25
TDS (mg/L)	642.7	615	661	640.0	619	671
Sulfate-dissolved (mg/L)	201.0	175	214	208.5	202	221
Nutrients (mg/L)						
Ammonia Nitrogen	0.0250	0.0076	0.0367	0.0438	0.0150	0.0673
Nitrate Nitrogen	0.234	0.198	0.269	0.0444	0.028	0.077
Nitrite Nitrogen	0.953	0.769	1.07	0.173	0.115	0.314
Dissolved Metals (mg/L)						
Silver	0.000010	<0.000010	<0.000010	0.000010	<0.000010	<0.000010
Aluminum	0.0014	<0.0010	0.0018	0.0018	0.0010	0.0028
Arsenic	0.00077	0.00060	0.00092	0.00057	0.00052	0.00062
Cadmium	0.0000050	<0.0000050	<0.0000050	0.0000099	<0.0000050	0.0000247
Chromium	0.00027	0.00011	0.00039	0.00021	<0.00010	0.00030
Copper	0.00020	<0.00020	<0.00020	0.00020	<0.00020	<0.00020
Lead	0.000050	<0.000050	<0.000050	0.000050	<0.000050	<0.000050
Molybdenum	0.00209	0.00189	0.00238	0.00281	0.00174	0.00400
Nickel	0.00050	<0.00050	<0.00050	0.00050	<0.00050	<0.00050
Selenium	0.000192	0.000052	0.000447	0.000143	<0.000050	0.000422
Zinc	0.0061	0.0035	0.0083	0.0062	0.0020	0.0096

Table 6-15: MW12-06-04 Water Quality Results Summary (2012 - 2017)

MW12-06-04	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.09	7.76	8.23	8.12	7.83	8.29
TDS (mg/L)	629	594	735	630.7	614	639
Sulfate-dissolved (mg/L)	169.5	159	182	183.0	180	190
Nutrients (mg/L)						
Ammonia Nitrogen	0.0159	<0.0050	0.028	0.0081	0.0064	0.0110
Nitrate Nitrogen	0.302	0.022	2.00	0.0852	0.0089	0.220
Nitrite Nitrogen	1.1819	0.0998	7.92	0.3584	0.0352	0.940
Dissolved Metals (mg/L)						
Silver	0.0000186	<0.0000050	<0.000020	0.000010	<0.000010	<0.000010
Aluminum	0.0046	0.0018	0.012	0.0018	0.0014	0.0024
Arsenic	0.00242	0.00163	0.00515	0.00243	0.00227	0.00267
Cadmium	0.0000128	<0.0000050	0.000039	0.0000053	<0.0000050	0.0000067
Chromium	0.00076	<0.00010	<0.0010	0.00011	<0.00010	0.00014
Copper	0.004326	0.000106	0.0722	0.00021	<0.00020	0.00030
Lead	0.000160	0.000031	<0.00020	0.000050	<0.000050	<0.000050
Molybdenum	0.00841	0.0074	0.0102	0.00841	0.00771	0.00906
Nickel	0.000895	<0.00050	0.0011	0.00050	<0.00050	<0.00050
Selenium	0.000233	0.000083	0.00101	0.000187	<0.000050	0.000569
Zinc	0.01355	<0.0050	0.0686	0.0223	0.0065	0.0667

Table 6-16: MW12-06-05 Water Quality Results Summary (2016 & 2017)

MW12-06-05	2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.98	7.73	8.14	8.03	7.81	8.21
TDS (mg/L)	637.0	624	646	625.3	610	640
Sulfate-dissolved (mg/L)	180.7	176	185	183.0	177	190
Nutrients (mg/L)						
Ammonia Nitrogen	0.0057	<0.0050	0.0070	0.0066	<0.0050	0.0131
Nitrate Nitrogen	0.111	0.038	0.255	0.0252	0.0155	0.034
Nitrite Nitrogen	0.426	0.125	1.00	0.0764	0.0252	0.117
Dissolved Metals (mg/L)						
Silver	0.000010	<0.000010	<0.000010	0.000010	<0.000010	<0.000010
Aluminum	0.0018	<0.0010	0.0029	0.0017	<0.0010	0.0026
Arsenic	0.00094	0.00085	0.00110	0.00072	0.00058	0.00077
Cadmium	0.0000057	<0.0000050	0.0000070	0.0000077	<0.0000050	0.0000112
Chromium	0.00010	<0.00010	<0.00010	0.00010	<0.00010	<0.00010
Copper	0.00027	<0.00020	0.00041	0.00023	<0.00020	0.00033
Lead	0.000050	<0.000050	<0.000050	0.000050	<0.000050	<0.000050
Molybdenum	0.00859	0.00833	0.00880	0.00931	0.00850	0.00993
Nickel	0.00061	0.00057	0.00067	0.00062	<0.00050	0.00083
Selenium	0.000094	<0.000050	0.000183	0.000070	<0.000050	0.000168
Zinc	0.0396	0.0145	0.0637	0.0146	0.0094	0.0236

Table 6-17: MW12-06-06 Water Quality Results Summary (2012 - 2017)

MW12-06-06	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.12	7.75	8.26	8.06	7.84	8.30
TDS (mg/L)	512.1	472	538	523.8	519	529
Sulfate-dissolved (mg/L)	152.6	143	171	154.4	153	155
Nutrients (mg/L)						
Ammonia Nitrogen	0.0187	<0.0050	0.085	0.0050	<0.0050	0.0050
Nitrate Nitrogen	1.012	0.45	1.31	1.08	1.05	1.10
Nitrite Nitrogen	0.1175	0.0521	0.499	0.0980	0.0455	0.221
Dissolved Metals (mg/L)						
Silver	0.0000154	<0.0000050	<0.000020	0.000010	<0.000010	<0.000010
Aluminum	0.00434	<0.0010	0.0142	0.0015	<0.0010	0.0027
Arsenic	0.00012	0.00009	0.00019	0.00011	<0.00010	0.00016
Cadmium	0.0000197	<0.0000050	0.000124	0.0000125	<0.0000050	0.0000423
Chromium	0.00061	<0.00010	<0.0010	0.00012	<0.00010	0.00022
Copper	0.000379	<0.00020	0.00155	0.00039	<0.00020	0.00060
Lead	0.000136	<0.000050	<0.00020	0.000050	<0.000050	<0.000050
Molybdenum	0.00569	0.0048	0.0066	0.00563	0.00514	0.00607
Nickel	0.000787	<0.00050	<0.0010	0.00050	<0.00050	<0.00050
Selenium	0.000264	0.00015	0.000511	0.000333	0.000280	0.000487
Zinc	0.02214	0.00312	0.0827	0.0230	0.0116	0.0488

6.3.11 MW12-07

Groundwater well MW12-07 water quality results from 2017 are summarized in Table 6-18 and Table 6-19, and compared to historical data. Both zones (01 and 02) were sampled and analyzed during 2017.

Table 6-18: MW12-07-01 Water Quality Results Summary (2012 - 2017)

MW12-07-01	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.98	7.38	8.38	7.97	7.59	8.23
TDS (mg/L)	976.05	763	1400	727	599	921
Sulfate-dissolved (mg/L)	316.18	105	640	78.2	12.4	311
Nutrients (mg/L)						
Ammonia Nitrogen	0.46	<0.0050	1.6	0.359	0.218	0.604
Nitrate Nitrogen	7.11	0.088	53.5	0.161	0.044	0.623
Nitrite Nitrogen	1.46	<0.050	4.96	0.3718	0.0891	1.47
Dissolved Metals (mg/L)						
Calcium	200.26	154	266	171.2	155	188
Cadmium	0.000072	<0.0000050	0.000633	0.0000150	<0.0000050	0.0000876
Copper	0.0073	<0.00020	0.077	0.00034	<0.00020	0.00139
Iron	0.252	0.022	0.705	0.032	<0.010	0.060
Selenium	0.00512	<0.00010	0.0347	0.002039	0.000271	0.00850

Table 6-19: MW12-07-02 Water Quality Results Summary (2012 - 2017)

MW12-07-02	2012 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.96	7.68	8.11	7.92	7.79	8.05
TDS (mg/L)	1080	748	1160	1138	1080	1180
Sulfate-dissolved (mg/L)	642	283	733	733.5	687	756
Nutrients (mg/L)						
Ammonia Nitrogen	0.1339	<0.0050	0.61	0.0363	0.0220	0.0594
Nitrate Nitrogen	0.724	0.075	21.3	0.103	0.060	0.212
Nitrite Nitrogen	0.491	0.148	1.47	0.293	0.140	1.00
Dissolved Metals (mg/L)						
Calcium	203.3	140	232	217.8	207	228
Cadmium	0.0000161	<0.0000050	0.000269	0.0000182	<0.0000050	0.0000865
Copper	0.00110	<0.00020	0.0217	0.00053	<0.00020	0.00123
Iron	0.2587	0.0069	1.3	0.124	<0.010	0.151
Selenium	0.000549	0.000055	0.0148	0.000219	0.000073	0.00072

6.3.12 MW17-08

This well was installed in July 2017 to monitor groundwater up-gradient of the Southwest Waste Dump and other mine activities. Four zones were sampled and analyzed in 2017 on two occasions, the results are summarized in Table 6-20 to 6-23 below. Well 17-08 was installed to monitor the background water quality as such, additional parameters are presented in the result summary tables. On November 20th, 2017, MW17-08-04 was sampled but the port had very little water, only dissolved metal analysis could be conducted.

Table 6-20: MW17-08-01 Water Quality Results Summary (2017)

MW17-08-01	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.12	8.10	8.15
TDS (mg/L)	275.0	269	281
Sulfate-dissolved (mg/L)	42.4	41.7	43.1
Nutrients (mg/L)			
Ammonia Nitrogen	0.0062	<0.0050	0.0073
Nitrate Nitrogen	0.347	0.329	0.365
Nitrite Nitrogen	0.0074	0.0012	0.0136
Dissolved Metals (mg/L)			
Silver	0.000010	<0.000010	<0.000010
Aluminum	0.0022	0.0014	0.0029
Arsenic	0.00023	0.00020	0.00026
Cadmium	0.0000516	0.0000396	0.0000635
Chromium	0.00014	<0.00010	0.00019
Copper	0.00064	0.00061	0.00068
Lead	0.000050	<0.000050	<0.000050
Molybdenum	0.00716	0.00525	0.00908
Nickel	0.00068	<0.00050	0.00087
Selenium	0.000912	0.000665	0.00116
Zinc	0.0316	0.0297	0.0336

Table 6-21: MW17-08-02 Water Quality Results Summary (2017)

MW17-08-02	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.12	8.12	8.13
TDS (mg/L)	171.0	162	180
Sulfate-dissolved (mg/L)	11.6	11.4	11.7
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.681	0.678	0.684
Nitrite Nitrogen	0.0028	<0.0010	0.0045
Dissolved Metals (mg/L)			
Silver	0.000010	<0.000010	<0.000010
Aluminum	0.0032	0.0027	0.0038
Arsenic	0.00030	0.00028	0.00033
Cadmium	0.0000196	0.0000133	0.0000258
Chromium	0.00046	<0.00010	0.00082
Copper	0.00208	0.00175	0.00240
Lead	0.000050	<0.000050	<0.000050
Molybdenum	0.00354	0.00336	0.00372
Nickel	0.00060	<0.00050	0.00070
Selenium	0.001000	0.000729	0.00127
Zinc	0.0190	0.0155	0.0224

Table 6-22: MW17-08-03 Water Quality Results Summary (2017)

MW17-08-03	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.15	8.11	8.17
TDS (mg/L)	148.3	142	160
Sulfate-dissolved (mg/L)	5.4	5.3	5.7
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.822	0.806	0.851
Nitrite Nitrogen	0.0027	<0.0010	0.0042
Dissolved Metals (mg/L)			
Silver	0.000010	<0.000010	<0.000010
Aluminum	0.0043	0.0036	0.0048
Arsenic	0.00018	0.00015	0.00023
Cadmium	0.0000077	<0.0000050	0.0000131
Chromium	0.00010	<0.00010	<0.00010
Copper	0.00064	0.00061	0.00069
Lead	0.000050	<0.000050	<0.000050
Molybdenum	0.00115	0.00114	0.00116
Nickel	0.00050	<0.00050	<0.00050
Selenium	0.000509	0.000372	0.000682
Zinc	0.0117	0.0068	0.0209

Table 6-23: MW17-08-04 Water Quality Results Summary (2017)

MW17-08-03	**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**
pH	8.07		
TDS (mg/L)	71.2		
Sulfate-dissolved (mg/L)	<5.0		
Nutrients (mg/L)			
Ammonia Nitrogen	<0.0050		
Nitrate Nitrogen	0.618		
Nitrite Nitrogen	0.0051		
Dissolved Metals (mg/L)			
Silver	0.000010	<0.000010	<0.000010
Aluminum	0.0047	0.0038	0.0056
Arsenic	0.00020	0.00013	0.00028
Cadmium	0.0000480	<0.0000050	0.0000910
Chromium	0.00014	<0.00010	0.00017
Copper	0.00046	0.00038	0.00053
Lead	0.000050	<0.000050	<0.000050
Molybdenum	0.000607	0.000500	0.000714
Nickel	0.00075	<0.00050	0.00100
Selenium	0.000436	0.000213	0.000659
Zinc	0.0708	0.0045	0.137

6.3.13 MW17-09

This well was installed in July 2017 to monitor groundwater down-gradient of the Southwest Waste Dump. One zone was identified below an ice-rich layer, it was sampled and analyzed once in 2017, and was found frozen in November 2017 during the Q4 sampling event; the results are summarized in Table 6-24 below.

Table 6-24: MW17-09-01 Water Quality Results Summary (2017)

MW17-09-01	2017 Summary Statistics
Parameters	**Mean**
pH	8.15
TDS (mg/L)	621
Sulfate-dissolved (mg/L)	56.8
Nutrients (mg/L)	
Ammonia Nitrogen	0.120
Nitrate Nitrogen	1.11
Nitrite Nitrogen	0.0653
Dissolved Metals (mg/L)	
Calcium	198
Cadmium	<0.00025
Copper	0.00459
Iron	1.41
Selenium	0.0111

6.3.14 MW17-10

This well was installed in July 2017 to monitor groundwater down-gradient of the Main Waste Dump. Three zones were identified, sampled and analyzed in 2017 on two occasions, the results are summarized in Table 6-25 to 6-27 below.

Table 6-25: MW17-10-01 Water Quality Results Summary (2017)

MW17-10-01	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.10	8.10	8.10
TDS (mg/L)	212.0	191	233
Sulfate-dissolved (mg/L)	60.1	58.3	61.9
Nutrients (mg/L)			
Ammonia Nitrogen	0.0182	0.0088	0.0275
Nitrate Nitrogen	2.53	1.96	3.10
Nitrite Nitrogen	0.0656	0.0484	0.0827
Dissolved Metals (mg/L)			
Calcium	44.1	37.9	50.3
Cadmium	0.0000556	0.0000229	0.0000884
Copper	0.00376	0.00321	0.00430
Iron	0.010	<0.010	<0.010
Selenium	0.001891	0.000882	0.00290

Table 6-26: MW17-10-02 Water Quality Results Summary (2017)

MW17-10-02	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.08	8.07	8.09
TDS (mg/L)	248.3	234	256
Sulfate-dissolved (mg/L)	25.2	24.8	25.9
Nutrients (mg/L)			
Ammonia Nitrogen	0.0052	<0.0050	0.0055
Nitrate Nitrogen	17.0	15.6	17.7
Nitrite Nitrogen	0.0028	0.0016	0.0045
Dissolved Metals (mg/L)			
Calcium	52.9	46.2	56.7
Cadmium	0.0000290	0.0000136	0.0000369
Copper	0.00372	0.00343	0.00419
Iron	0.010	<0.010	<0.010
Selenium	0.00137	0.00118	0.00153

Table 6-27: MW17-10-03 Water Quality Results Summary (2017)

MW17-10-03	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.10	8.09	8.10
TDS (mg/L)	247.3	240	262
Sulfate-dissolved (mg/L)	23.3	23.2	23.3
Nutrients (mg/L)			
Ammonia Nitrogen	0.0104	<0.0050	0.0172
Nitrate Nitrogen	18.2	17.4	19.9
Nitrite Nitrogen	0.0050	0.0036	0.0062
Dissolved Metals (mg/L)			
Calcium	51.3	48.9	55.9
Cadmium	0.0000257	0.0000092	0.0000561
Copper	0.00341	0.00295	0.00371
Iron	0.010	<0.010	<0.010
Selenium	0.00128	0.00119	0.00145

6.3.15 MW17-11

This well was installed in July 2017 to monitor groundwater down-gradient of the Minto North Pit. Five zones were identified, sampled and analyzed in 2017 on two occasions, the results are summarized in Table 6-28 to 6-32 below. Zone 5, was only sampled in November 2017.

Table 6-28: MW17-11-01 Water Quality Results Summary (2017)

MW17-11-01	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.18	8.08	8.27
TDS (mg/L)	177.0	171	183
Sulfate-dissolved (mg/L)	38.8	38.7	39.0
Nutrients (mg/L)			
Ammonia Nitrogen	0.0058	<0.0050	0.0067
Nitrate Nitrogen	0.2032	0.0674	0.339
Nitrite Nitrogen	0.0311	0.0187	0.0435
Dissolved Metals (mg/L)			
Calcium	34.0	32.1	36.0
Cadmium	0.0000576	0.0000538	0.0000614
Copper	0.00074	0.00052	0.00095
Iron	0.018	<0.010	0.026
Selenium	0.000366	0.000137	0.000596

Table 6-29: MW17-11-02 Water Quality Results Summary (2017)

MW17-11-02	**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**
pH	8.21	8.10	8.27
TDS (mg/L)	188.7	178	196
Sulfate-dissolved (mg/L)	29.8	28.7	31.3
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.0308	<0.0050	0.0748
Nitrite Nitrogen	0.0031	0.0020	0.0053
Dissolved Metals (mg/L)			
Calcium	37.7	32.5	43.4
Cadmium	0.0000203	0.0000073	0.0000348
Copper	0.00043	<0.00020	0.00061
Iron	0.061	0.028	0.085
Selenium	0.001065	0.000202	0.00261

Table 6-30: MW17-11-03 Water Quality Results Summary (2017)

MW17-11-03	**2017 Summary Statistics**		
Parameters	**Mean**	**Min**	**Max**
pH	8.25	8.18	8.32
TDS (mg/L)	188.5	183	194
Sulfate-dissolved (mg/L)	22.5	21.1	23.8
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.333	0.331	0.335
Nitrite Nitrogen	0.0712	0.0395	0.103
Dissolved Metals (mg/L)			
Calcium	41.8	39.5	44.1
Cadmium	0.0000058	<0.0000050	0.0000065
Copper	0.00035	0.00033	0.00036
Iron	0.010	<0.010	<0.010
Selenium	0.000330	0.000075	0.000586

Table 6-31: MW17-11-04 Water Quality Results Summary (2017)

MW17-11-04	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.03	7.84	8.27
TDS (mg/L)	347.0	313	367
Sulfate-dissolved (mg/L)	7.5	6.3	8.1
Nutrients (mg/L)			
Ammonia Nitrogen	0.0175	0.0145	0.0202
Nitrate Nitrogen	9.18	9.10	9.23
Nitrite Nitrogen	0.0264	0.0181	0.0316
Dissolved Metals (mg/L)			
Calcium	107.1	95.3	113
Cadmium	0.0000417	0.0000375	0.0000491
Copper	0.00891	0.00674	0.0100
Iron	0.010	<0.010	<0.010
Selenium	0.000303	0.000182	0.000502

Table 6-32: MW17-11-05 Water Quality Results Summary (2017)

MW17-11-05	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.28		
TDS (mg/L)	305		
Sulfate-dissolved (mg/L)	4.7		
Nutrients (mg/L)			
Ammonia Nitrogen	<0.0050		
Nitrate Nitrogen	9.23		
Nitrite Nitrogen	0.0045		
Dissolved Metals (mg/L)			
Calcium	96.2		
Cadmium	0.0000083		
Copper	0.00229		
Iron	<0.010		
Selenium	0.000349		

6.3.16 MW17-12

This well was installed in July 2017 to monitor groundwater down-gradient of the Dry Stack Tailing Storage Facility (DSTSF) and all other mine activities. Eight zones were identified, sampled and analyzed in 2017 on two occasions, the results are summarized in Table 6-33 to 6-40 below.

Table 6-33: MW17-12-01 Water Quality Results Summary (2017)

MW17-12-01	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	7.80	7.68	7.93
TDS (mg/L)	2165.0	2160	2170
Sulfate-dissolved (mg/L)	1390.0	1370	1410
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.075	<0.050	<0.10
Nitrite Nitrogen	0.017	0.014	<0.020
Dissolved Metals (mg/L)			
Calcium	334.0	326	342
Cadmium	0.0000107	0.0000087	0.0000127
Copper	0.00020	<0.00020	<0.00020
Iron	3.00	2.93	3.08
Selenium	0.000072	0.000060	0.000083

Table 6-34: MW17-12-02 Water Quality Results Summary (2017)

MW17-12-02	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	7.89	7.80	7.98
TDS (mg/L)	1810.0	1780	1840
Sulfate-dissolved (mg/L)	1125.0	1110	1140
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.075	<0.050	<0.10
Nitrite Nitrogen	0.015	<0.010	<0.020
Dissolved Metals (mg/L)			
Calcium	267.5	266	269
Cadmium	0.0000080	0.0000060	<0.000010
Copper	0.00030	<0.00020	<0.00040
Iron	2.32	2.29	2.35
Selenium	0.000075	<0.000050	<0.00010

Table 6-35: MW17-12-03 Water Quality Results Summary (2017)

MW17-12-03	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.04	7.87	8.21
TDS (mg/L)	551.0	541	561
Sulfate-dissolved (mg/L)	137.5	133	142
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.1481	0.0221	0.274
Nitrite Nitrogen	0.0070	<0.0050	0.0091
Dissolved Metals (mg/L)			
Calcium	82.4	80.1	84.8
Cadmium	0.0000065	<0.0000050	0.0000080
Copper	0.00020	<0.00020	<0.00020
Iron	0.370	0.270	0.470
Selenium	0.000050	<0.000050	<0.000050

Table 6-36: MW17-12-04 Water Quality Results Summary (2017)

MW17-12-04	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.08	7.97	8.19
TDS (mg/L)	474.5	469	480
Sulfate-dissolved (mg/L)	120.5	115	126
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.252	0.242	0.261
Nitrite Nitrogen	0.0043	0.0036	<0.0050
Dissolved Metals (mg/L)			
Calcium	68.7	67.5	69.9
Cadmium	0.0000151	0.0000113	0.0000189
Copper	0.00360	0.00347	0.00374
Iron	0.010	<0.010	<0.010
Selenium	0.000622	0.000569	0.000674

Table 6-37: MW17-12-05 Water Quality Results Summary (2017)

MW17-12-05	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.11	8.01	8.21
TDS (mg/L)	480.0	474	486
Sulfate-dissolved (mg/L)	111.0	102	120
Nutrients (mg/L)			
Ammonia Nitrogen	0.0055	<0.0050	0.0060
Nitrate Nitrogen	0.308	0.279	0.336
Nitrite Nitrogen	0.0108	<0.0050	0.0165
Dissolved Metal (mg/L)			
Calcium	70.4	69.2	71.7
Cadmium	0.0000250	0.0000151	0.0000348
Copper	0.00123	0.00086	0.00160
Iron	0.014	<0.010	0.018
Selenium	0.000575	0.000562	0.000588

Table 6-38: MW17-12-06 Water Quality Results Summary (2017)

MW17-12-06	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.18	8.10	8.27
TDS (mg/L)	442.0	422	462
Sulfate-dissolved (mg/L)	91.2	88.2	94.1
Nutrients (mg/L)			
Ammonia Nitrogen	0.0152	<0.0050	0.0253
Nitrate Nitrogen	0.0255	<0.0050	0.046
Nitrite Nitrogen	0.0032	0.0015	<0.0050
Dissolved Metals (mg/L)			
Calcium	65.2	62.9	67.6
Cadmium	0.0000312	0.0000223	<0.000040
Copper	0.00070	0.00062	0.00077
Iron	0.775	<0.010	1.54
Selenium	0.000538	0.000532	0.000544

Table 6-39: MW17-12-07 Water Quality Results Summary (2017)

MW17-12-07	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.12	8.02	8.23
TDS (mg/L)	318.5	304	333
Sulfate-dissolved (mg/L)	62.1	60.9	63.3
Nutrients (mg/L)			
Ammonia Nitrogen	0.0050	<0.0050	<0.0050
Nitrate Nitrogen	0.984	0.970	0.997
Nitrite Nitrogen	0.0016	<0.0010	0.0021
Dissolved Metals (mg/L)			
Calcium	48.8	47.7	50.0
Cadmium	0.0000059	<0.0000050	0.0000068
Copper	0.00164	0.00122	0.00207
Iron	0.010	<0.010	<0.010
Selenium	0.000338	0.000332	0.000345

Table 6-40: MW17-12-08 Water Quality Results Summary (2017)

MW17-12-08	2017 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	8.13	8.05	8.27
TDS (mg/L)	328.7	321	337
Sulfate-dissolved (mg/L)	62.0	60.8	62.7
Nutrients (mg/L)			
Ammonia Nitrogen	0.0054	<0.0050	0.0061
Nitrate Nitrogen	0.948	0.936	0.963
Nitrite Nitrogen	0.0040	<0.0010	0.0058
Dissolved Metals (mg/L)			
Calcium	49.3	48.2	50.5
Cadmium	0.0000085	0.0000075	0.0000103
Copper	0.00145	0.00141	0.00151
Iron	0.042	<0.010	0.060
Selenium	0.000343	0.000340	0.000347

6.4 Vibrating Wire Piezometers

There are currently 21 operating vibrating wire piezometers installed on site, listed in Table 6-41. SDP-2A became inoperative in October 2017, there were no other changes to the operational status of any piezometers in 2017. Summaries of data collected from each piezometer are provided in the following sections.

Table 6-41: Vibrating Wire Piezometer Summary

Vibrating Wire Piezometer	Location	Operational Status
DSP-1	DSTSF	Destroyed (2011)
DSP-2	DSTSF	Destroyed (2011)
DSP-3	DSTSF	Destroyed (2012)
DSP-4	DSTSF	Inoperative (2011)
DSP-5	DSTSF	Operational
DSP-6	DSTSF	Operational
DSP-7	DSTSF	Operational
DSP-8	DSTSF	Operational
DSP-9	DSTSF	Inoperative (2016)
DSP-10	DSTSF	Operational
SDP-2	Southwest Dump	2A - Inoperative (2017)
SDP-3	Southwest Dump	Operational
SDP-4	Southwest Dump	Operational
WDP-2	Water Storage Pond Dam	Operational
WDP-3A	Water Storage Pond Dam	Operational
WDP-3	Water Storage Pond Dam	Operational
WDP-4	Water Storage Pond Dam	Operational
WDP-5	Water Storage Pond Dam	Operational
WDP-6	Water Storage Pond Dam	Operational
WDP-7	Water Storage Pond Dam	Operational
WDP-8	Water Storage Pond Dam	Operational
WDP-9	Water Storage Pond Dam	Operational
WDP-10	Water Storage Pond Dam	Operational
WDP-11	Water Storage Pond Dam	Operational
WDP-12	Water Storage Pond Dam	Operational
WDP-13	Water Storage Pond Dam	Operational

6.4.1 DSTSF Piezometers

Data collected from DSTSF vibrating wire piezometers are presented in Figure 6-2 to 6-5. Sensor DSP-6A is reading negative pressures and has not been included in the figure.

Pore water pressures in DSP-5A and DSP-5B have been gradually increasing since installation in 2013. Analysis carried out by SRK Consulting in 2015 to consider the increasing pressures indicated high FOS values (FOS>2) even without consideration of the constructed MVFE2. DSP-7 and DSP-8 water pressures have been gradually increasing since installation in late 2015. Review of the data by SRK consulting in 2016 identified no stability concern. DSP-10 water pressures increased significantly upon installation, and the trend has gradually been increasing since March 2016. Review of DSP-10 data by SRK consulting in 2016 identified no stability concern.

DSP-05 and DSP-06 data are collected monthly, DSP-07 and DSP-08 data are collected bi-monthly, and DSP-10 data are collected weekly.

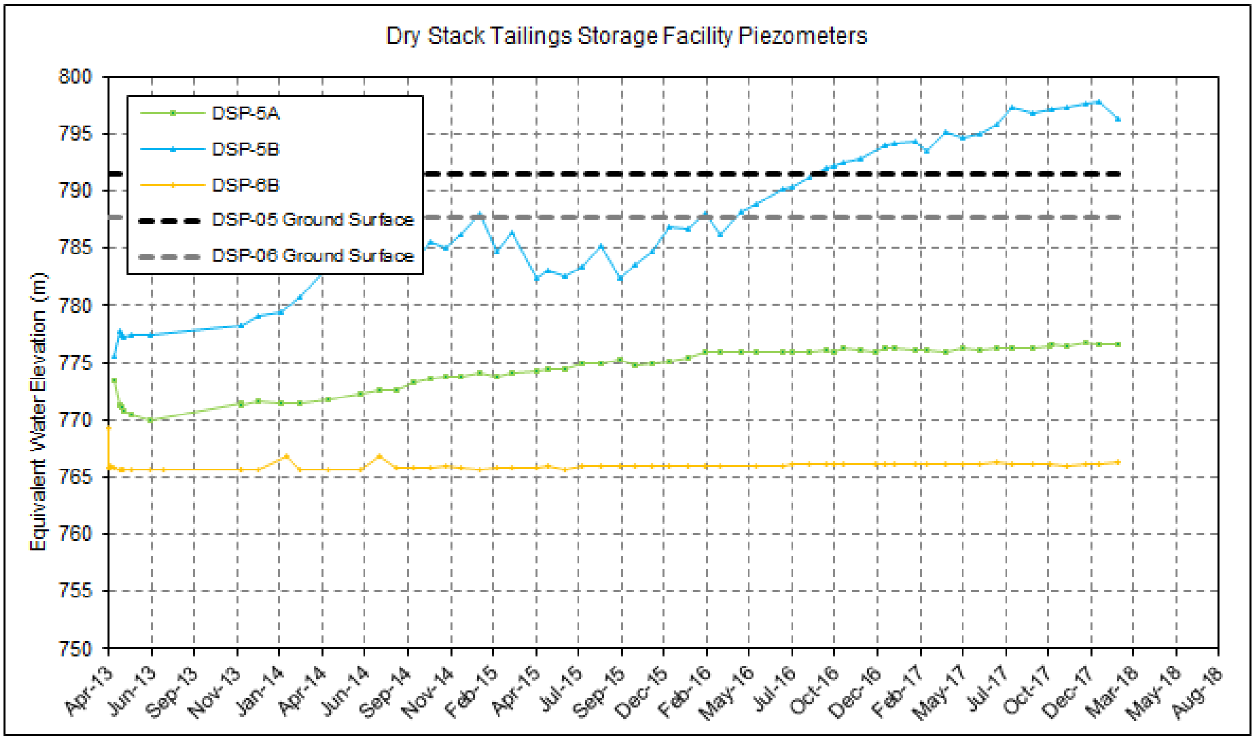


Figure 6-2: DSTSF Piezometer Data – DSP-05 and DSP-06 (2013-2017)

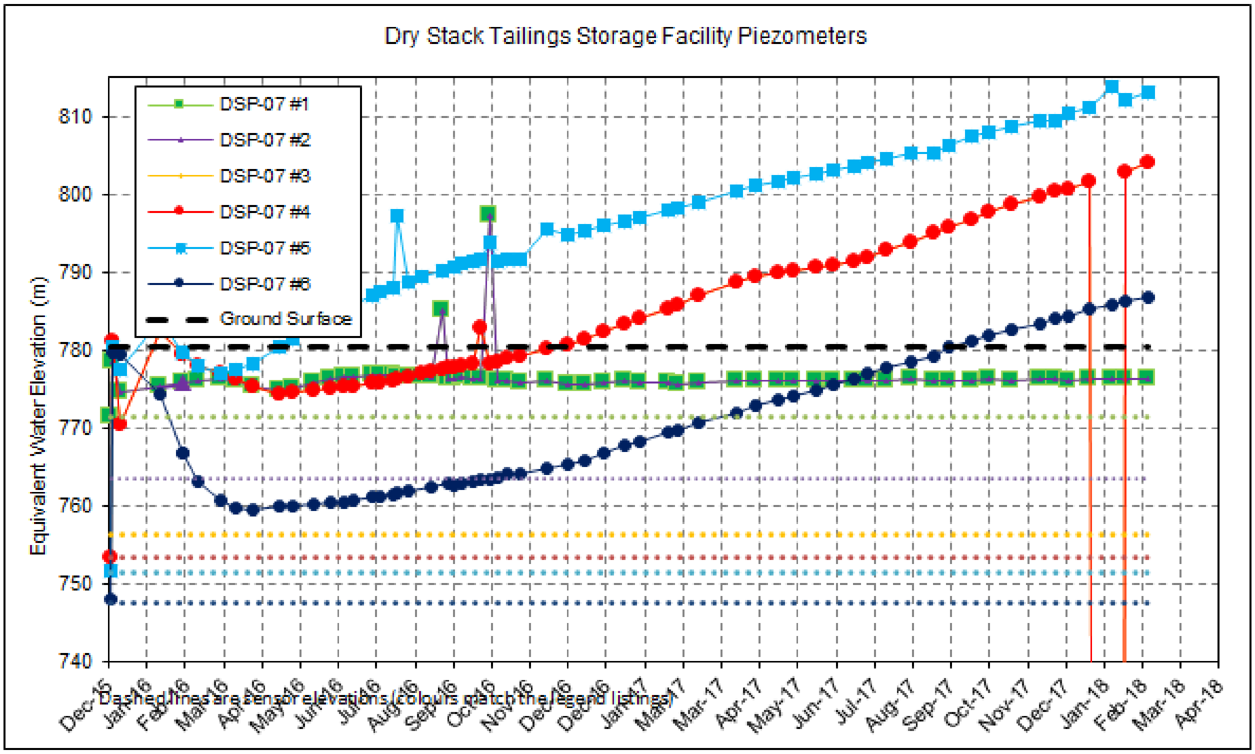


Figure 6-3: DSTSF Piezometer Data – DSP-07 (2015-2017)

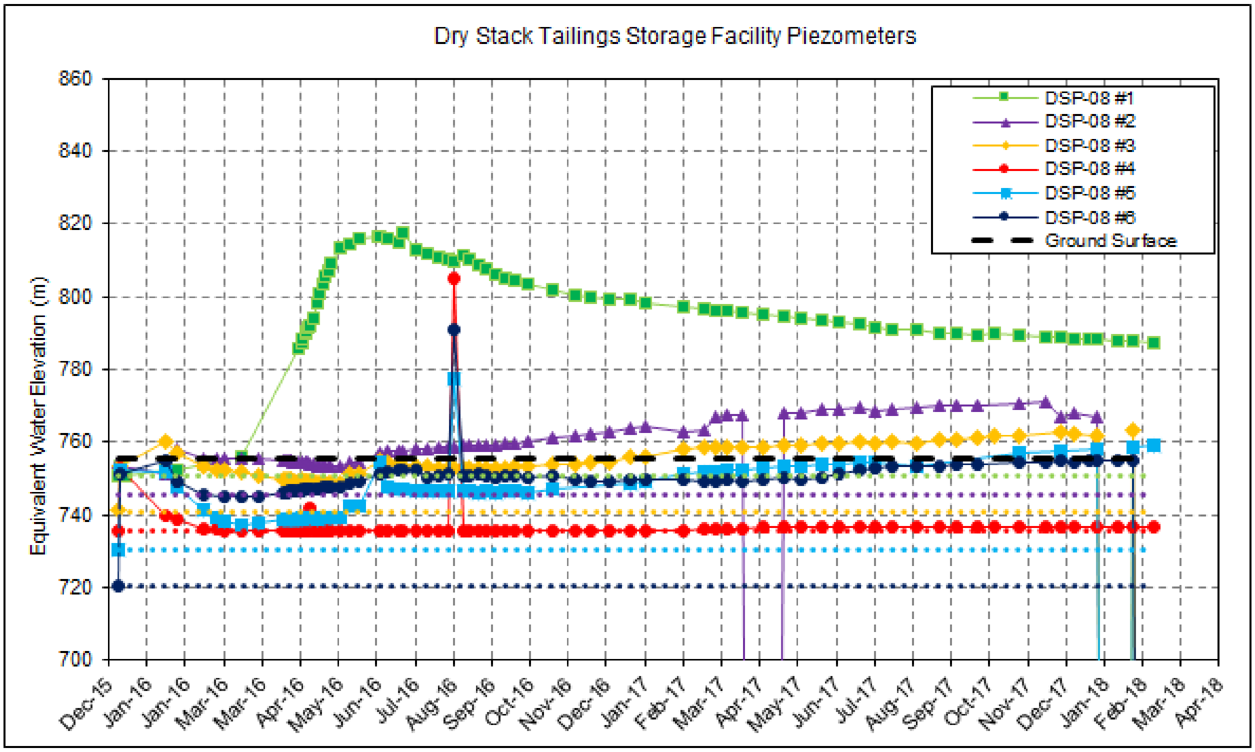


Figure 6-4: DSTSF Piezometer Data – DSP-08 (2015-2017)

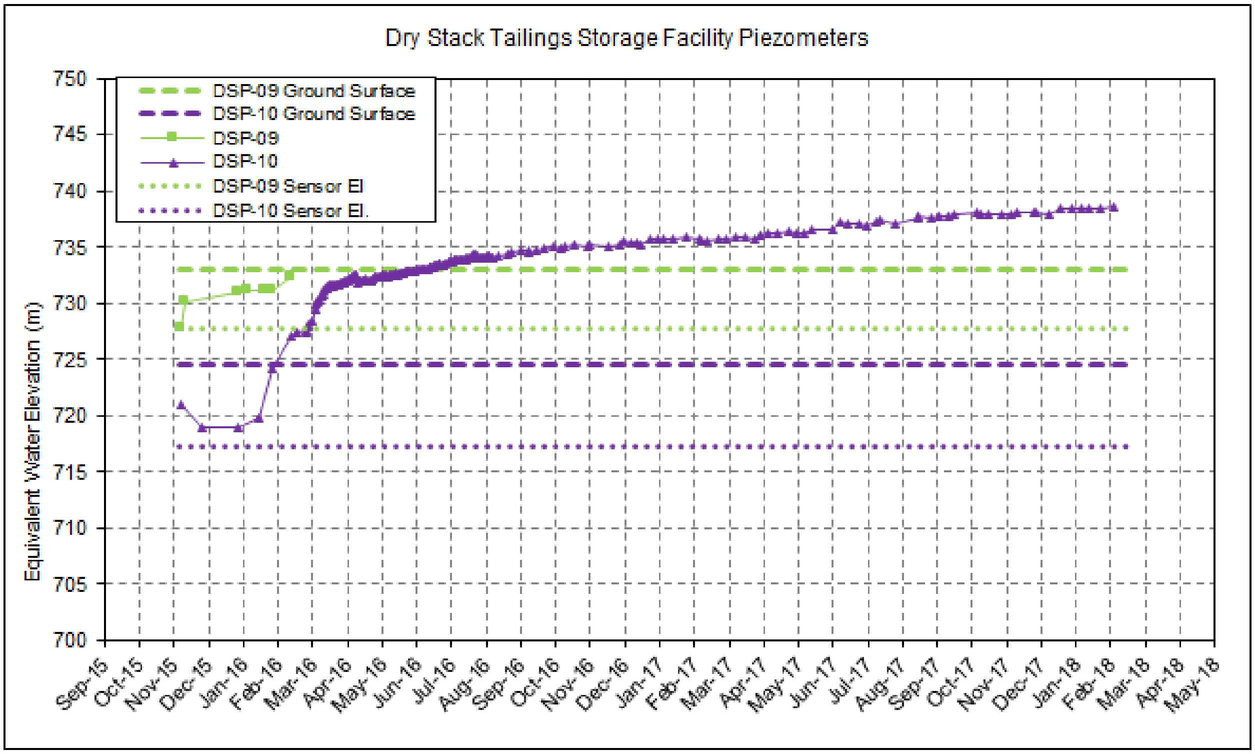


Figure 6-5: DSTSF Piezometer Data – DSP-09 and DSP-10 (2015-2017)

6.4.2 Southwest Dump Piezometers

Data collected from Southwest Dump vibrating wire piezometers are presented in Figure 6-6. Sensors SDP-3A and SDP-3B are reading negative pressures and have not been included in the figure. Data are collected monthly. Data indicate relatively consistent and indicate seasonal changes in pore pressure in 2017. Work on the dump in 2017 consisted primarily of re-sloping for closure.

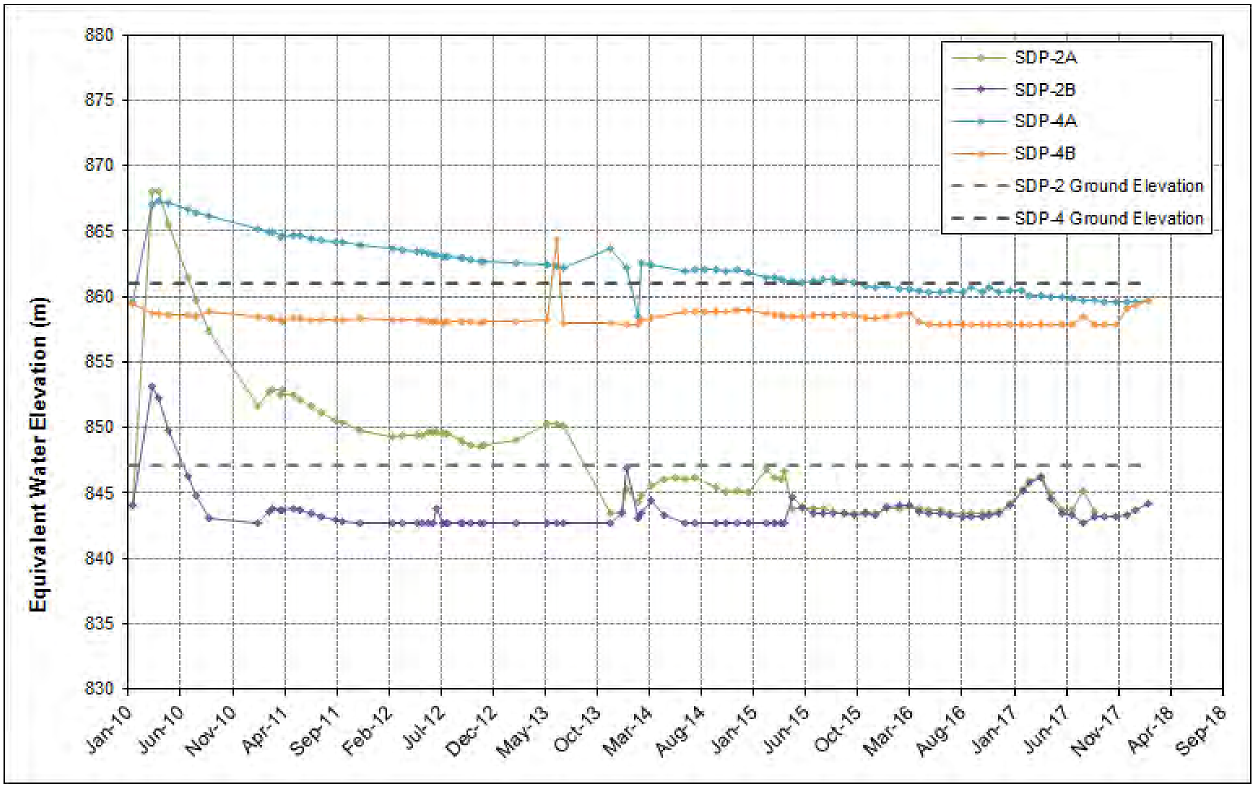


Figure 6-6: Southwest Dump Piezometer Data (2010-2017)

6.4.3 Water Storage Pond Dam Piezometers

Data collected from WSP Dam vibrating wire piezometers are presented in Figure 6-7. WDP-2, WDP-3, WDP-5, and WDP-11 are reading negative pressures and have not been included in the figure. Data are collected monthly. Pressures in 2017 generally followed the trend of the water level in the water storage pond as in previous years.

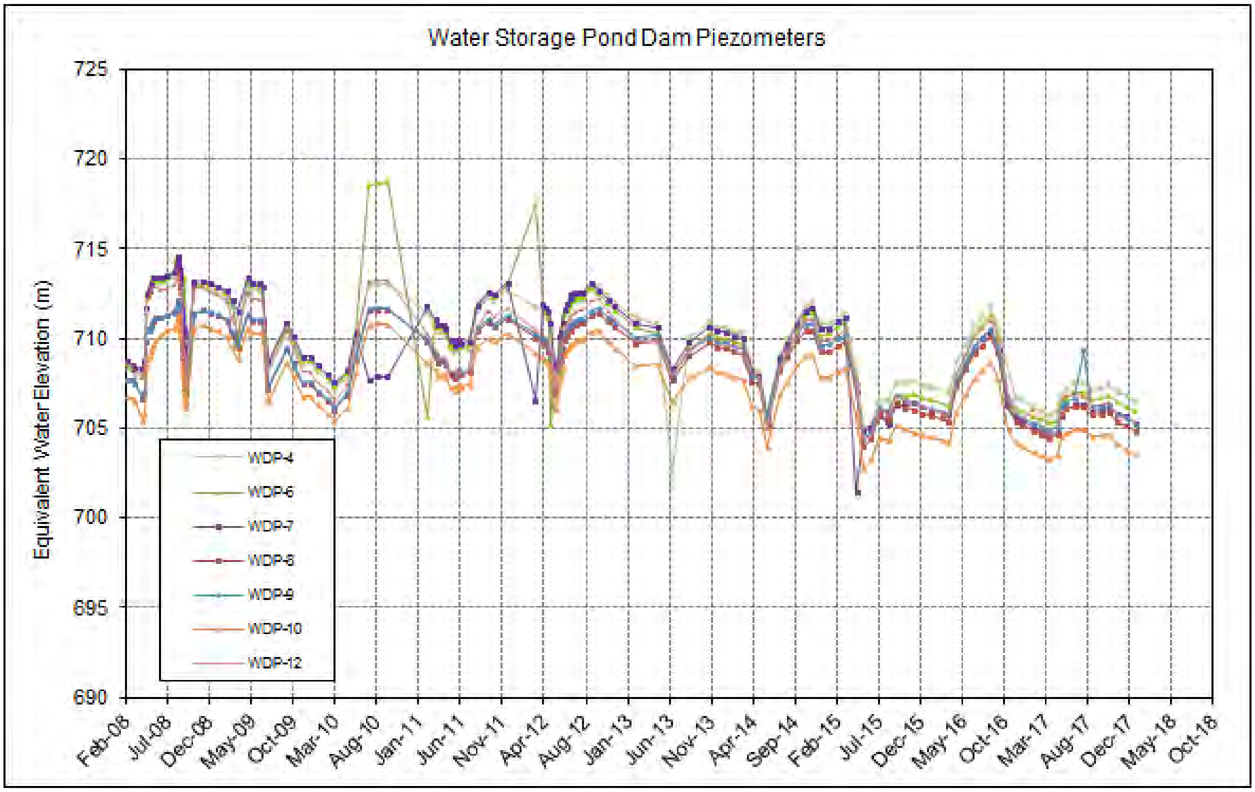


Figure 6-7: WSP Dam Piezometer Data (2008-2017)

6.5 Ground Temperature Cables

There are currently 22 operating thermistors (ground temperature cables) installed on site, listed in Table 6-42. There were no changes to the operational status of any of the existing thermistors in 2017. Summaries of data collected from each thermistor are contained in the following sections.

Table 6-42: Thermistor Summary (2017)

Thermistor	Location	Operational Status
A2T-1	DSTSF	Operational
DST-1	DSTSF	Destroyed (2011)
DST-2	DSTSF	Destroyed (2011)
DST-3	DSTSF	Destroyed (2012)
DST-4	DSTSF	Inoperative (2012)
DST-5	DSTSF	Destroyed (2011)
DST-6	DSTSF	Destroyed (2011)
DST-7	DSTSF	Destroyed (2010)
DST-8	DSTSF	Destroyed (2011)
DST-9	DSTSF	Destroyed (2011)
DST-10	DSTSF	Operational
DST-11	DSTSF	Operational
DST-12	DSTSF	Inoperative (2012)
DST-13	DSTSF	Operational
DST-14	DSTSF	Operational
DST-15	DSTSF	Operational
MWPT1	Mill Water Pond	Destroyed (2016)
MWPT2	Mill Water Pond	Destroyed (2016)
MW11-01A	Mill Water Pond	Destroyed (2016)
MPDT-1	Main Pit Dam	Destroyed (2016)
MPDT-2	Main Pit Dam	Destroyed (2016)
MW-11-02	Ridgetop	Operational
MW-11-03	Ridgetop	Operational
SDT-1	Southwest Dump	Operational
SDT-2	Southwest Dump	Operational
SDT-3	Southwest Dump	Operational
SDT-4	Southwest Dump	Operational
08SWC271	Southwest Dump	Destroyed (2010)
08SWC274	Southwest Dump	Destroyed (2011)
08SWC275	Southwest Dump	Destroyed (2008)
08SWC277	Southwest Dump	Destroyed (2008)
08SWC278	Southwest Dump	Destroyed (2008)
08SWC280	Southwest Dump	Destroyed (2008)

Thermistor	Location	Operational Status
WDT – 1	Water Storage Pond Dam	Operational
WDT – 2	Water Storage Pond Dam	Operational
WDT – 3	Water Storage Pond Dam	Operational
WDT – 4	Water Storage Pond Dam	Operational
WDT – 5	Water Storage Pond Dam	Operational
WDT – 6	Water Storage Pond Dam	Operational
WDT – 7	Water Storage Pond Dam	Operational
WDT – 8	Water Storage Pond Dam	Operational

6.5.1 DSTSF Thermistors

Data collected from DSTSF thermistors are presented in Figure 6-8 through Figure 6-13. Data are collected quarterly. No major changes to ground temperatures at the DSTSF were observed in 2017.

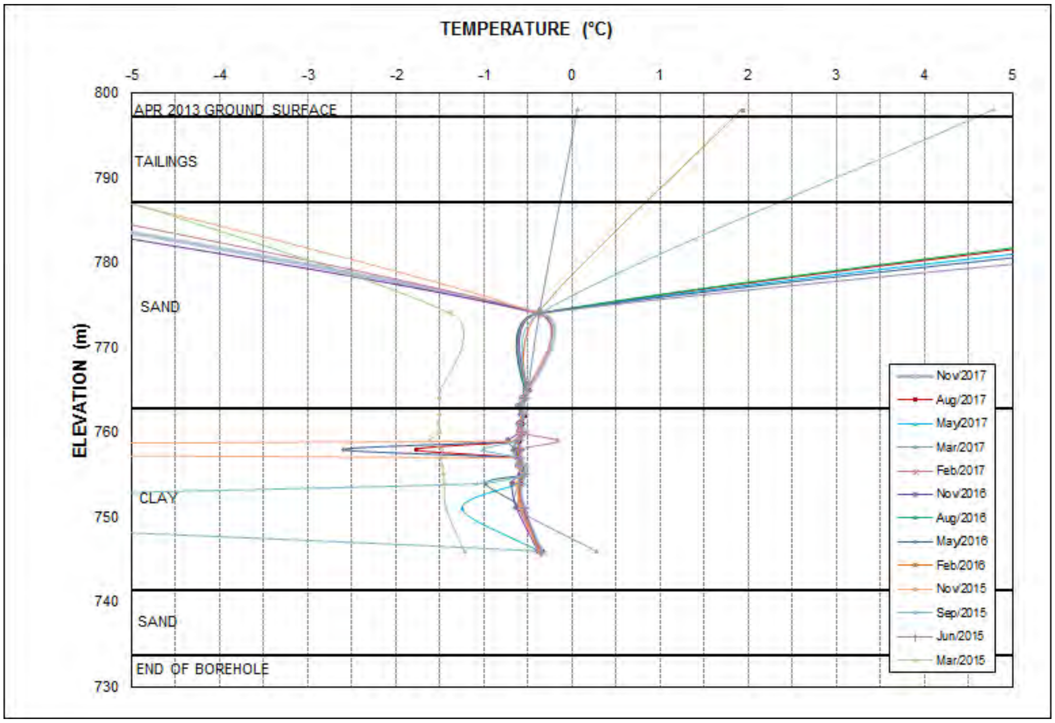


Figure 6-8: Thermistor DST-10 (2015-2017)

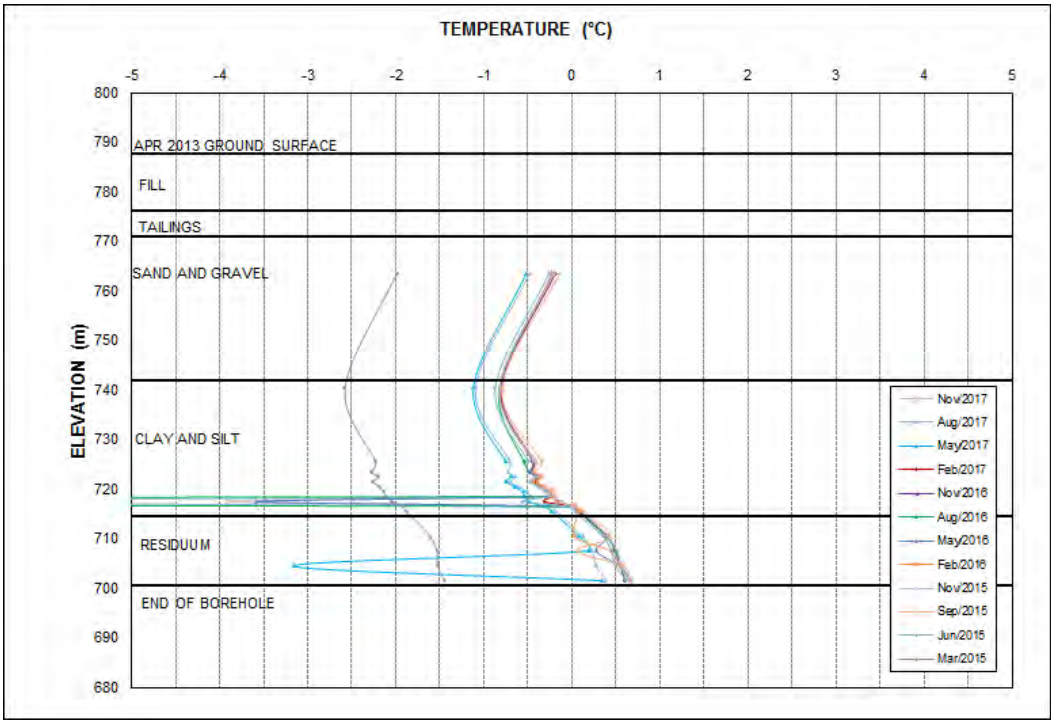


Figure 6-9: Thermistor DST-11 (2015-2017)

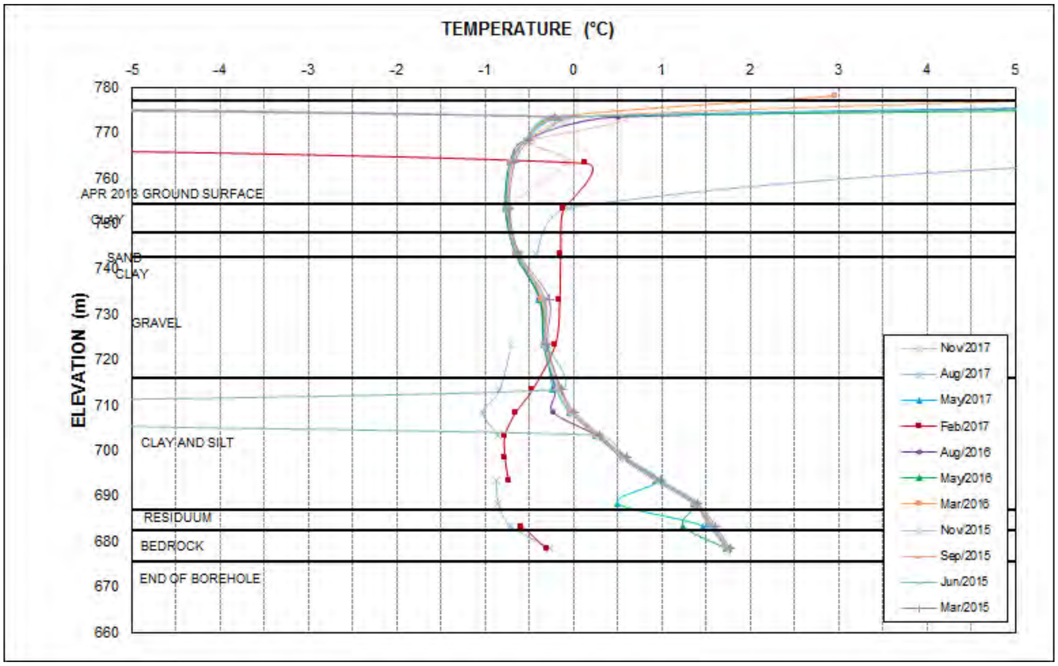


Figure 6-10: Thermistor DST-13 (2015-2017)

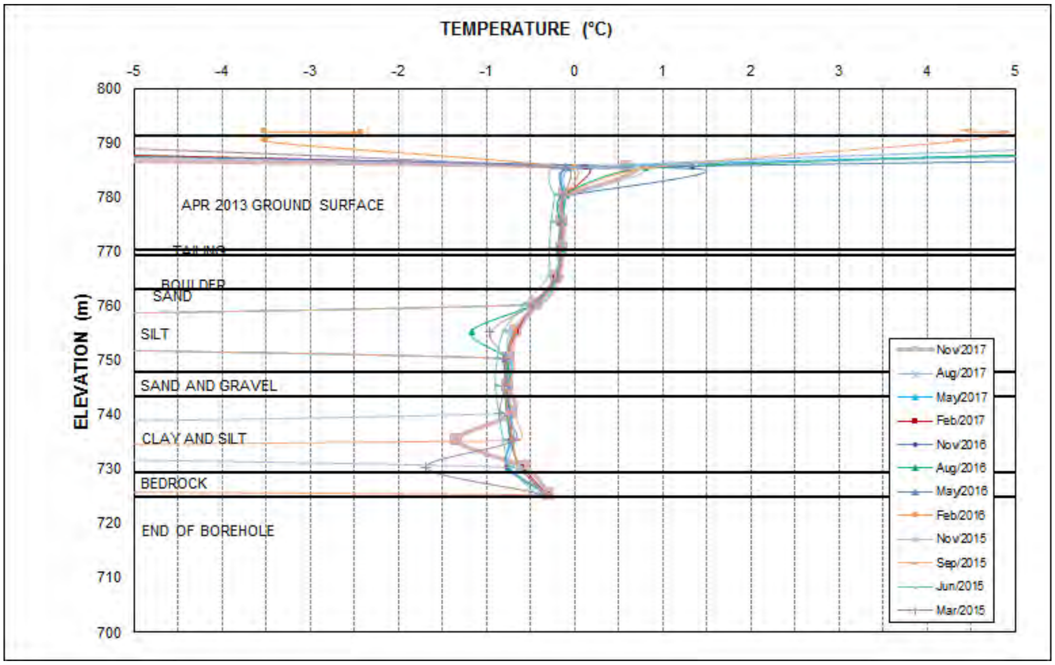


Figure 6-11: Thermistor DST-14 (2015-2017)

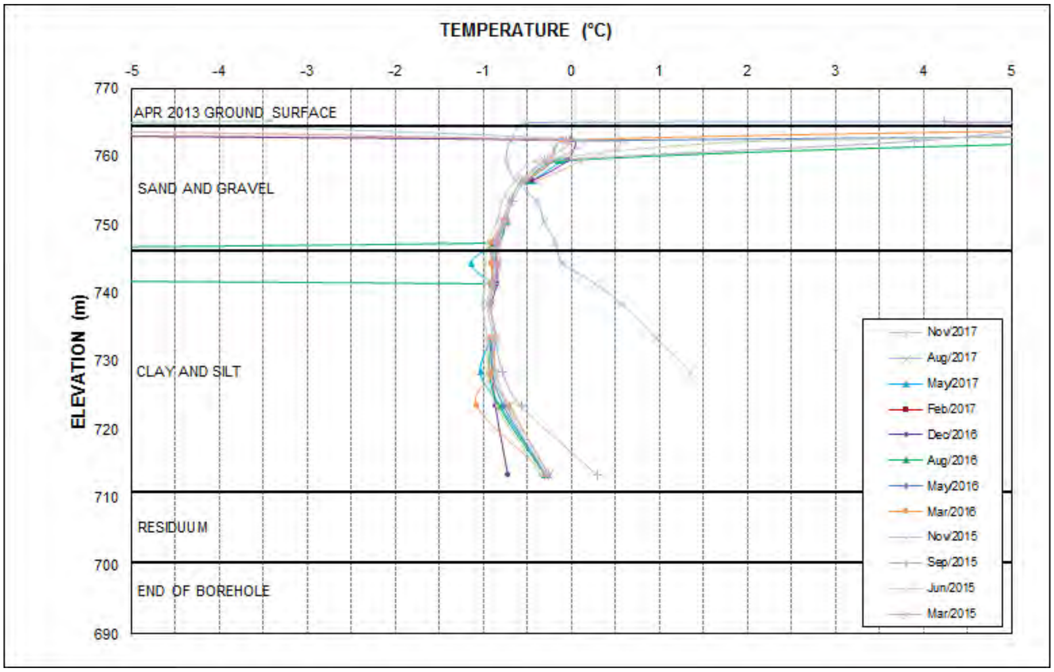


Figure 6-12: Thermistor DST-15 (2015-2017)

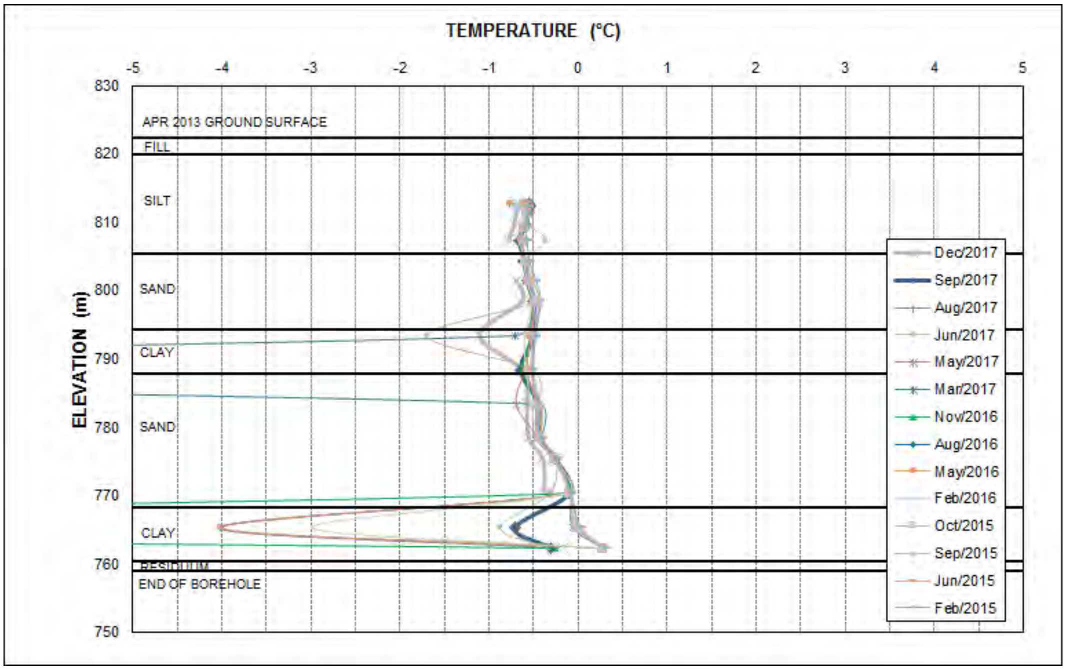


Figure 6-13: Thermistor AT2-1 (2015-2017)

6.5.2 Ridgetop Thermistors

Data collection has reduced to annually for both Ridgetop thermistors. No major changes to ground temperatures at the Ridgetop were observed in 2017.

6.5.3 Southwest Dump Thermistors

Data collected from SWD thermistors are presented in Figure 6-14 6-14 through 6-17. Data are collected quarterly. No major changes to ground temperatures at the SWD were observed in 2017.

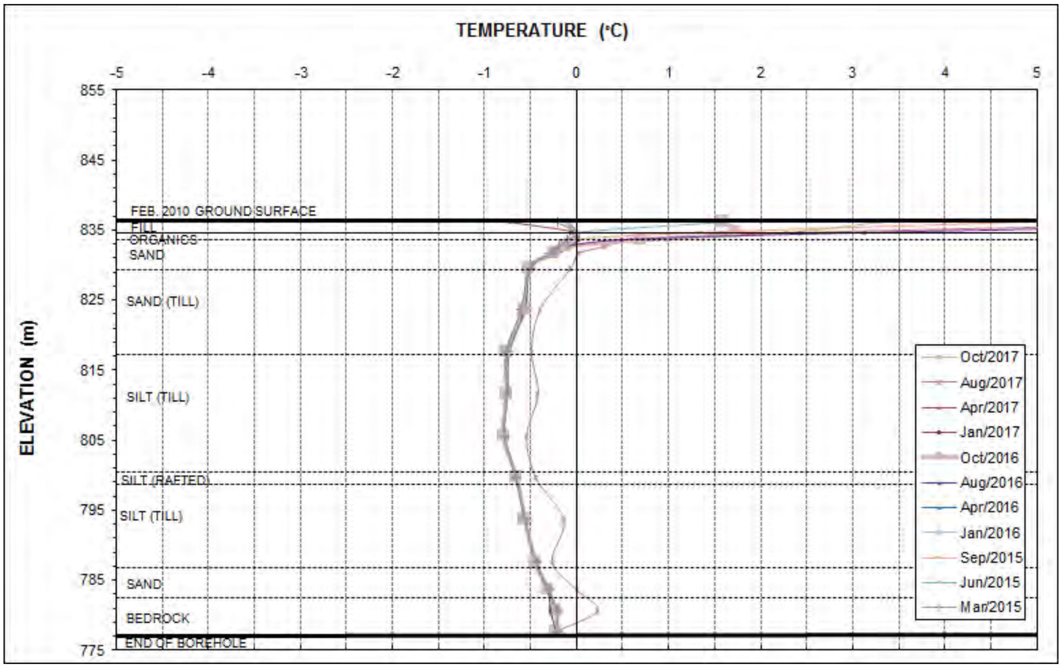


Figure 6-14: Thermistor SDT-1 (2015-2017)

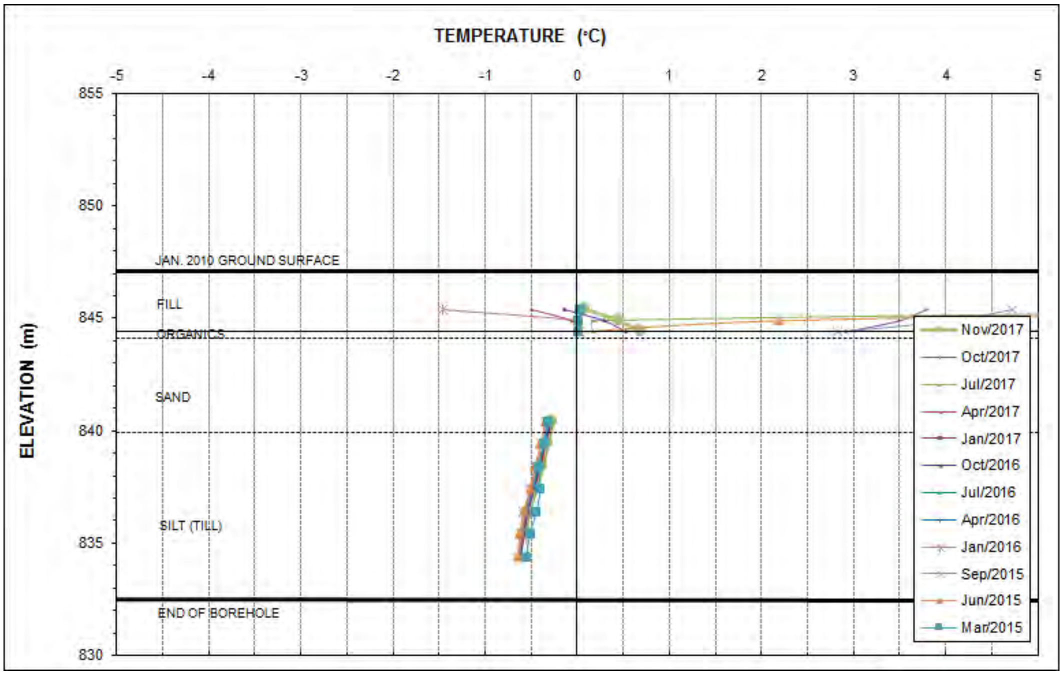


Figure 6-15: Thermistor SDT-2 (2015-2017)

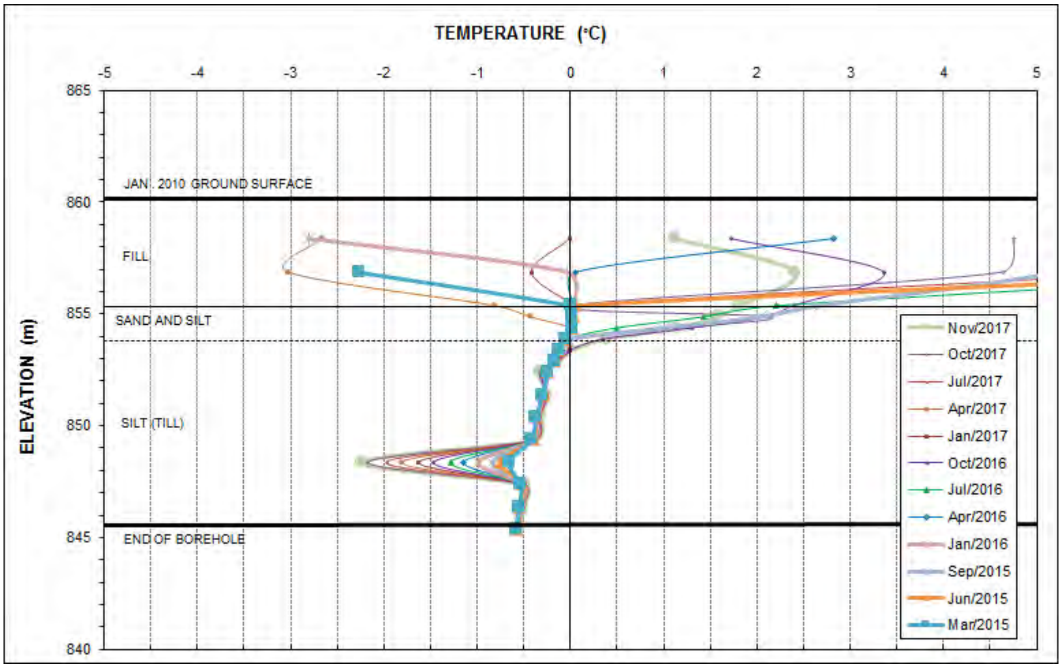


Figure 6-16: Thermistor SDT-3 (2015-2017)

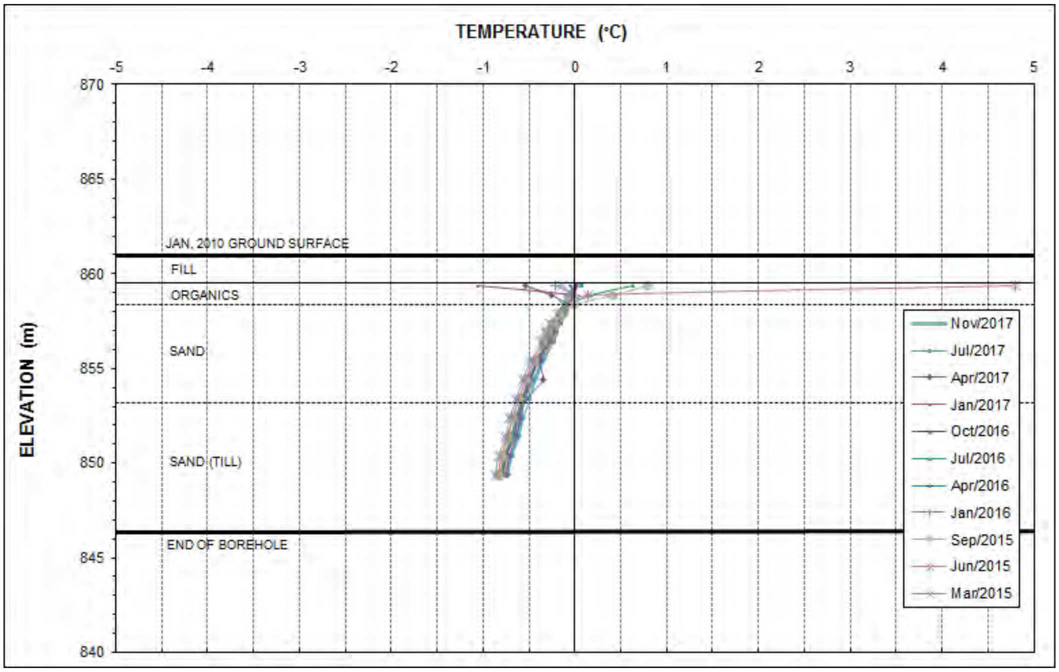


Figure 6-17: Thermistor SDT-4 (2014-2017)

6.5.4 Water Storage Pond Dam Thermistors

Data are collected monthly from all water retention dam thermistors. All thermistors continue to show temperatures well above zero since installation.

7 Seepage Water Quality Monitoring Program

Minto Mine implements a Seepage Monitoring Plan (SMP) to assess acid rock drainage and metal leaching conditions from several sources, including: pit wall seepage, ore stockpile areas, overburden dumps, waste rock dumps, DSTSF, Mill Valley Fill Extension 1 and 2, the mill area and other seepage locations.

Seepage monitoring conducted in 2017 was carried out in accordance with the EMSRP. The EMSRP states that seepage surveys will be conducted twice a year, during spring runoff and in early fall, by walking the toe of each waste dump, stockpile or other areas of interest. The survey route for each seepage monitoring event are recorded using the tracking function of a GPS. A map showing the 2017 survey routes and monitoring locations can be found in Figure 7-1.

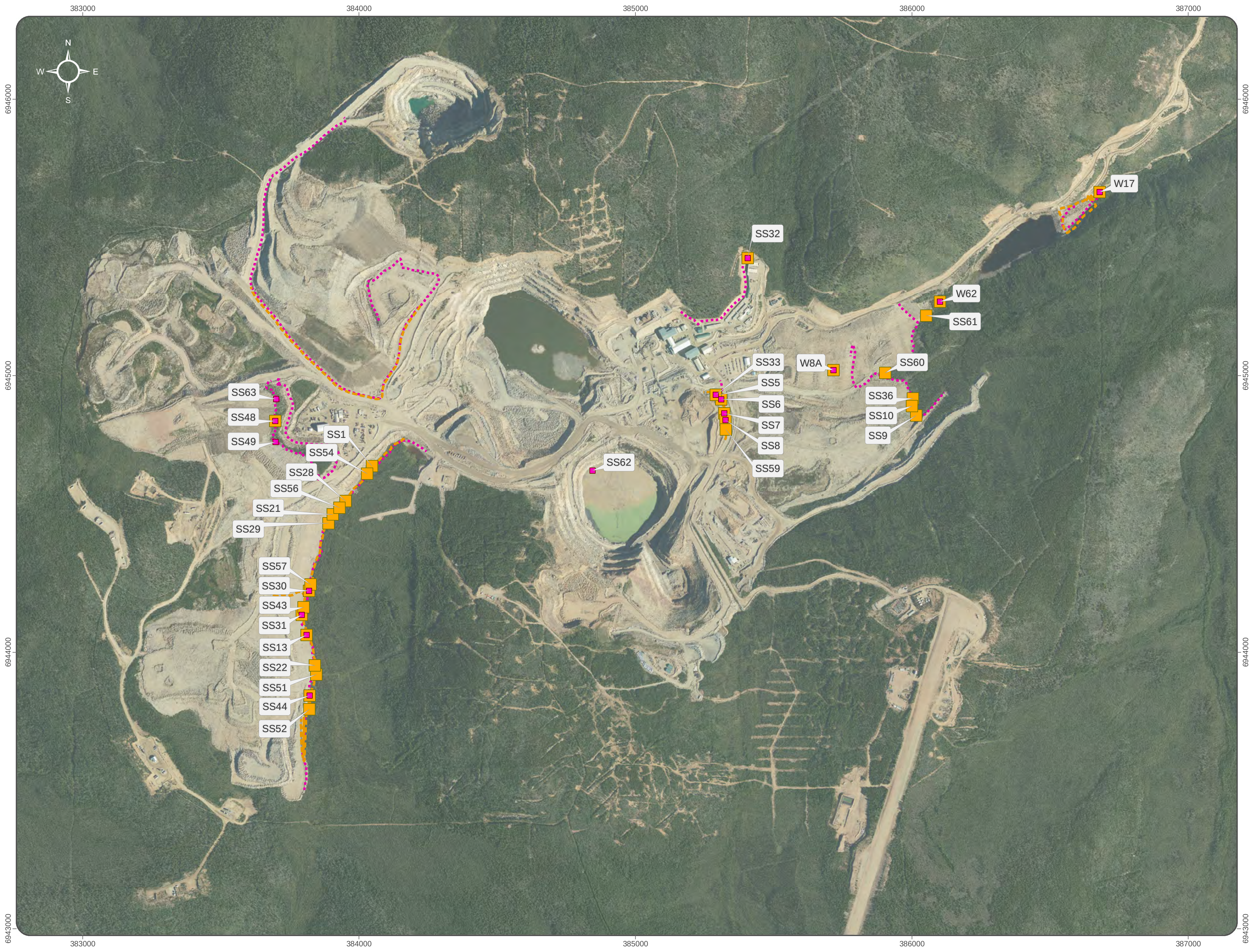
WUL QZ14-031 identifies a Surface Water Surveillance Program which requires regular monitoring of seepage at several permanent seepage water quality stations. These stations include: W8, W8A, W17, (W36, W37 – destroyed in 2016), and W62. Prior to WUL QZ14-031, Minto operated under WUL QZ96-006 which included seepage monitoring sites W32, W38, W39 and W40 in the Surface Water Surveillance Program. The water quality results for these permanent seepage quality stations are additionally reported to the Yukon Water Board (YWB) monthly. Other seepage sites that have been located have been recorded by GPS to ensure continued monitoring. These additional sites are visited during the spring and fall and, if water is present, a sample is collected. Substantial variability in flow presence and/or volume has been observed at many seepage sites. All lab results for 2017 spring and fall seepage monitoring programs are provided in Appendix D.

Seepage site locations are marked by GPS and data is stored in the Minto Mine Water Quality Database, along with results from WUL sampling stations. Minto will continue to monitor these seepage areas and monitor the site workings for seeps on a semi-annual basis.

Observations from the 2017 Seepage Monitoring Program indicate that many seepage sites identified are seasonally variable. It has also been observed that weather patterns have an impact, where snow melt or rain contribute to observable flows that are absent during warm, dry weather. Analysis of seepage results and water quality analysis assists in improving understanding of water chemistry, load, and water balance issuing from waste dumps, overburden dumps, ore stockpiles, and tailings facilities.

Constituents of concern, namely dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, ammonia, nitrate, and nitrite have been graphed below for each site sampled. In cases where a graph's trend is skewed due to visual outliers (i.e. data points that are larger than the mean by an order of magnitude), a second graph with outliers removed is provided and labelled as "Reduced Concentration."

Per current EMSRP, field data and observations including coordinates, weather, field measurements (pH, conductivity and temperature), a sketch of the location, water conditions and colour of sediment and number of filters used. The original field sheets are presented with the pictures that were obtained at each site in Appendix D.



MINTO MINE

capstone
MINTO MINE

SEEPAGE MONITORING PROGRAM ANNUAL REPORT

FIGURE 7-1

2017 SEEPAGE MONITORING PROGRAM

OCTOBER 2017

- ■ Fall 2017 Seepage Survey Monitoring Stations
- 🟧 Spring 2017 Seepage Survey Monitoring Stations
- ---- Spring 2017 Seep Survey Lines
- ····· Fall 2017 Seep Survey Lines

1:13,000

when printed on 11 x 17 inch paper

0 100 200 300 400 500

Meters

ALEXCO ENVIRONMENTAL GROUP

Aerial imagery obtained from Challenger Geomatics.
Imagery acquired August 9rd 2017.

Datum: NAD 83 Projection: UTM Zone 8N

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent.

D:\Project\AllProjects\Minto\gis\mxd\Studies\SeepMonitoring\2017\SeepMonitoring_2017_20171031.mxd (*Last edited by: mducharme;10/31/2017/15:34 PM*)

7.1 Mill Valley Fill

The first phase of the Mill Valley Fill (MVF) was completed in 2012 and vertical culverts were installed at both W8 and W8A to enable water quality monitoring at these locations. Obtaining water samples at W8 has been sporadic since the installation of the vertical culvert. The last time this station produced water was in late 2013. The second phase of the Mill Valley Fill Extension was completed in early 2016. Additional extensions were added to the vertical culverts of W8 and W8A to preserve the sampling stations. In fall 2017, W8 culvert was covered during reclamation operations and could no longer be accessed. Water quality results for W8 and W8A are outlined in Figure 7-2 through 7-10 and include 2017 results as well as historic data for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

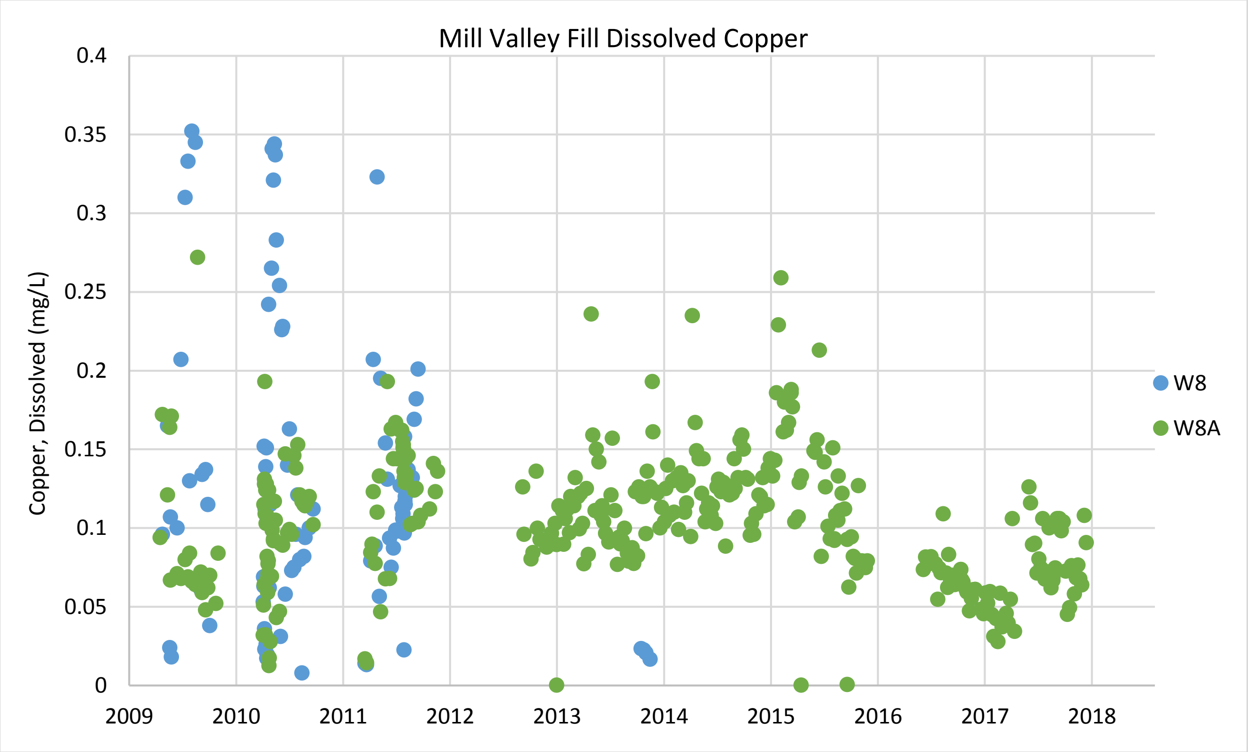


Figure 7-2: Mill Valley Fill Dissolved Copper

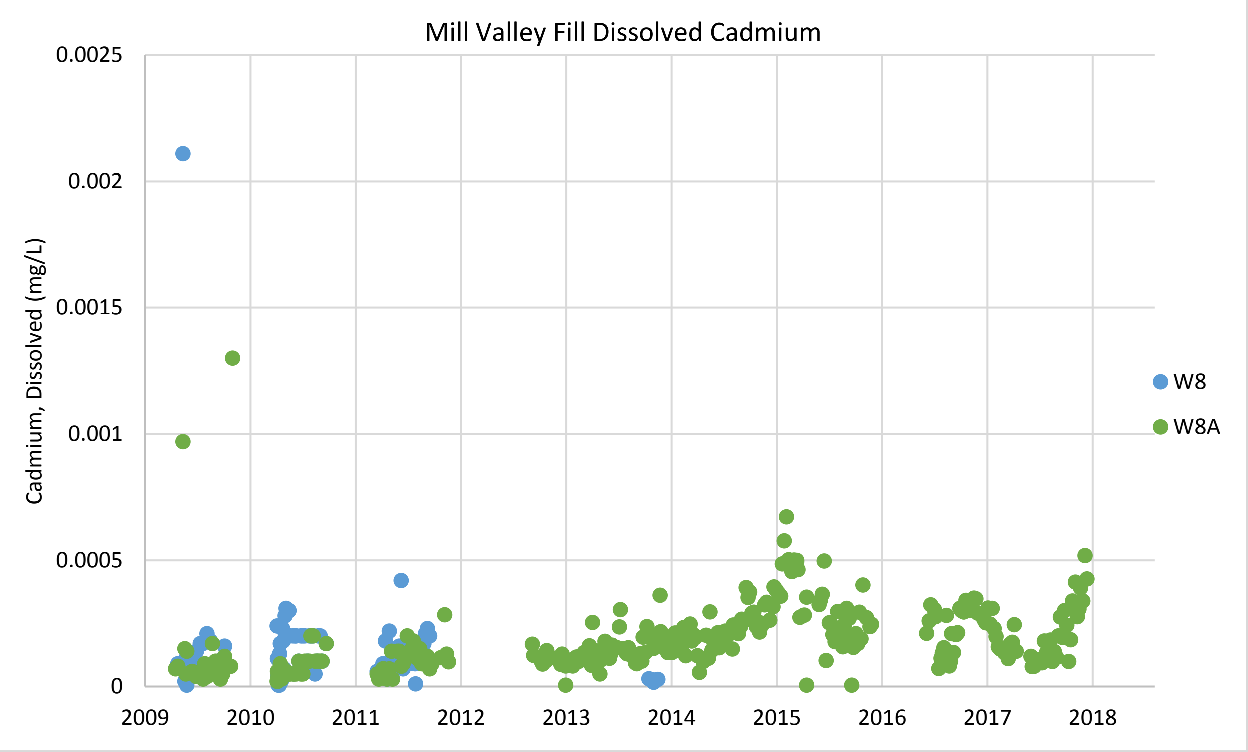


Figure 7-3: Mill Valley Fill Dissolved Cadmium

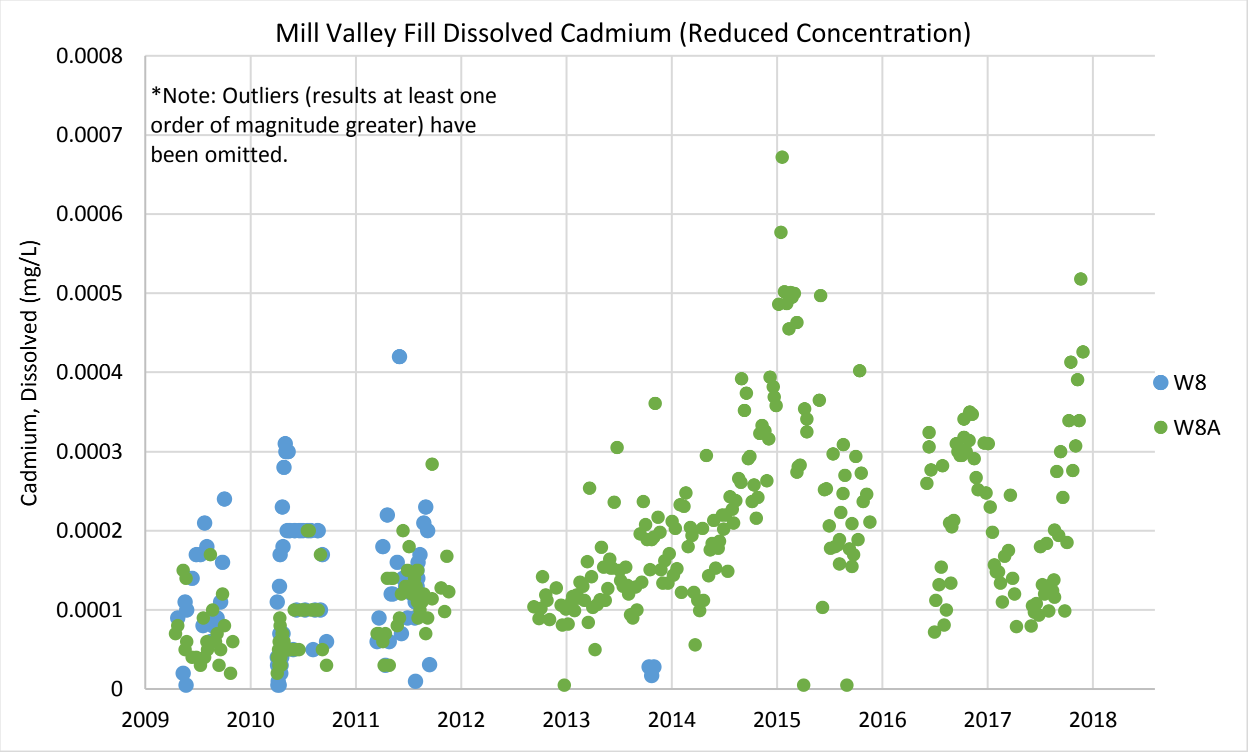


Figure 7-4: Mill Valley Fill Dissolved Cadmium (Reduced Concentration)

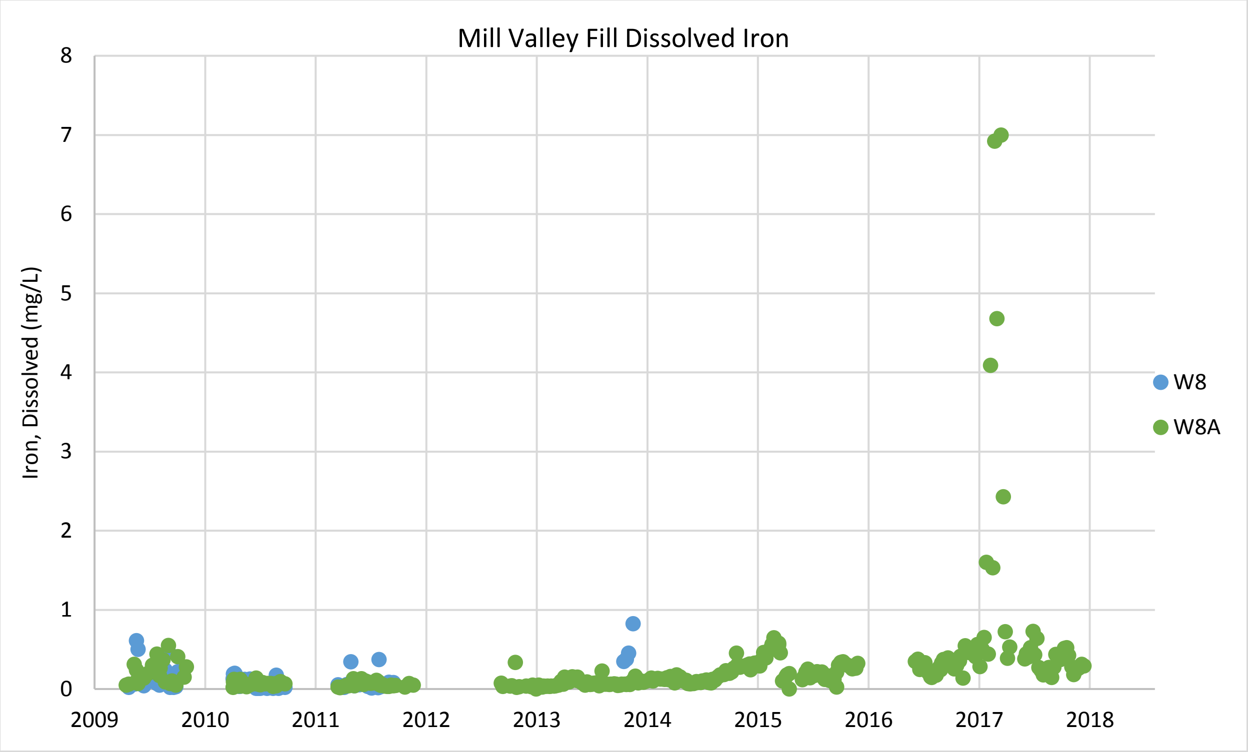


Figure 7-5: Mill Valley Fill Dissolved Iron

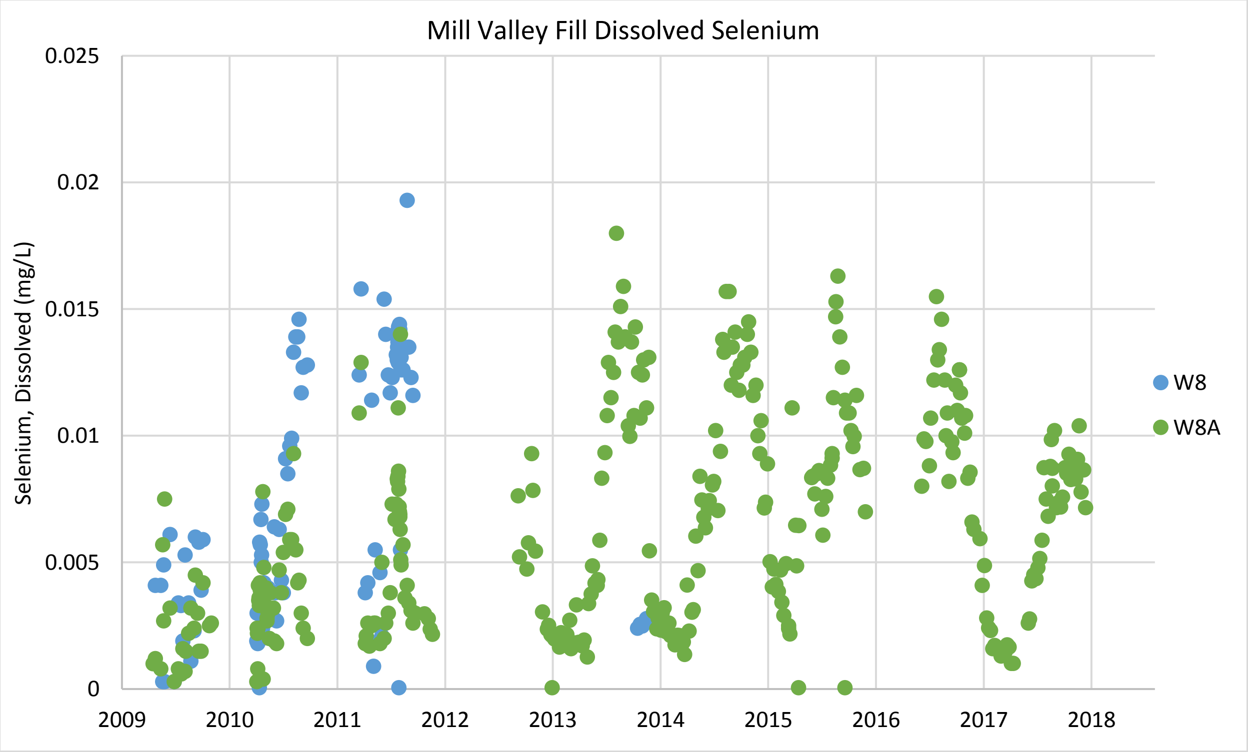


Figure 7-6: Mill Valley Fill Dissolved Selenium

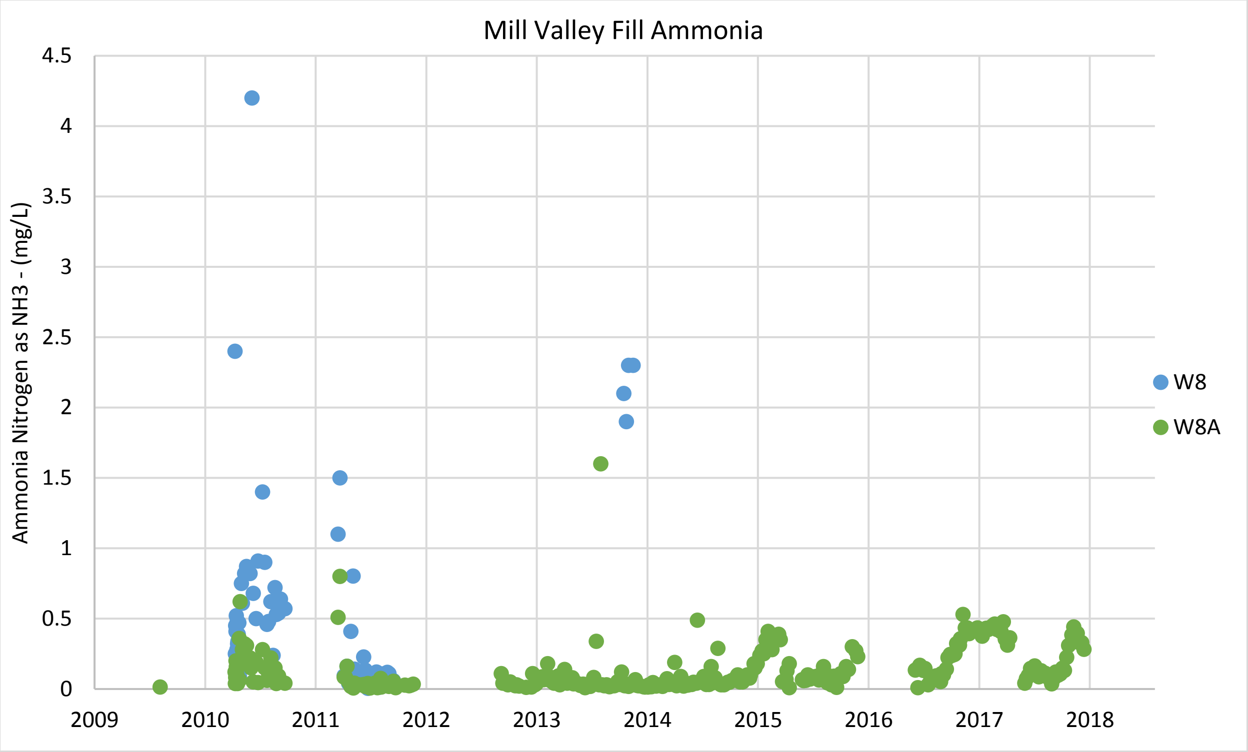


Figure 7-7: Mill Valley Fill Ammonia

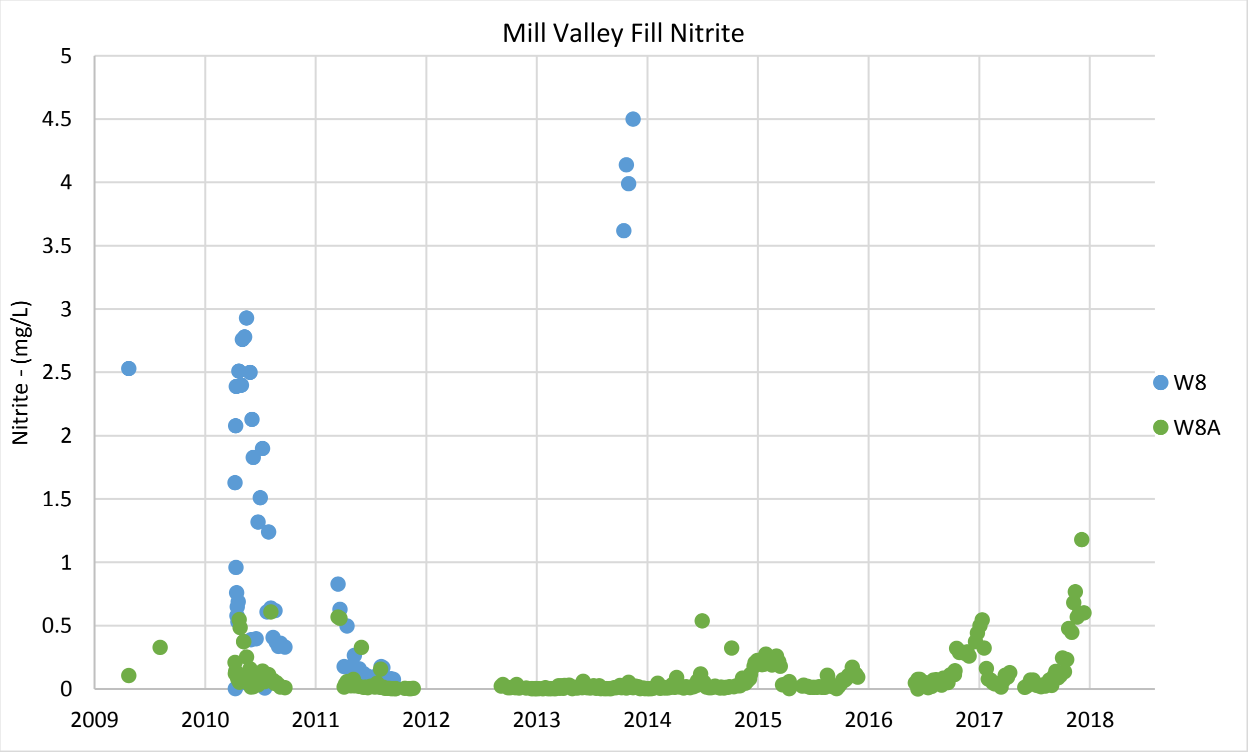


Figure 7-8: Mill Valley Fill Nitrite

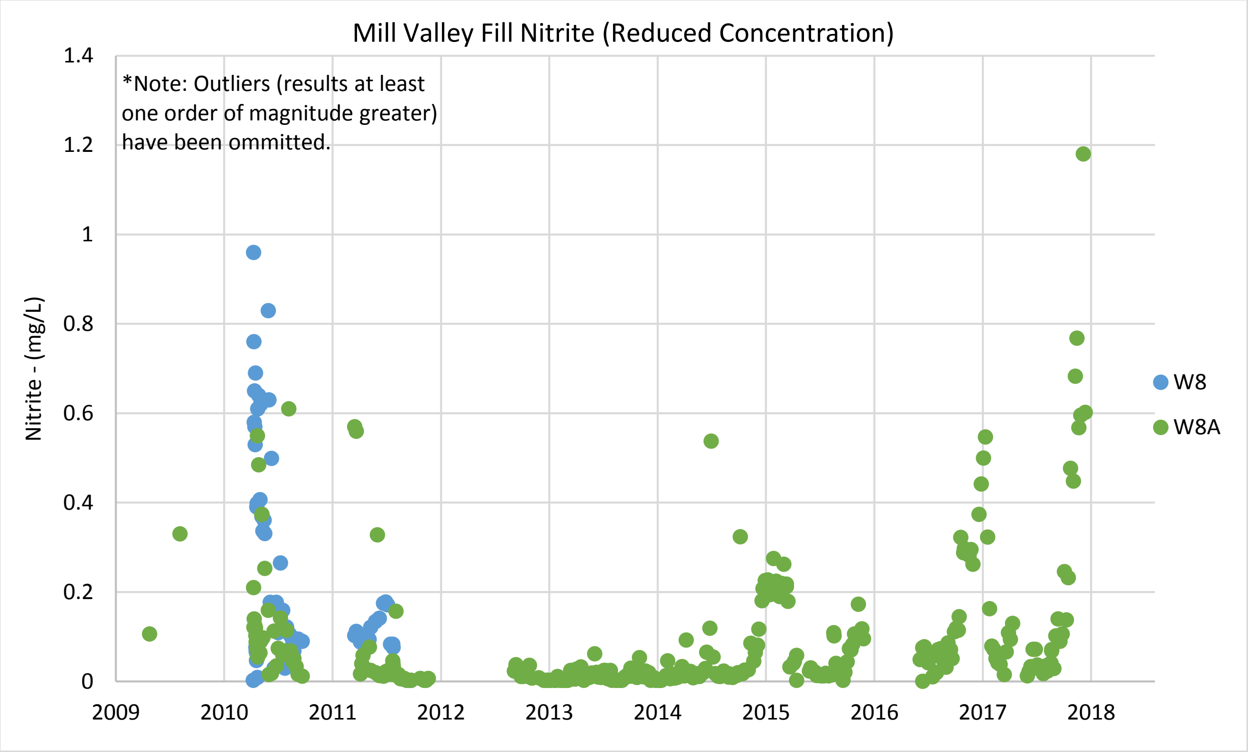


Figure 7-9: Mill Valley Fill Nitrite (Reduced Concentration)

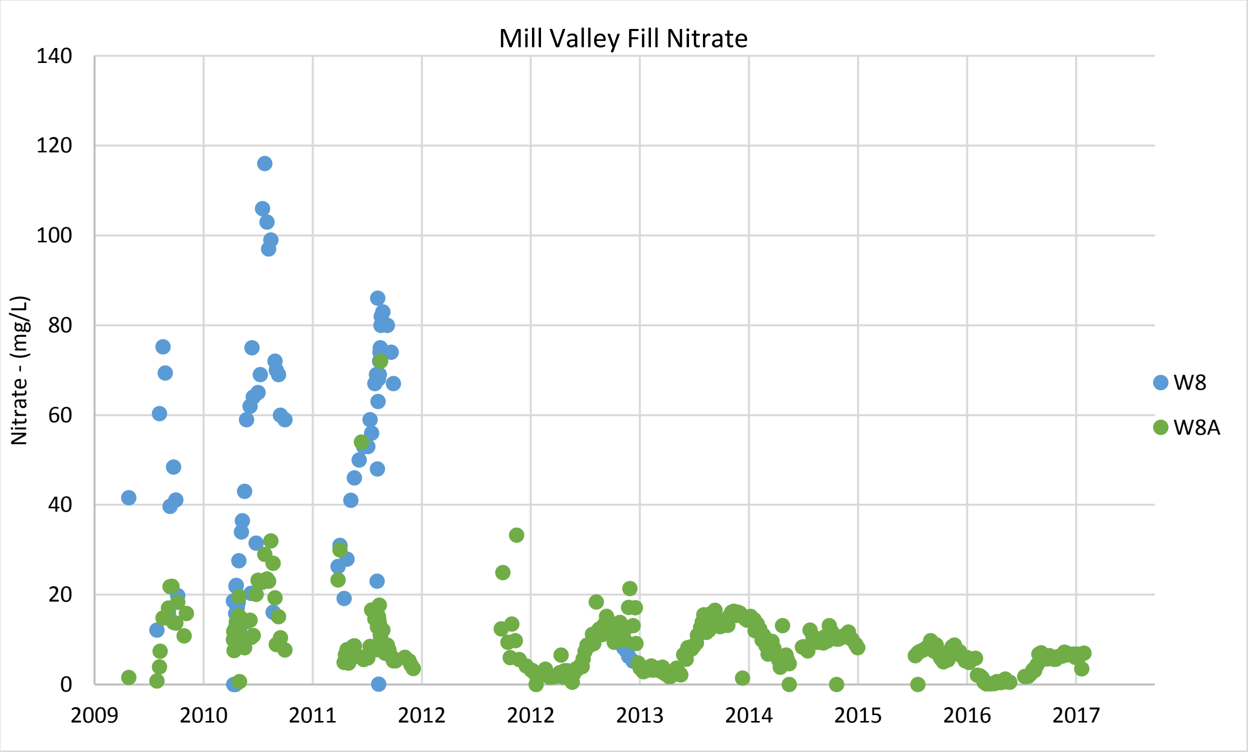


Figure 7-10: Mill Valley Fill Nitrate

7.2 Southwest Dump

Seepage was collected at stations SS1, SS28, SS29, SS30, SS31, SS43, SS44, SS48, SS49, SS51, and SS52, SS54, SS56, SS57 and SS63. Additionally, W32, W38, W39 and W40 were monitored during the summer season. Samples are taken within ±5m of the original GPS point. If there is no seepage within the 5m buffer, the site is considered dry during that sampling session. SS54, SS56 and SS57 were seepage sites newly discovered in spring of 2017 and SS63 was discovered in fall 2017. Water quality results from the 2017 survey program for W38 and W39, as well as W32 and W40 historical data, are presented in Figure 7-11 to 7-18. Historical data and 2017 seepage water quality results for SS1, SS13, SS21, SS22, SS28, SS29, SS30, SS31, SS39, SS43, SS44, SS48, SS49, SS50, SS51, SS52, SS54, SS556 and SS57 are summarized in Figure 7-19 to Figure 7-39. Data was separated between the north (SS1, SS21, SS28, SS29, SS54 and SS56), the south end of the southwest dump (SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52, and SS57) and the ice rich overburden dump seep (SS48, SS49 and SS63). The figures include water quality results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

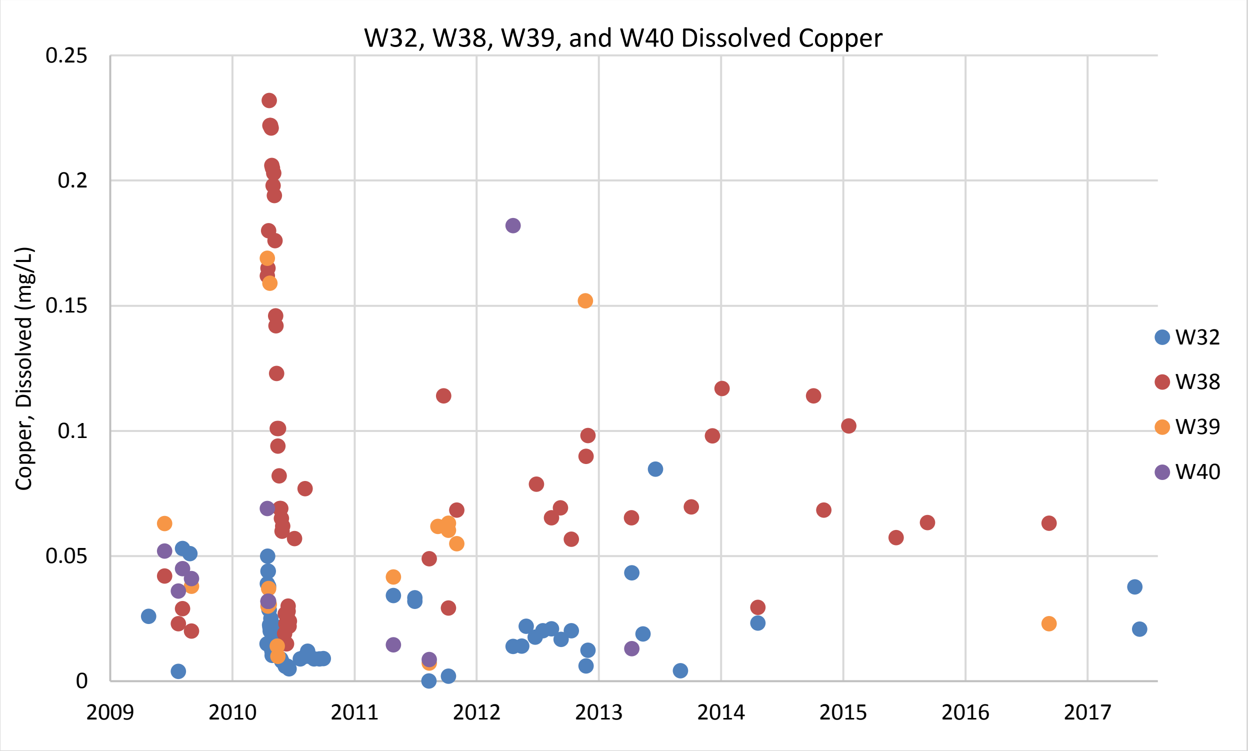


Figure 7-11: W32, W38, W39, and W40 Dissolved Copper

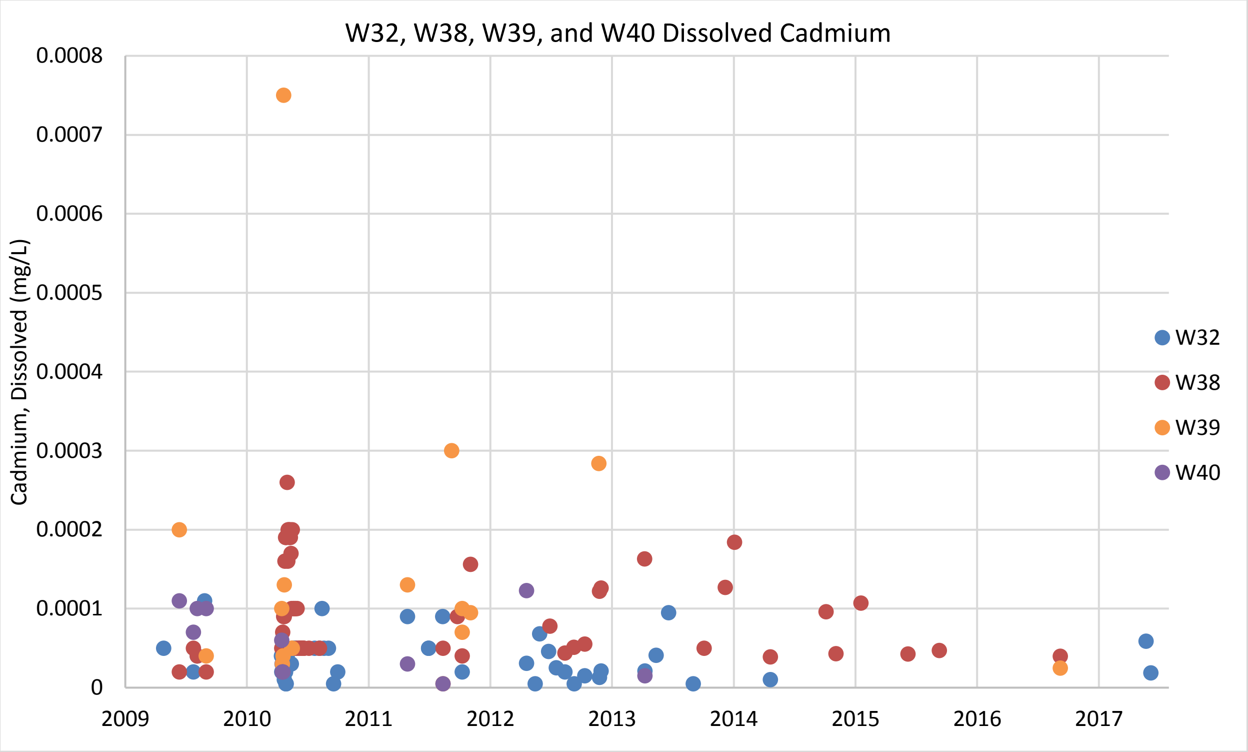


Figure 7-12: W32, W38, W39, and W40 Dissolved Cadmium

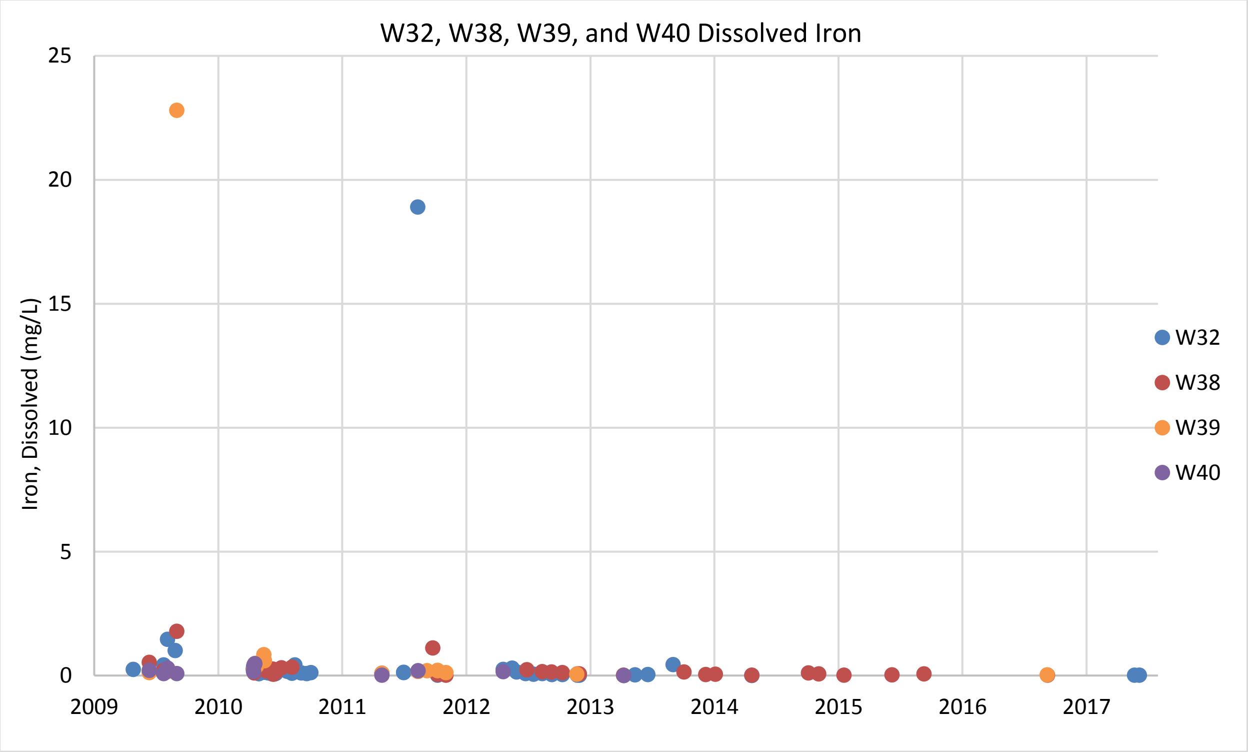
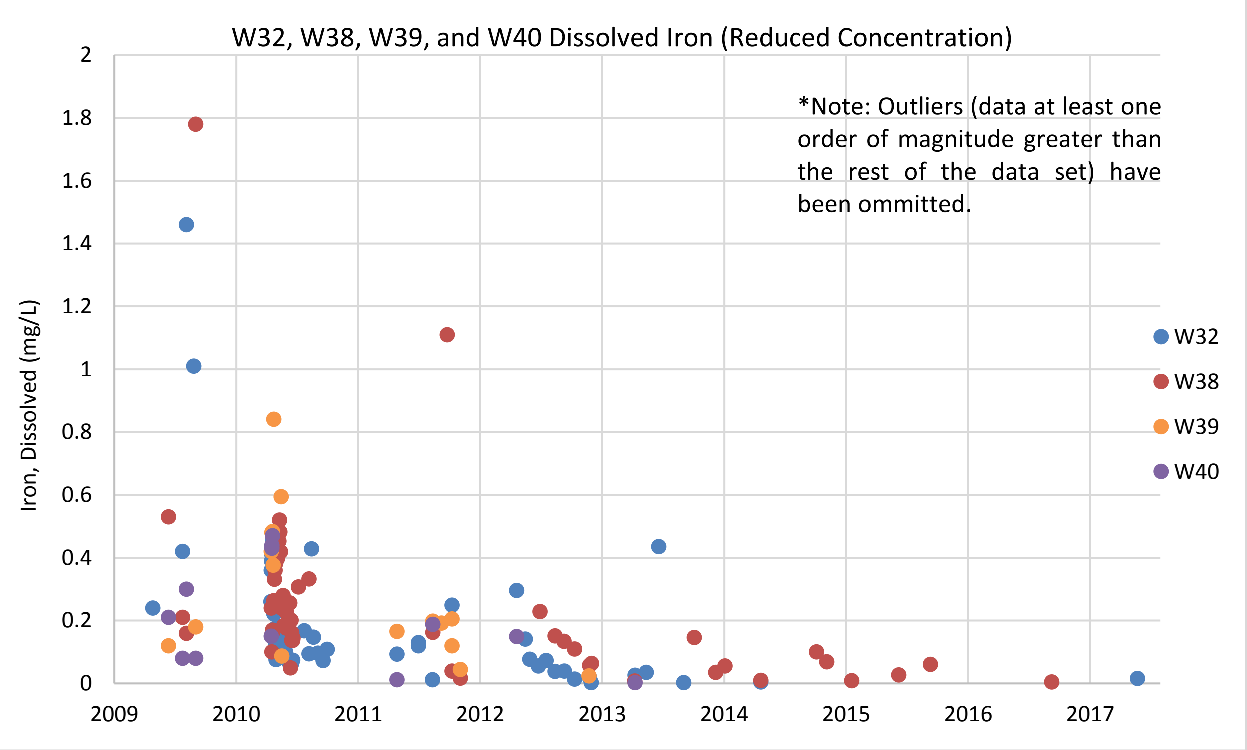


Figure 7-13: W32, W38, W39, and W40 Dissolved Iron



*Note: Outliers (data at least one order of magnitude greater than the rest of the data set) have been ommitted.

Figure 7-14: W32, W38, W39, and W40 Dissolved Iron (Reduced Concentration)

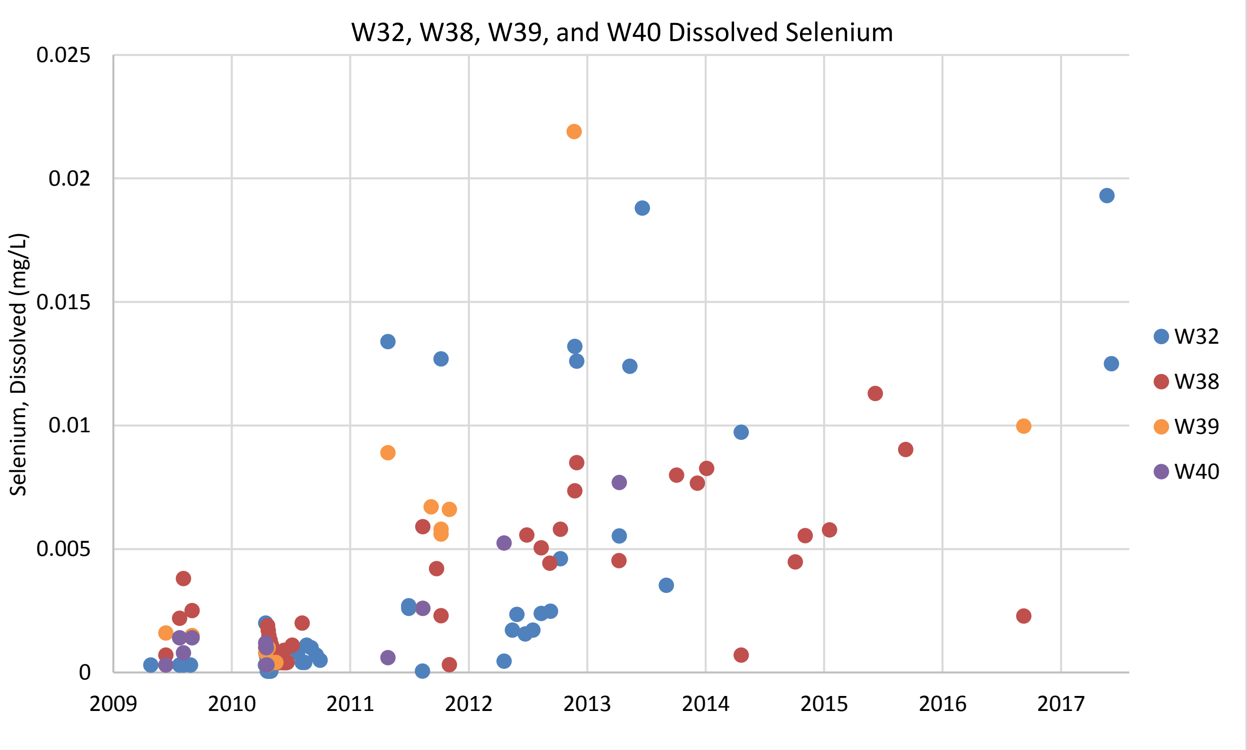


Figure 7-15: W32, W38, W39, and W40 Dissolved Selenium

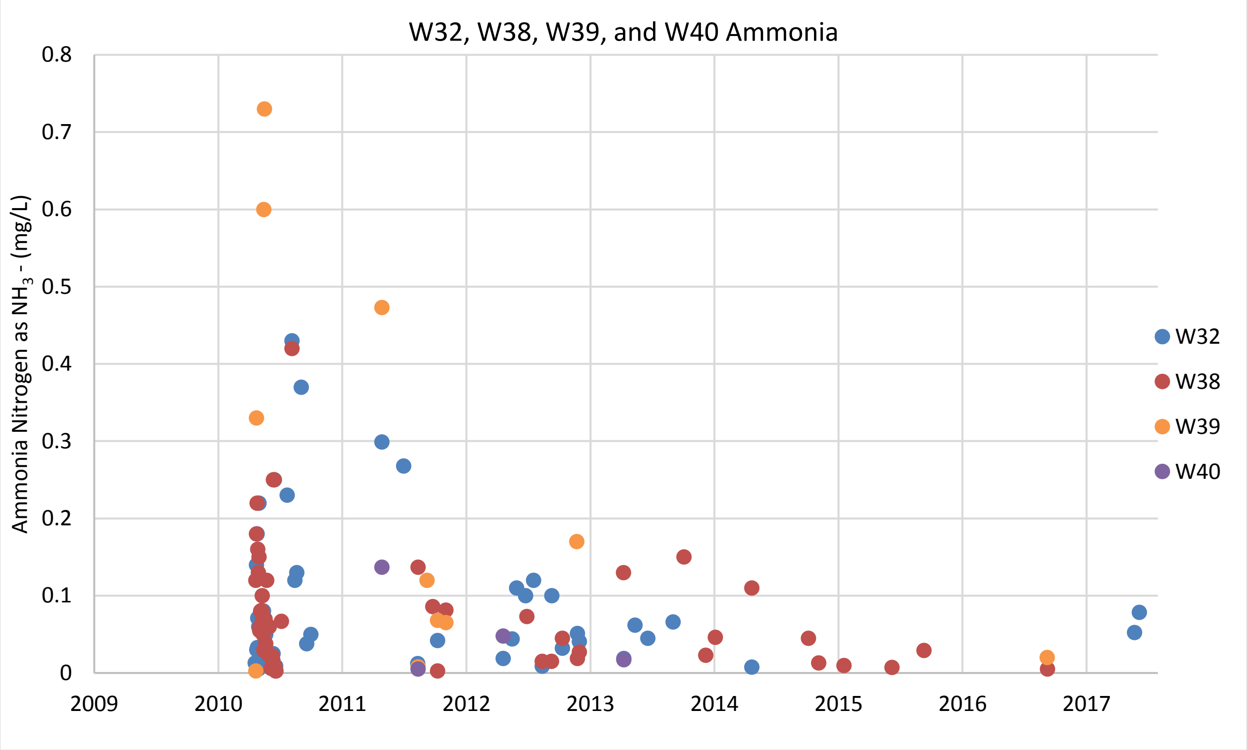


Figure 7-16: W32, W38, W39, and W40 Ammonia

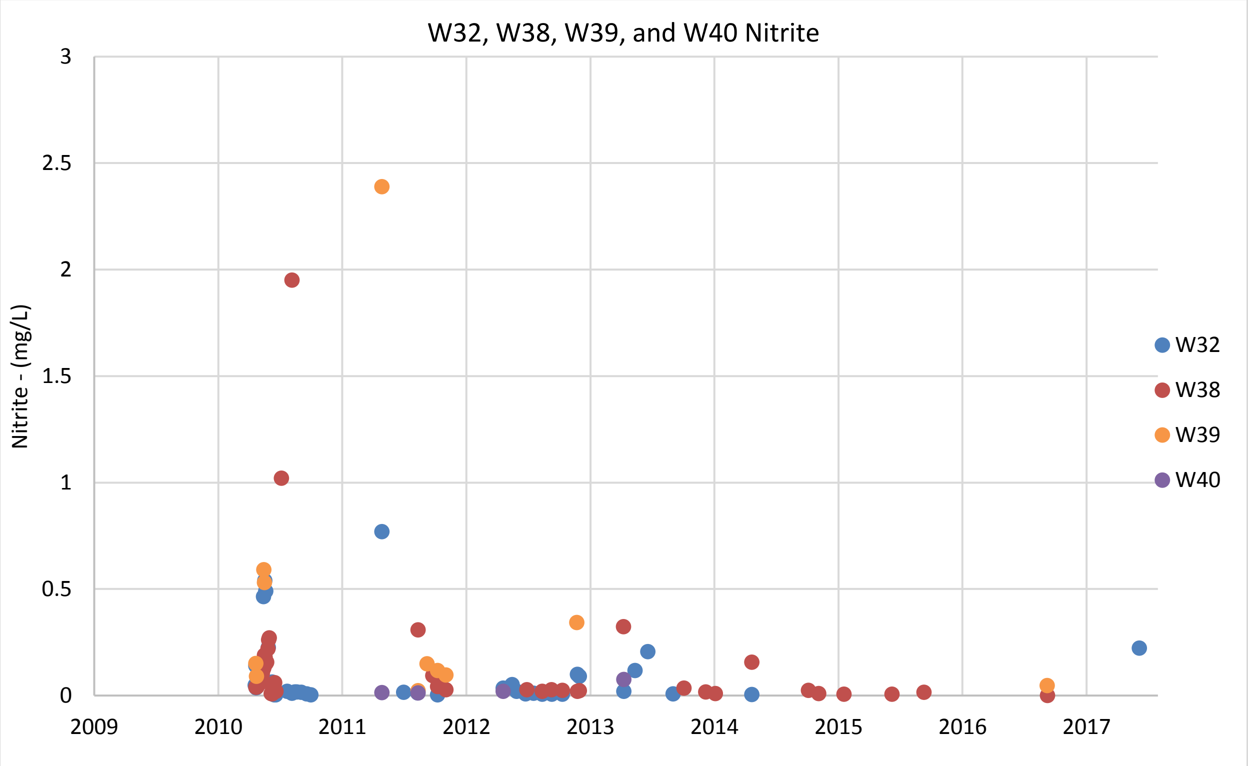


Figure 7-17: W32, W38, W39, and W40 Nitrite

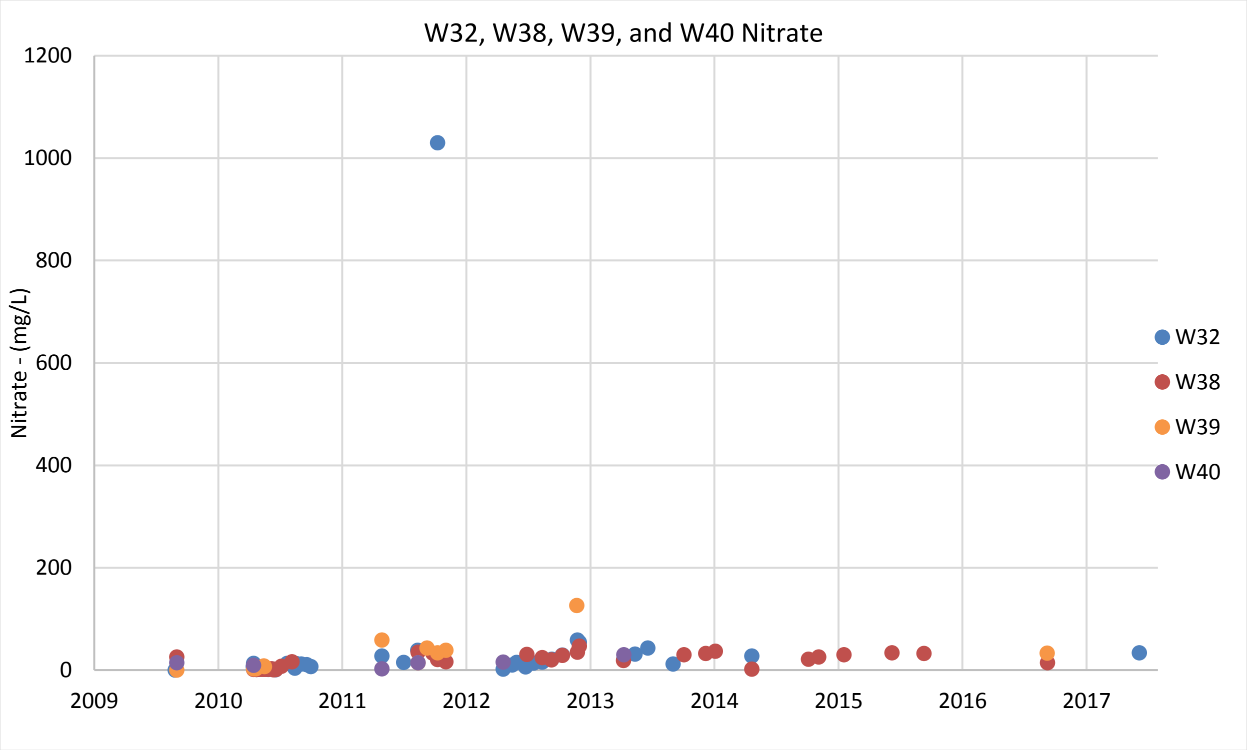


Figure 7-18: W32, W38, W39, and W40 Nitrate

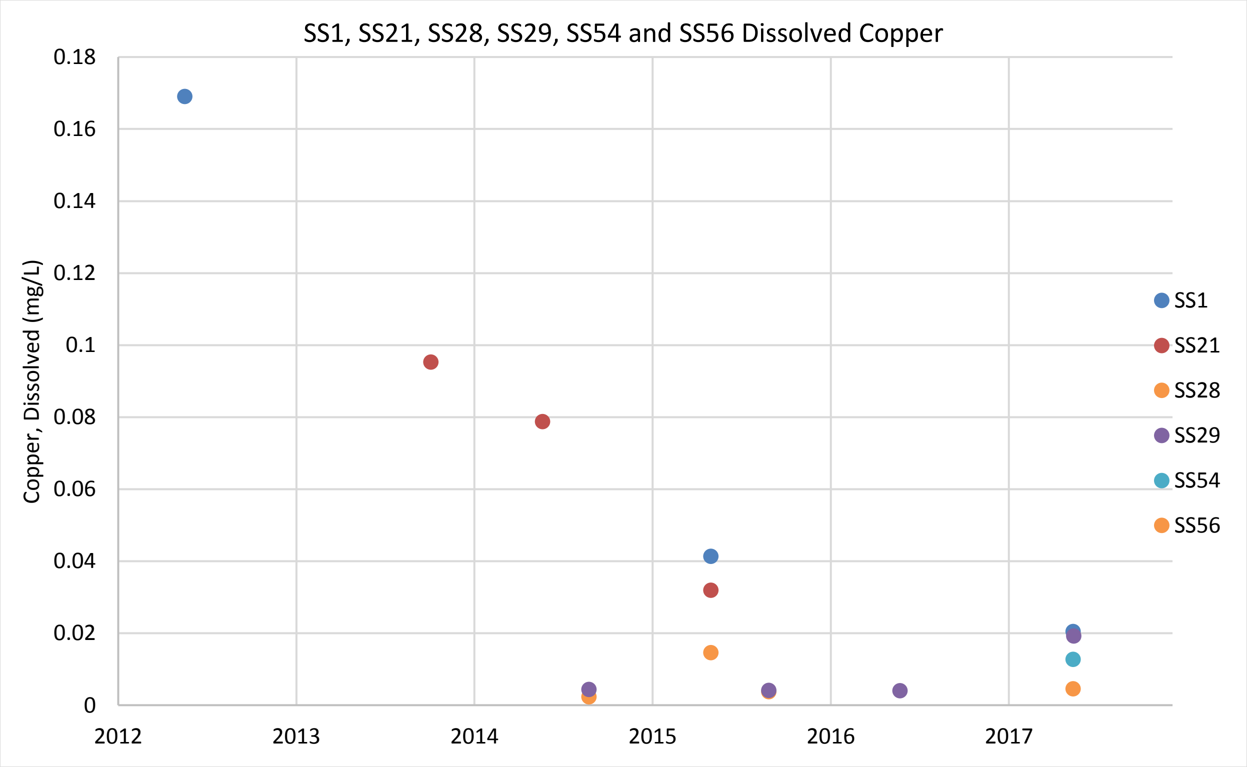


Figure 7-19: SS1, SS21, SS28, SS29, SS54 and SS56 Dissolved Copper

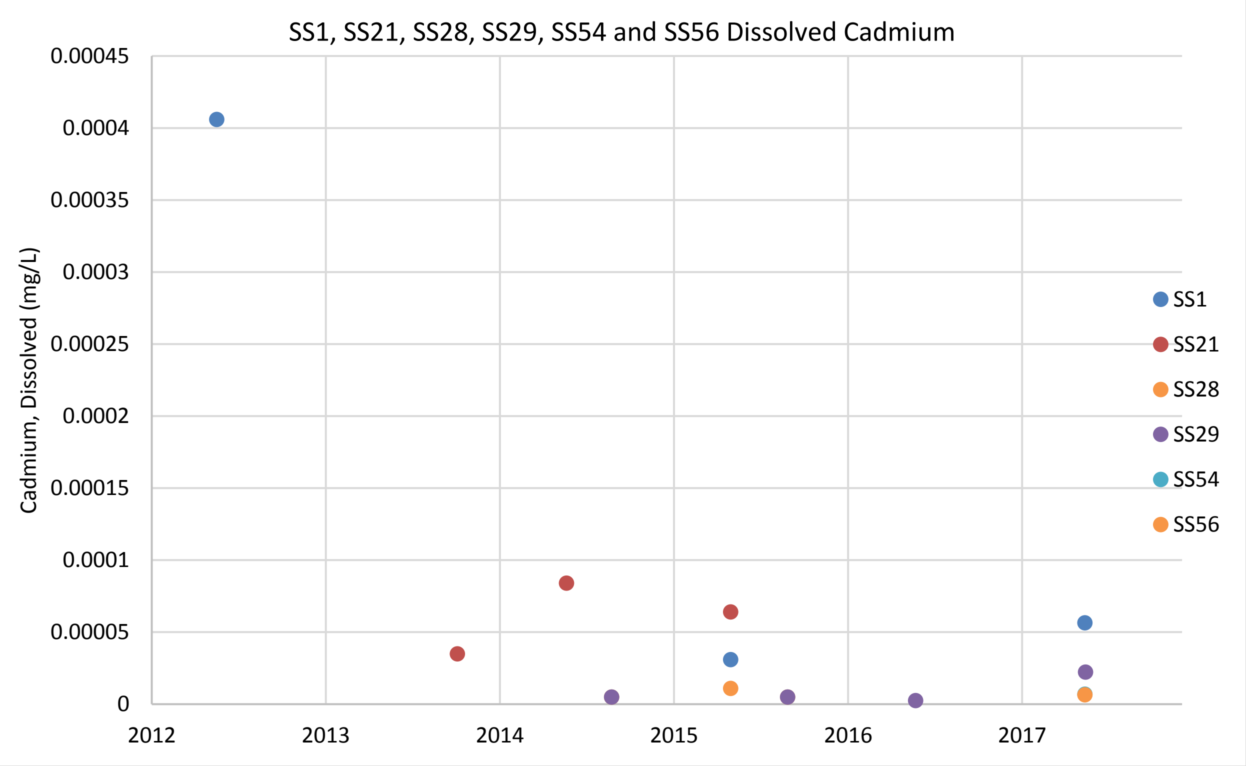


Figure 7-20: SS1, SS21, SS28, SS29, SS54 and SS56 Dissolved Cadmium

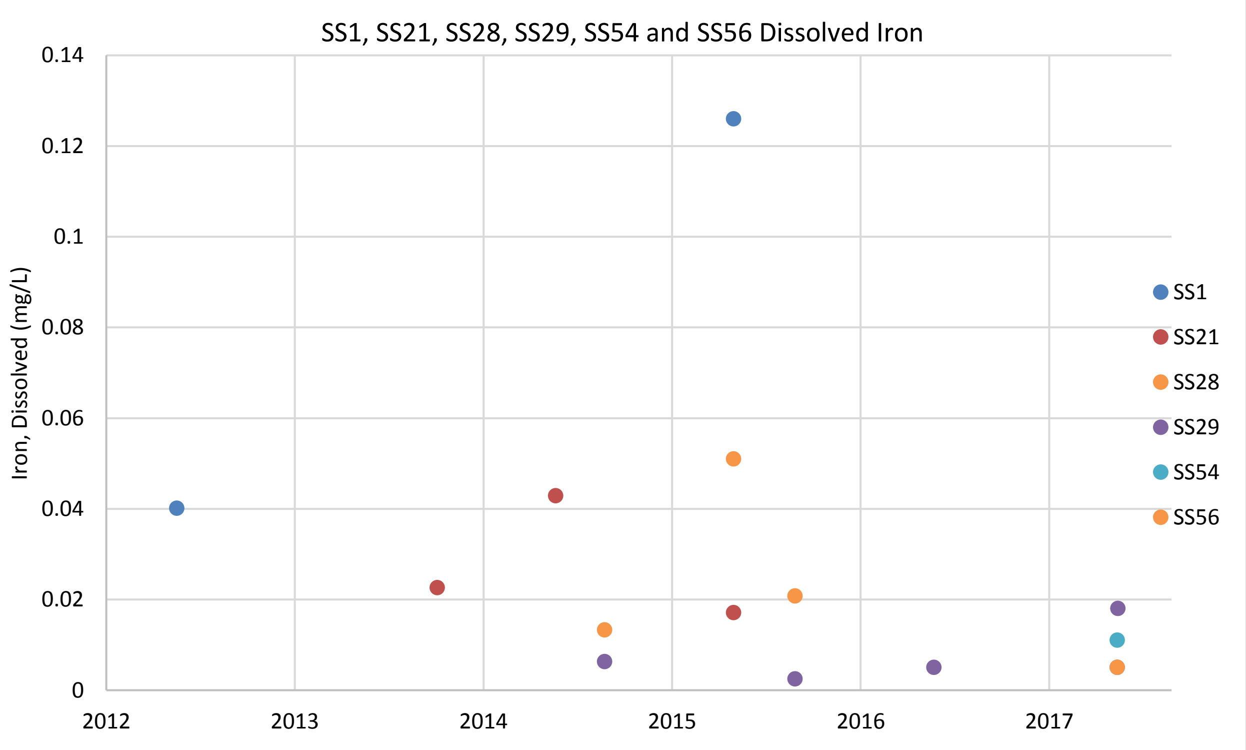


Figure 7-21: SS1, SS21, SS28, SS29, SS54 and SS56 Dissolved Iron

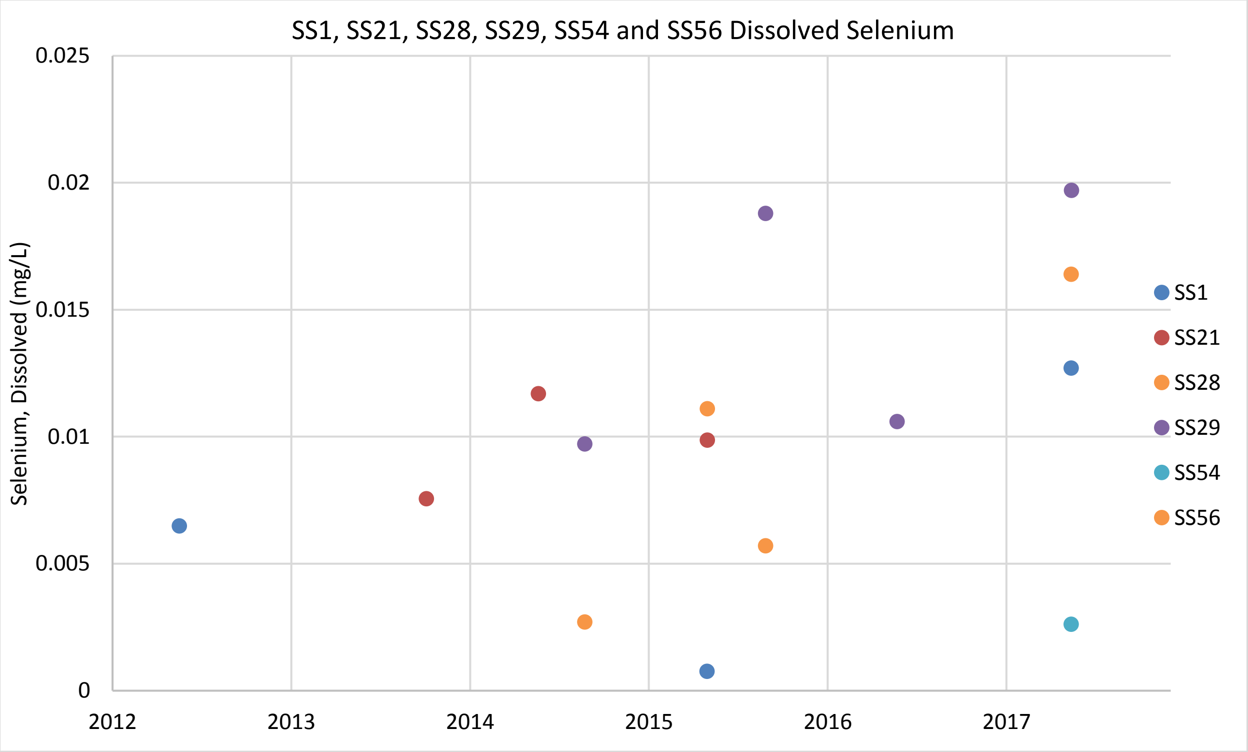


Figure 7-22: SS1, SS21, SS28, SS29, SS54 and SS56 Dissolved Selenium

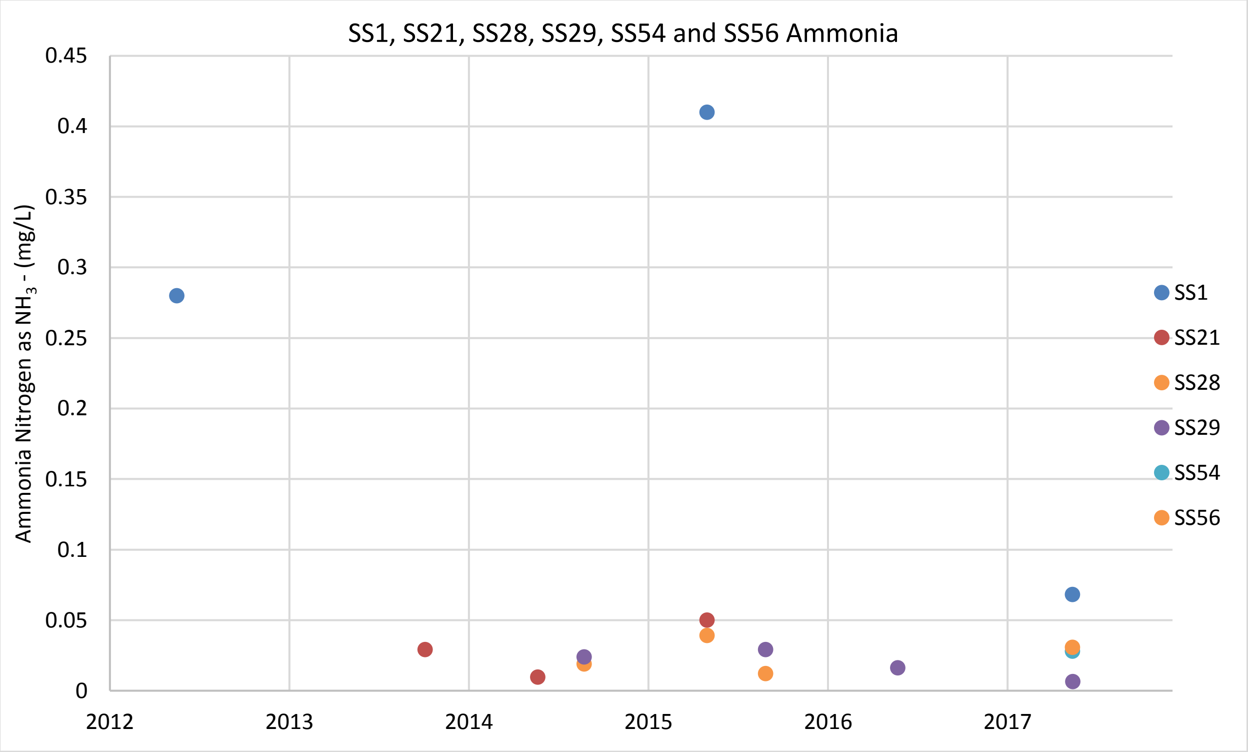


Figure 7-23: SS1, SS21, SS28, SS29, SS54 and SS56 Ammonia

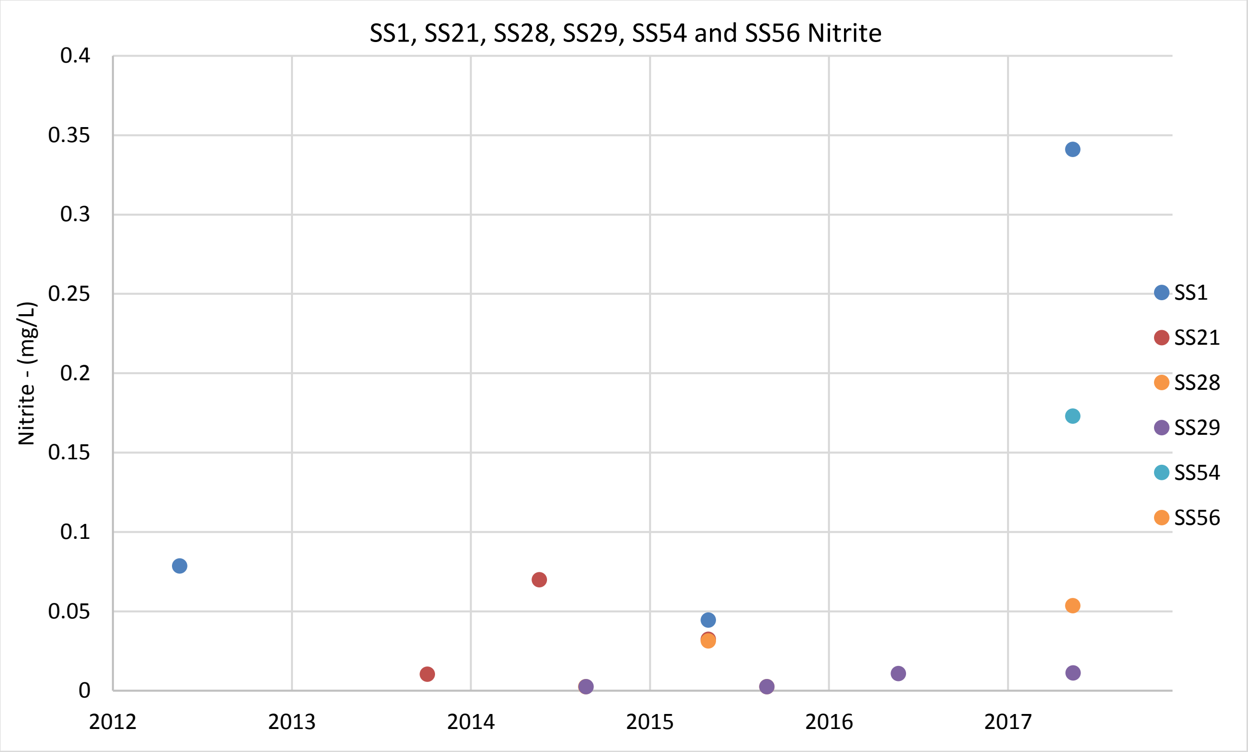


Figure 7-24: SS1, SS21, SS28, SS29, SS54 and SS56 Nitrite

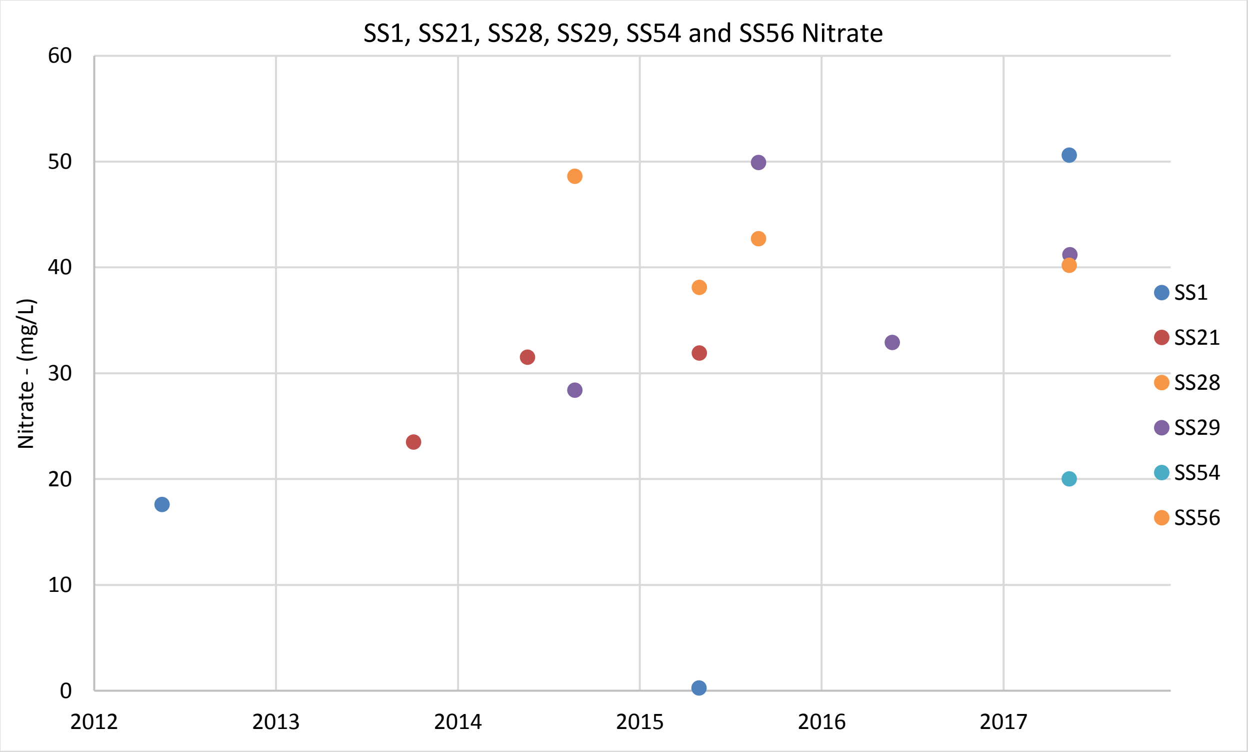


Figure 7-25: SS1, SS21, SS28, SS29, SS54 and SS56 Nitrate

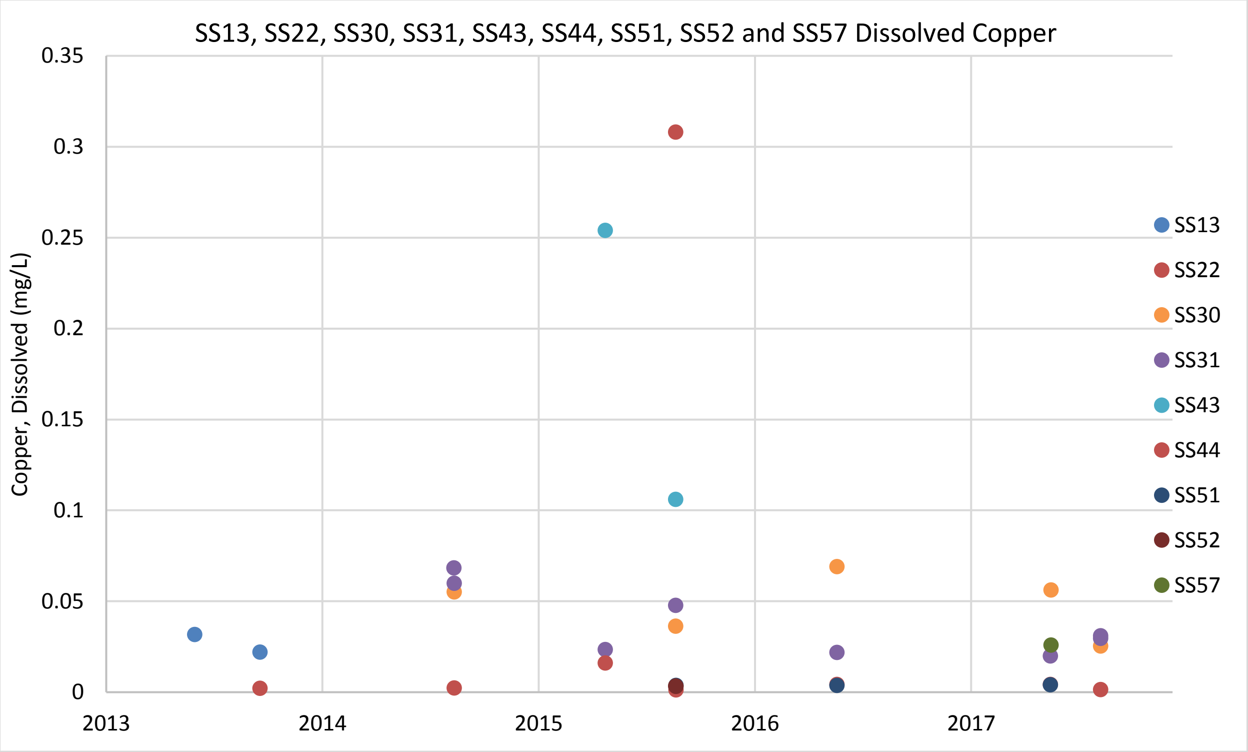


Figure 7-26: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Dissolved Copper

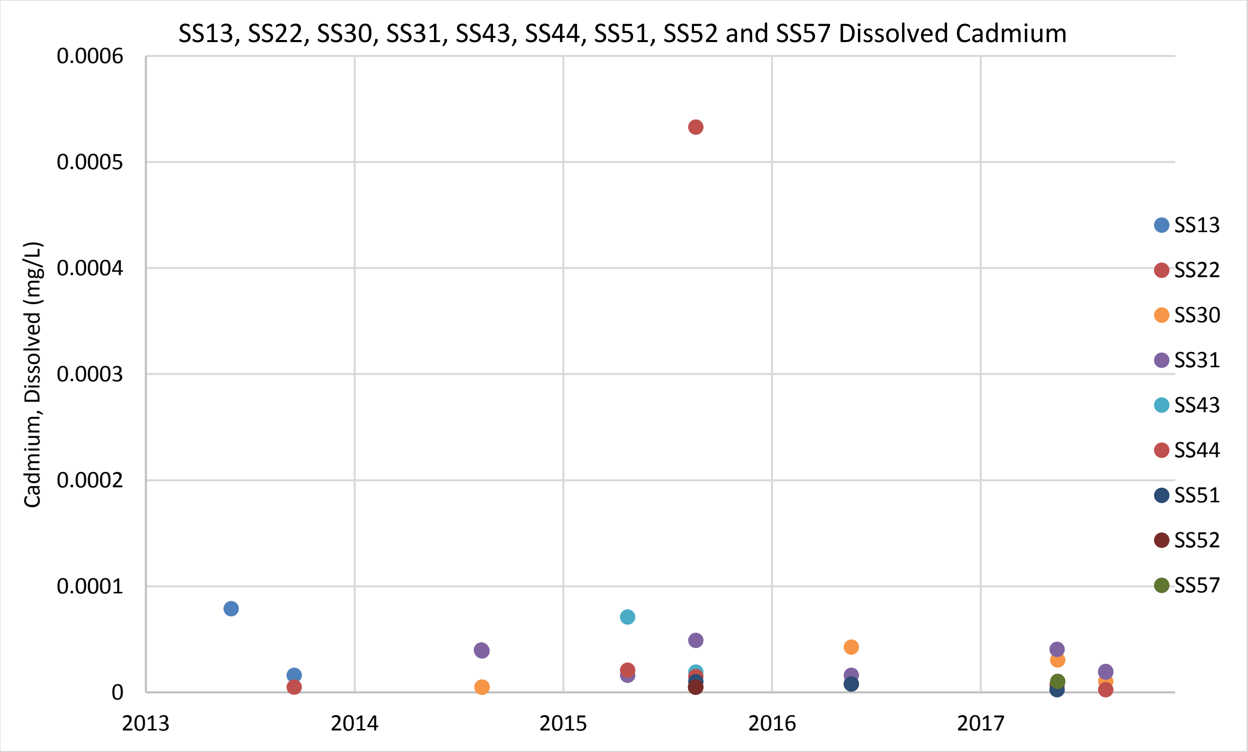


Figure 7-27: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Dissolved Cadmium

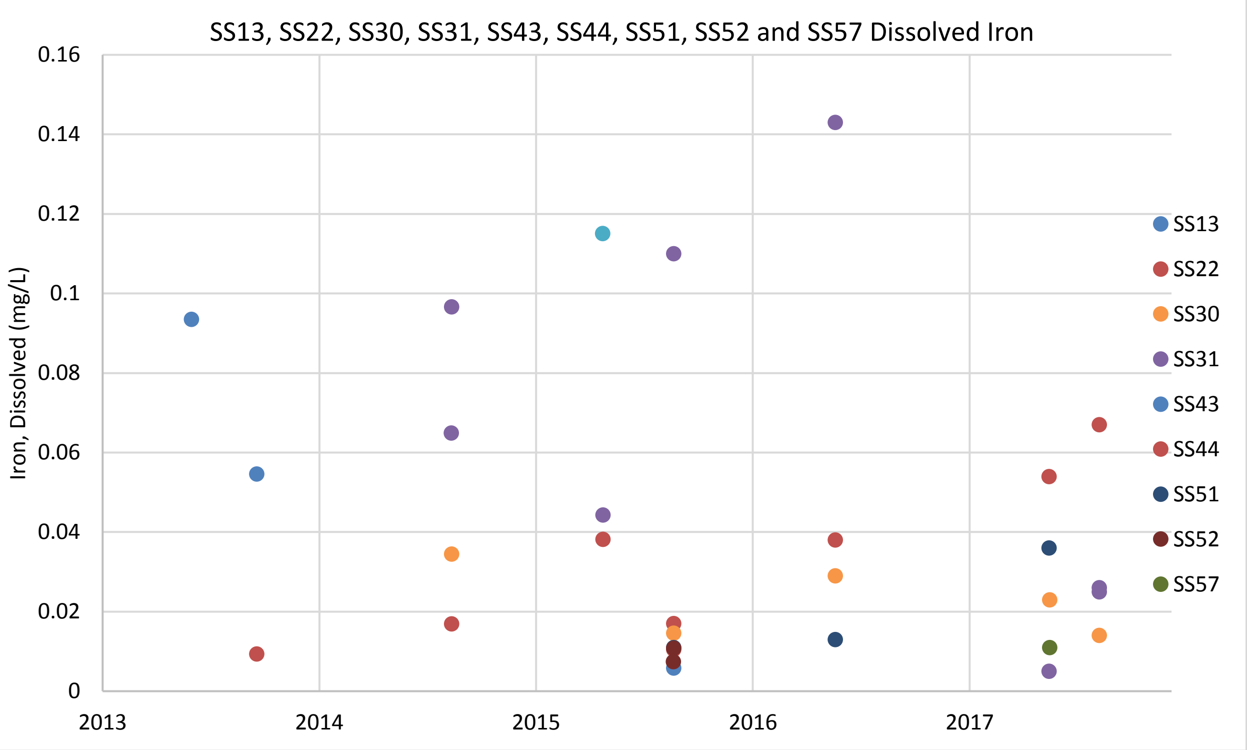


Figure 7-28: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Dissolved Iron

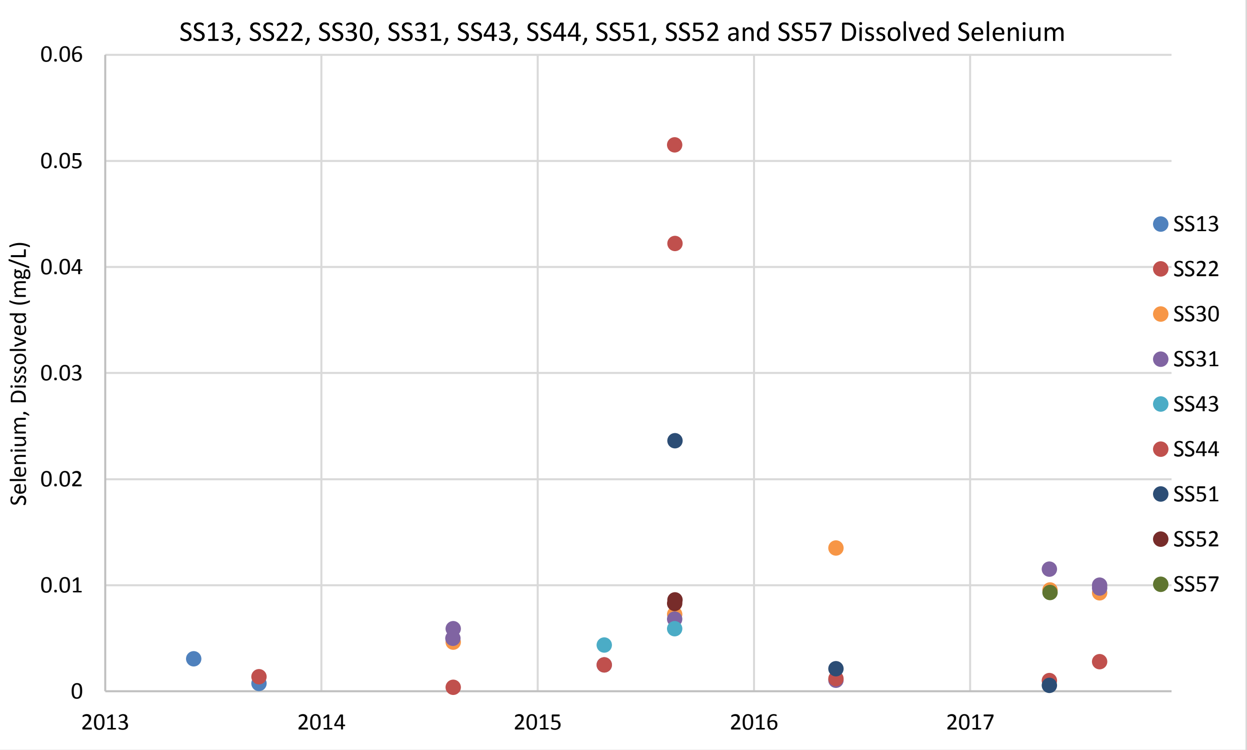


Figure 7-29: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Dissolved Selenium

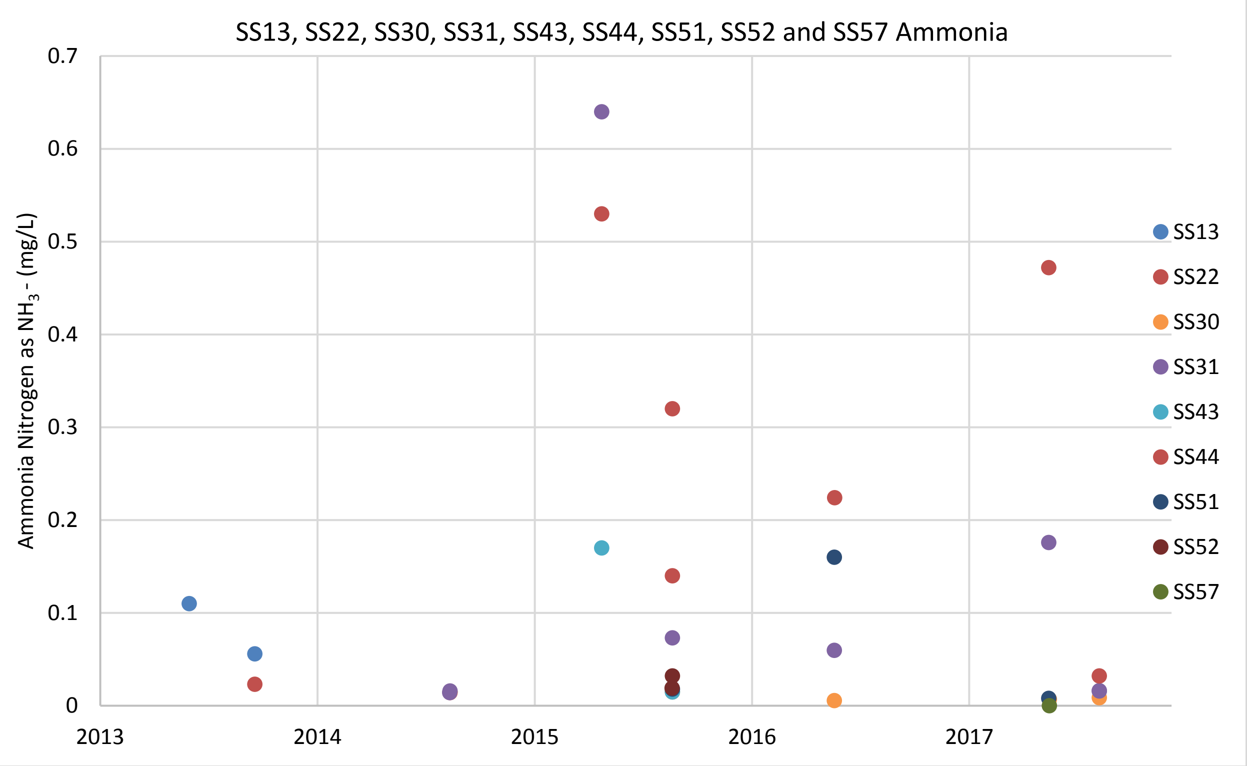


Figure 7-30: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Ammonia

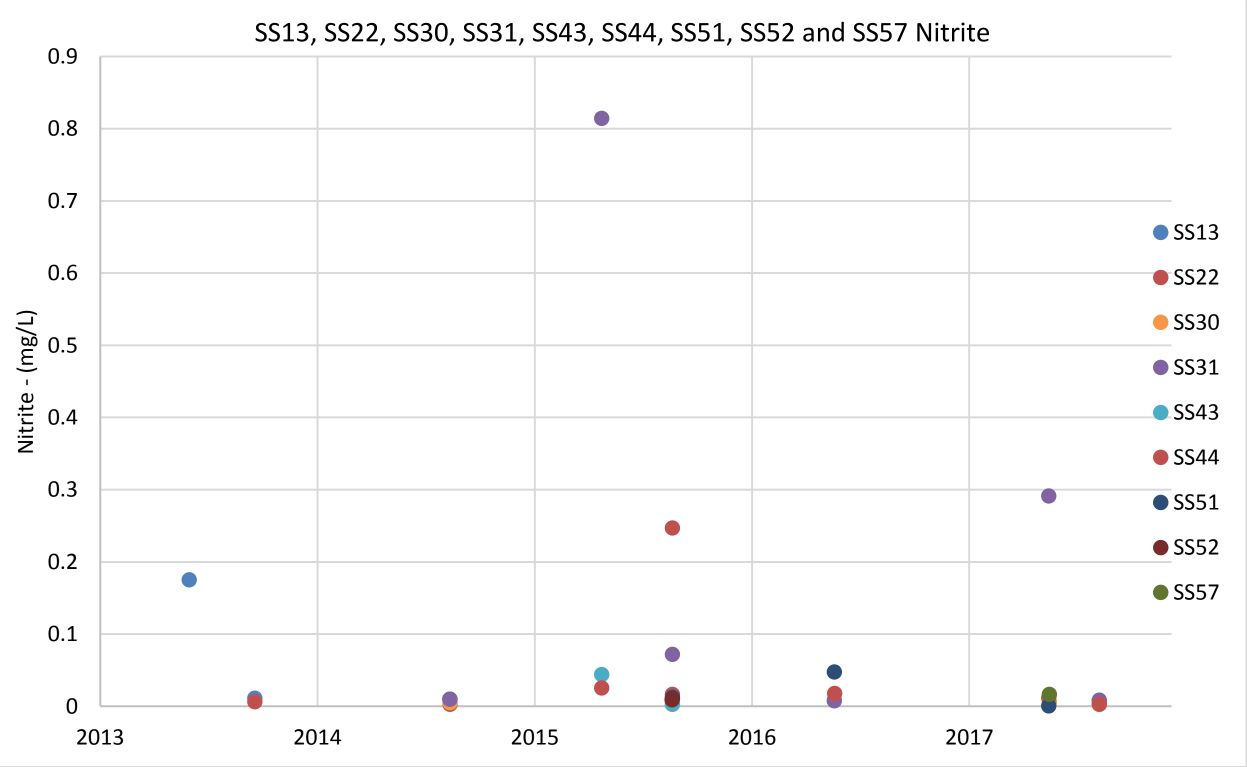


Figure 7-31: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Nitrite

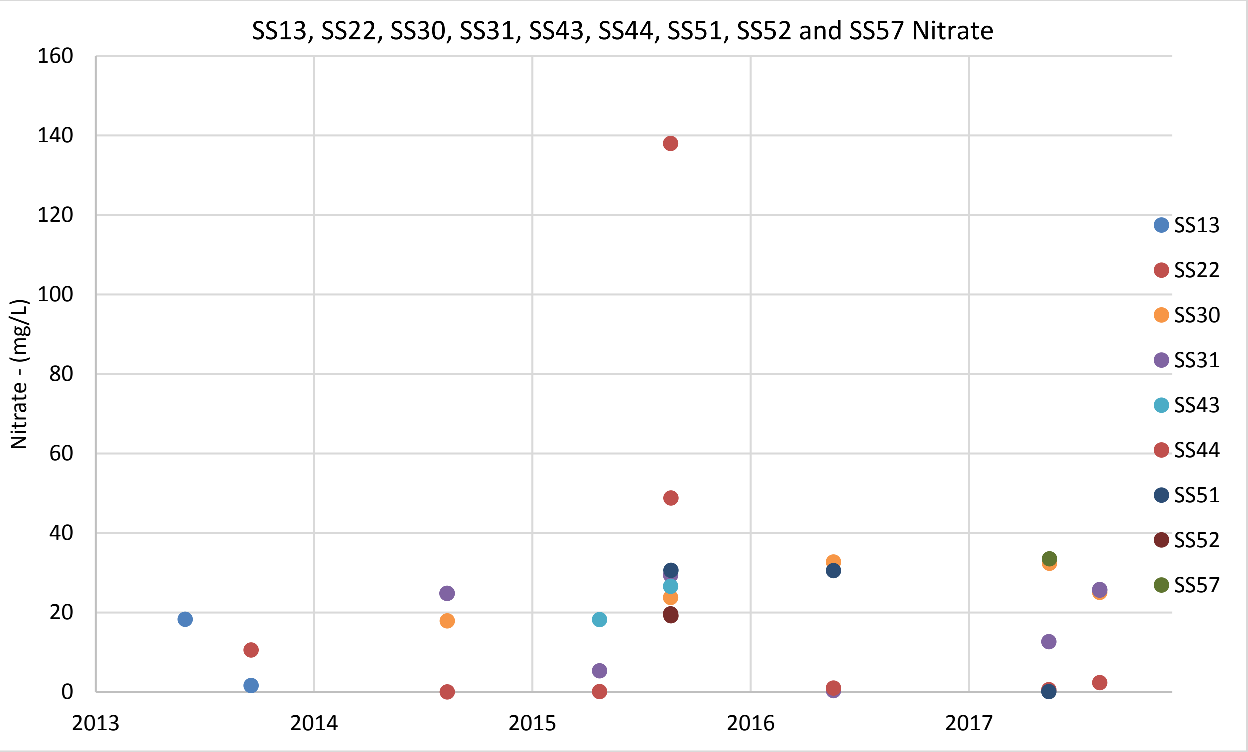


Figure 7-32: SS13, SS22, SS30, SS31, SS43, SS44, SS51, SS52 and SS57 Nitrate

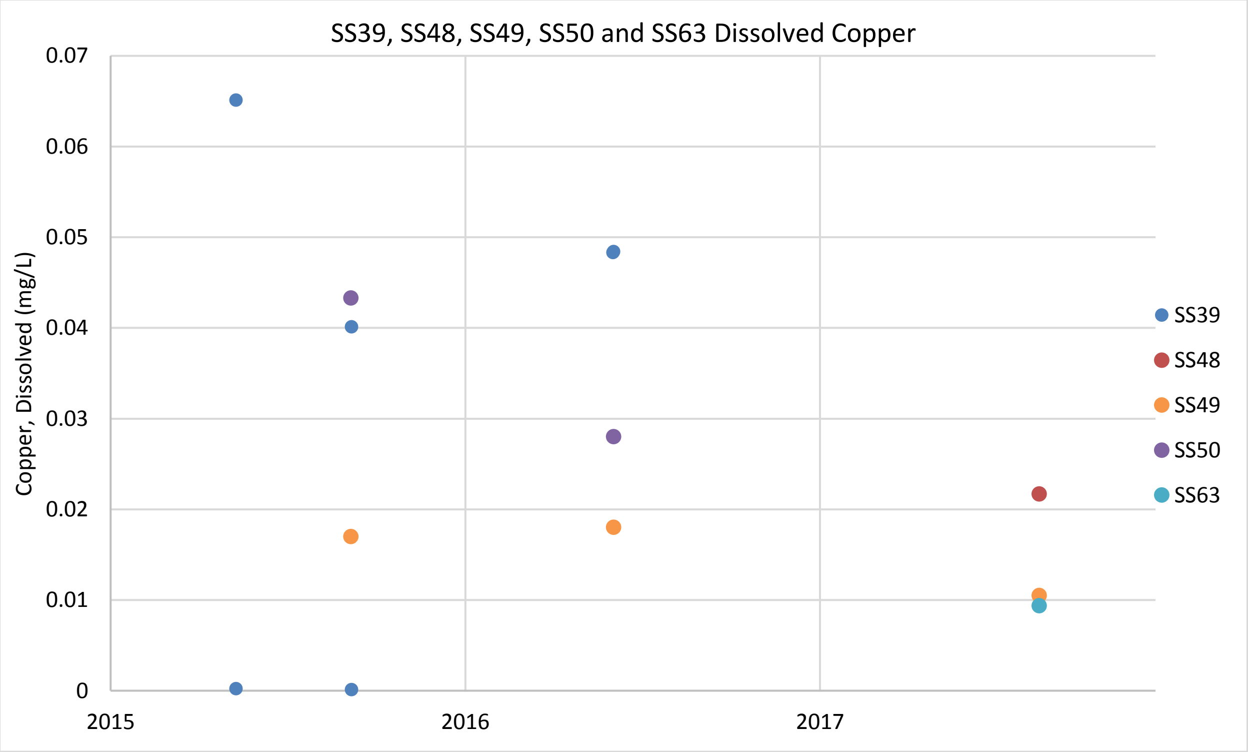


Figure 7-33: SS39, SS48, SS49, SS50 and SS63 Dissolved Copper

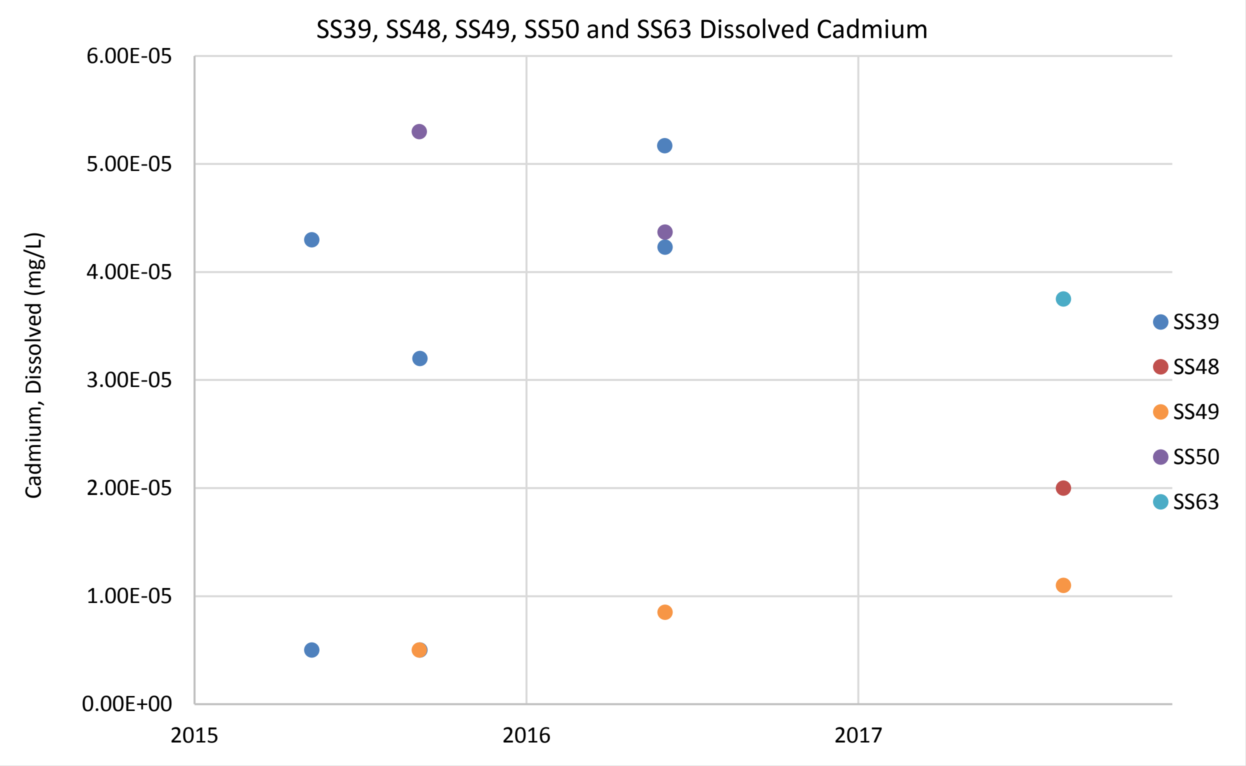


Figure 7-34: SS39, SS48, SS49, SS50 and SS63 Dissolved Cadmium

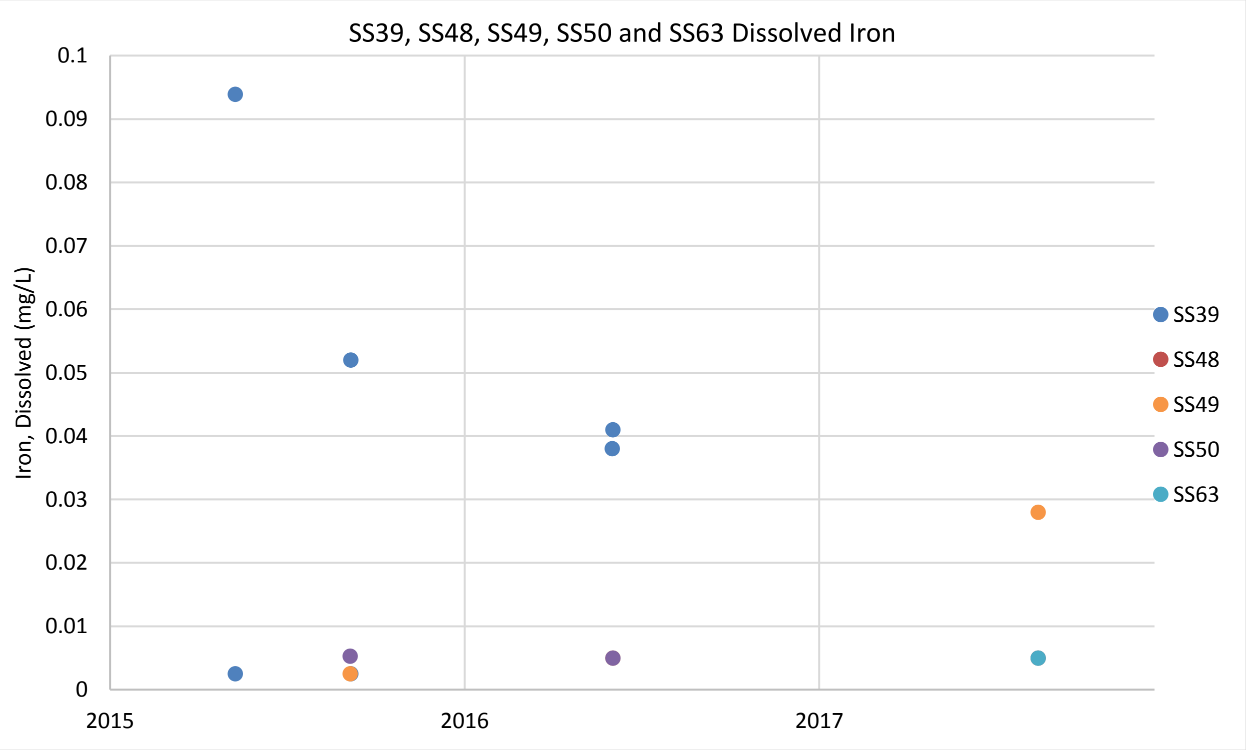


Figure 7-35: SS39, SS48, SS49, SS50 and SS63 Dissolved Iron

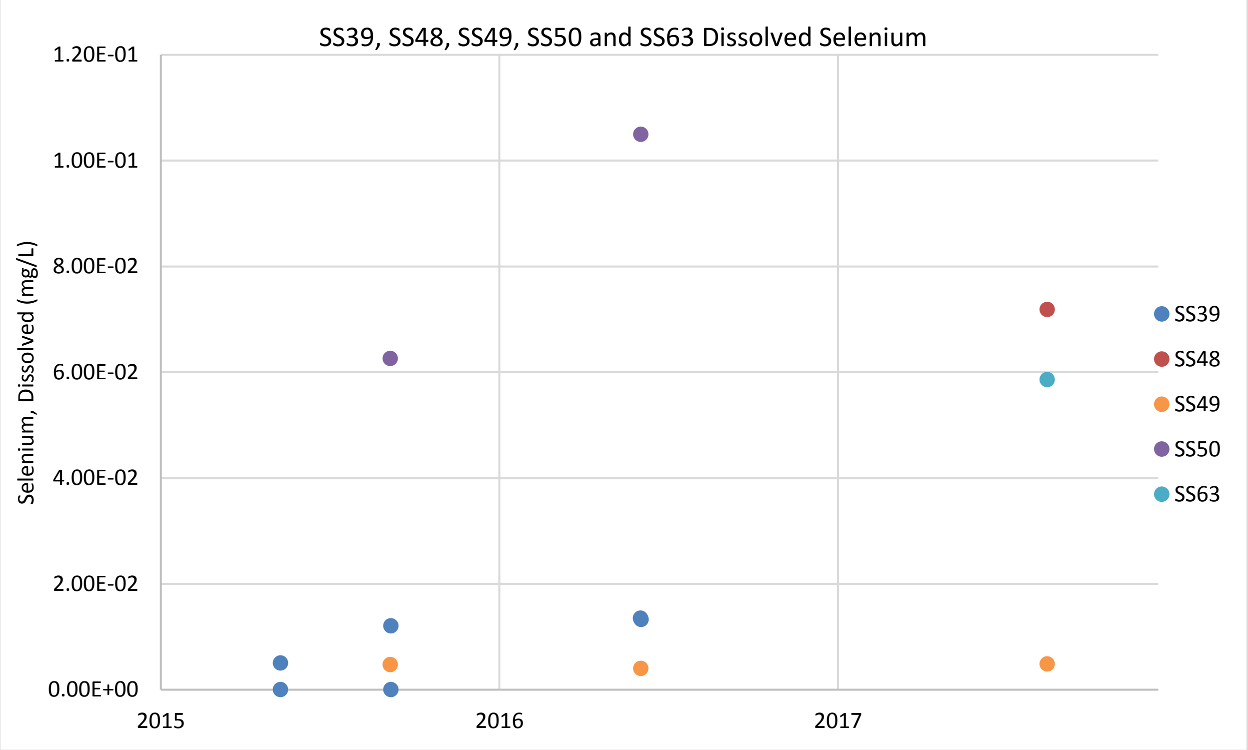


Figure 7-36: SS39, SS48, SS49, SS50 and SS63 Dissolved Selenium

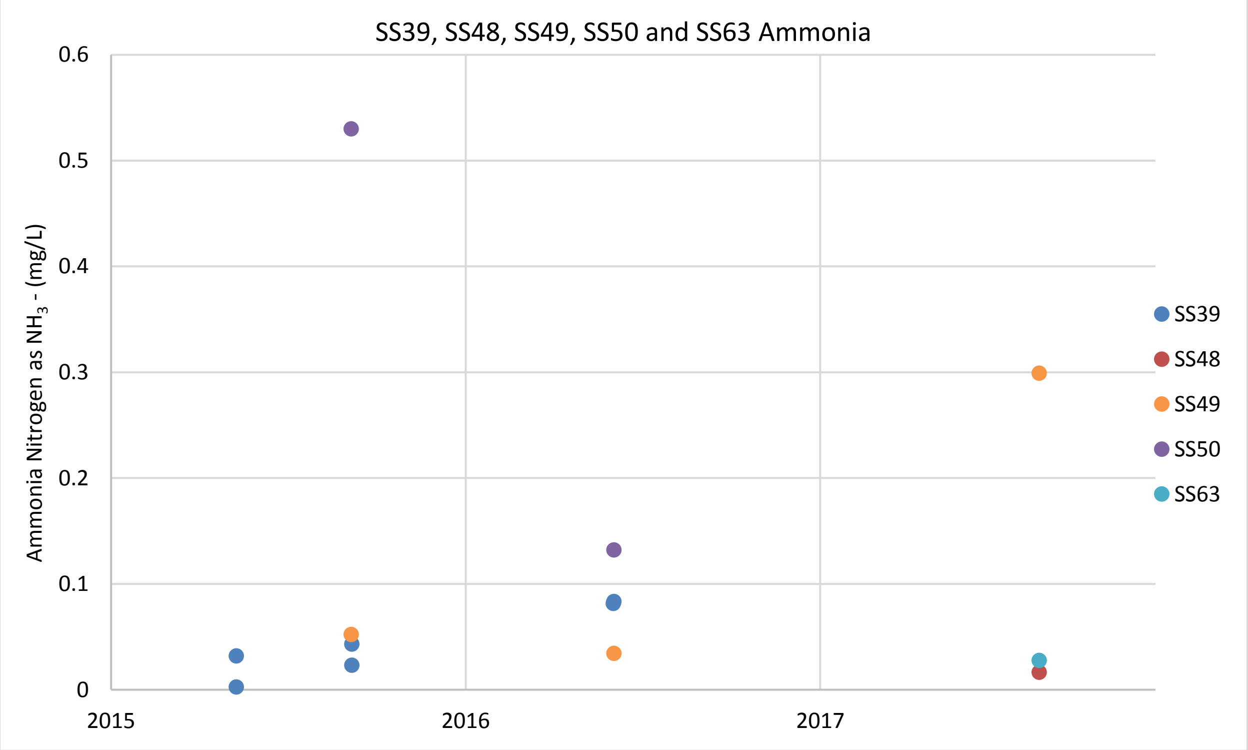


Figure 7-37: SS39, SS48, SS49, SS50 and SS63 Dissolved Ammonia

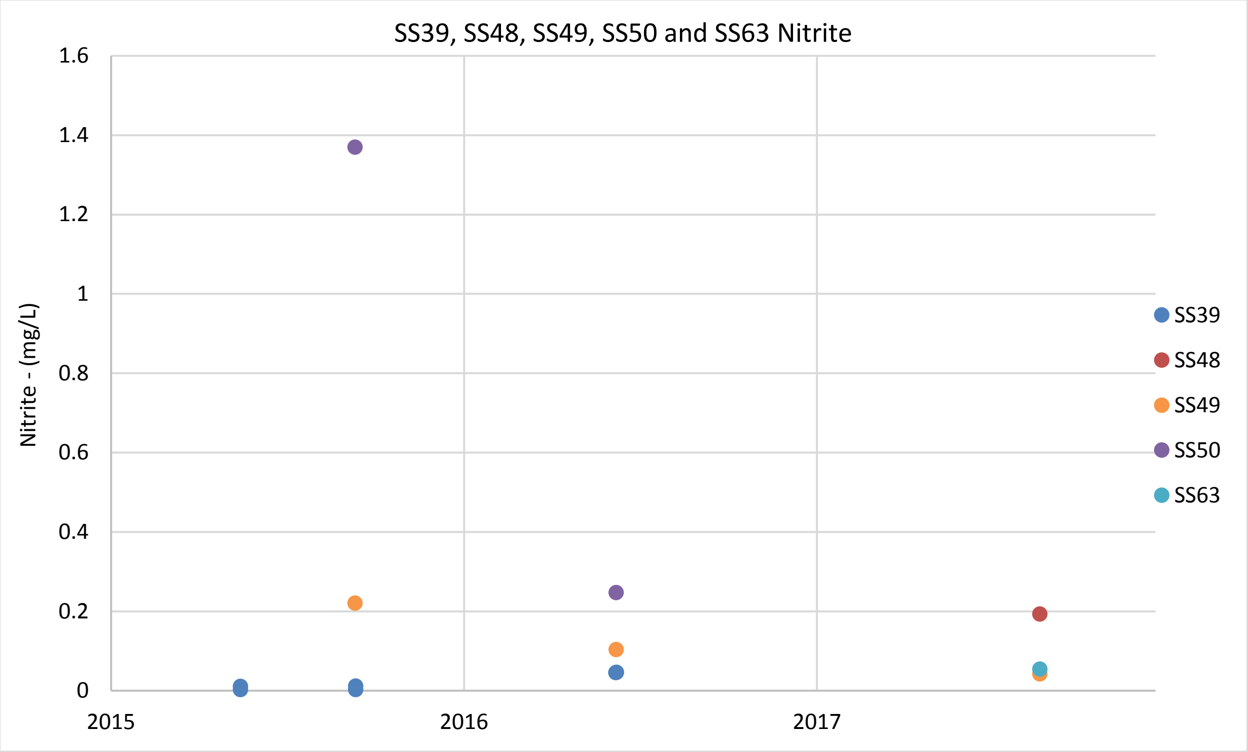


Figure 7-38: SS39, SS48, SS49, SS50 and SS63 Dissolved Nitrite

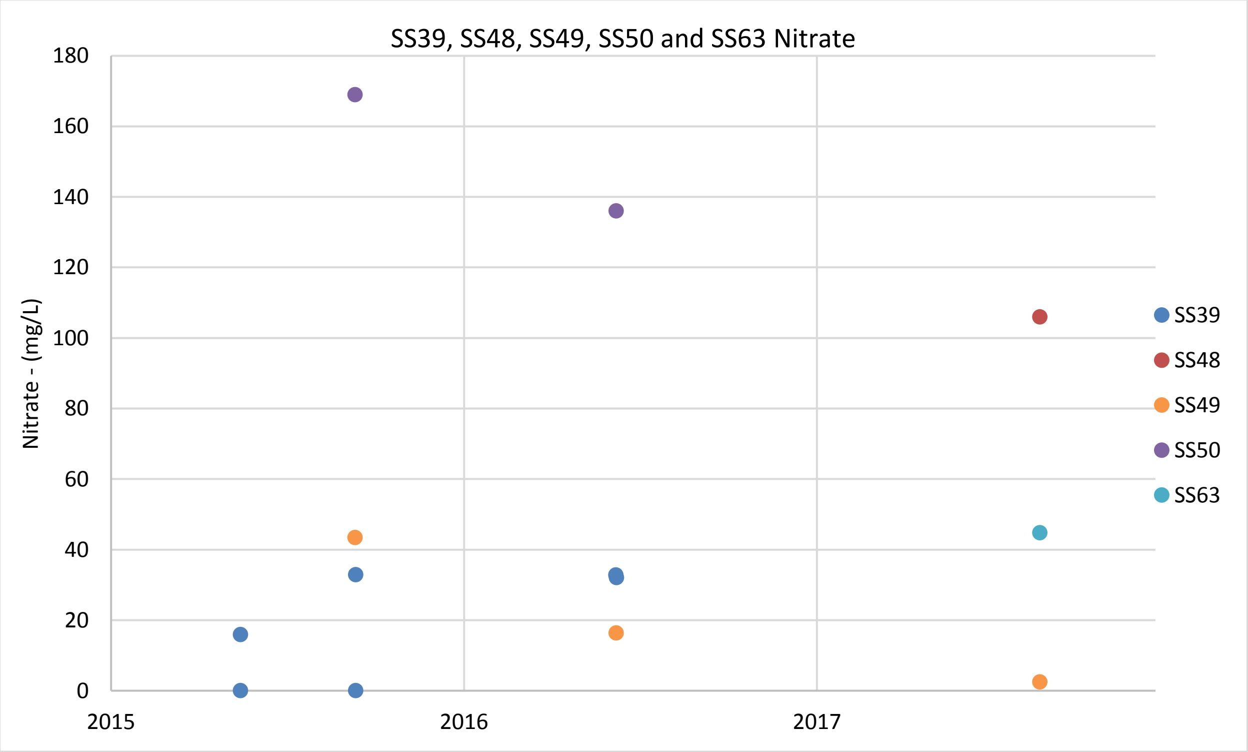


Figure 7-39: SS39, SS48, SS49, SS50 and SS63 Dissolved Nitrate

7.3 Minto Creek Detention Structure (MCDS) and Water Storage Pond

The Mill Valley Fill Extension Stage 2 (MVFE2) collection sump (W62) was constructed during the period of November 9, 2015 to February 7, 2016 as a replacement for the Minto Creek Detention Structure (W37) used prior to 2016. W37 was decommissioned and buried in February, 2016 as part of the MVFE2 construction. W62 is approximately 30m downslope from W37 and collects runoff and seepage from the Dry Stack Tailing Storage Facility and the Mill Valley Fill.

Water collected at W62 is pumped to the Main Pit. Water quality results for W37 (historical) and W62 are outlined in Figure 7-40 through Figure 7-46 and include results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

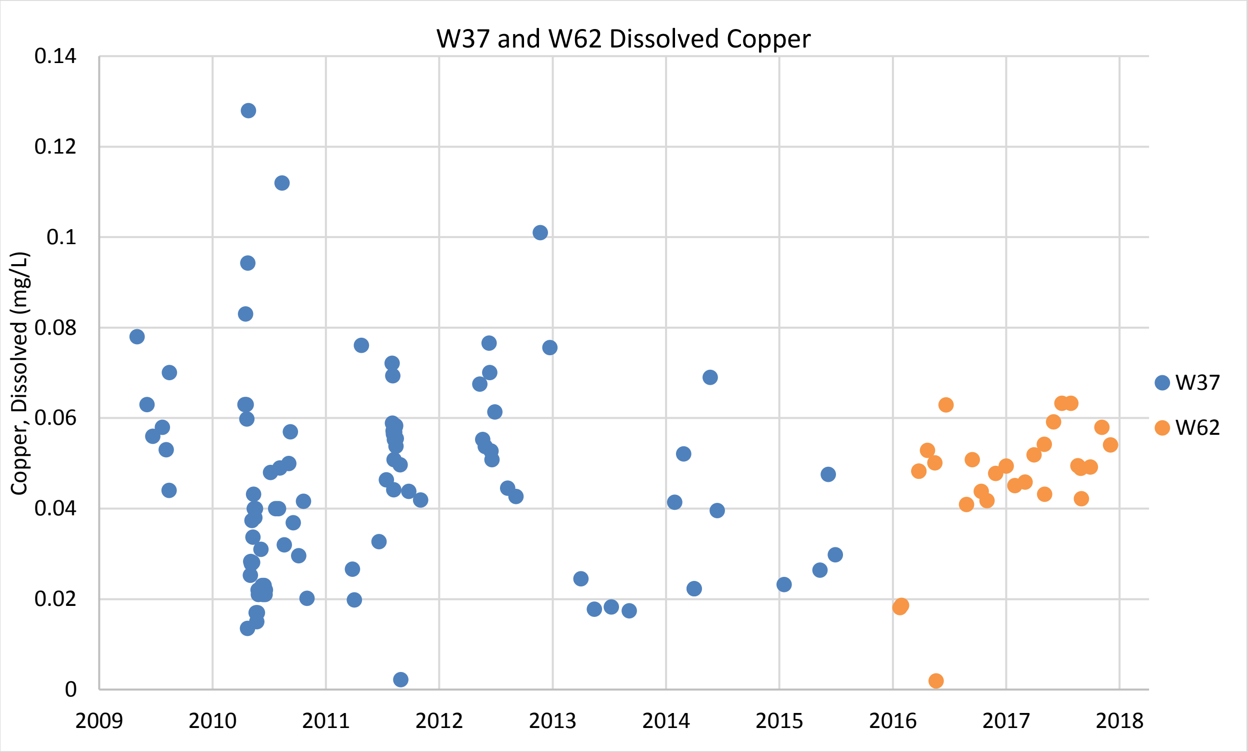


Figure 7-40: W37 and W62 Dissolved Copper

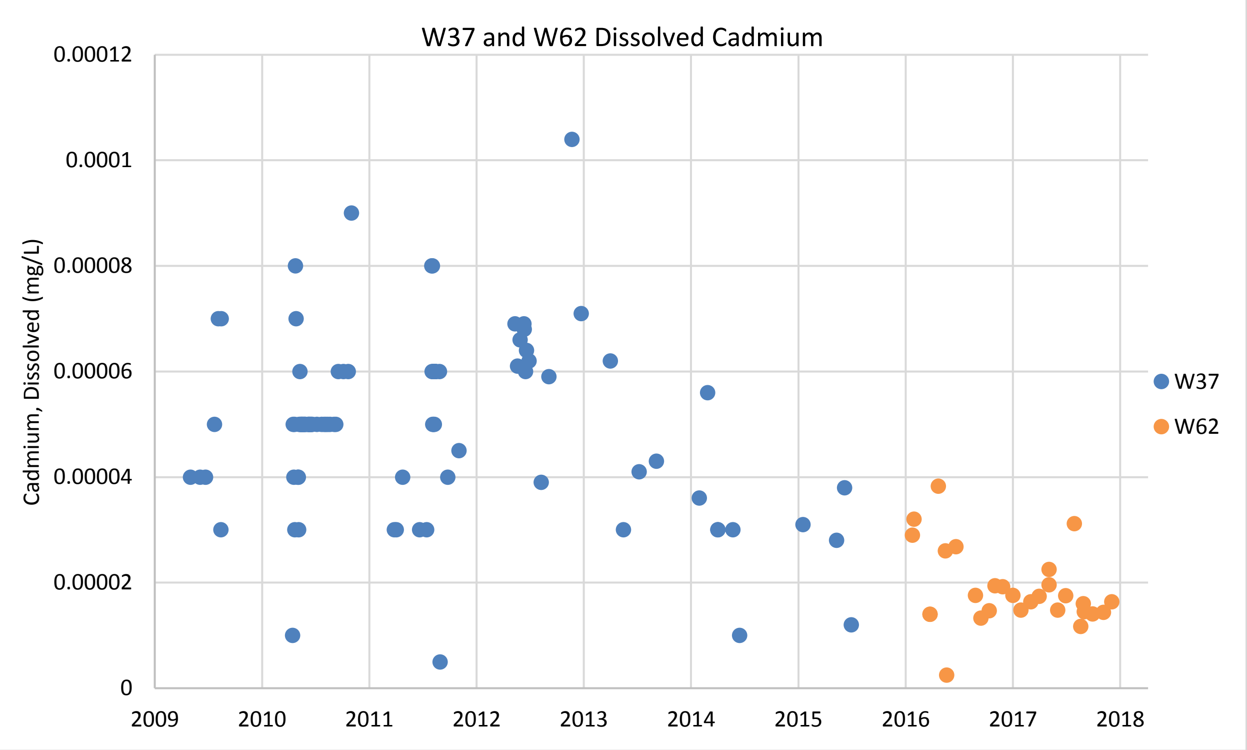


Figure 7-41: W37 and W62 Dissolved Cadmium

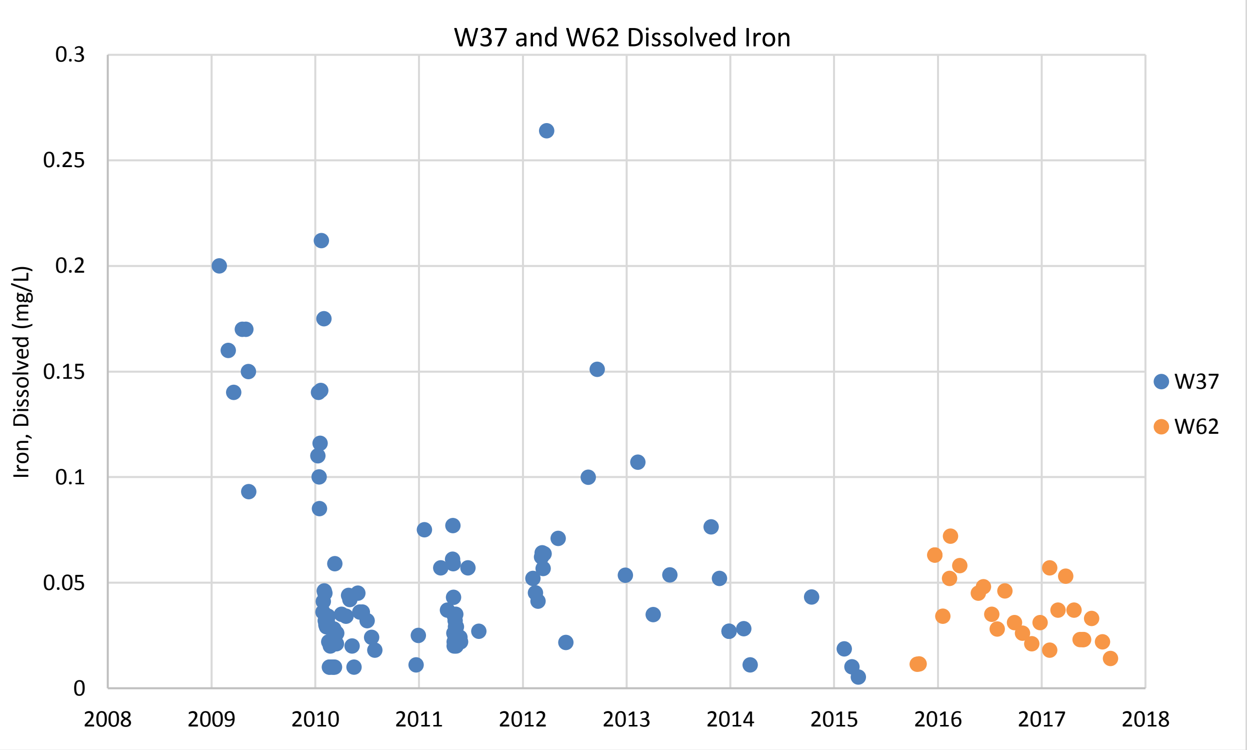


Figure 7-42: W37 and W62 Dissolved Iron

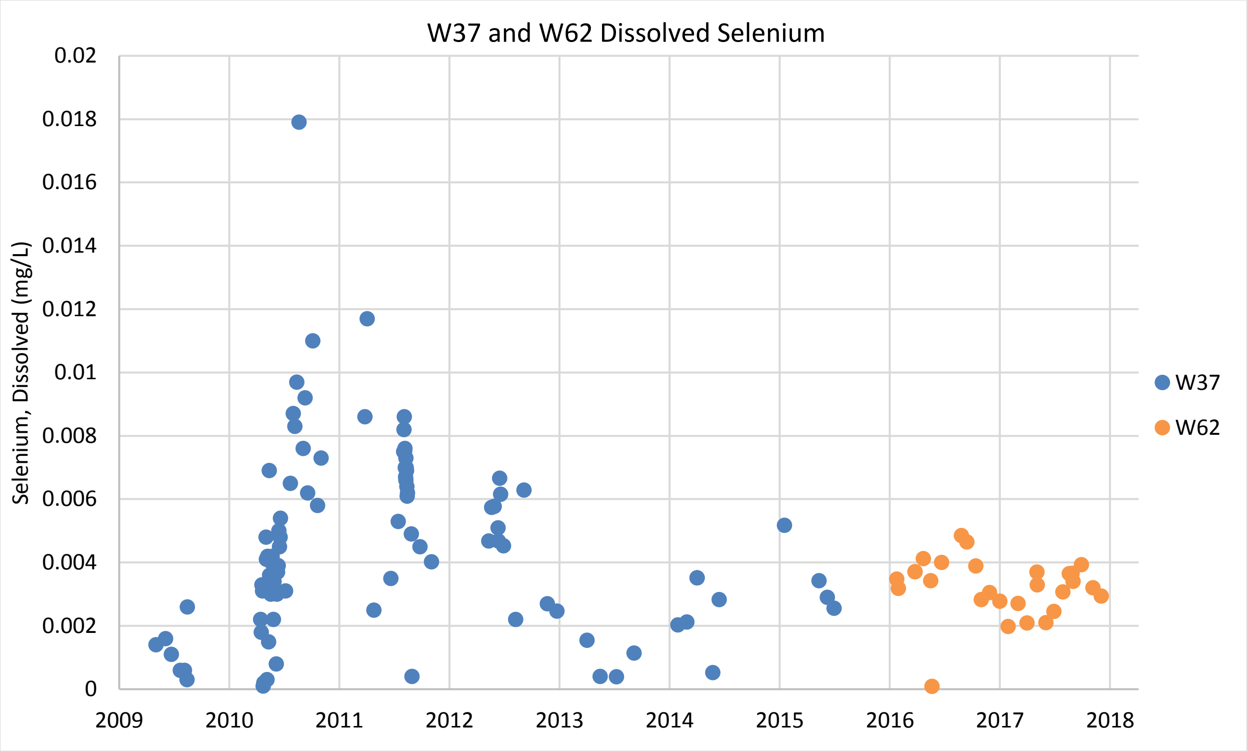


Figure 7-43: W37 and W62 Dissolved Selenium

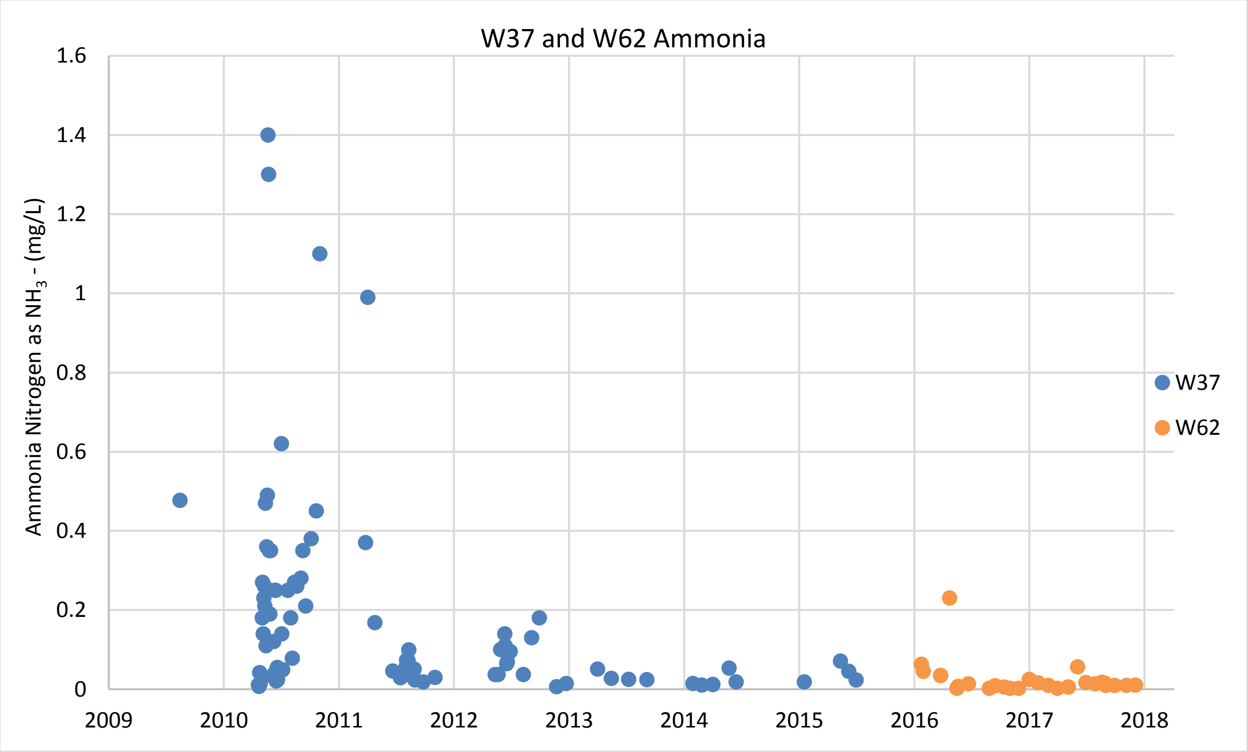


Figure 7-44: W37 and W62 Ammonia

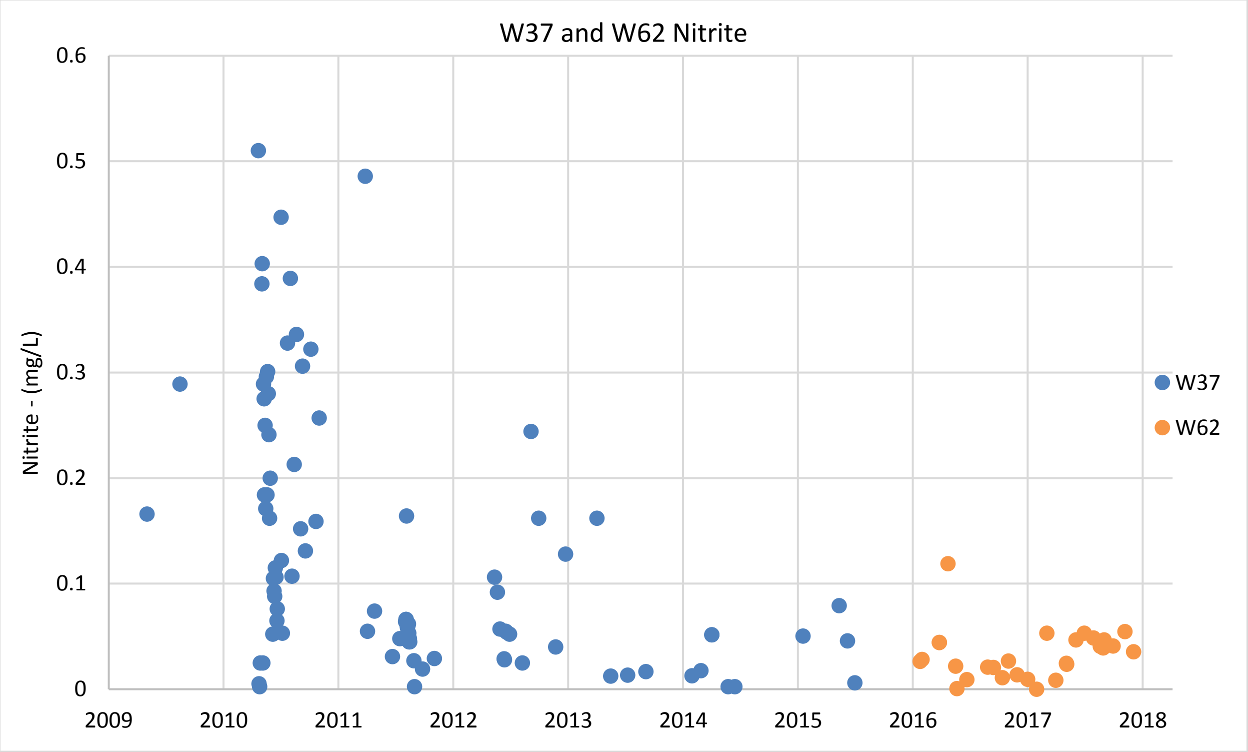


Figure 7-45: W37 and W62 Nitrite

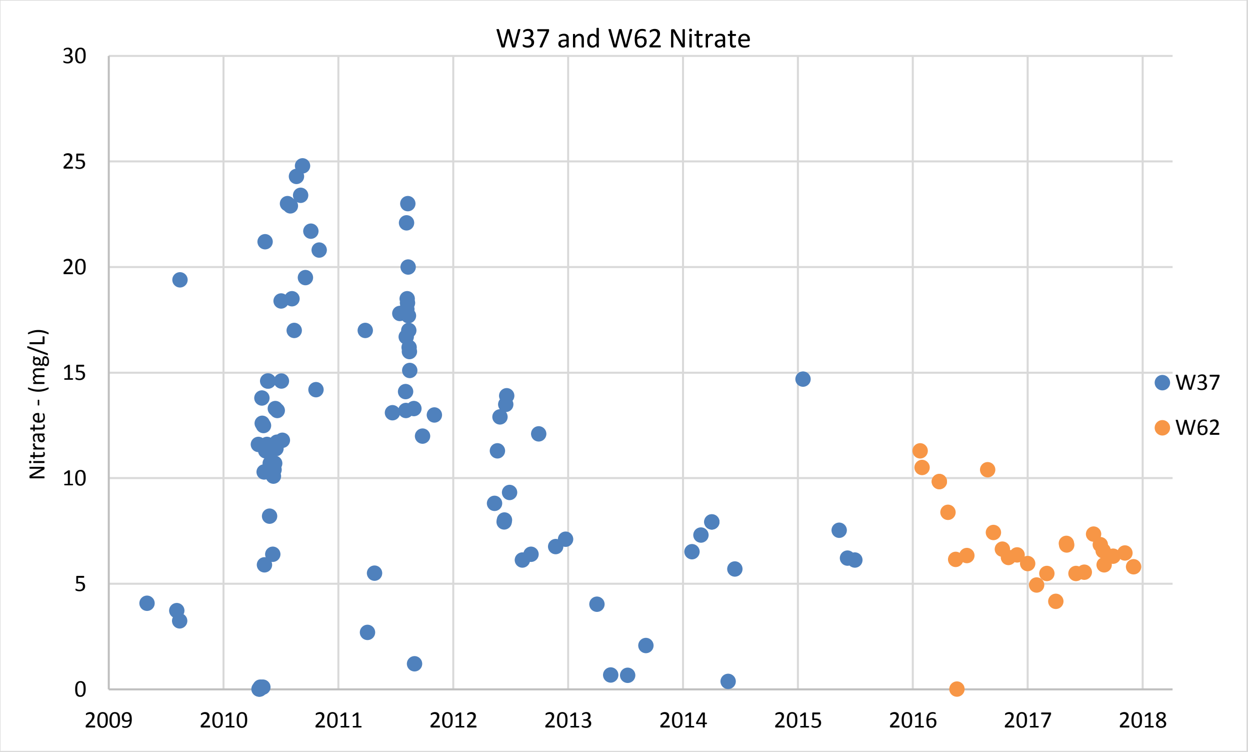


Figure 7-46: W37 and W62 Nitrate

7.4 Water Storage Pond Dam Seep

Seepage water quality at the Water Storage Pond Dam is represented by station W17. Water quality at station W17 is relatively consistent due to its being fed by a large stable body of water (Water Storage Pond). All dam seepage is collected in a vertical culvert and pumped back to the WSP via a 4” insulated heat traced pipe. Water quality statistics for station W17 from 2007 to 2017 are summarized below in Table 7-1. A total of 62 samples were collected in the 2017 monitoring period. Water quality results for W17 are further outlined in Figure 7-47 through Figure 7-55 and include historic water quality results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

Table 7-1: W17 Water Quality Results Summary (2007-2017)

W17	Effluent Quality Standards (WUL Clause 9)	2007 - 2016 Summary Statistics			2017 Summary Statistics		
Parameters		**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	6.0-9.0	8.13	5.43	8.5	8.25	8.04	8.47
TSS (mg/L)	15	2.02	0.5	**267**	1.98	1.5	14.8
Nutrients (mg/L)							
Ammonia	0.75	0.030	-0.01	**0.85**	0.0041	0.0025	0.059
Nitrite Nitrogen	0.18	0.042	0.0005	**7.85**	0.00066	0.0005	0.0107
Nitrate Nitrogen	27.3	4.09	0.0025	12.4	0.344	0.0903	1.9
Dissolved Metals (mg/L)							
Aluminum	0.3	0.0060	0.0005	0.26	0.0023	0.0005	0.0111
Arsenic	0.015	0.00037	0.00005	0.0037	0.000346	0.00025	0.00043
Cadmium	0.004104*	0.000030	0.0000025	0.0028	0.0000042	0.0000025	0.0000148
Chromium	0.003	0.00062	0.00005	**0.008**	0.000068	0.00005	0.0002
Copper	0.039	0.0063	0.0001	0.031	0.00690	0.00508	0.022
Iron	3.3	0.011	0.0025	0.45	0.00686	0.005	0.056
Lead	0.012	0.00011	0.000009	0.0008	0.000025	0.000025	0.000025
Molybdenum	0.219	0.0065	0.000025	0.022	0.00545	0.00289	0.00629
Nickel	0.33	0.00095	0.00025	0.011	0.000627	0.00025	0.00087
Selenium	0.006	0.0011	0.000025	0.005	0.000404	0.0002	0.000722
Zinc	0.09	0.0036	0.0005	0.043	0.000819	0.0005	0.0047

Bold values indicate exceedances of the WUL standards
***Based on measured hardness**

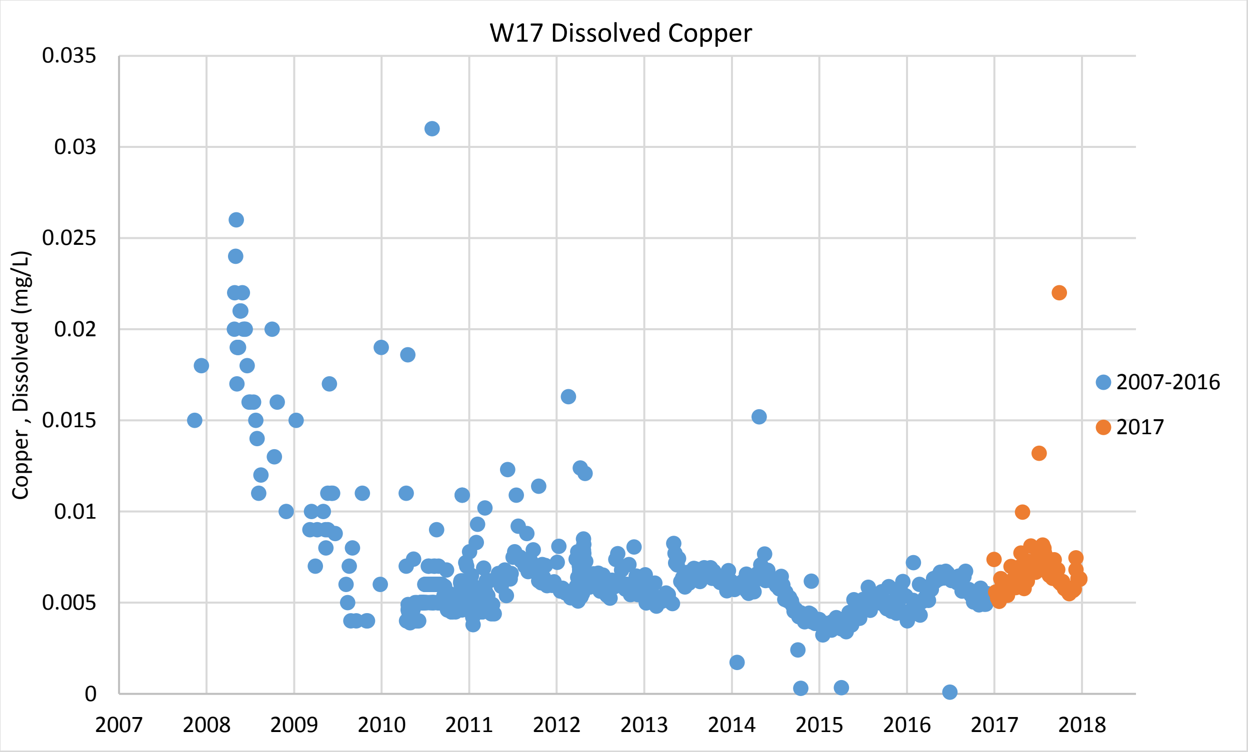


Figure 7-47: W17 Dissolved Copper

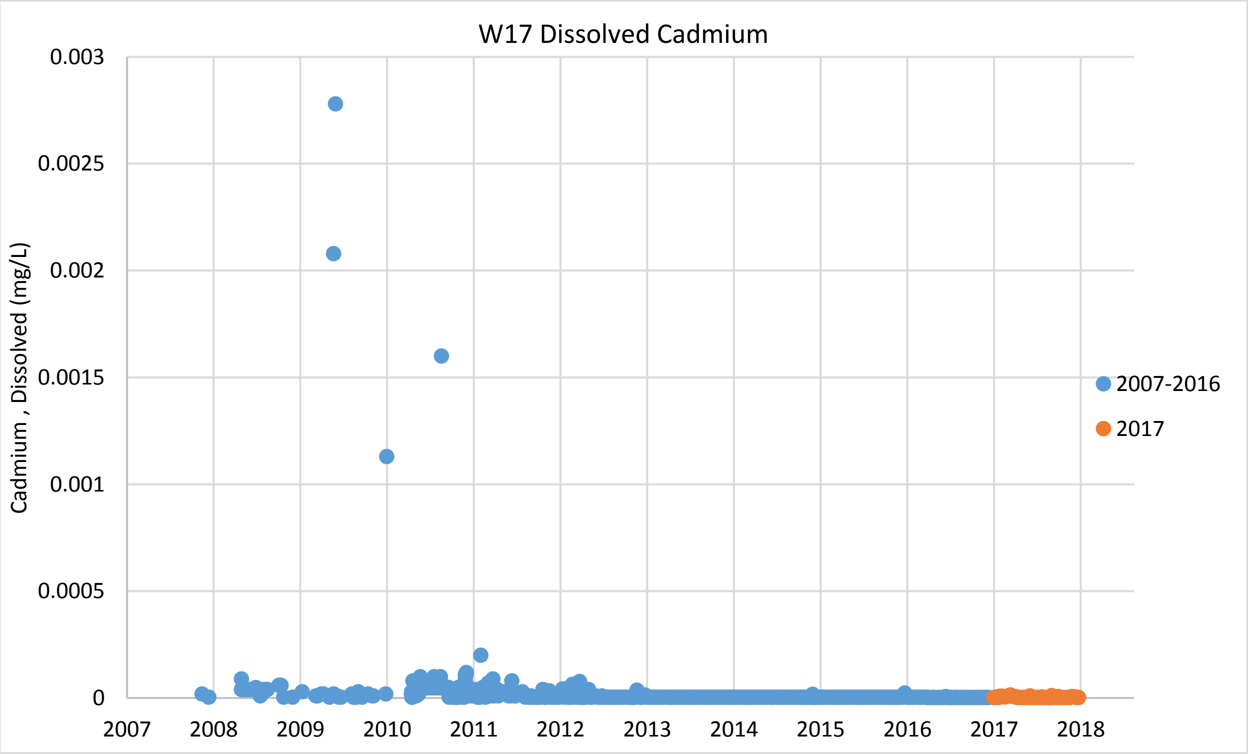


Figure 7-48: W17 Dissolved Cadmium

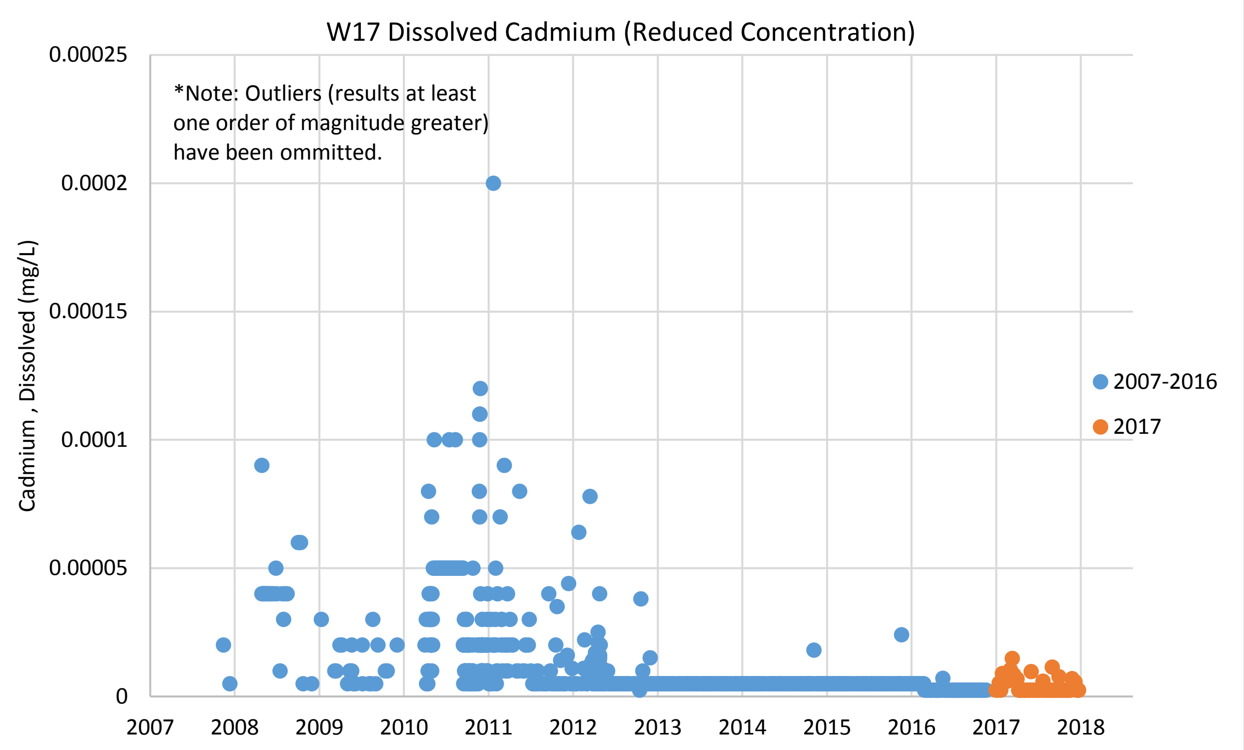


Figure 7-49: W17 Dissolved Cadmium (Reduced Concentration)

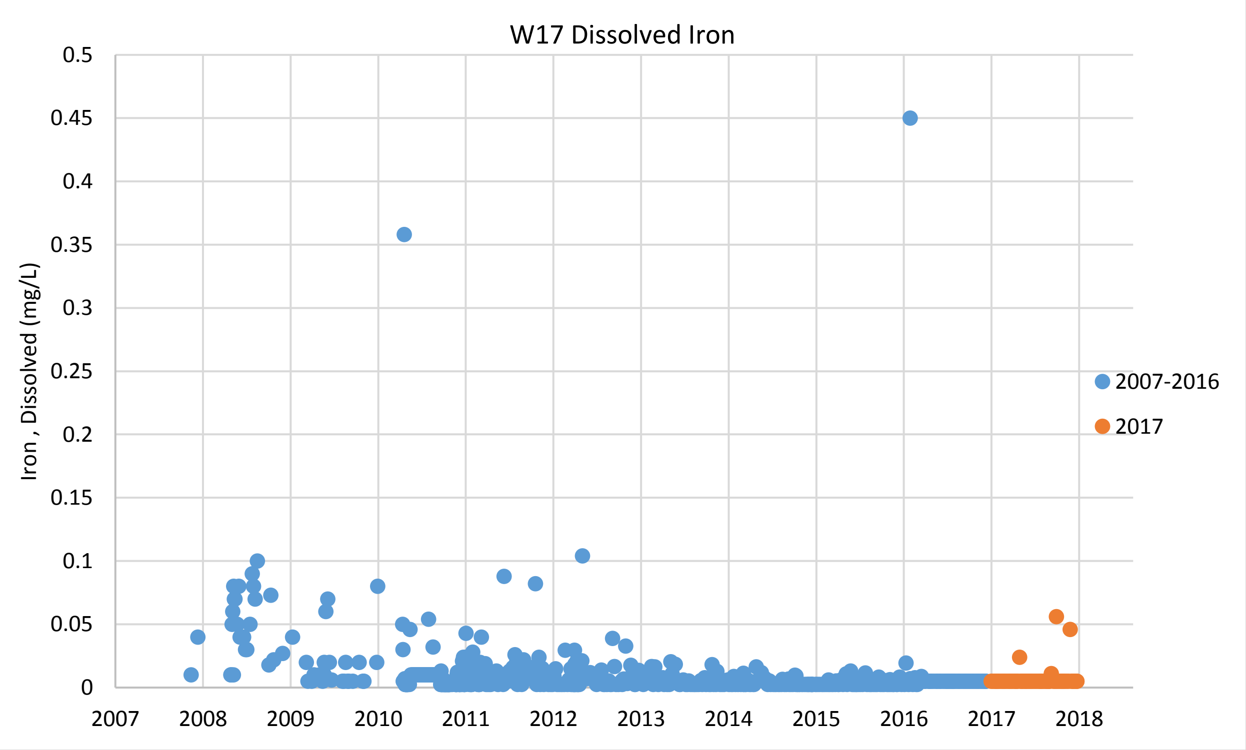


Figure 7-50: W17 Dissolved Iron

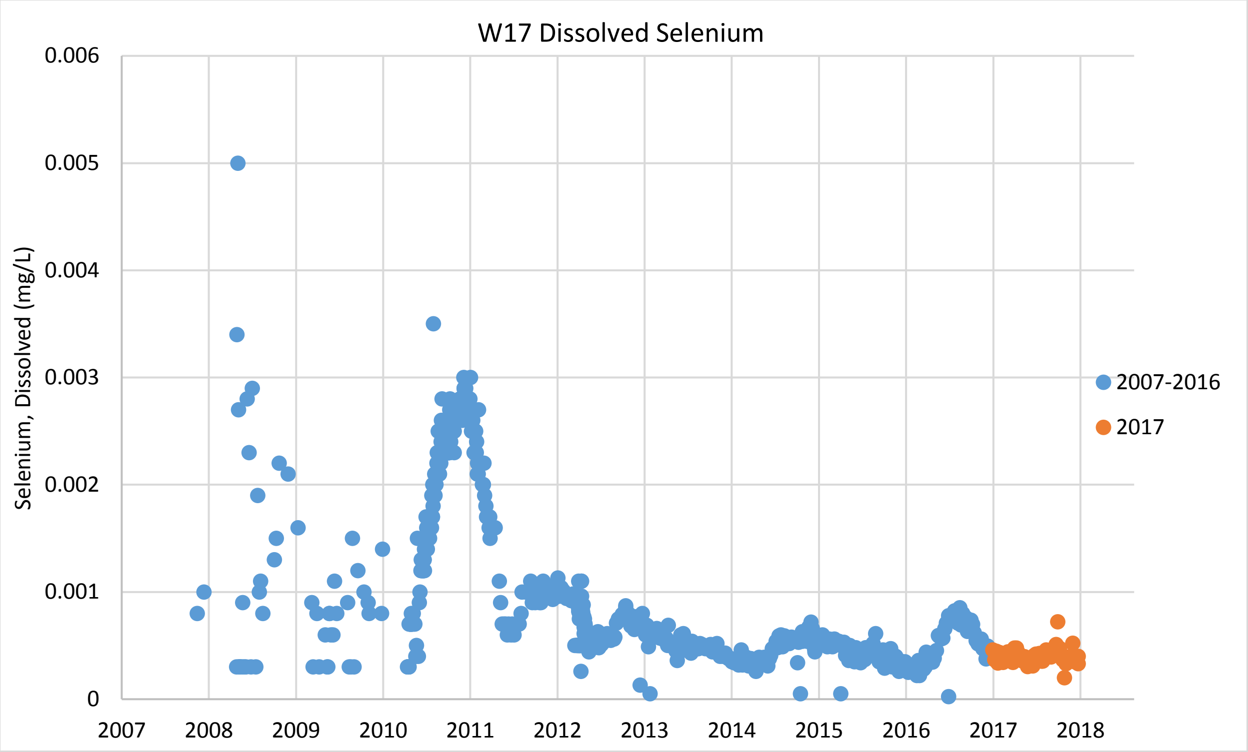


Figure 7-51: W17 Dissolved Selenium

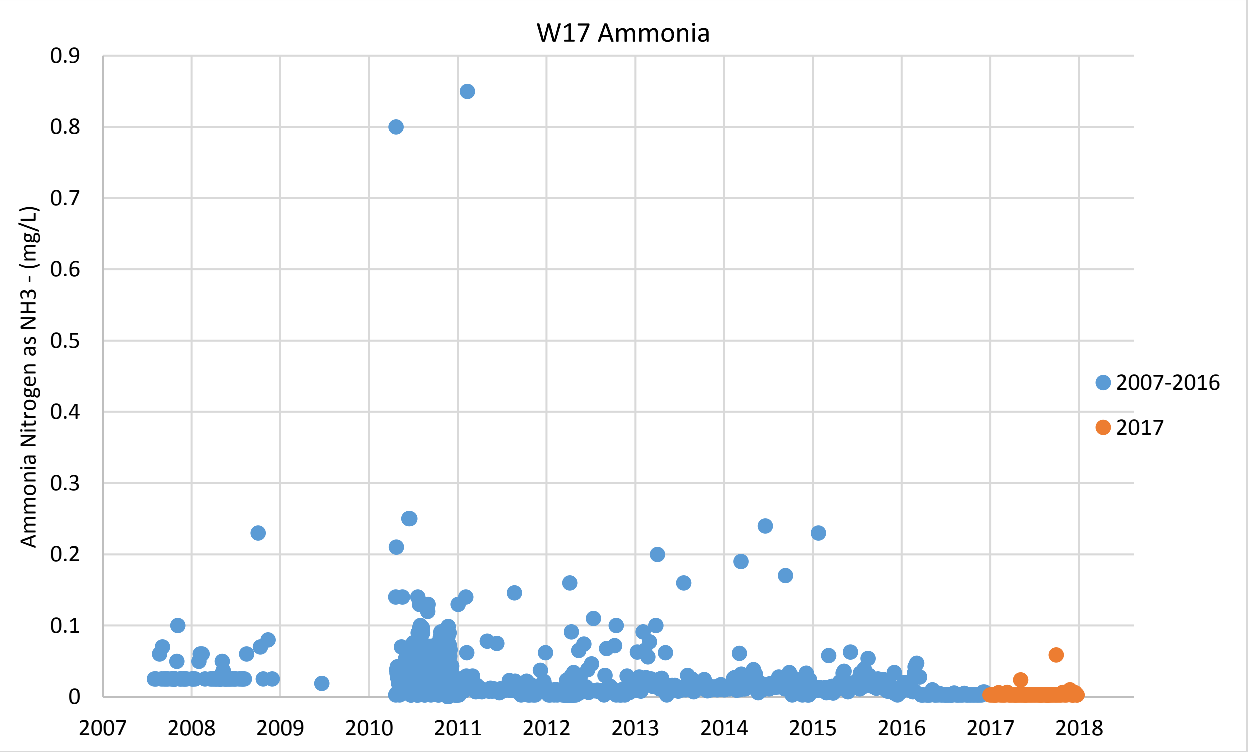


Figure 7-52: W17 Ammonia

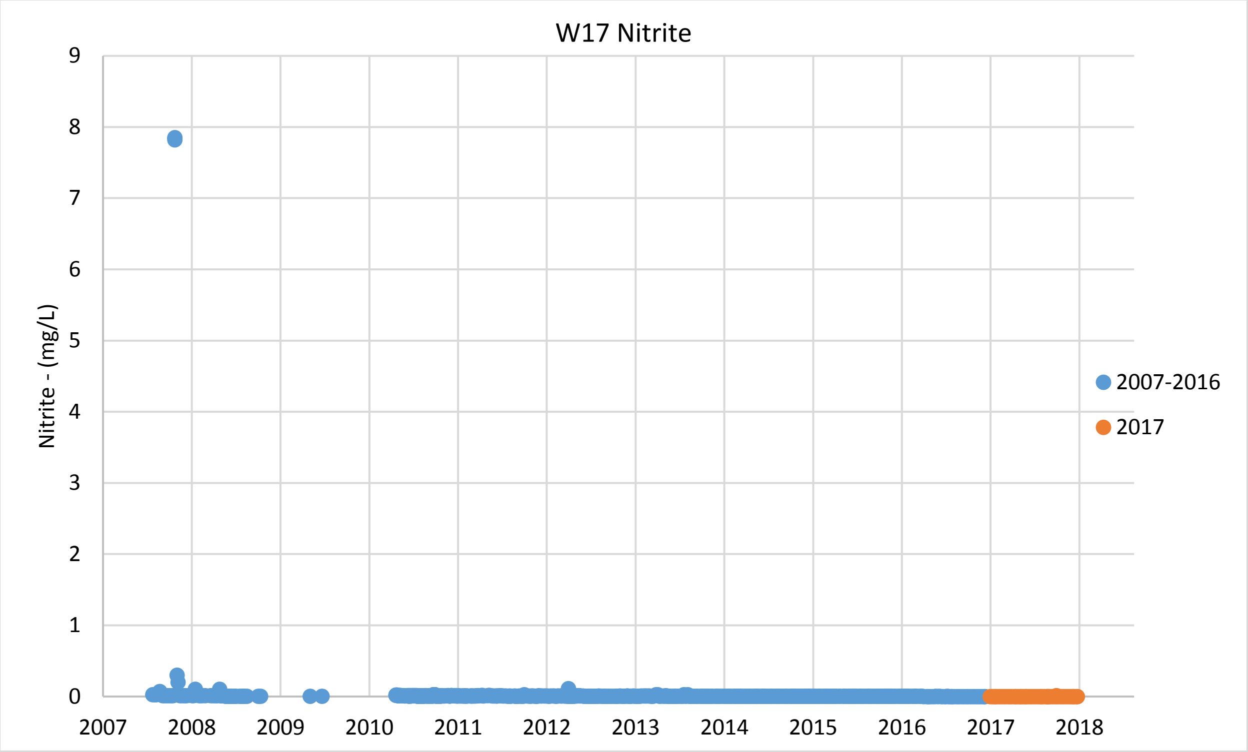
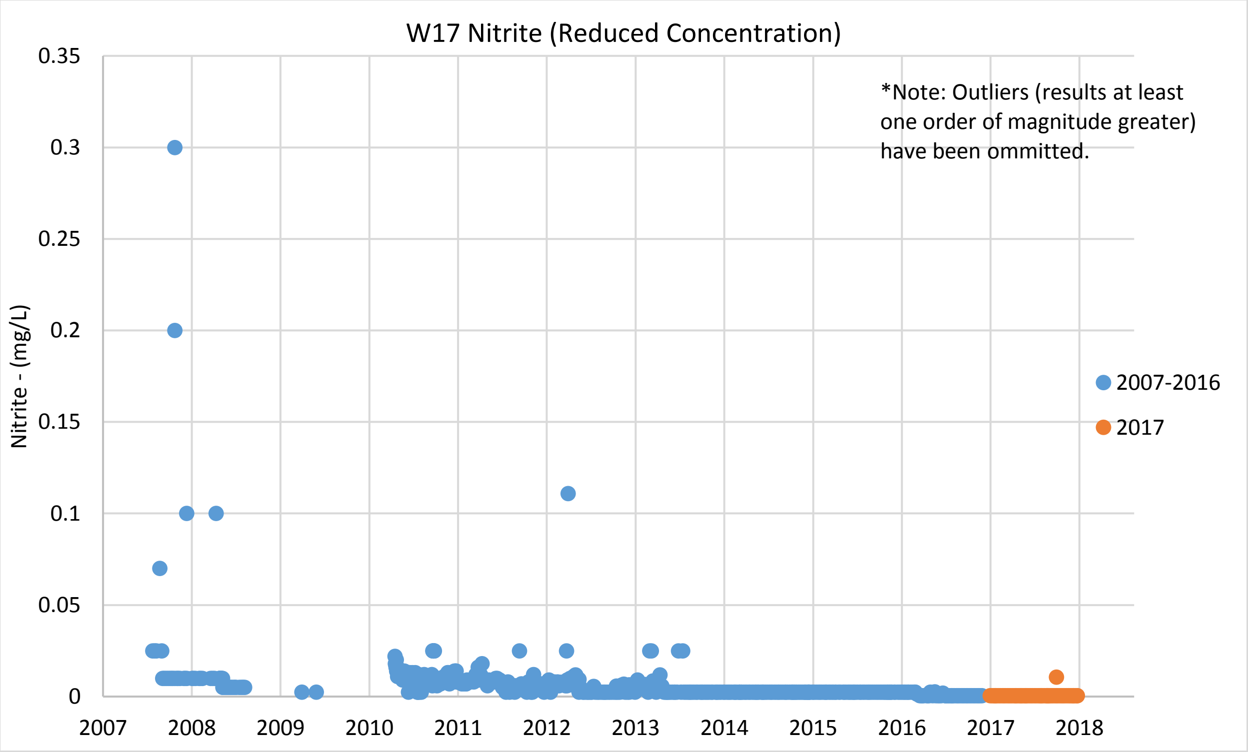


Figure 7-53: W17 Nitrite



*Note: Outliers (results at least one order of magnitude greater) have been ommitted.

Figure 7-54: W17 Nitrite (Reduced Concentration)

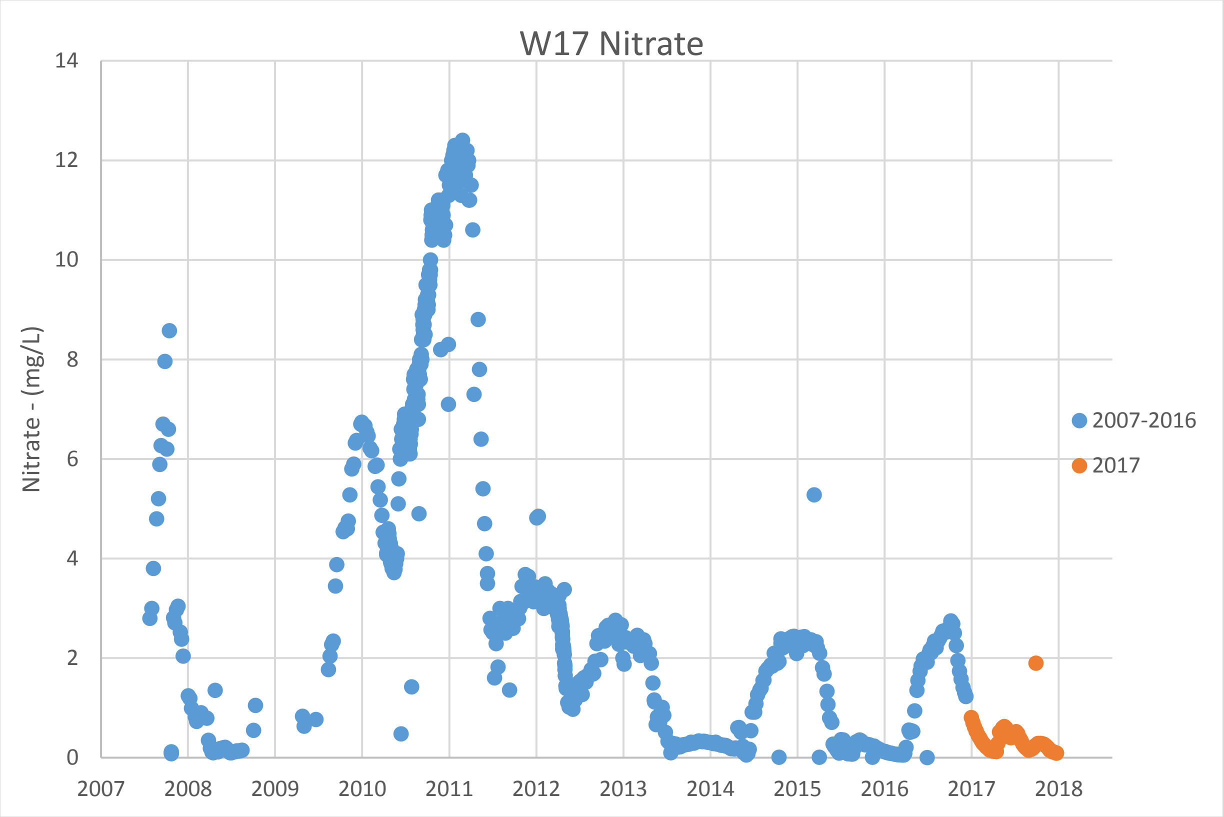


Figure 7-55: W17 Dissolved Nitrate

7.5 Dry Stack Tailings Storage Facility (DSTSF)

Seepage flow was observed during the spring survey at SS9 and SS60. Previously, water has flowed along the tailings diversion ditch road and down the toe of the south side of the DSTSF. Historical water quality results, 2017 seepage surveys and historical results for the DSTSF-associated seepage sites (SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, and SS45) are outlined in Figure 7-56 through Figure 7-62 and include results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

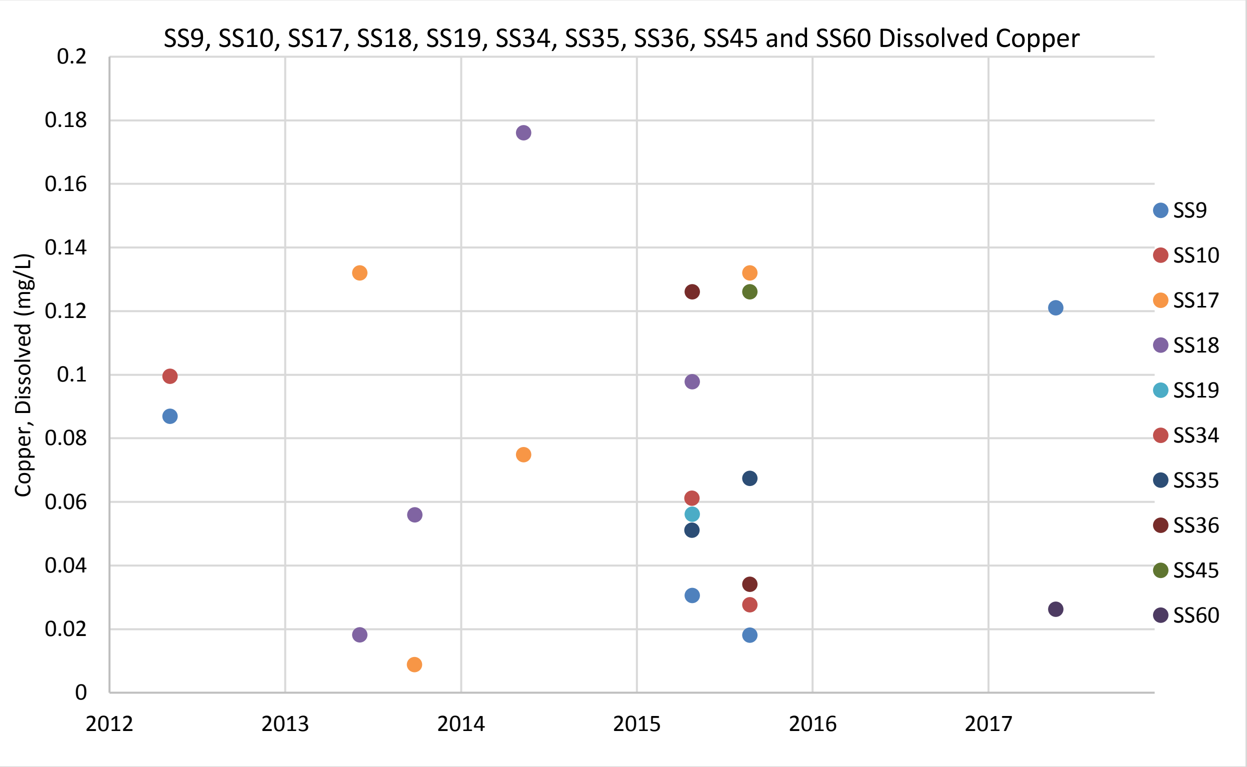


Figure 7-56: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Dissolved Copper

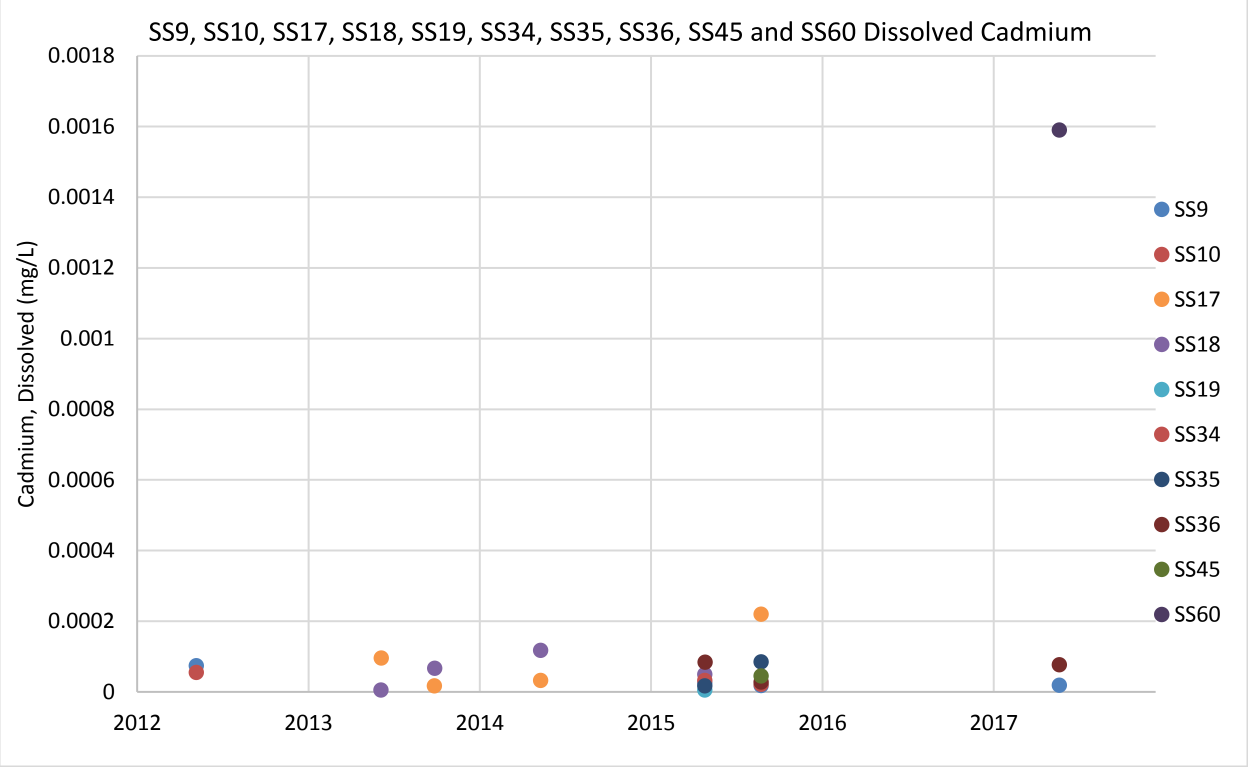


Figure 7-57: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Dissolved Cadmium

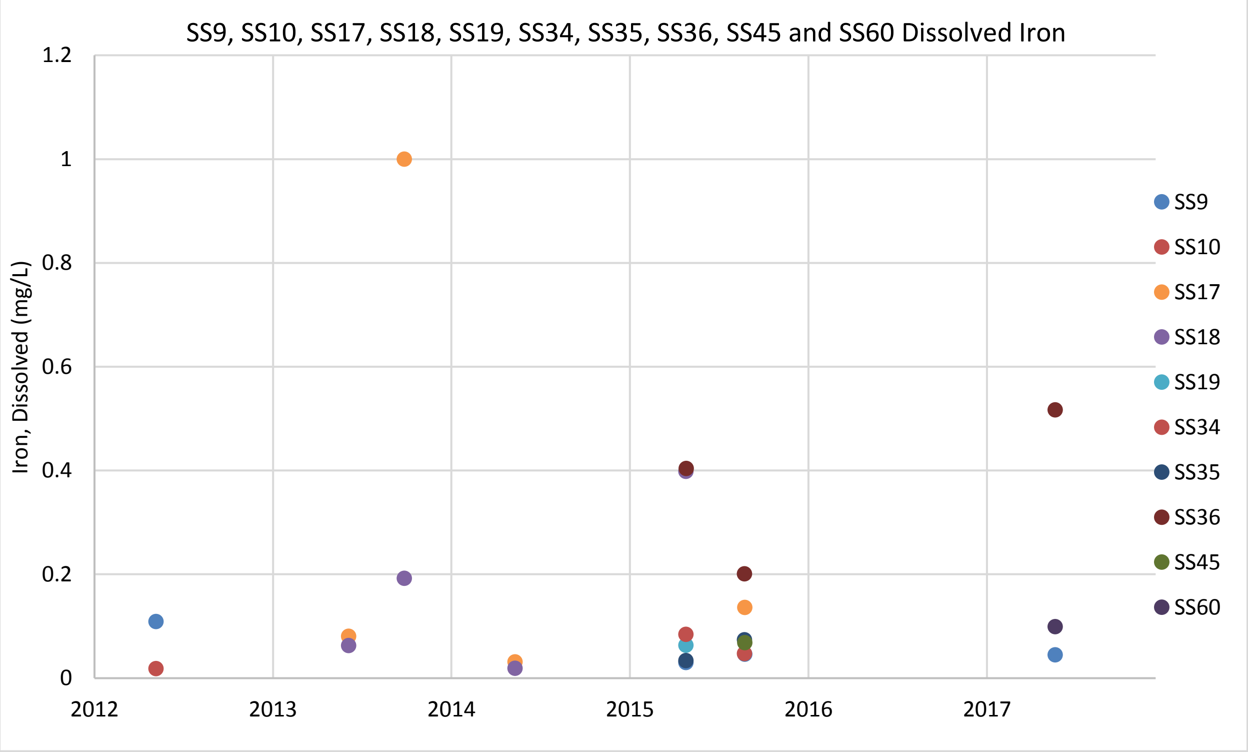


Figure 7-58: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Dissolved Iron

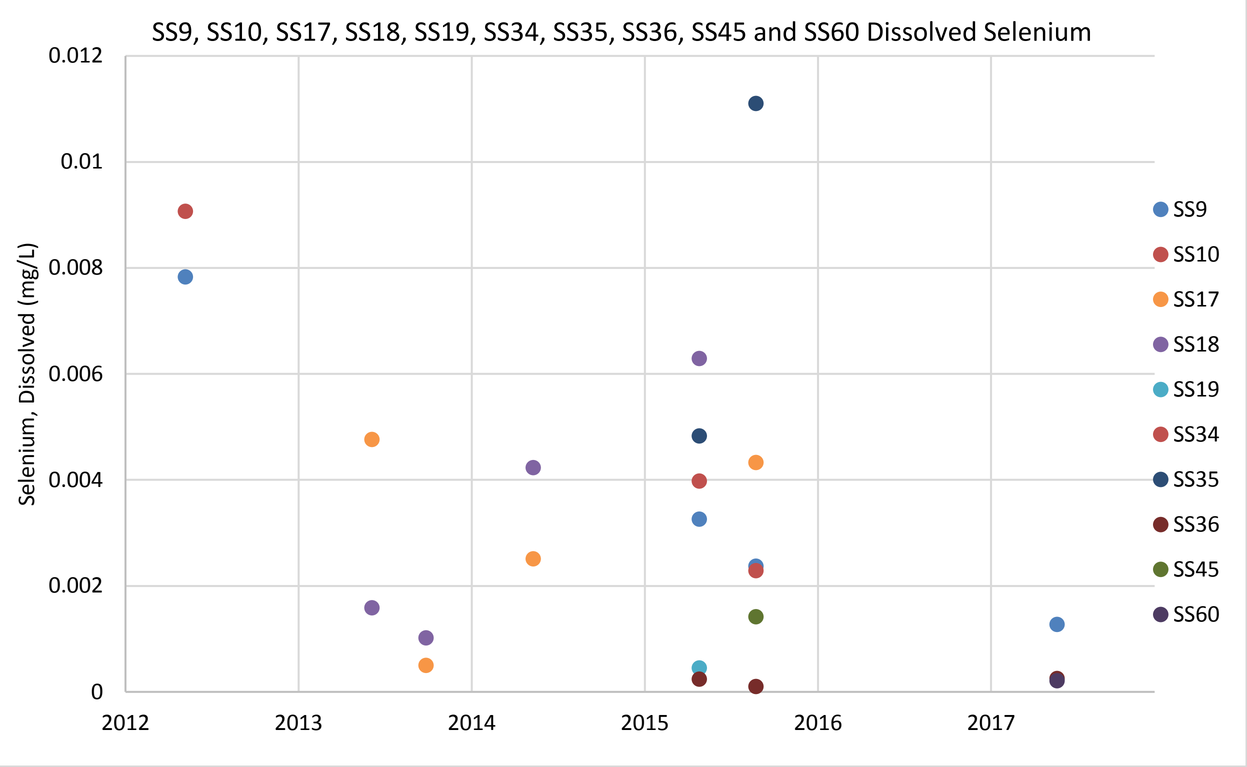


Figure 7-59: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Dissolved Selenium

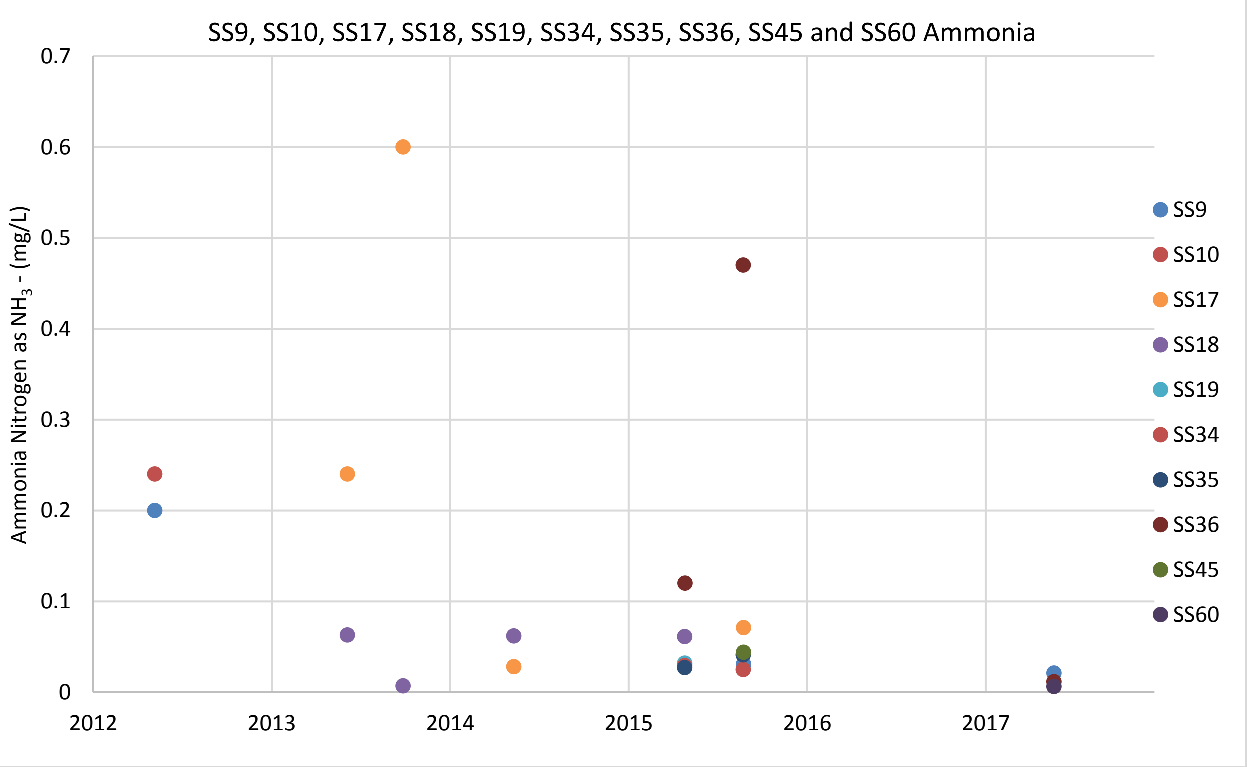


Figure 7-60: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Ammonia

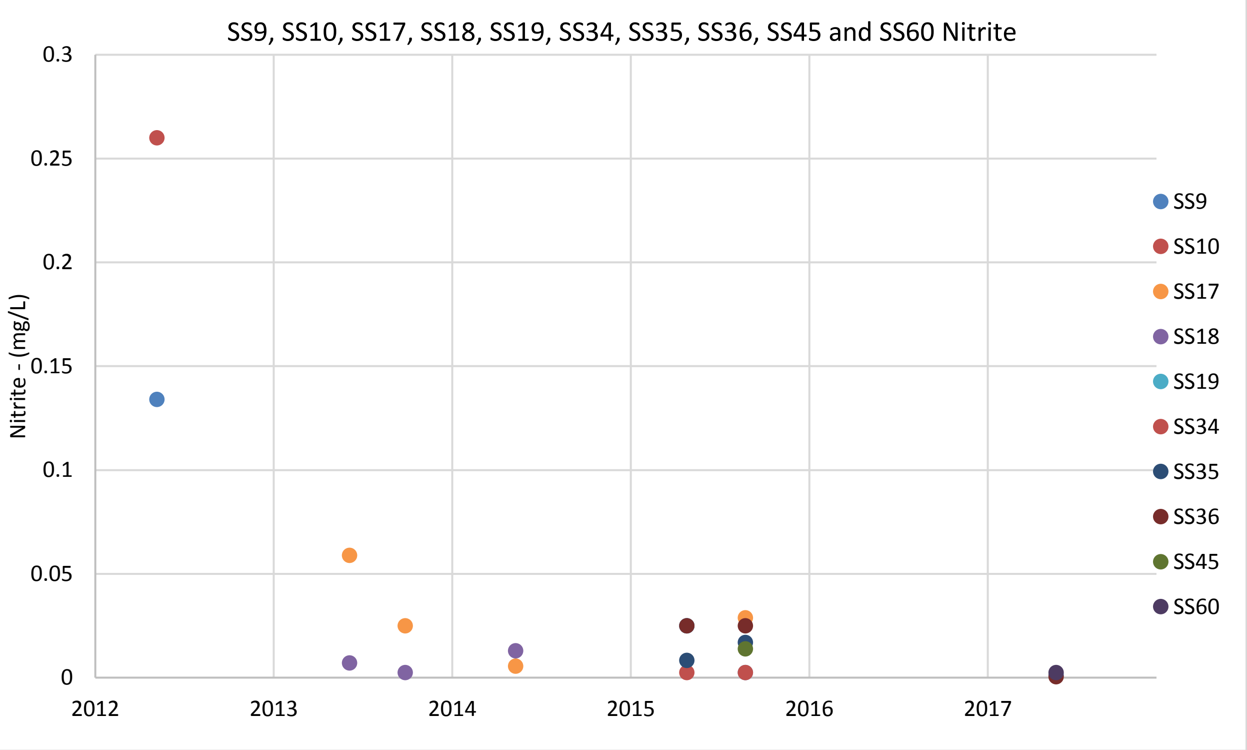


Figure 7-61: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Nitrite

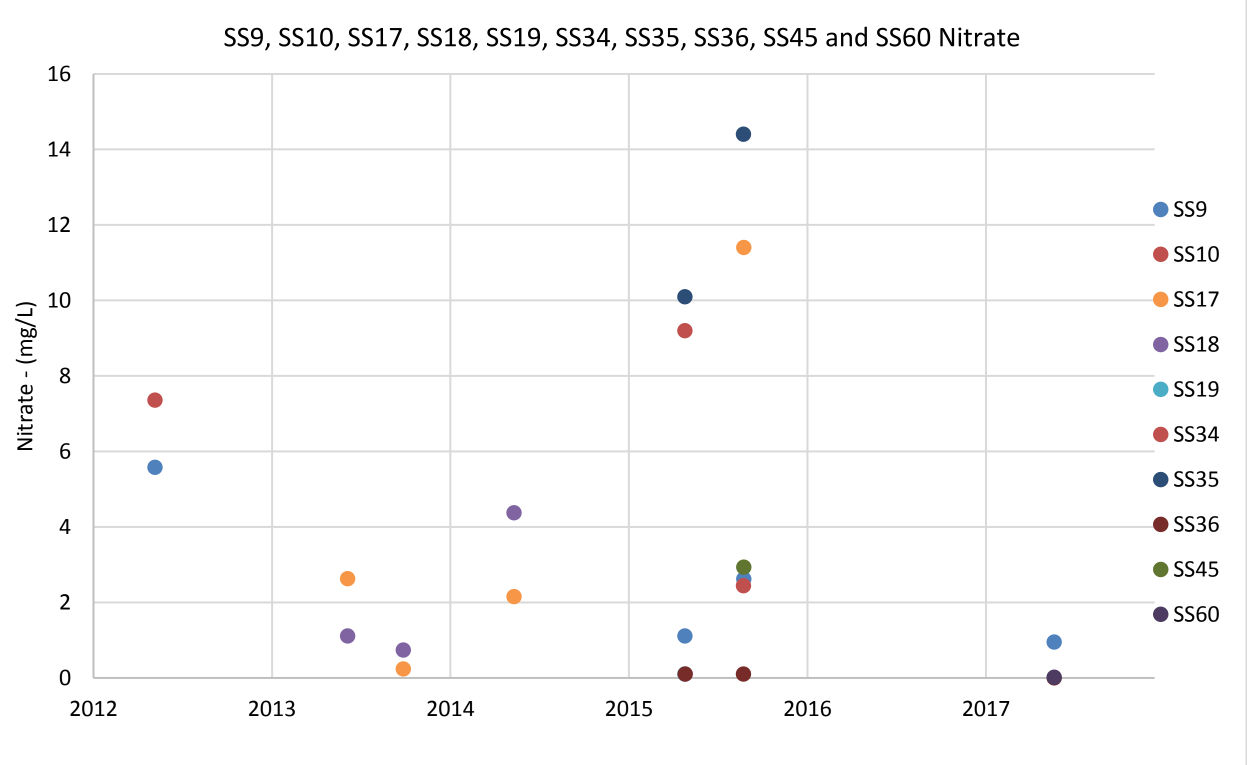


Figure 7-62: SS9, SS10, SS17, SS18, SS19, SS34, SS35, SS36, SS45 and SS60 Nitrate

7.6 Ore Stockpiles

Surface seepage runs along the toe of the west ore stockpile and into the ditch parallel to the heavy vehicle road. All seeps in this area drain into the west ore stockpile sump and are pumped to the Main pit. Seepage monitoring stations SS5, SS6, SS7, SS8 and SS33 capture seepage from the stockpile during spring and fall sampling program, SS59 was discovered during Spring 2017. Seepage sites SS46 and SS47 at the toe of the underground ore stockpiles were discovered and added to the network in the fall of 2015. Water quality results are outlined in Figure 7-63 through Figure 7-70 and include historic water quality results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

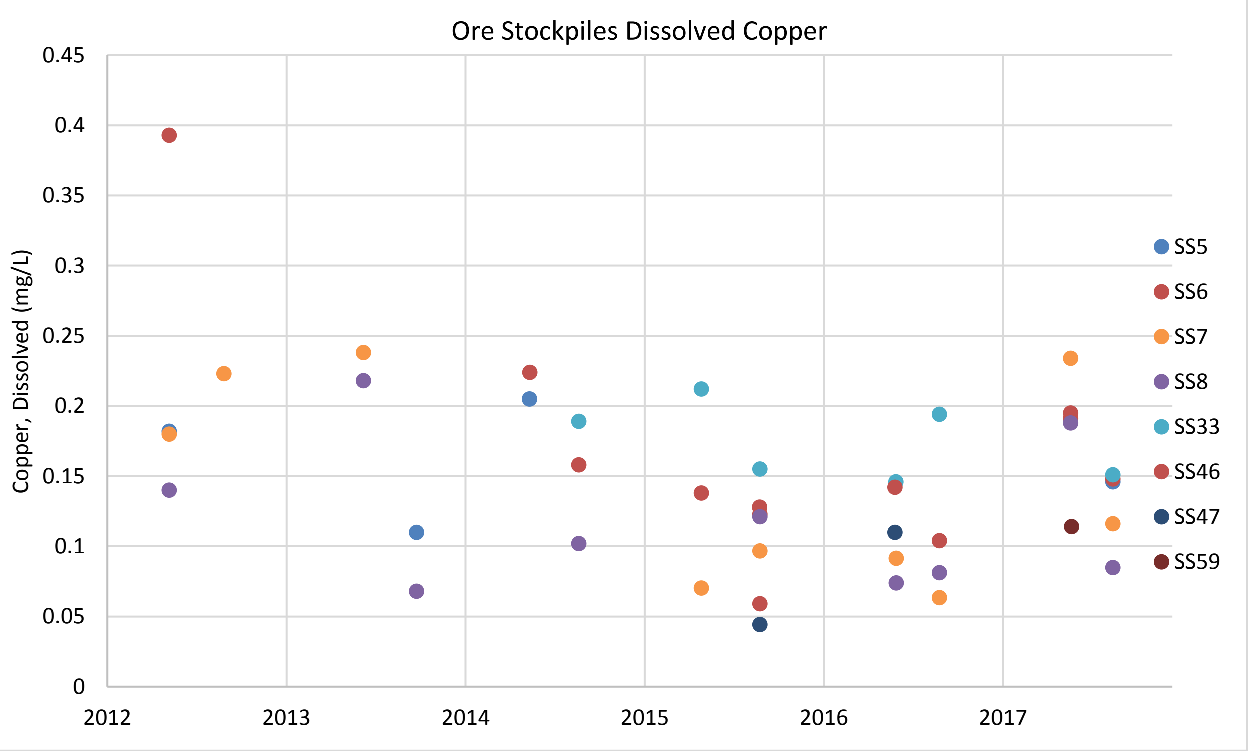


Figure 7-63: Ore Stockpile Dissolved Copper

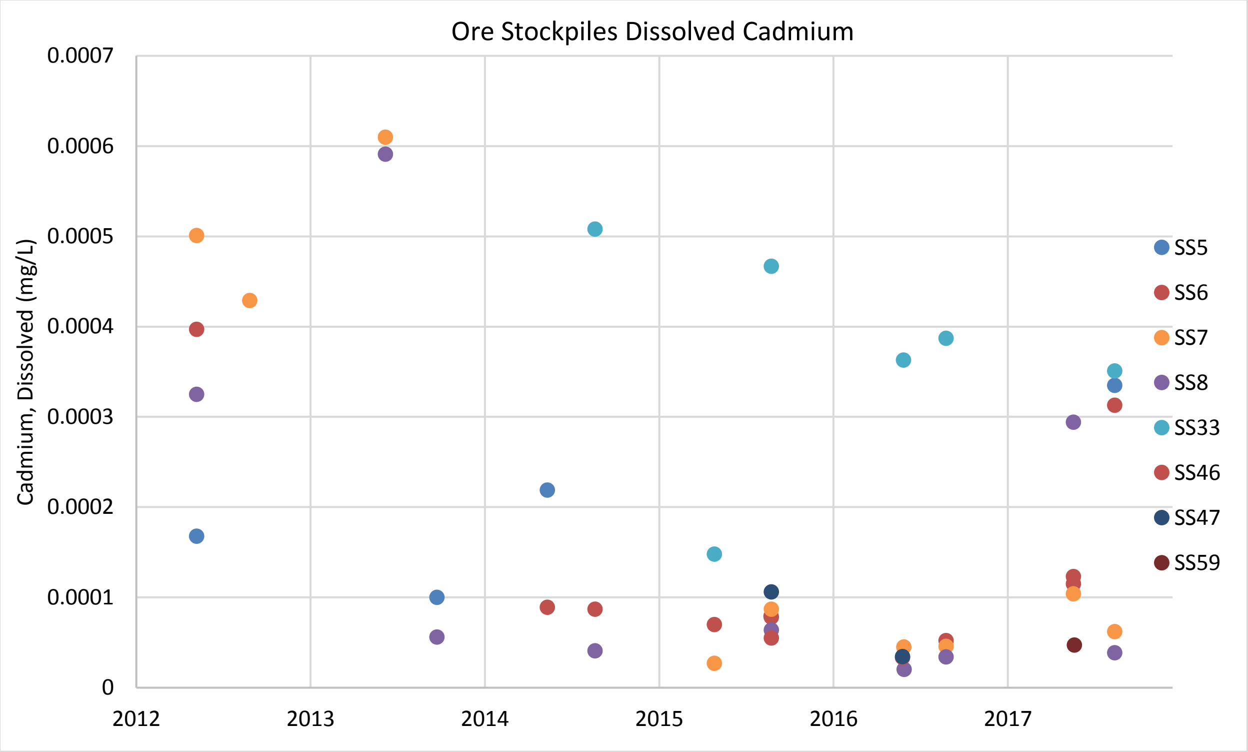


Figure 7-64: Ore Stockpile Dissolved Cadmium

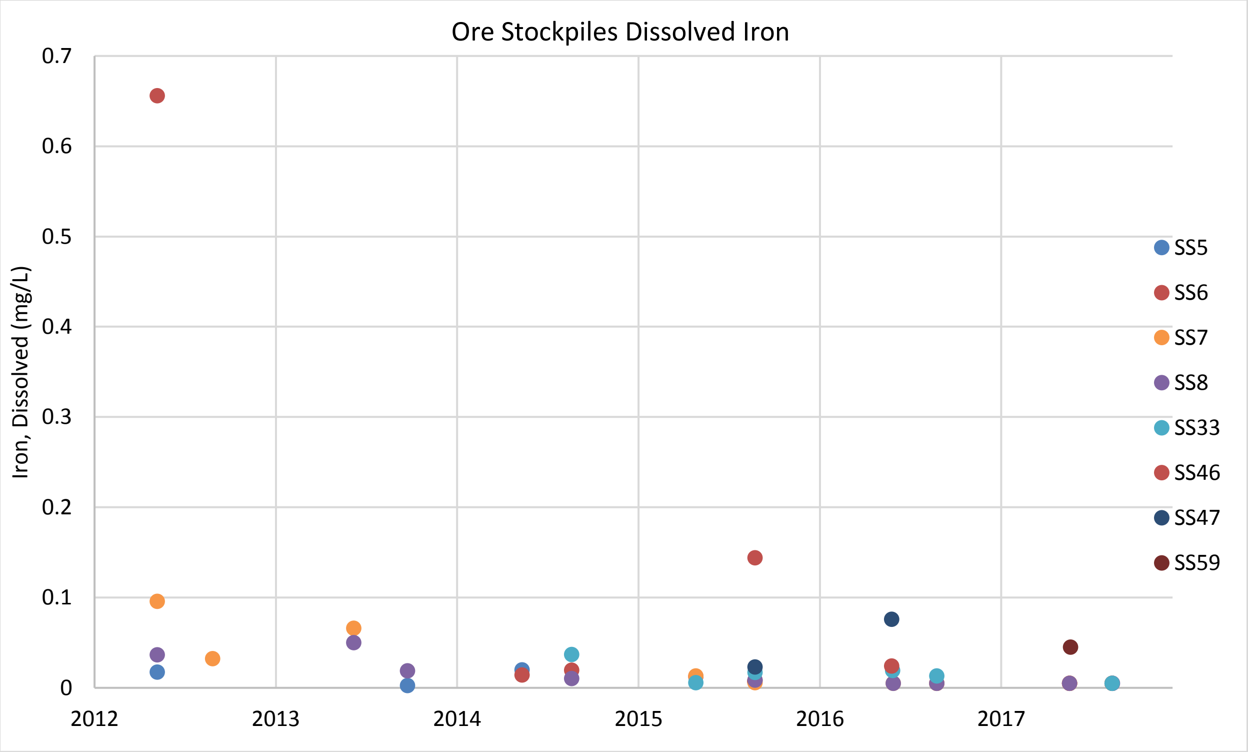


Figure 7-65: Ore Stockpile Dissolved Iron

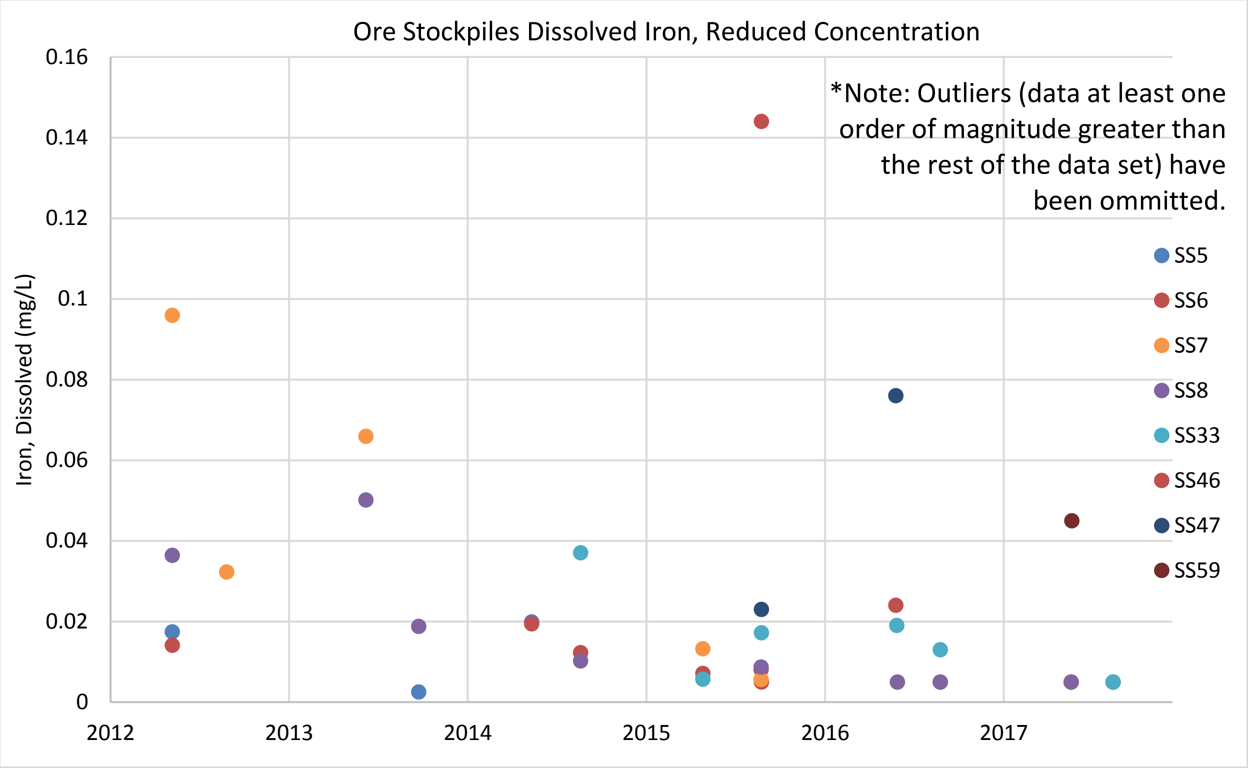


Figure 7-66: Ore Stockpile Dissolved Iron (Reduced Concentration)

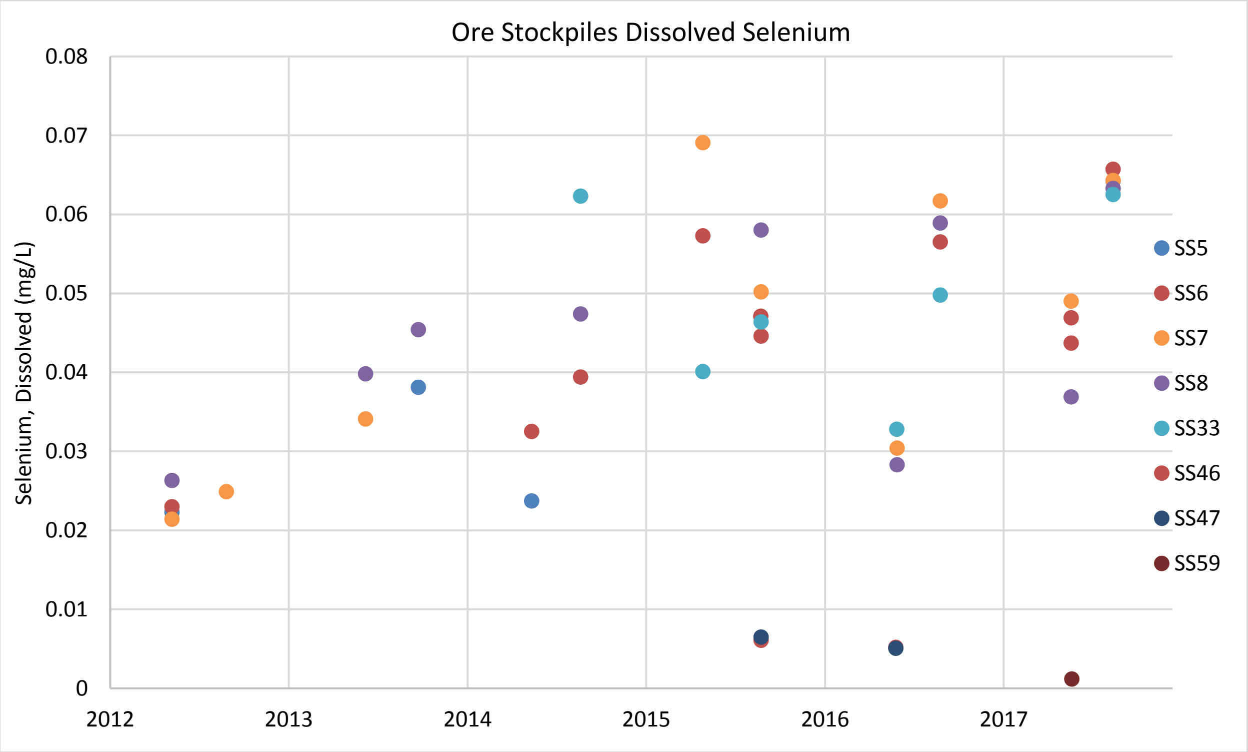


Figure 7-67: Ore Stockpile Dissolved Selenium

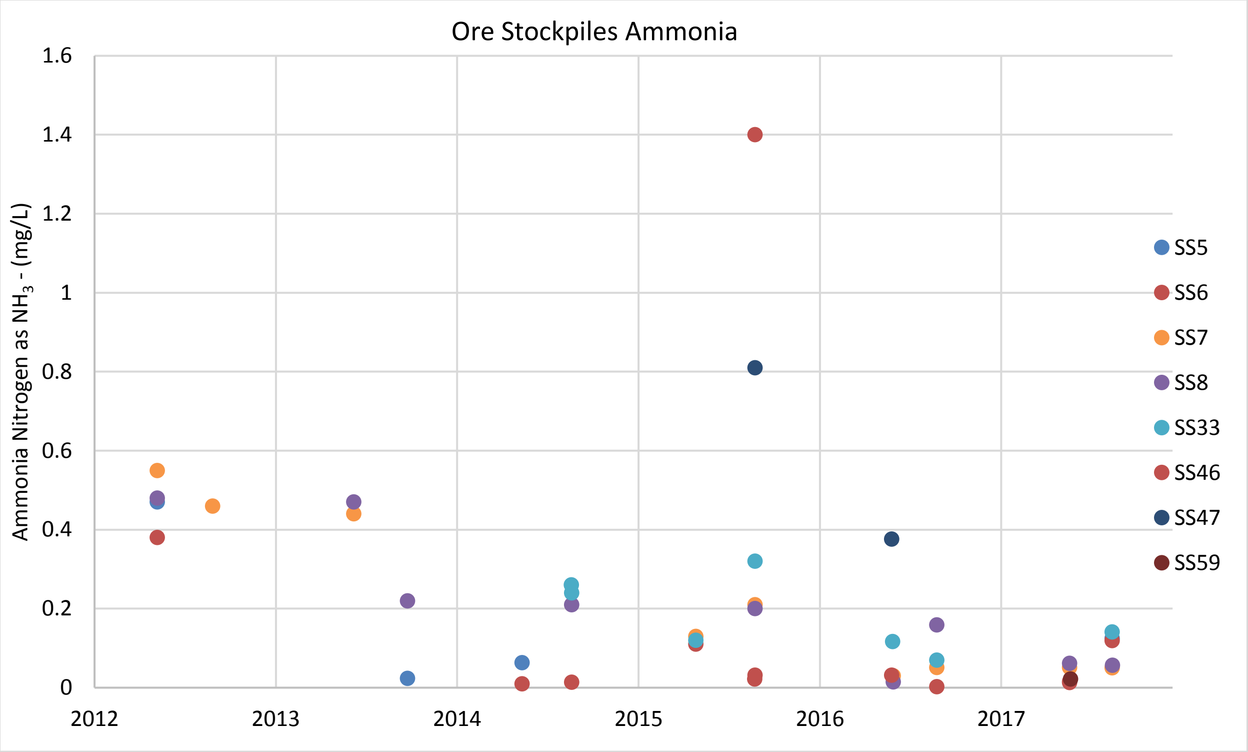


Figure 7-68: Ore Stockpile Dissolved Ammonia

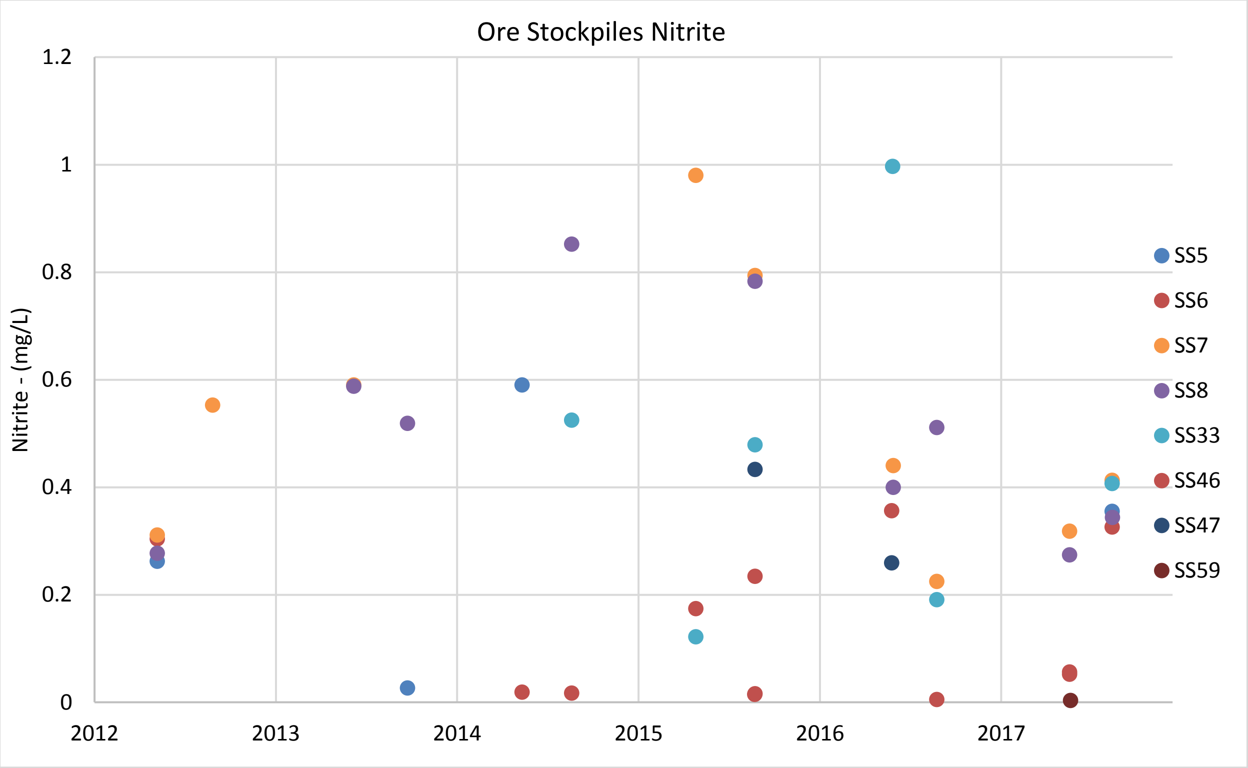


Figure 7-69: Ore Stockpile Dissolved Nitrite

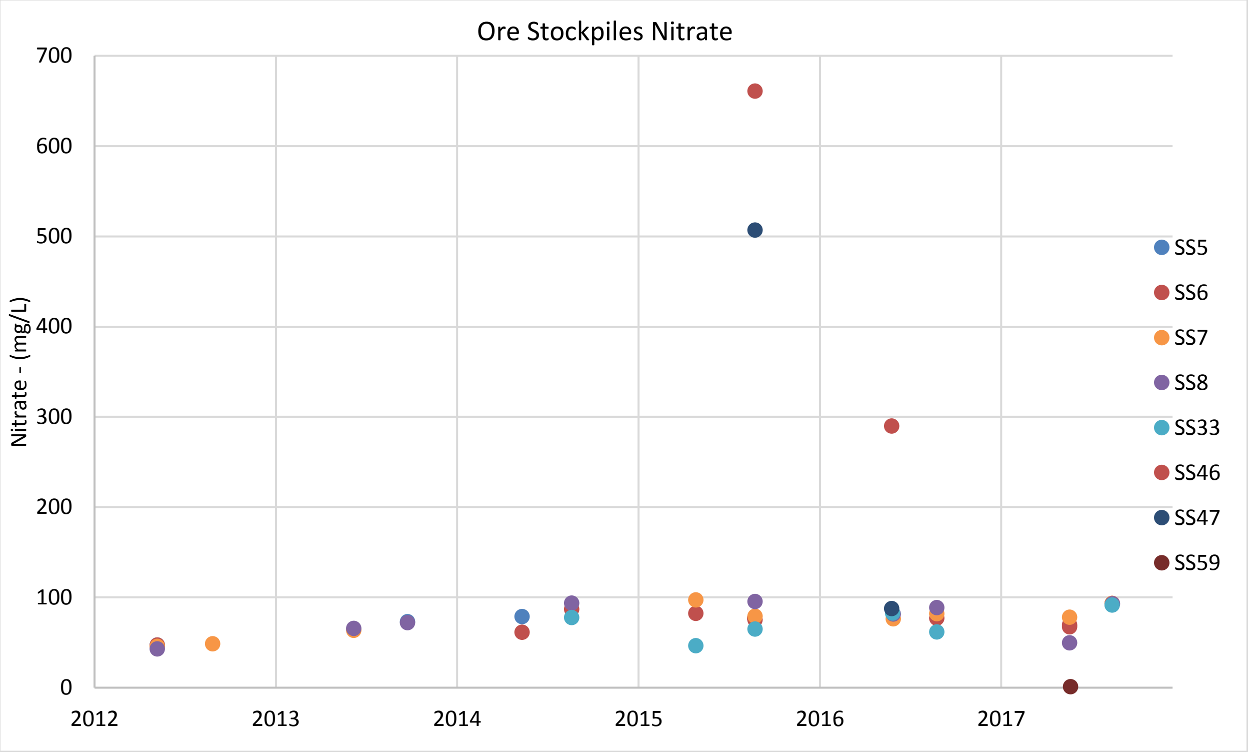


Figure 7-70: Ore Stockpile Dissolved Nitrate

7.7 Reclamation Overburden Dump (ROD)

In the 2017 Seepage Monitoring Survey, no water samples were collected from sites SS2, SS3, SS11, SS14, and SS15. All sites along the ROD were observed to be dry during the 2014, 2015, 2016 and 2017 surveys. Therefore, the Seepage Monitoring Program will no longer include surveys of the ROD.

7.8 Main Waste Dump

No new seeps were discovered along the toe of the Main Waste Dump (MWD), and existing seeps were observed to be dry during both sampling events in 2017. Historical data is presented in Figure 7-71 through Figure 7-77 and include water quality results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate.

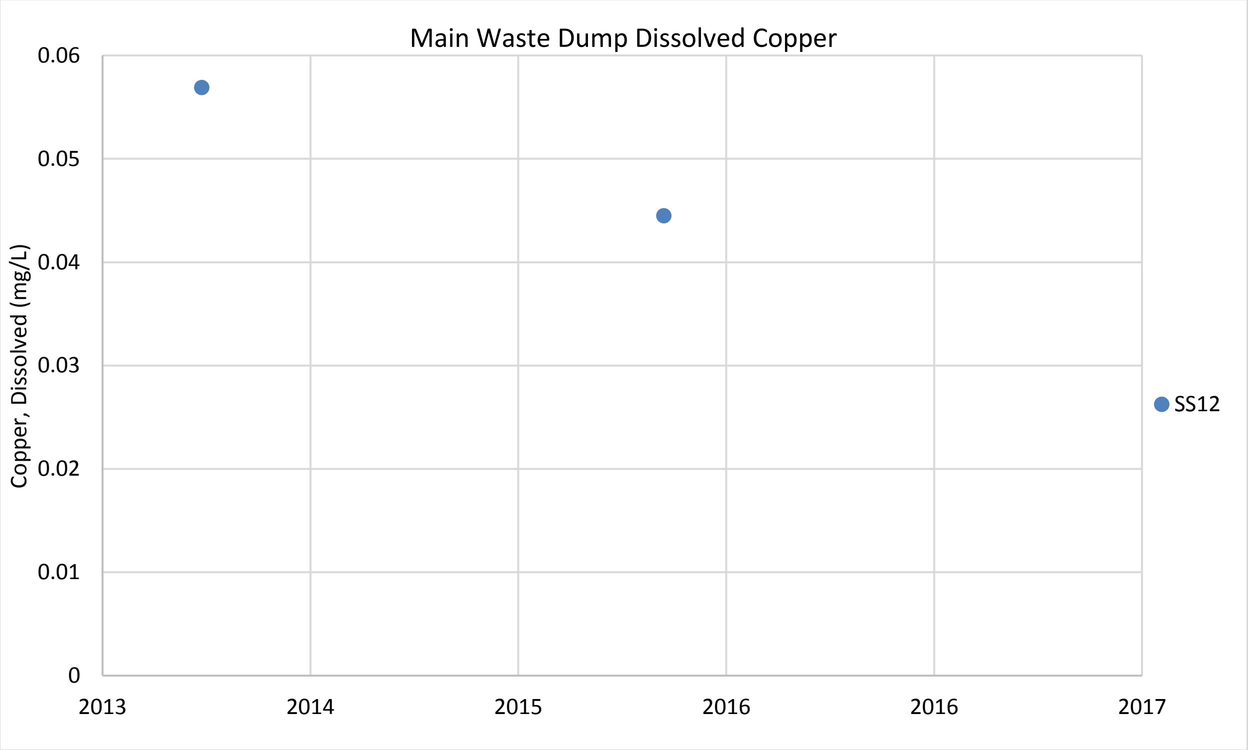


Figure 7-71: Main Waste Dump Dissolved Copper

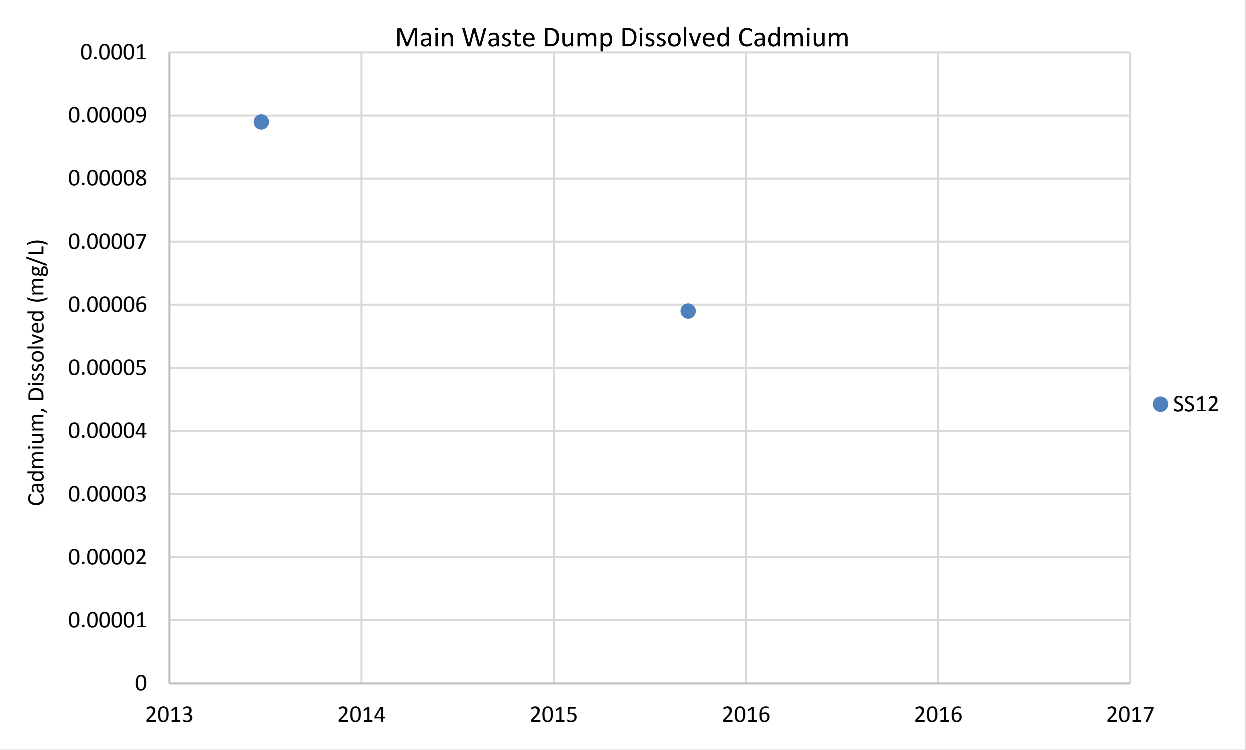


Figure 7-72: Main Waste Dump Dissolved Cadmium

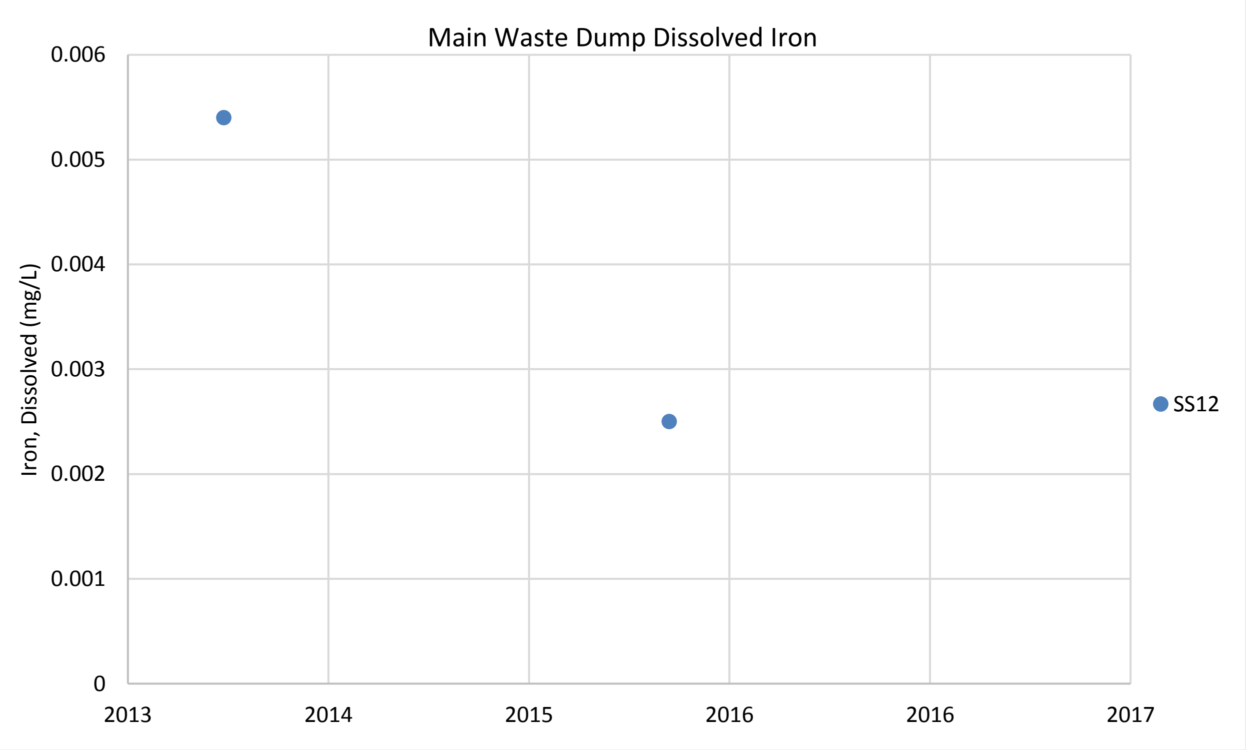


Figure 7-73: Main Waste Dump Dissolved Iron

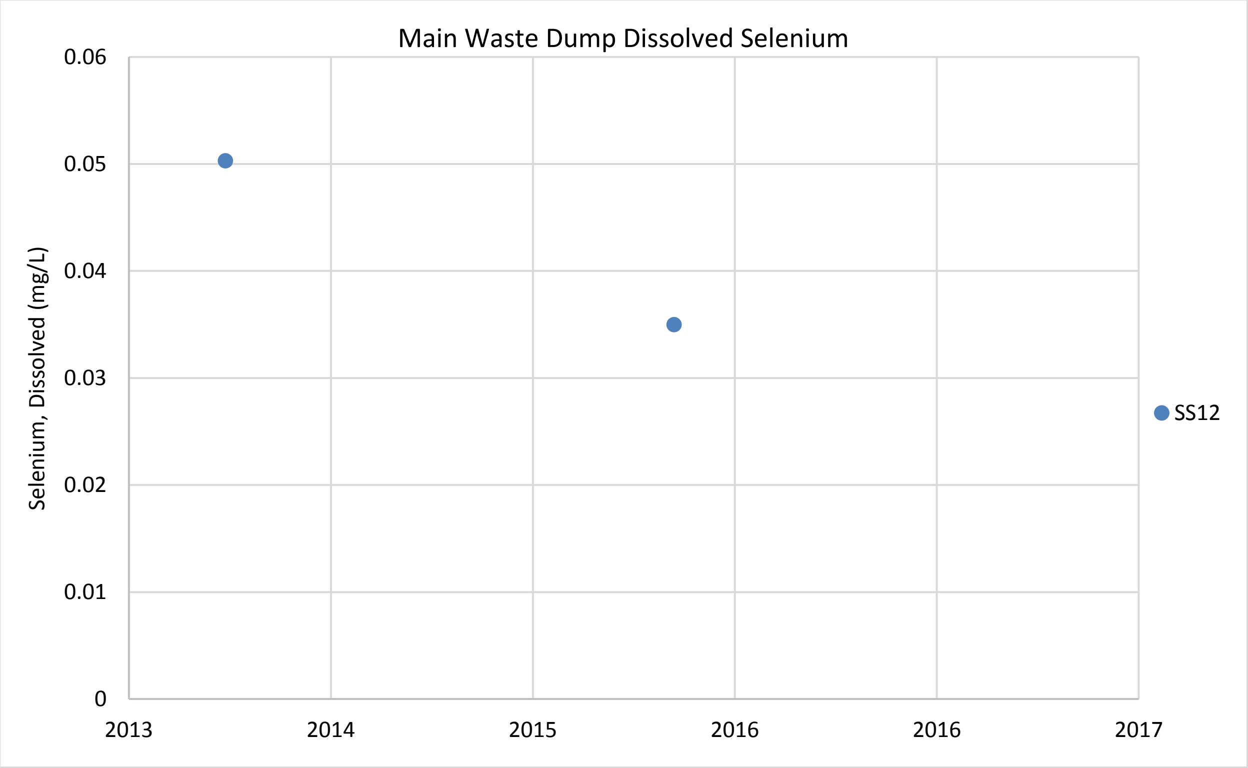


Figure 7-74: Main Waste Dump Dissolved Selenium

Figure 7-75: Main Waste Dump Ammonia

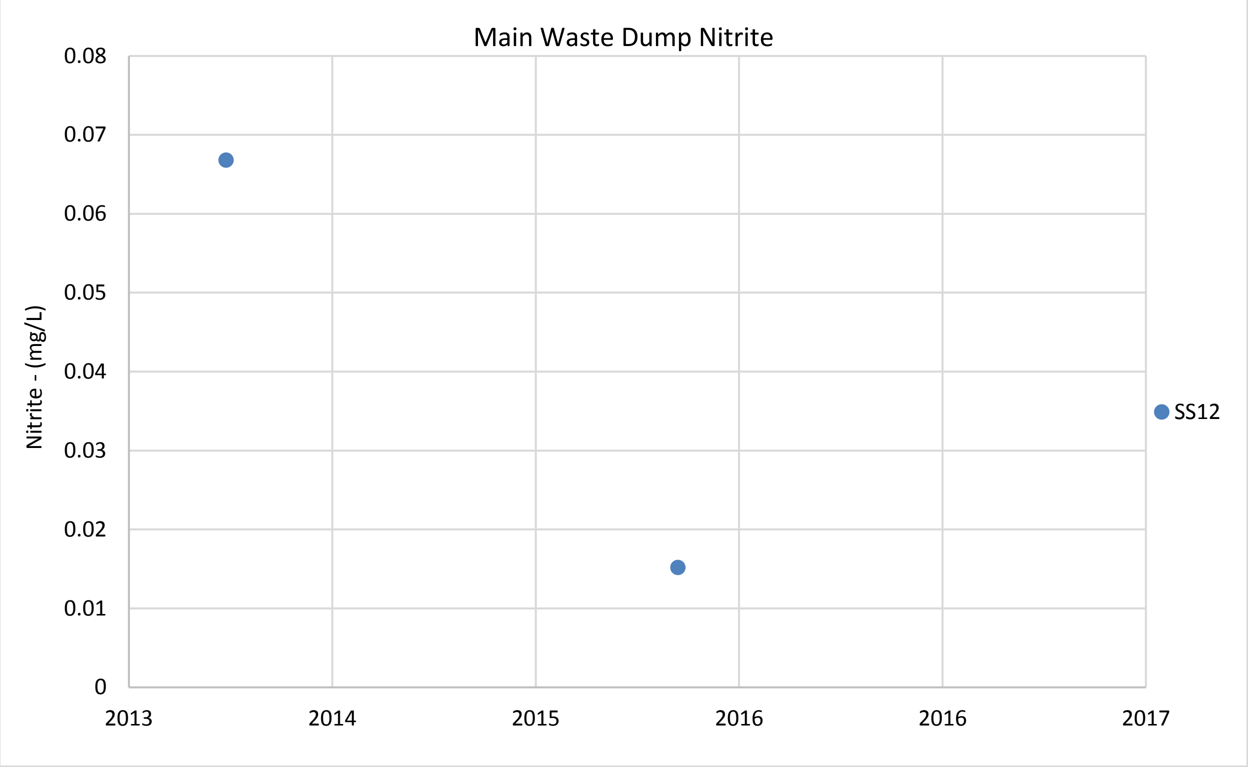


Figure 7-76: Main Waste Dump Nitrite

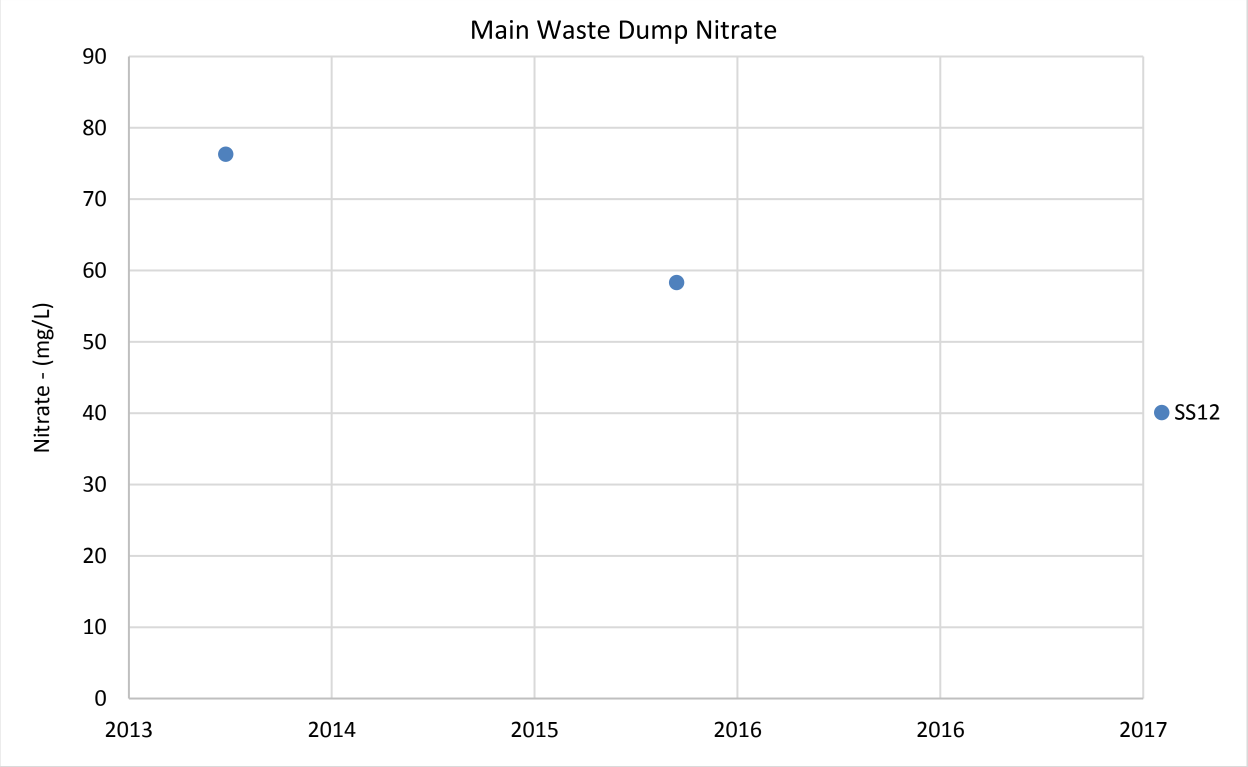


Figure 7-77: Main Waste Dump Nitrate

7.9 Mill Area

SS32 was discovered in 2014 behind the camp along the mill area survey route. SS32 was sampled in both the spring and fall of 2017 and the results for dissolved copper, dissolved cadmium, dissolved iron, dissolved selenium, and nutrient levels for ammonia, nitrite, and nitrate are displayed in Figure 7-78 through Figure 7-84 along with historical results. No other seeps were identified along the toe of the north ridge behind the camp and mill.

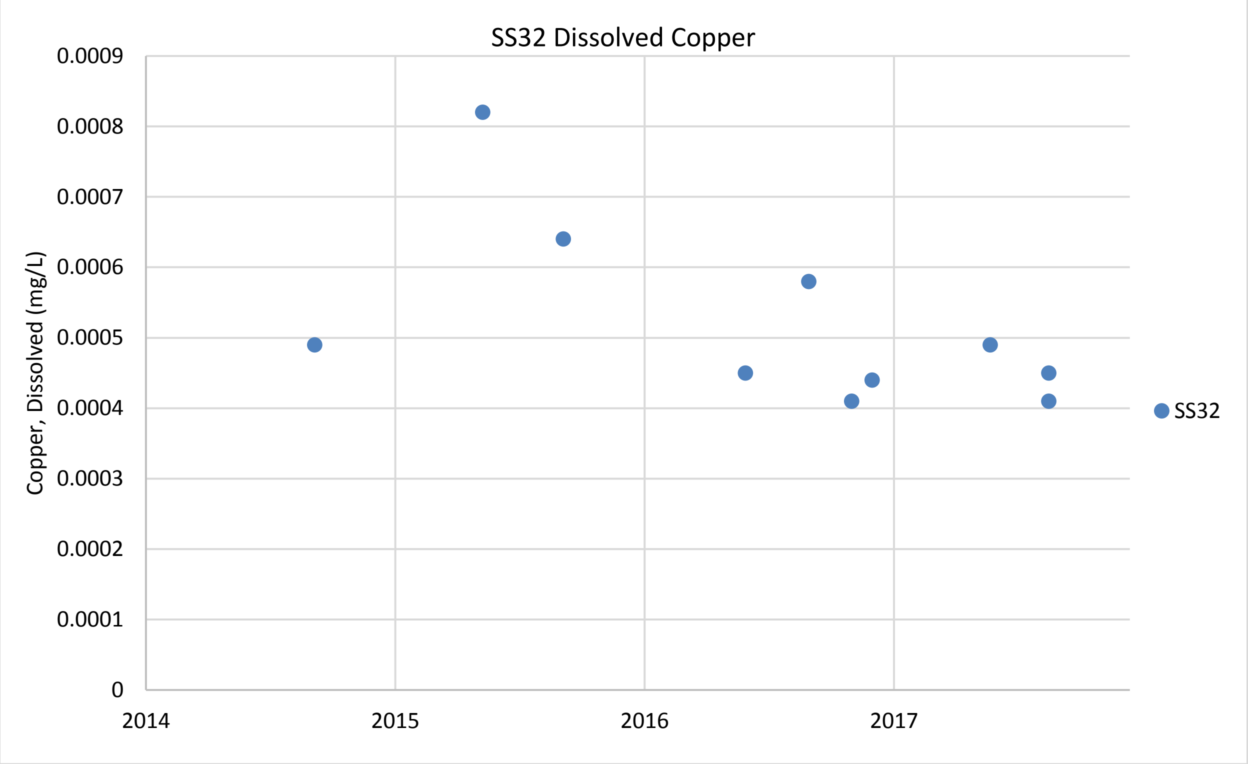


Figure 7-78: SS32 Dissolved Copper

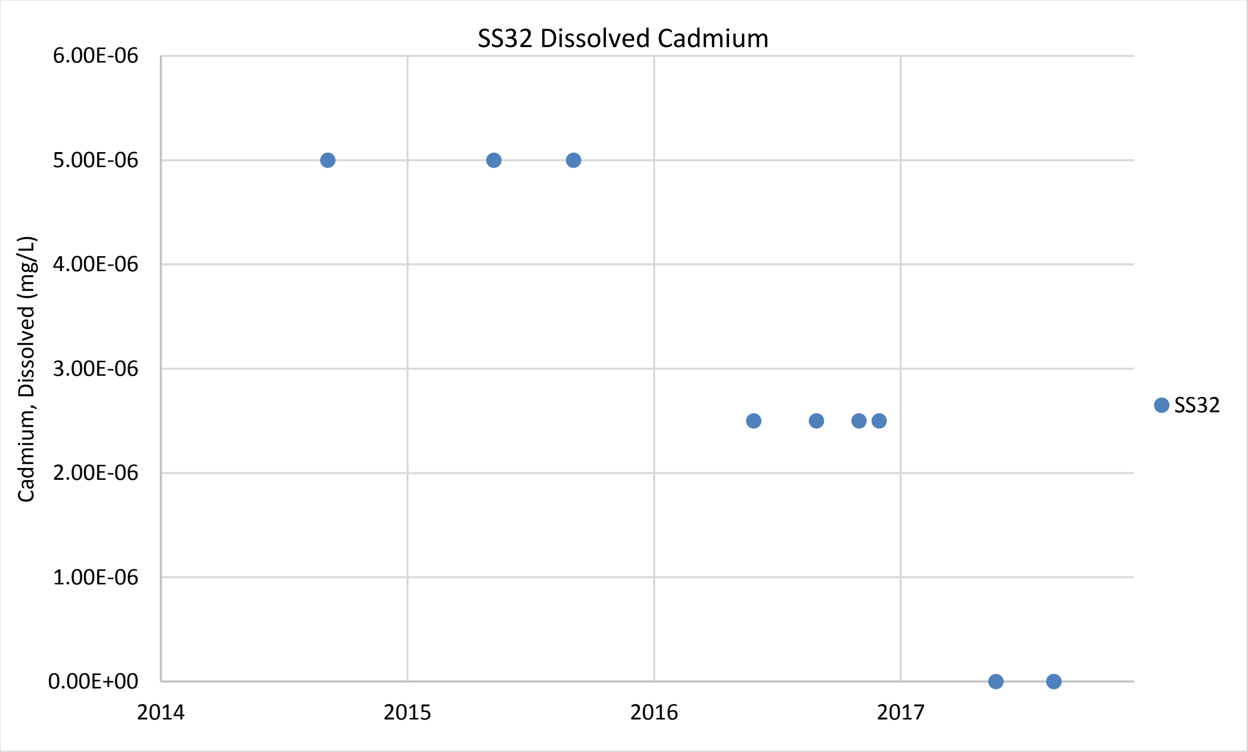


Figure 7-79: SS32 Dissolved Cadmium

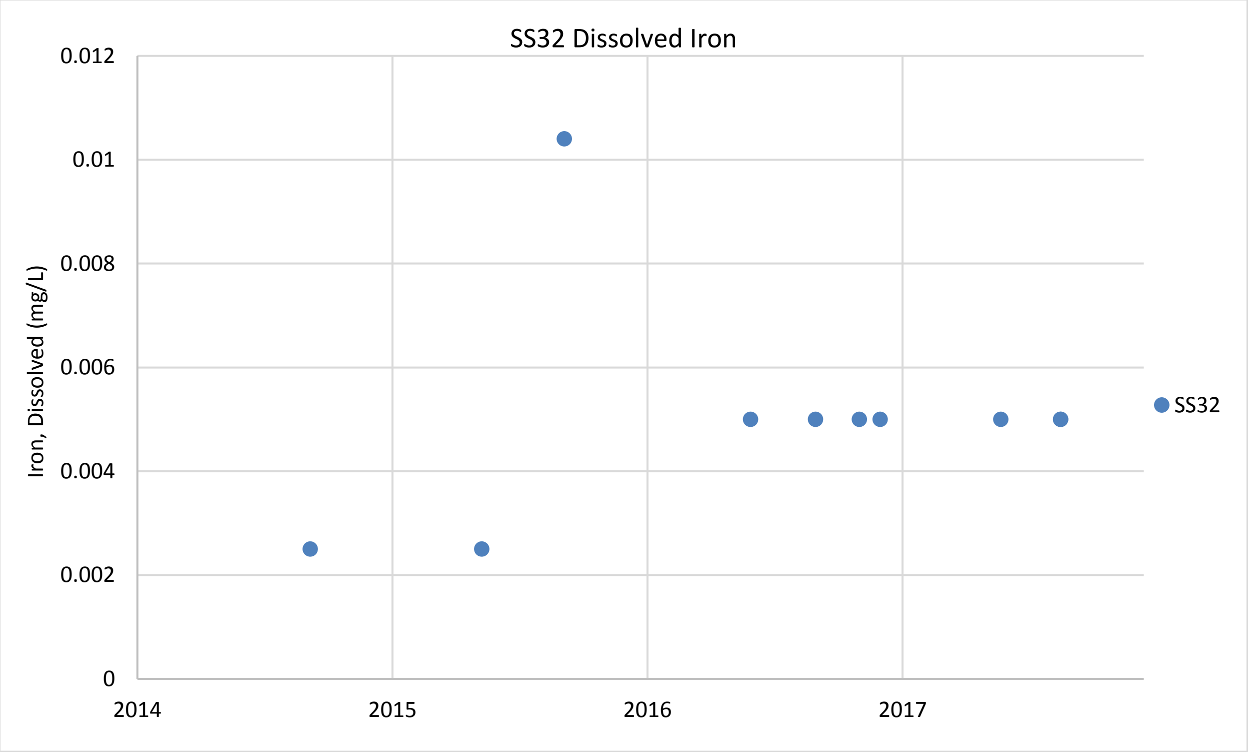


Figure 7-80: SS32 Dissolved Iron

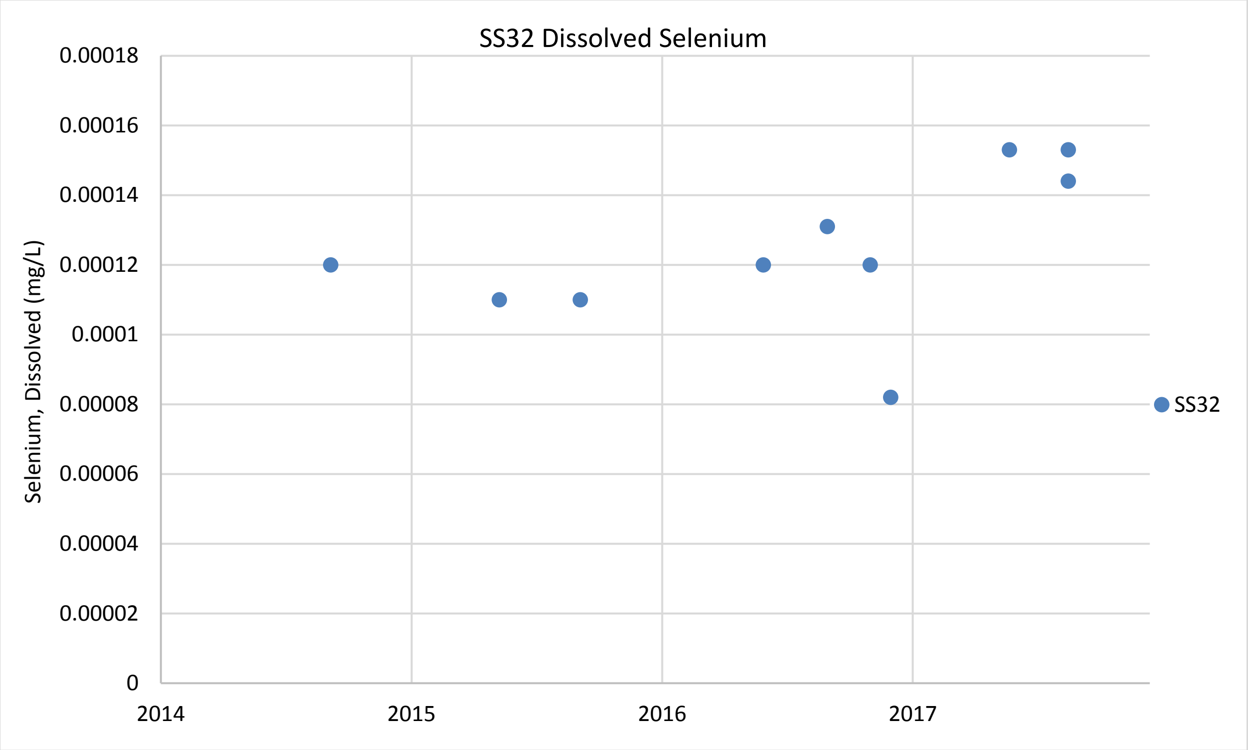


Figure 7-81: SS32 Dissolved Selenium

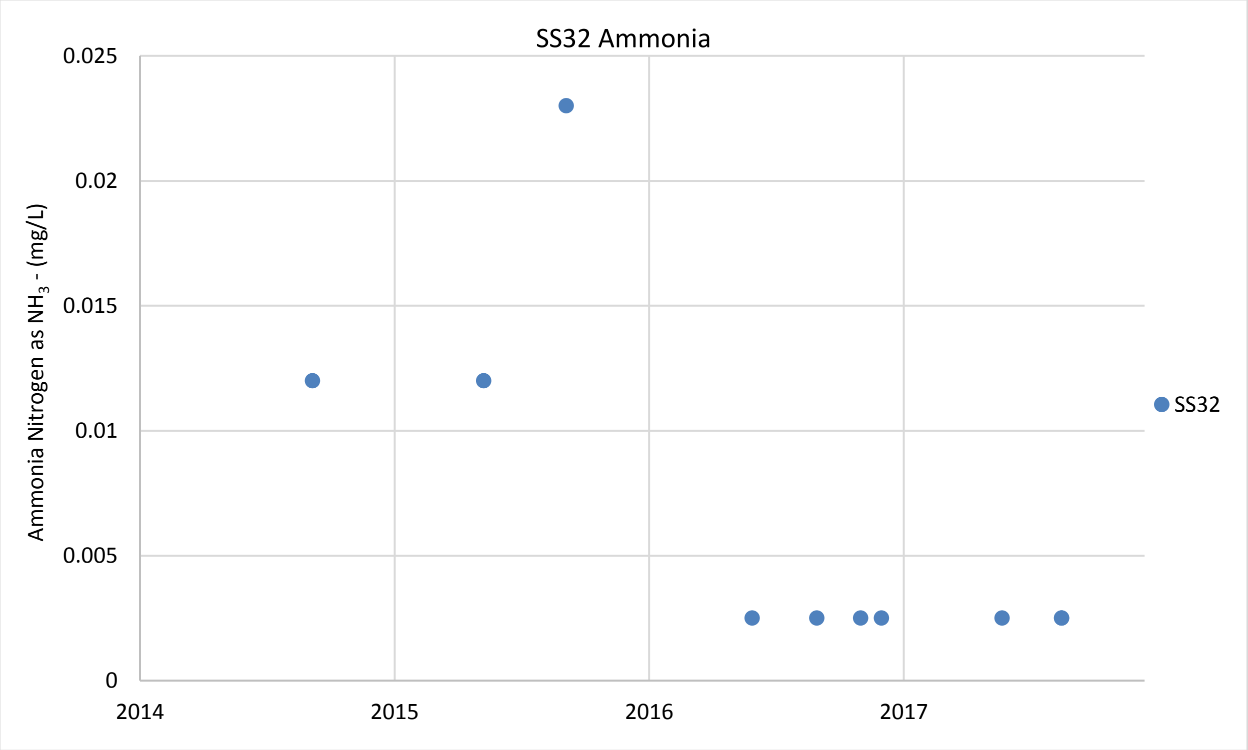


Figure 7-82: SS32 Ammonia

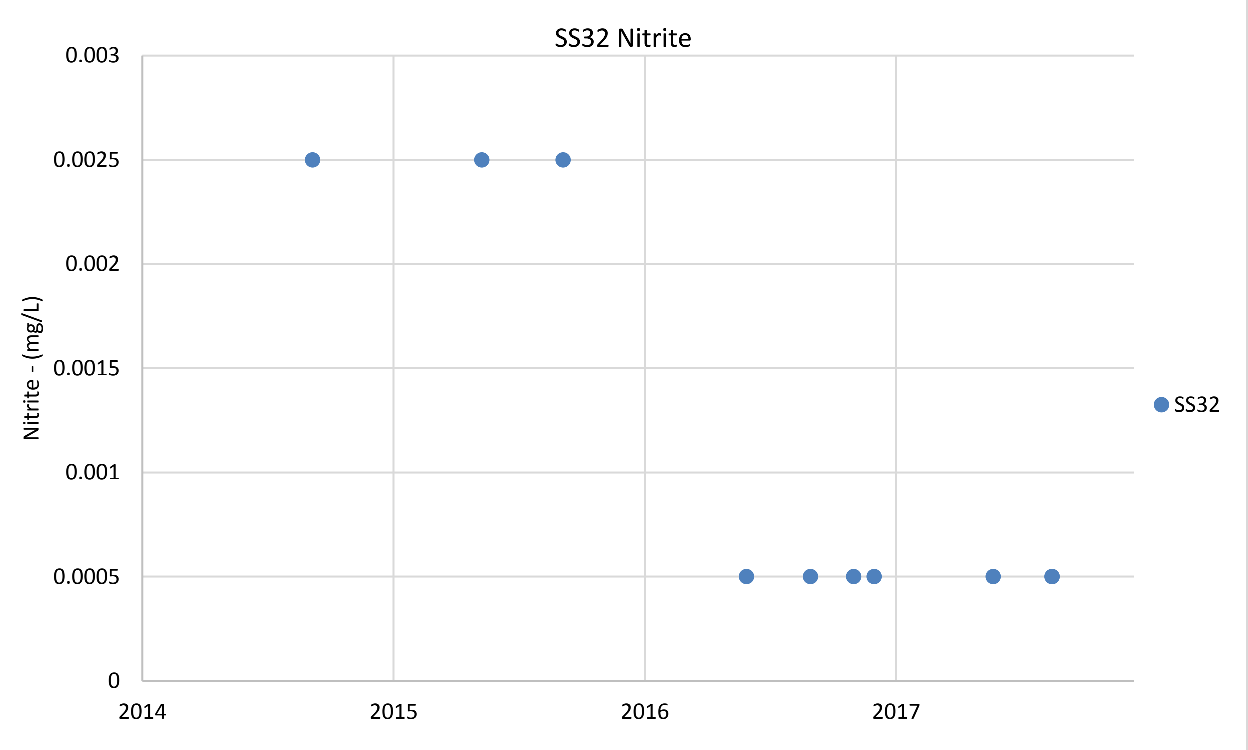


Figure 7-83: SS32 Nitrite

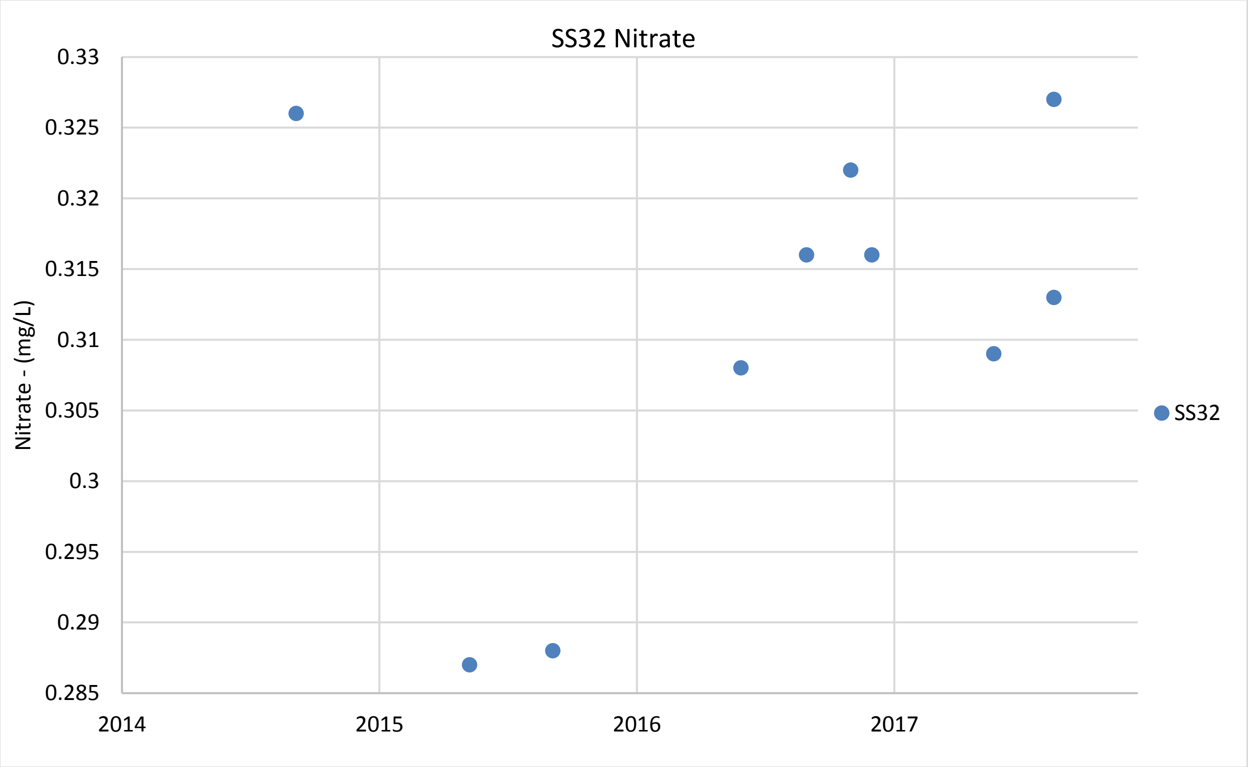


Figure 7-84: SS32 Nitrate

7.10 Pit Walls

Seepage monitoring could not be conducted at the pit walls of the Main Pit, Area 2 Pit, and Minto North Pit; all pits were too unsafe to access during the fall 2017 seepage survey due to geotechnical instability. Records were taken for each pit where seeps were observable from a distance. SS62 is a new seep in area 2 stage 3 pit that was identified in an accessible location and hence was sampled on July 8th, 2017. Results for dissolved copper, cadmium, iron, selenium as well as ammonia, nitrite and nitrate are presented in Table 7-2.

Table 7-2: SS62 Seep Water Quality Results

SS62 Parameters	Concentration (mg/L)
Dissolved Copper (Cu)	0.0142
Dissolved Cadmium (Cd)	0.0000135
Dissolved Iron (Fe)	<0.010
Dissolved Selenium (Se)	0.00102
Ammonia (NH_3)	<0.0050
Nitrite (NO_2)	<0.0050
Nitrate (NO_3)	0.521

8 Water Management

The water balance for the Minto Mine forms the basis of the water management strategy at the site. The water management strategy at the site is for conveyance structures to either divert or release clean surface water or direct impacted water to the Main Pit and eventually treatment.

The Minto Mine generally has a positive water balance, meaning that the site-wide annual runoff is greater than the volume of water required to operate the mine. Therefore, it is necessary to release water to Minto Creek. In the event surface runoff does not meet the discharge limits stipulated in the WUL, Minto Mine has the ability to treat and release water using a combination of active treatment, conveyance structures and water storage features. The following sections will summarize water treatment, conveyance and storage during the reporting period.

8.1 Water Storage and Conveyance Network

There were two major changes to Minto's conveyance structures in 2017.

- Due to A2S3 pit development the location of the W35 sampling station was relocated to the south, or upstream. W35 now reports via a pipe to the A2 pit or to the Tailings Diversion Ditch, the selection of which is controlled by a valve.
- Area 118 pit (W47) was backfilled with waste rock and off-spec overburden from A2S3 pit development. As such, it is no longer used for water storage.

The strategy for managing the mine water inventory was unchanged in 2017, and the water conveyance network is illustrated in Figure 8-1. Compliant (clean) surface water was collected and diverted to the WSP, and subsequently discharged to Minto Creek. Runoff from developed mine areas (mine water) was collected and stored in the Main Pit and Area 2 Pit, and was used for ore processing, deposition of tailings and feed water for the Water Treatment Plant.

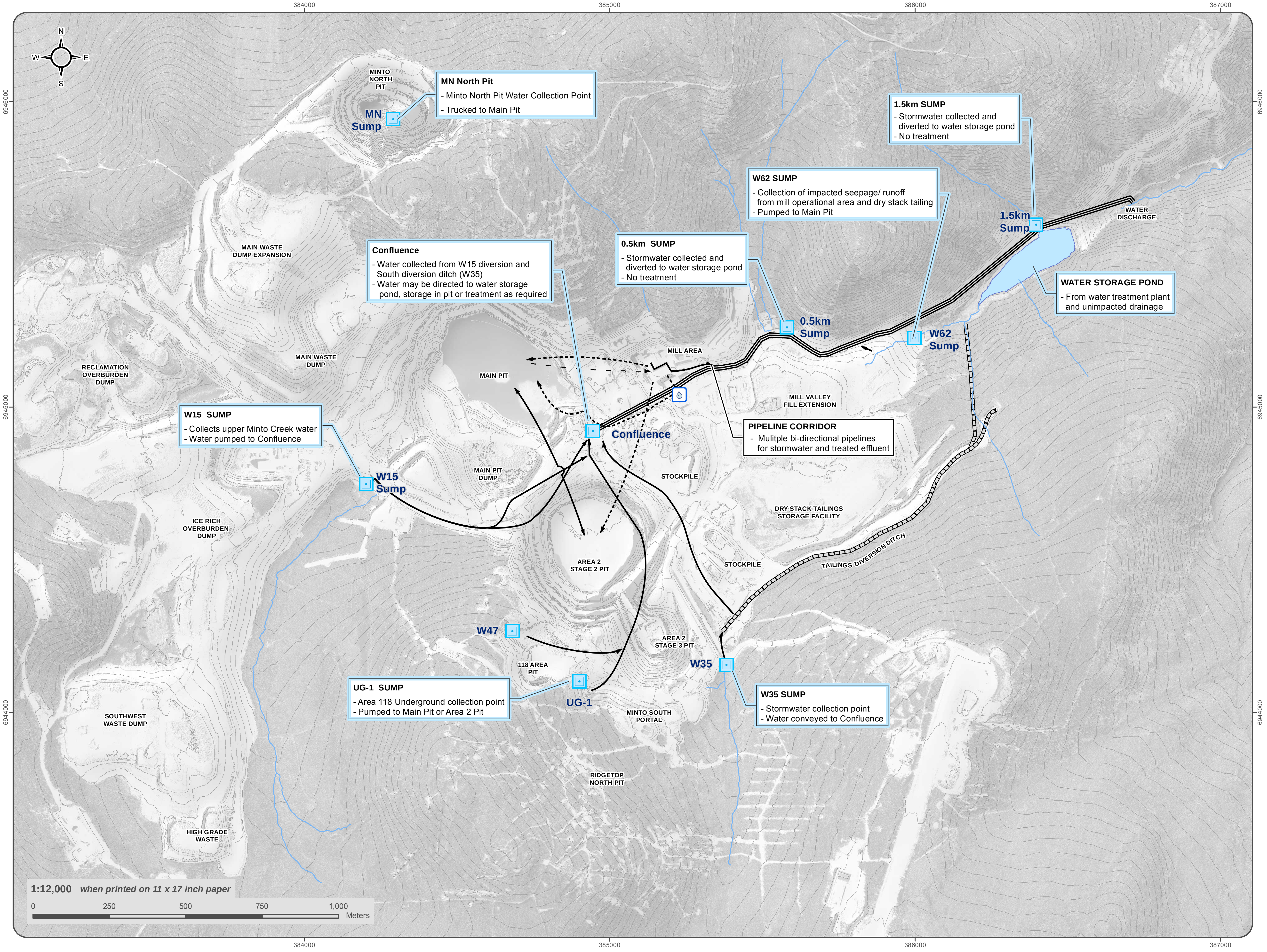
In November 2017, the Main Pit and Area 2 Pit volume calculations were updated with current survey data to reflect changes in tailings and rock deposition from the previous bathymetry survey. Due to this adjustment, it is not possible to present meaningful data for water and tailings volume change over 2017. Instead, 2017 year end volumes are presented.

MINTO MINE

Water License
QZ14-031/QML-0001
2017 Annual Report

FIGURE 8-1

OPERATIONAL WATER MANAGEMENT



MN North Pit
- Minto North Pit Water Collection Point
- Trucked to Main Pit

1.5km SUMP
- Stormwater collected and diverted to water storage pond
- No treatment

W62 SUMP
- Collection of impacted seepage/ runoff from mill operational area and dry stack tailing
- Pumped to Main Pit

0.5km SUMP
- Stormwater collected and diverted to water storage pond
- No treatment

Confluence
- Water collected from W15 diversion and South diversion ditch (W35)
- Water may be directed to water storage pond, storage in pit or treatment as required

WATER STORAGE POND
- From water treatment plant and unimpacted drainage

W15 SUMP
- Collects upper Minto Creek water
- Water pumped to Confluence

PIPELINE CORRIDOR
- Mulitple bi-directional pipelines for stormwater and treated effluent

UG-1 SUMP
- Area 118 Underground collection point
- Pumped to Main Pit or Area 2 Pit

W35 SUMP
- Stormwater collection point
- Water conveyed to Confluence

▣	Collection Point
- - →	Mill Water Reclaim Line
——→	Pipe
☰	Piping Corridor
---→	Tailings Slury Discharge

Aerial imagery obtained from Challenger Geomatics. Imagery acquired Sept 9 th 2014.
Site contours derived from 2014 aerial imagery obtained from Challenger Geomatics.

Hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

D:\Project\AllProjects\Minto\gis\mxd\Overview_Maps\03-SpecificTopics\Water_Management\Operational Water Management_20171219.mxd
(*Last edited by: amatlashevska;19/12/2017/14:02 PM*)

8.2 Water Storage Volumes Movement and Tracking

Water movement is tracked with flow meters on site, monitored and inspected on a weekly basis. Table 8-1 to 8-6 provide a summary of water volumes moved by conveyance structures around site in 2017. Please note that the total and net volume for each facility (WSP, MPTMF, A2PTMF) in the following tables only account for flow meter totals and do not account for evaporation and other losses/inputs.

Table 8-1: Water Storage Pond (WSP) Conveyance for 2017

WSP		
Input Volume (m^3)		**Total**
W15	53,512	155,087
W35	31,947	
WTP	36,877	
W17	32,751	
Output Volume (m^3)		**Total**
WTP	0	115,646
W17 Seep	32,751	
Minto Creek (Environment)	82,895	
Net		39,441

Table 8-2: Reverse Osmosis (RO) Conveyance for 2017

WTP		
Output Volume (m^3)		**Total**
WSP	36,877	36,870
Output Volume (m^3)		**Total**
Minto Creek (Environment)	7	7
Total		36,877

Table 8-3: Main Pit Conveyance for 2017

Main Pit		
Input Volume (m^3)		**Total**
W62	76,314	1,737,231
Minto North	0	
Area 2 Pit	1,567,439	
W15	62,465	
W35	31,013	
Output Volume (m^3)		**Total**
Mill	1,683,934	1,683,934
Net		53,297

Table 8-4: Area 2 Pit Conveyance for 2017

Area 2 Pit		
Input Volume (m^3)		Total
UG1	81,130	1,624,309
Mill	1,543,179	
Output Volume (m^3)		Total
Main Pit	1,567,439	1,567,439
Net		56,870

Table 8-5: Water Truck Deliveries on Site for 2017

Water Trucks		Total (m^3)
Drills	566	10,886
Nuway/ Mill crusher	50	
Pit (for cleaning)	176	
Steamer trailer	6	
Core shack	2	
Driftwood	245	
Dust Suppression	9,772	
Truck	36	
Safescape - Construction	33	

The reported volumes are estimates only.

Table 8-6: Well Usage in 2017

Wells		Total (m^3)
Camp	10,644.90	12,574
ERT	1929.48	

8.2.1 Water Conveyance Tracking

Diversion of W35 water (SDD): Water was diverted from the south catchment (collected at station W35) to the Main Pit and the WSP. An estimated total of 62,960 m^3 moved through the SDD in 2017 as measured by a Mace FloSeries® 3 open pipe flow measuring device. The Mace Flo Series device was calibrated to the pipe diameter size before operating, however due to ongoing issues with sediment deposit from haul road on the flow meter, readings were less accurate at times. During periods of heavy hauling in this area, the SDD was diverted to the Main Pit. In September 2017, the SDD was removed due to changes in the construction of the A2S3 pit. New conveyance infrastructure was installed to reroute water from W35 to the TDD or A2 Pit depending on water quality.

Diversion of W15 water: The W15 sump collects surface runoff from adjacent undisturbed catchments, the SWD and part of the MWD. A total of 115,977 m^3 was conveyed through the W15 conveyance structure in 2017. The W15 flows were measured and recorded using a Seametrics® mag flow meter with digital head relay module.

Pump Back of W62 water (MVFES2 Sump): Water collected downstream of the mill area, ore stockpiles and DSTSF is collected at the MVFES2 Sump (which replaced the MCDS in 2016) and pumped back to the Main Pit for treatment. A total of 76,314 m^3 was conveyed through this structure in 2017. The flow volumes were measured and recorded using a Seametrics® mag flow meter with digital head relay module.

8.2.2 Water Storage Tracking

Water storage on site is monitored for Minto reservoirs which include the Main Pit, the Area 2 Pit, their respective tailings management facilities, the Water Storage Pond (WSP), the Minto North Pit, and the Area 2 Stage 3 Sump. Appendix E provides a more comprehensive analysis of water movement, but presented below, Tables 8-7a and 8-7b provide a summary of their year-end storage volumes and the site-wide water yield.

Main Pit: The Main Pit was used as a reservoir to support the following: water use for the Mill process; collection of impacted runoff; supply feed water to the water treatment plant; and receive water from Area 2 Pit.

Area 2 Pit: The Area 2 Pit was used to support the following: supply water to the Mill via the Main Pit; collection of impacted site water; receiving water/tailings from the Mill.

WSP: The WSP worked effectively as a storage location for un-impacted water and maintained the water quality below effluent quality standards.

Table 8-7a: Minto Mine Water Storage Inventory, 2017

Month/	MPTMF Volume Occupied (Water + Tailings)^A	Change in MPTMF Water Inventory	Tailings Solids Deposition in MPTMF	A2PTMF Volume Occupied (Water + Tailings)^A	Change in A2PTMF Water Inventory	Tailings Solids Deposition in A2PTMF	WSP Volume^A	Change in WSP Water Inventory
Year	m^3	m^3/month	BCM/month	m^3	m^3/month	BCM/month	m^3	m^3/month
Jan-17	3,924,000	41,000	0	2,077,000	-2,000	45,000	67,000	-4,000
Feb-17	3,965,000	48,000	0	2,120,000	5,000	40,000	63,000	-5,000
Mar-17	4,013,000	32,000	0	2,164,000	20,000	48,000	58,000	-3,000
Apr-17	4,046,000	-140,000	0	2,231,000	147,000	43,000	55,000	18,000
May-17	3,906,000	68,000	0	2,421,000	43,000	47,000	73,000	5,000
Jun-17	3,974,000	71,000	0	2,511,000	-29,000	47,000	78,000	6,000
Jul-17	4,045,000	17,000	0	2,529,000	24,000	43,000	84,000	-5,000
Aug-17	4,061,000	63,000	0	2,596,000	-17,000	40,000	79,000	-7,000
Sep-17	4,124,000	-8,000	0	2,618,000	98,000	41,000	72,000	6,000
Oct-17	4,116,000	-162,000	0	2,757,000	162,000	45,000	77,000	0
Nov-17	3,954,000	-100,000	0	2,964,000	89,000	39,000	77,000	-4,000
Dec-17	3,854,000	49,000	0	3,092,000	-37,000	42,000	74,000	-2,000
Jan-18	3,903,000		0	3,098,000			72,000	
SUM		**-22,000**	**0**		**501,000**	**524,000**		**6,000**

Table 8-8b: Water Balance Summary for the Minto Mine Site 2017 (Jan to Dec)

	Units	Main Pit TMF	Area 2 Pit TMF	WSP
Volume Change 2017 (water + tailings)	m^3	-22,000	1,021,000	6,000
Tailings Deposited, total	BCM	-	524,000	-
Water Volume Change 2017	m^3	-22,000	501,000	6,000
Estimated Groundwater Inflow	m^3	-	30,000	-
Total Water Inventory Increase in 2017	**m^3**	515,000		
Total Water Discharged to Minto Creek	m^3	80,000		
Total Site-Wide Yield in 2017	**m^3**	**595,000**		

8.2.3 Water Conveyance Construction

Maintenance activities consisted of routine maintenance on water conveyance structures. In September 2017, the SDD was removed due to changes in the construction of the A2S3 pit. New conveyance infrastructure was installed to reroute water from W35 to the TDD or A2 Pit depending on water quality.

W47 (Area 118 Pit Sump) was backfilled with waste rock and off-spec overburden from the A2S3 pit.

At the end of 2017 the W45 piping from A2 pit to the Main pit was moved from the west side to the east side of the pit to improve access and facilitate pumping.

8.2.4 Water Balance and Water Quality Predictions Modeling

As per the WUL Clause 108, Minto is required to update the Water Balance and Water Quality Model. Minto retained SRK Consulting to complete a 2017 site water balance and water quality prediction model update. An updated 2017 Water Balance and Water Quality Model Summary for the Minto Mine is provided by SRK Consulting in Appendix E.

8.3 Water treatment

Surface runoff that did not meet the WUL effluent standards was directed to the Main Pit through the W15 Pipeline, W35 SDD, or via the W62 pump back.

Minto has the option of treating for:

- Total suspended solids (TSS) only: clarification;
- TSS, copper and cadmium: clarification and chemical precipitation; or
- All water quality parameters present in the Main Pit: clarification and reverse osmosis (RO).

Water treatment by-products including TSS sludge and RO reject is pumped back to the Main Pit.

8.3.1 Operations Overview

The water treatment plant operated 62 days in 2017. From April 14 to May 31, 2017 and again from June 7 to June 21, 2017. The RO units operated for 729.6 hours producing 36,877.7 m^3 of permeate. A total of 36,877.7 m^3 of water was discharged to the WSP. The water treatment plant was shut down on June 21 because the nitrite concentrations in the effluent were above discharge criteria due to contaminant build up and membrane fouling.

Recovery for the water treatment plant in 2017 was low at 27.7% due to the high nitrite levels in the permeate.

Table 8-9: WTP Operating Statistics (2017)

WTP Statistics 2017	
Plant Feed (m^3)	132,910
RO Treated (m^3)	36,877
Discharged to WSP (including blending) (m^3)	36,877
Runtime (hour) (Discharge hours)	729.6
Recovery (%)	27.7
Reagent Consumption	
Polyclear 2528 (floc) (m^3)	7
Average Flow Rate floc (average ml/min)	2200
Hydrex (m^3)	12
Average Flow Rate Hydrex (average ml/min)	52
Actisand (85 micron sand) kg	365
Sodium Bicarbonate (m^3)	27
Antiscalant liters	911
1 micron filters each	492
RO membranes each	120
CUNO 10 micron filters each	96

Table 8-10: WTP Constituent Removal Summary (2017)

Parameter	Units	Average WTP Intake	Average WTP Product (RO)
pH-L	pH units	7.3	6.4
Cond-L	µS/cm	2137	158.7
TDS	mg/L	1792	101.4
TSS	mg/L	5.57	1.0
Nutrients (mg/L)			
Ammonia	mg/L	5.08	.8852
N-NO2	mg/L	.9974	.51
N-NO3	mg/L	15.31	5.731
Dissolved Metals (mg/L)			
Al-D	mg/L	0.027	0.02
Cd-D	mg/L	0.00006966	0.00007
Cr-D	mg/L	0.00016	0.00010
Cu-D	mg/L	0.0414	0.0063
Fe-D	mg/L	0.021	0.011
Pb-D	mg/L	0.000093	0.000055
Mo-D	mg/L	0.0686	0.00184
Ni-D	mg/L	0.00276	0.0005
Se-D	mg/L	0.01119	0.00150
Zn-D	mg/L	0.0044	0.0037

8.4 Water Discharge

8.4.1 Discharge Volumes

Minto Mine discharged approximately 81,303.68 m^3 of water to Minto Creek from the WSP via W16A in 2017. An additional 7 m^3 was discharged from the WTP/RO to Minto Creek, this is discussed in the water quality section.

8.4.2 Compliance

As per WUL Clause 6 the rate of water discharge to Minto Creek is calculated based on daily creek flow measurements. The daily discharge volumes are presented below.

The calculated maximum allowable discharge was exceeded on one occasion in 2017. On May 31st the mine discharged 1554 m^3 while the calculated allowable volume was 1553m^3. This exceedance was believed to be due to a fluctuation in the pumping and was reported in the monthly WUL report. When the calculations were reviewed in July, the actual discharge was determined to be 1550 m^3, with a maximum allowable discharge of 1379 m^3. There were no other exceedances, before or after the calculation correction. The 2017 daily discharge corrected values are presented in Table 8-10 and is presented graphically in Figure 8-2 below.

Table 8-11: 2017 Discharge Data

Date	Daily flow rate in Minto Creek	Treated water from RO to Minto Creek, *day previous*	Daily water discharged WSP to Environment, *day previous*	Actual Daily Discharge	Qeff-c, Maximum Allowable Daily Discharge
1-May-17	0.145	0	0	818	4176
2-May-17	0.079	0	818	1070	2003
3-May-17	0.171	0	1070	1068	4568
4-May-17	0.110	0	1068	1066	2812
5-May-17	0.296	0	1066	1070	8169
6-May-17	0.202	0	1070	1074	5461
7-May-17	0.113	0	1074	1076	2896
8-May-17	0.113	0	1076	838	2896
9-May-17	0.123	0	838	1084	3263
10-May-17	0.085	0	1084	1085	2087
11-May-17	0.079	0	1085	1094	1913
12-May-17	0.093	0	1094	1095	2314
13-May-17	0.122	0	1095	1091	3149
14-May-17	0.121	0	1091	1096	3121
15-May-17	0.093	0	1096	1101	2313
16-May-17	0.102	0	1101	1107	2571
17-May-17	0.130	0	1107	1100	3375
18-May-17	0.066	0	1100	1118	1534
19-May-17	0.100	0	1118	1118	2507
20-May-17	0.079	0	1118	1134	1903
21-May-17	0.070	0	1134	1142	1638
22-May-17	0.081	0	1142	1159	1952
23-May-17	0.093	0	1159	1161	2292
24-May-17	0.074	0	1161	1165	1744
25-May-17	0.070	0	1165	1116	1628
26-May-17	0.270	0	1116	1161	7404
27-May-17	0.171	0	1161	1153	4538
28-May-17	0.103	0	1153	1152	2582
29-May-17	0.083	0	1152	1623	2006
30-May-17	0.086	0	1623	1653	1936
31-May-17	0.067	0	1653	**1550**	**1379**
1-Jun-17	0.068	0	1550	676	1442

Date	Daily flow rate in Minto Creek	Treated water from RO to Minto Creek, *day previous*	Daily water discharged WSP to Environment, *day previous*	Actual Daily Discharge	Qeff-c, Maximum Allowable Daily Discharge
2-Jun-17	0.039	0	676	483	898
3-Jun-17	0.072	0	483	1677	1913
4-Jun-17	0.268	0	1677	3516	7160
5-Jun-17	0.191	0	3516	3909	4329
6-Jun-17	0.144	0	3909	2516	2844
7-Jun-17	0.1	0	2516	1812	2041
8-Jun-17	0.074	0	1812	717	1527
9-Jun-17	0.045	0	717	261	1057
10-Jun-17	0.047	0	261	619	1067
11-Jun-17	0.04	0	619	291	586
12-Jun-17	0.343	0	291	3459	9461
13-Jun-17	0.227	0	3459	4411	5384
14-Jun-17	0.165	0	4411	2095	3282
15-Jun-17	0.097	0	2095	1777	2095
16-Jun-17	0.081	0	1777	1499	1740
17-Jun-17	0.081	0	1499	1666	1833
18-Jun-17	0.071	0	1666	1277	1489
19-Jun-17	0.054	0	1277	960	1130
20-Jun-17	0.053	0	960	1096	1207
21-Jun-17	0.05	0	1096	778	1075
22-Jun-17	0.034	0	778	474	720
23-Jun-17	0.036	0	474	663	879
24-Jun-17	0.036	0	663	672	816
25-Jun-17	0.03	0	672	628	640
26-Jun-17	0.029	0	628	223	626
27-Jun-17	0.019	0	223	0	473
No discharge					
11-Jul-17	0.04	0	0	642	1152
12-Jul-17	0.045	0	642	967	1082
13-Jul-17	0.038	0	967	296	772
14-Jul-17	*	0	296	0	0
No discharge					
25-Jul-17	0.008	0	0	0	230
26-Jul-17	0.028	0	0	333	806
27-Jul-17	0.047	0	333	955	1243
28-Jul-17	0.05	0	955	772	1122

Date	Daily flow rate in Minto Creek	Treated water from RO to Minto Creek, *day previous*	Daily water discharged WSP to Environment, *day previous*	Actual Daily Discharge	Qeff-c, Maximum Allowable Daily Discharge
29-Jul-17	0.056	0	772	660	1355
30-Jul-17	0.038	0	660	673	875
31-Jul-17	0.037	0	673	662	841
1-Aug-17	0.046	0	662	657.6	1104
2-Aug-17	0.031	0	658	434.2	674
3-Aug-17	0.023	0	434	313.2	518
4-Aug-17	0.022	0	313	309.5	529
5-Aug-17	0.015	0	310	137.3	329
No discharge					

*** not measured, not discharging**

Water Quality monitoring stations are discussed in Section 5.2.

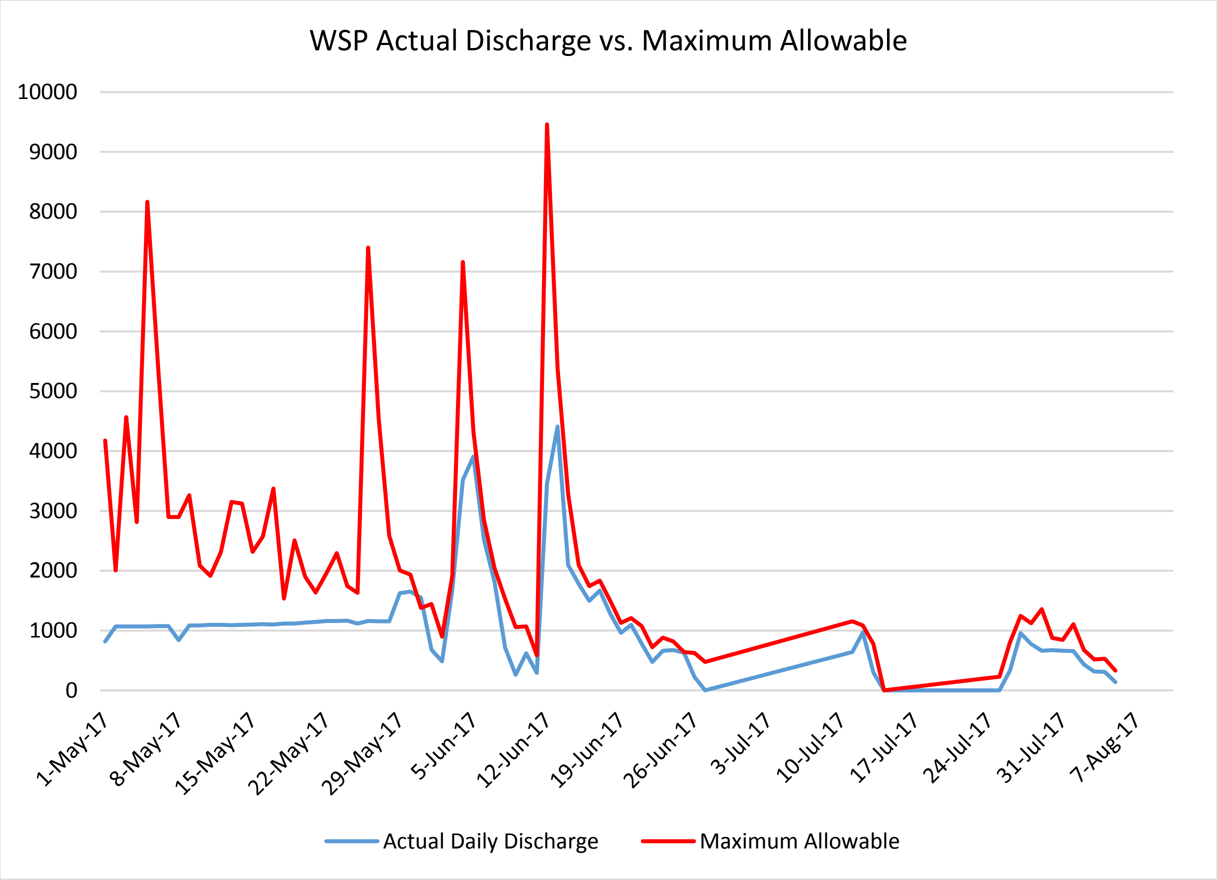


Figure 8-2: 2017 Discharge to Minto Creek

8.5 Hydrology

In 2017, and as part of the EMSRP, Minto monitored hydrological conditions at water quality stations including the following: stations within the operational mine area; stations downstream from the mine operational area that are influenced by mine effluent discharge; and reference stations downstream from the mine operational area that are not exposed to effluent. Hydrological monitoring is performed using a variety of methods including: manual discrete discharge measurements with combinations of flow meters, continuous stage measurements through the deployment of Solinst Level Loggers and Barometric Loggers and monitoring of an engineered flume.

8.5.1 Minto Creek Hydrology

Hydrological monitoring on Minto Creek is conducted in accordance with the requirements outlined in the WUL. During the 2017 monitoring period, Minto Mine maintained and collected data from the following four hydrometric stations along Minto Creek.

- W3: Flume downstream of the Water Storage Pond (WSP);
- MC-1: Located in Minto Canyon – mid-catchment;
- W1: Located approximately 1 km upstream of Yukon River – lower catchment; and
- W7: Tributary on the south side of Minto Creek.

At the hydrometric stations, Solinst Level Loggers and Barometric Loggers were used in conjunction with staff gauge readings and manual flow measurements to produce volumetric flow rates.

For details on the 2017 results of Minto Creek hydrology see the *Summary of Minto and McGinty Creek 2017 Surface Hydrology Memo* in Appendix F.

8.5.2 McGinty Creek Hydrology

In 2017, hydrological monitoring on McGinty Creek was not conducted as per the schedule outlined in the EMSRP. It was noted late in the season that MN-1.5 was not monitored for continuous flow as there was no suitable location to set up a station in this area, however MN-0.5 was monitored instead. During the 2017 monitoring period, Minto Mine maintained and collected data from the following three hydrometric stations along McGinty Creek.

- MN-0.5: West Tributary of McGinty Creek
- MN-2.5: East Tributary of McGinty Creek
- MN-4.5: McGinty Creek near the Mouth

At the hydrometric stations, Solinst Level Loggers and Barometric Loggers were used in conjunction with staff gauge readings and manual flow measurements to produce volumetric flow rates.

For details on the 2017 results of McGinty Creek hydrology see the *Summary of Minto and McGinty Creek 2017 Surface Hydrology Memo* in Appendix F.

8.5.3 Hydrology QA/QC

Detailed procedures for hydrology monitoring at the Minto Mine are detailed in the *Minto Mine Surface Water Hydrology* SOP. No changes were made to the hydrology SOP in 2017.

9 Physical Monitoring Program

Minto’s physical monitoring program consists of a combination of instrumentation and visual inspections. Site wide inspections are carried out semi-annually - May/June post thaw and September pre freeze-up. Q2 inspection must be completed by an external geotechnical engineering consultant in accordance with Clause 13.2 of the QML. As specified in the WUL and *Minto Physical Monitoring Plan*, the following additional inspections are also performed:

- Active waste rock and overburden dumps – daily during construction;
- Active open pits – weekly;
- Diversion ditch – daily during water conveyance;
- Dry Stack Tailings Storage Facility, Mill Valley Fill Extension and Mill Valley Fill Extension 2 – monthly;
- Main Pit and Area 2 Pit tailings storage facilities – quarterly; and
- WSP dam – weekly (seepage), monthly (stability).

Deformation monitoring instrumentation includes survey hubs and borehole inclinometers, described in the following sections. A layout of physical monitoring instrumentation is provided in Figure 9-1, below. The updated *Physical Monitoring Plan* can be found in Appendix G.

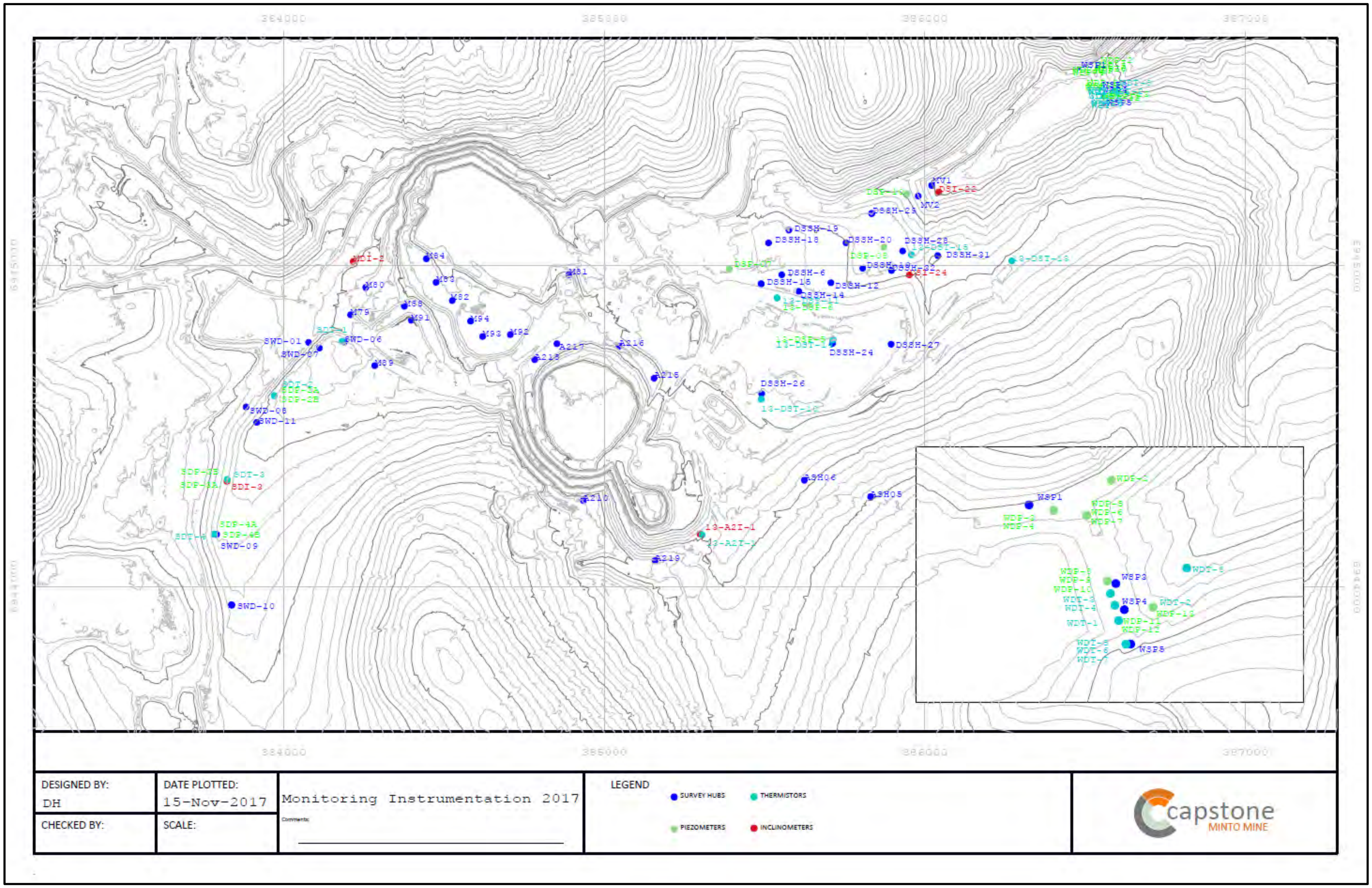


Figure 9-1: Physical Monitoring Program Installation (2017)

9.1 Physical Deformation Monitoring Instrumentation

9.1.1 Survey Hubs

Physical deformation monitoring consists of survey hubs at the Main Pit, Area 2 Pit, DSTSF, SWD and WSP dam. The monitoring results are summarized below.

9.1.1.1 Main Pit/South Wall Buttress Survey Hubs

There are currently 11 operating survey hubs on the Main Pit south wall buttress. Data collected are presented in Figure 9-2. Data was collected weekly for hubs M79, M80, M81, M89, M92, M93, M94. Data was collected weekly for hubs M82, M83, M84 and M88, and increased to twice-weekly when required as per the Adaptive Management Plan.

In general, the movement rates continued a gradual decrease in 2017, with rates now nearing zero movement in some of the hubs. The in-pit survey hubs indicated relatively consistent movement rates in 2017 as presented in Figure 9-3. M82 and M83 saw an increase in movement in May during the construction of the Main Pit Dump (MPD), prompting the installation of additional hubs and review of the data by the SRK Consulting (the Engineer of Record). This movement is associated with settlement of the in-pit dump, not part of the south wall buttress. M82, M83, M93, and M94 still show higher rates of movement, however, these rates are significantly less than those observed in survey hubs prior to the south wall failure and are not considered to be a stability concern.

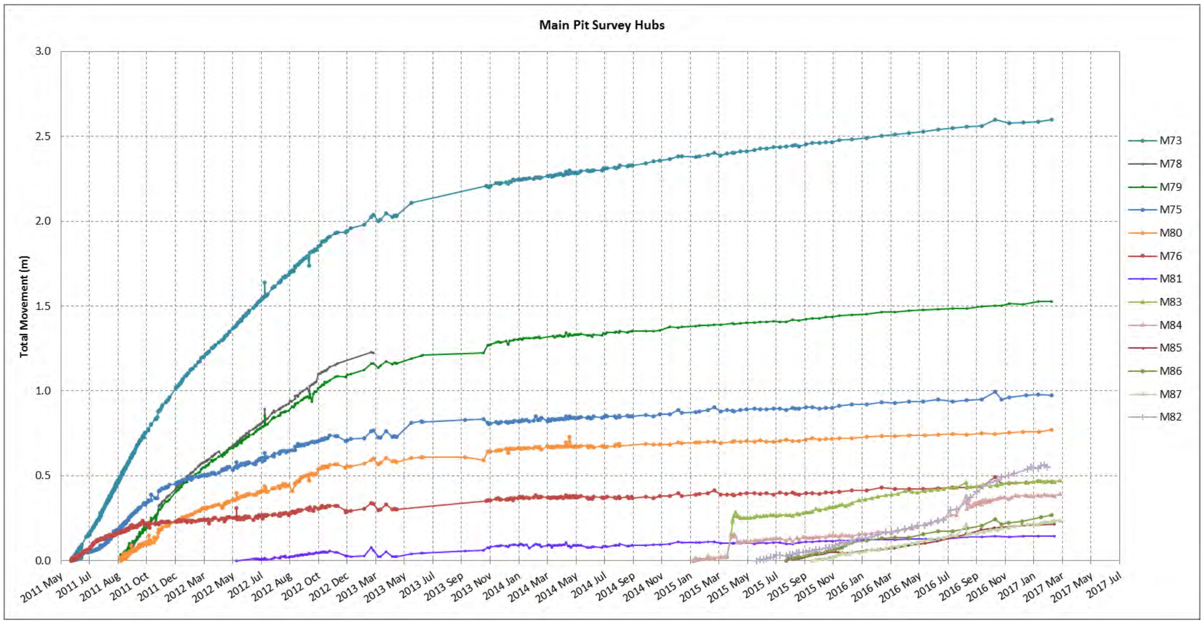


Figure 9-2: Main Pit/South Wall Buttress Survey Hub Data (2011-2017)

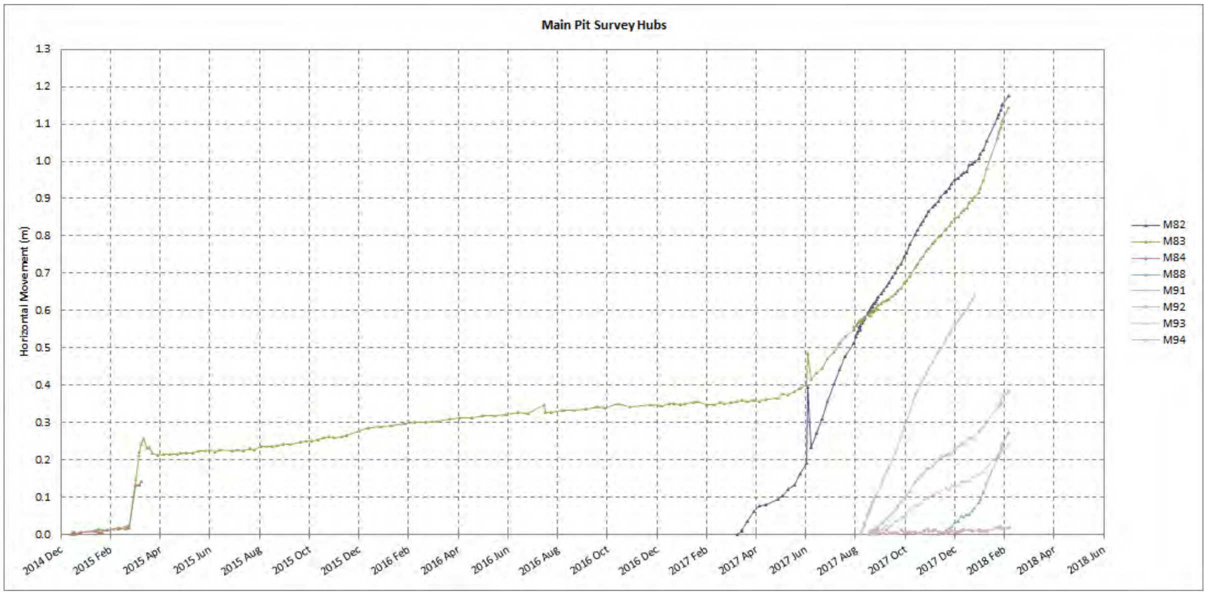


Figure 9-3: Main Pit/South Wall Buttress Survey Hub Data (2014-2017)

9.1.1.2 Dry Stack Tailings Storage Facility/Mill Valley Fill Survey Hubs

There are currently 17 operating survey hubs on the DSTSF and MVFE2. Data collected are presented in Figures 9-4 and 9-5. Data are collected weekly. All hubs indicated a continued gradual decrease in movement rates in 2017. Most hubs have shown a decrease in movement rate since the construction of the MVFE2 in summer, 2016.

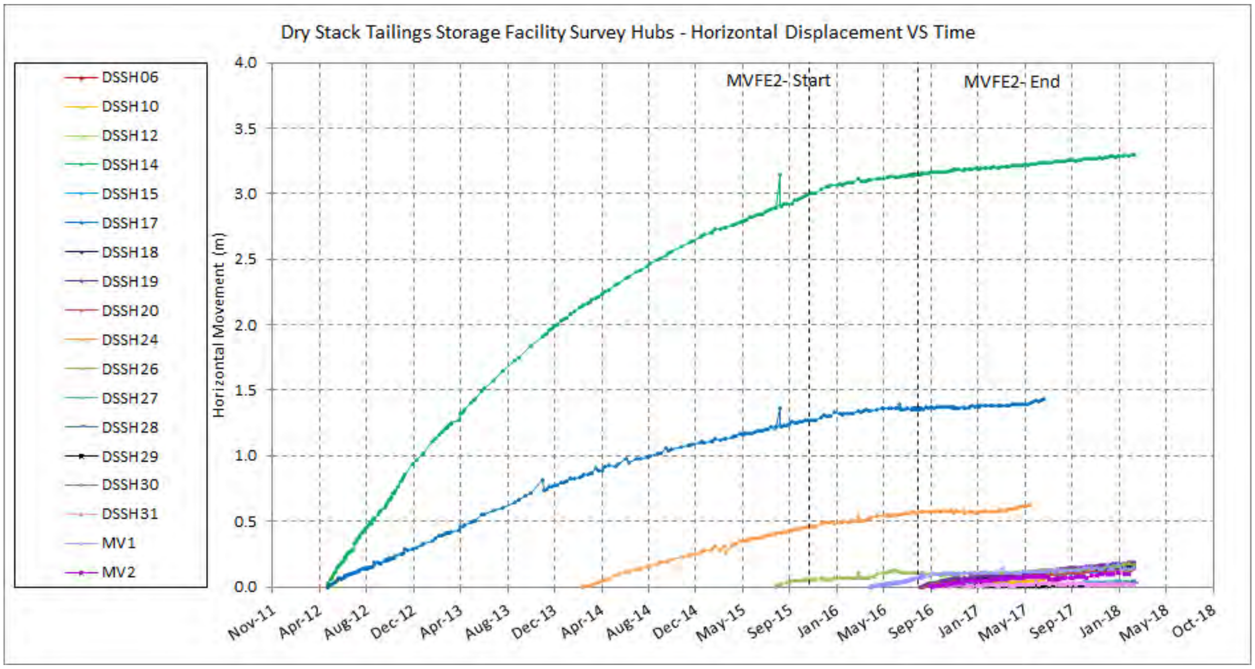


Figure 9-4: DSTSF Survey Hub Data (2012-2017)

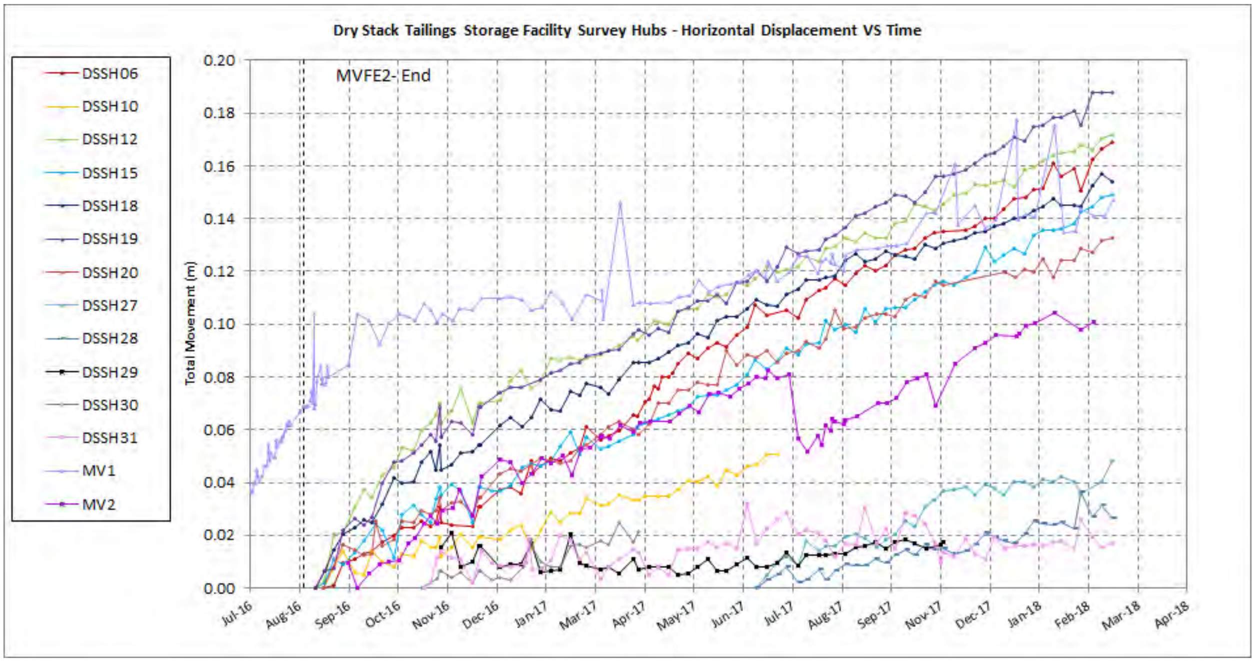


Figure 9-5: DSTSF Survey Hub Data (2016-2017)

9.1.1.3 Southwest Dump Survey Hubs

There are currently 7 operating survey hubs on the SWD. SWD-03A and SWD-05A were replaced in July 2017 with SWD-10 and SWD-11. Data collected are presented in Figure 9-6. Data are collected monthly. Hubs indicated relatively consistent movement rates in 2017.

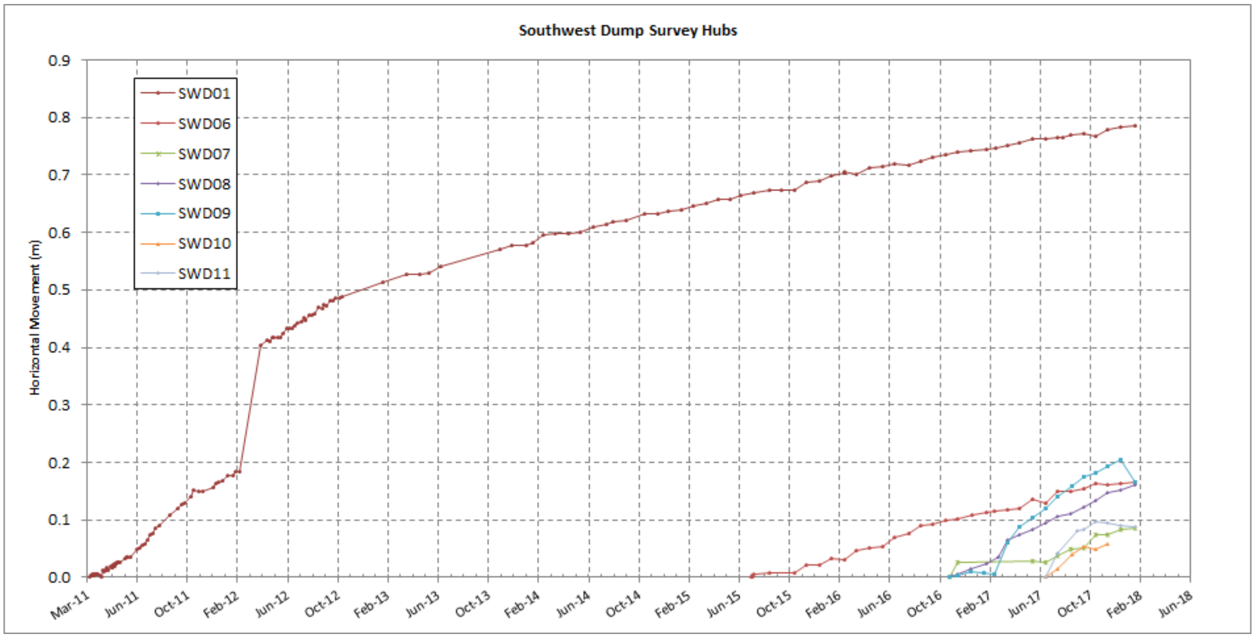


Figure 9-6: SWD Survey Hub Data (2011-2017)

9.1.1.4 Water Storage Pond Dam Survey Hubs

There are currently four operating survey hubs on the WSP dam. There was no change to the operational status of any the hubs in 2017 Data collected are presented in Figure 9-7. Data are collected monthly. Data continue to indicate no movement.

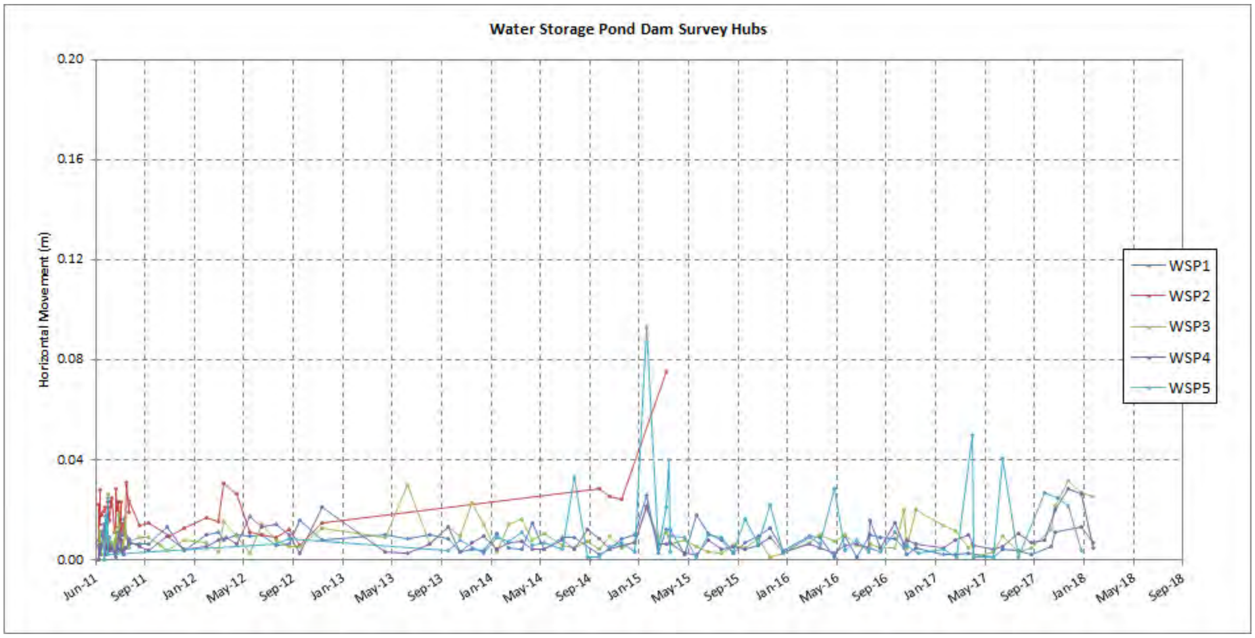


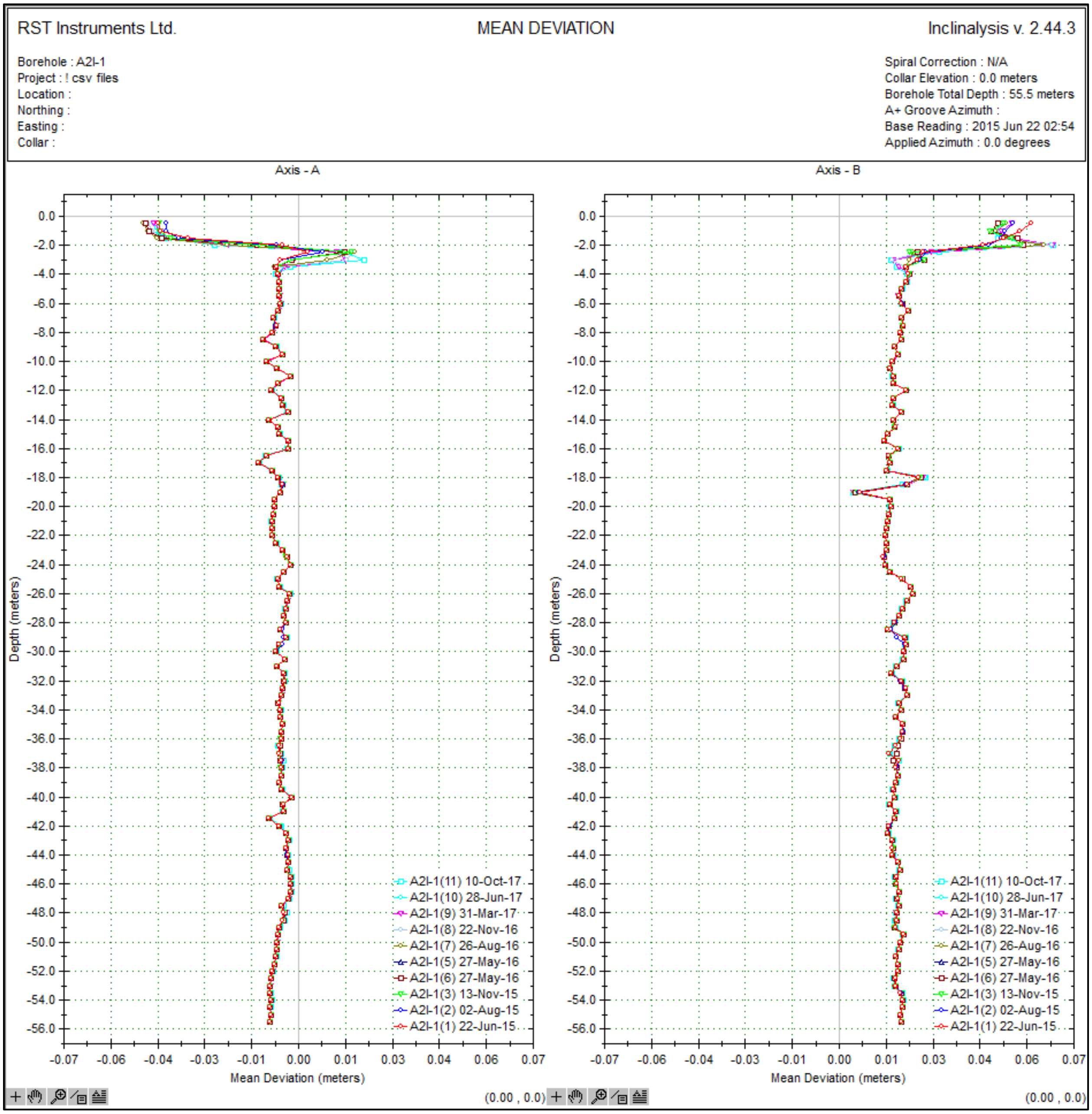
Figure 9-7: Water Retention Dam Survey Hub Data (2011-2017)

9.1.2 Inclinometers

Physical deformation monitoring consists of monitoring of inclinometers at the DSTSF and Main Pit. The monitoring results are summarized below.

9.1.2.1 DSTSF Inclinometers

There are currently three operating inclinometers in the DSTSF area. DSI-23 sheared off in April 2017. The inclinometer probe was stuck in DSI-23 from April 2017 to July 2017 and was damaged in December 2017. Data collected are presented in Figure 9-8 through Figure 9-11. A2I-1 is monitored quarterly. DSI-22 and DSI-24 are monitored monthly.



RST Instruments Ltd.

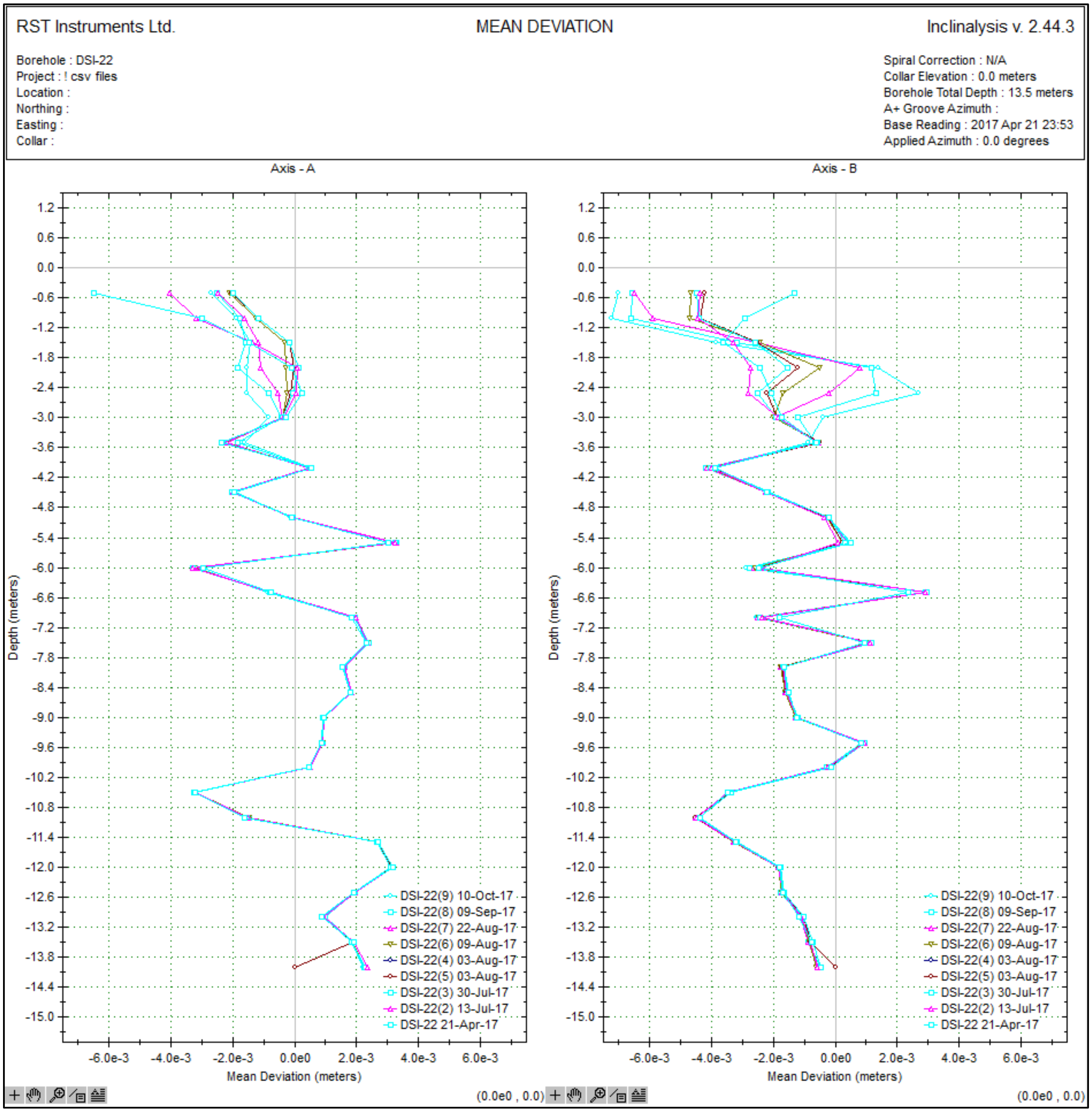
MEAN DEVIATION

Inclinalysis v. 2.44.3

Borehole : A2I-1
Project : ! csv files
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 meters
Borehole Total Depth : 55.5 meters
A+ Groove Azimuth :
Base Reading : 2015 Jun 22 02:54
Applied Azimuth : 0.0 degrees

Figure 9-8: DSTSF Inclinometer A2I-1 (2015-2017)



RST Instruments Ltd.

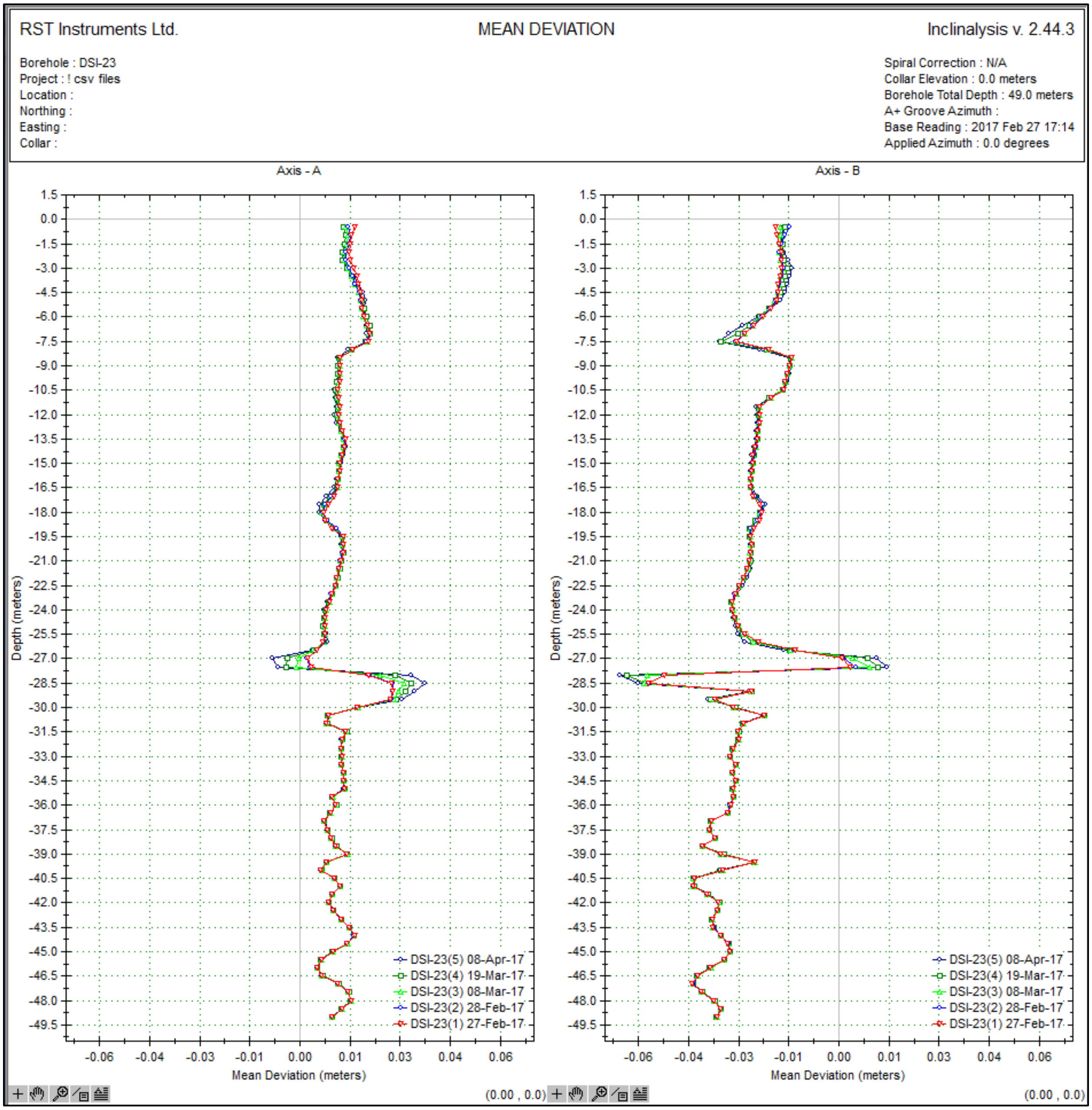
MEAN DEVIATION

Inclinalysis v. 2.44.3

Borehole : DSI-22
Project : ! csv files
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 meters
Borehole Total Depth : 13.5 meters
A+ Groove Azimuth :
Base Reading : 2017 Apr 21 23:53
Applied Azimuth : 0.0 degrees

Figure 9-9: DSTSF Inclinometer DSI-22 (2017)



RST Instruments Ltd.

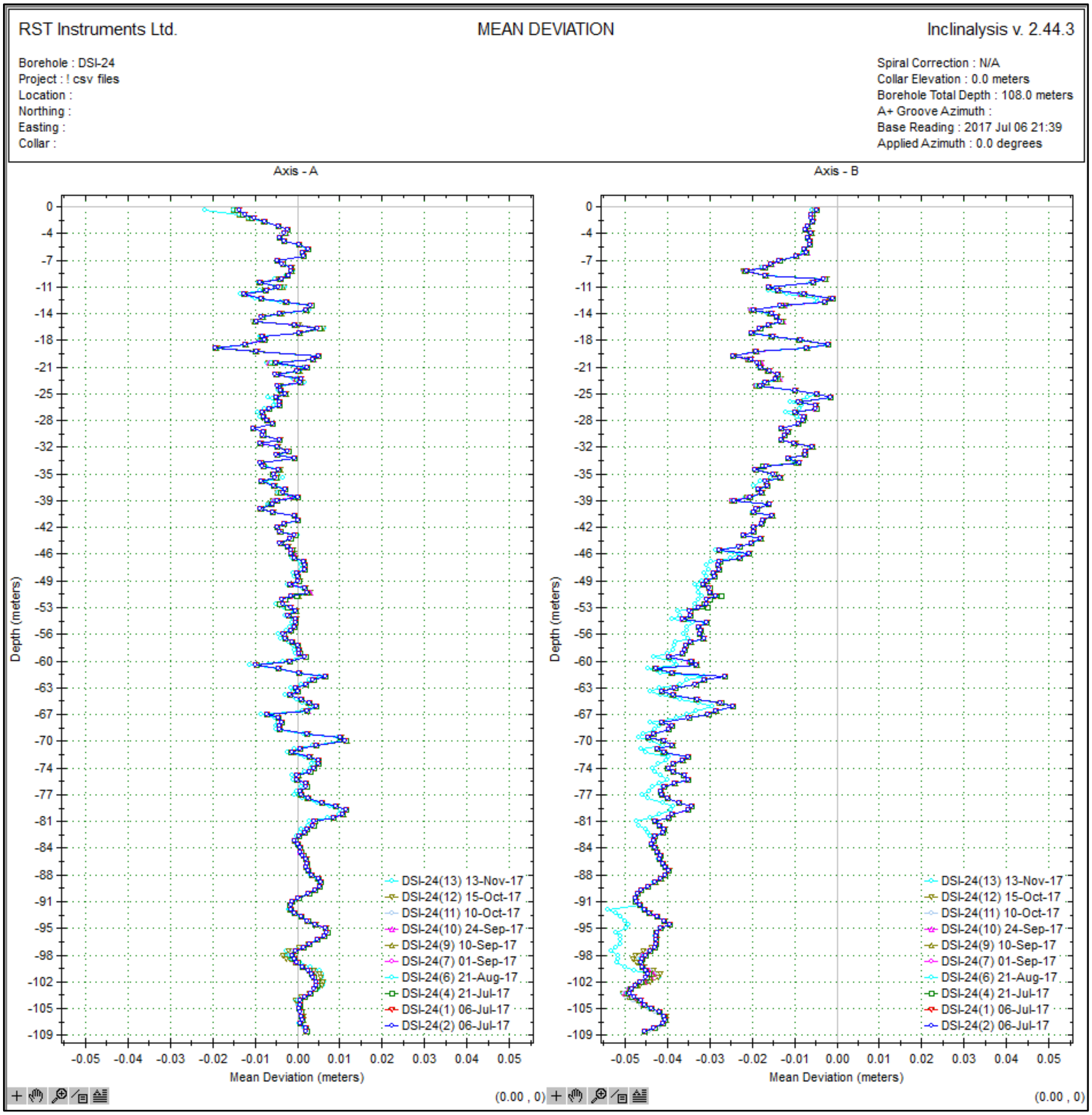
MEAN DEVIATION

Inclinalysis v. 2.44.3

Borehole : DSI-23
Project : ! csv files
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 meters
Borehole Total Depth : 49.0 meters
A+ Groove Azimuth :
Base Reading : 2017 Feb 27 17:14
Applied Azimuth : 0.0 degrees

Figure 9-10: DSTSF Inclinometer DSI-23 (2017)



RST Instruments Ltd.

MEAN DEVIATION

Inclinalysis v. 2.44.3

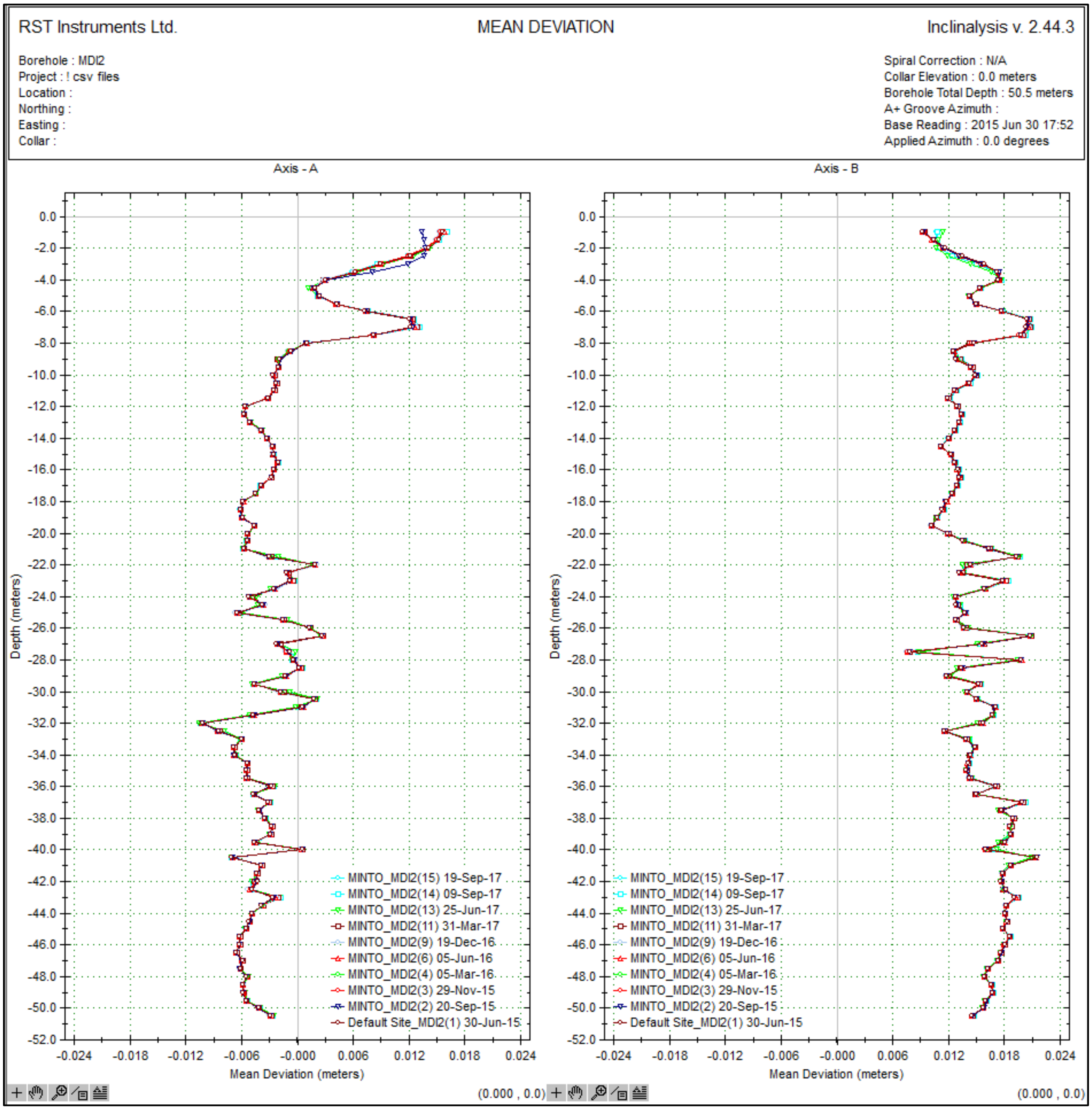
Borehole : DSI-24
Project : ! csv files
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 meters
Borehole Total Depth : 108.0 meters
A+ Groove Azimuth :
Base Reading : 2017 Jul 06 21:39
Applied Azimuth : 0.0 degrees

Figure 9-11: DSTSF Inclinometer DSI-24 (2017)

9.1.2.2 Main Pit Inclinometers

There is currently one operating inclinometer in the Main Pit west/south wall area. Readings re-commenced in October 2013 after not having been recorded since November 2012. Data are collected quarterly. Data collected are presented in Figure 9-12.



RST Instruments Ltd. MEAN DEVIATION Inclinalysis v. 2.44.3

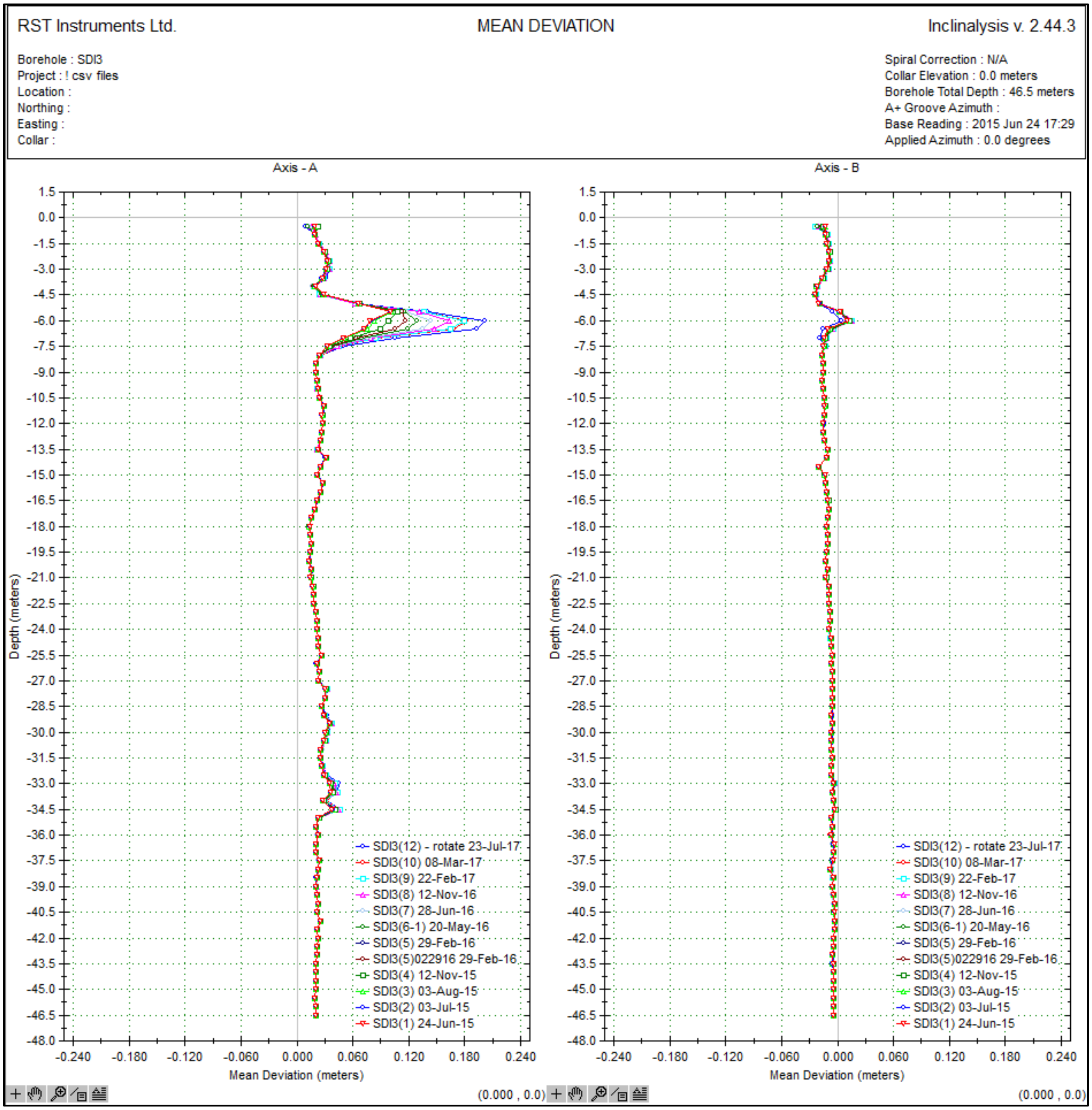
Borehole : MDI2
Project : ! csv files
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 meters
Borehole Total Depth : 50.5 meters
A+ Groove Azimuth :
Base Reading : 2015 Jun 30 17:52
Applied Azimuth : 0.0 degrees

Figure 9-12: Main Pit Inclinometer MDI-2 (2015-2017)

9.1.2.3 Southwest Dump Inclinometers

There is currently one operating inclinometer in the Southwest Dump area. Readings re-commenced in April 2014 after not having been recorded since November 2012. Data are collected quarterly. Data collected are presented in Figure 9-13.



RST Instruments Ltd.
MEAN DEVIATION
Inclinalysis v. 2.44.3

Borehole : SDI3
Project : ! csv files
Location :
Northing :
Easting :
Collar :

Spiral Correction : N/A
Collar Elevation : 0.0 meters
Borehole Total Depth : 46.5 meters
A+ Groove Azimuth :
Base Reading : 2015 Jun 24 17:29
Applied Azimuth : 0.0 degrees

Figure 9-13: Main Pit Inclinometer SDI-3 (2015-2017)

9.2 Engineer's Annual Physical Inspection Reports

As required by the WUL and QML, the following structures are inspected semi-annually by Minto's geotechnical engineer and annually by an external geotechnical engineering consultant:

- Big Creek Bridge;
- Mill and camp site;
- Dry Stack Tailings Storage Facility and Mill Valley Fill Extension (Stage 1 and 2);
- Fuel containment facility;
- Main Waste Dump;
- Ore stockpiles;
- Reclamation Overburden Dump;
- Ice Rich Overburden Dump;
- South Diversion Ditch;
- Tailings Diversion Ditch
- Southwest Waste Dump;
- Main Pit including South Wall Buttress and In-Pit Dumps;
- Water Storage Dam;
- Area 118 and Area 2 Pit; and,
- Minto North Pit.

Table 9-1 summarizes the recommendations from the most recent external inspection conducted June 26-28, 2017 and the associated planned actions.

Table 9-1: Annual Physical Inspection Report Summary (2017)

Area	Recommendation	Action
DSTSF/MVFE2	Two readings should be collected from DSI-24 on the same day confirm accuracy of the readings, and readings collected on a weekly basis until the quality of inclinometer data can be confirmed.	Readings were collected on DSI-24 has per recommendation. No concerns about data quality, additional training of monitoring technicians was required.
	Additional fill should be placed in the pooled depression at the south end of the facility to prevent ponding.	Additional fill was placed in August 2017.
	Continue to monitor the exposed slope south of the Minto Creek Seepage Collection System for signs of retrogressive failure to determine if any slope stabilization measures are required.	Slope has been monitored monthly during the MFE2 inspections. No changes have been noted.
Tailings Diversion Ditch	The vegetation in the western portion of the channel should be removed prior to the planned diversion of the South Diversion Ditch into the Tailings Diversion Ditch.	Completed in November 2017.

Area	Recommendation	Action
Camp Site	Continue to monitor the slough at the west end of the camp area and the erosion channels below the camp pad following large rainfall events.	Monitoring of erosion channels already apart of the Camp Site inspection carried out bi-annually.
South Diversion Ditch	No actions are required provided the SDD is decommissioned in August 2017, as planned. However, should the SDD not be decommissioned the followings actions are recommended: o Clean the overflow spillway on both sides of the access road and clear the inlet to the culverts. o Clear the vegetation within the SDD prior to 2018 freshet.	SDD was decommissioned in August 2017.
WSP Dam	Continue regular monitoring of the dam as per the OMS Manual.	Monitored during monthly inspections as per OMS Manual.
South Wall Buttress / In Pit Dump	Clear the loose rocks beneath M82 During SAT material placement, truck traffic is to be maintained a minimum of 5 meters away from the dump face, or a spotter is to be present. Continue to limit access to the In-Pit Dump area near M84.	M82 was inspected and data reviewed. Determined there was no need to move the hub. Recommendations were already apart of the SAT dumping Safe Work Practice. Access has remained limited to the Geotechnical EITs and Mine Technical Assistants
Area 2 pit	Review radar data of the Area 2 Stage 3 Pit to confirm any areas of movement and the rate of movement. Based on the results, establish a survey hub(s) to monitor area.	Radar date was reviewed in June 2017. No movement of the overburden was observed. One survey hub was installed along the pit crest to monitor for any movement.
Instrumentation	More attention needs to be paid to the stability of the inclinometer readings during collection to ensure quality data is collected. Data should be reviewed following collection and new readings should be taken if data is of poor quality. All survey hubs mounted on lock-blocks should be inspected to determine if readings may be affected by uneven ground conditions. The ground should be level and clear of all debris/loose rocks.	Additional training of monitoring technicians was required; training was completed in July 2017. Inspection of all survey hubs completed in July 2017.

10 Adaptive Management Plan - Operations

The Operations Adaptive Management Plan has been in use since WUL QZ14-031 became active. Adaptive Management Plan 2017-01 (AMP 2017-01) is currently approved by Energy, Mines and Resources (EMR) under the current Quartz Mining License (QML-0001); while the Adaptive Management Plan 2017-02 (AMP 2017-02) is approved under by the Yukon Water Board under the current Water Use Licence (QZ41-031). This section includes the assessment to the AMP of 2017-02 specific thresholds.

The comparative tables and associated trigger levels for the adaptive management stations and the required trend analyses are included in the monthly WUL reports.

A summary of the AMP 2017-02 exceedances is included in the sections below. Not all threshold concentration exceedances result in the triggering of AMP responses, as determined by the AMP2017-02.

10.1 Surface Water Quality – Minto Creek

There were no triggers of the AMP in January, February, March, or September to December.

10.1.1 Minto Creek – W2

A summary of the W2 exceedances of the AMP are discussed below in Table 10-1. Trend analysis, evaluations and data has been presented in the monthly reports.

Table 10-1: Minto Creek Surface Water threshold exceedances, Station W2

Date	Parameter	Exceedance Threshold Triggered	Context
30-Apr-17	Al	SPT1	1 out of 37 samples exceeded threshold concentration, prior to the discharge period
24-May-17	As	SPT3	3 out of 37 samples exceeded threshold concentration, during the discharge period
6-Jun-17		SPT3	
13-Jun-17		SPT3	
18-Apr-17	Cu	SPT1	3 out of 37 samples exceeded threshold concentration, prior to the discharge period
30-Apr-17		SPT3	
1-May-17		SPT1	
24-May-17	Mo	SPT3	8 out of 37 samples exceeded threshold concentration, during the discharge period.
31-May-17		SPT3	
13-Jun-17		SPT3	
20-Jun-17		SPT3	
27-Jun-17		SPT3	
11-Jul-17		SPT3	
27-Jul-17		SPT3	
1-Aug-17		SPT3	
13-Jun-17	NH3	SPT1	1 out of 37 samples exceeded threshold concentration, during a period of high precipitation

Ongoing events are addressed specifically as follows:

Arsenic – Trend analysis and comparison to W3 results indicate the source of the As-D is not mine related, as presented in monthly reports. A trend analysis was conducted on arsenic concentrations at W2 and W3 over 2 years. W2 concentrations are higher than W3, indicating a natural source in the Minto Creek watershed. No further investigation is required.

Copper - The comparison of the W3 results, including trend analysis was conducted and showed W3 values to be stable and lower than those at W2 for dissolved copper. The mine was not actively discharging during April and the W3 values were lower than W2; therefore, mine loading is not indicated. Elevated levels did not continue into the discharge season. No further investigation is required.

Molybdenum - Minto applied the specific responses as detailed in Table 2-1 of the Adaptive Management Plan (AMP Dec 2015) following the first event in May 2016. An investigation was conducted, AMP1 - Molybdenum Investigation, the report has been submitted to the inspector and to SFN. Mo-D will continue to be monitored but no further investigation will occur unless there is an increased level equivalent to half the CCME guideline for the protection of aquatic life (0.0365 mg/L). The concentrations of Mo-D appear to have stabilized during discharge events.

10.1.2 Minto Creek – W50

Minto monitored the specific performance thresholds for surface water quality in Minto Creek at WQO station W50 after October 30, 2017. There was no water and therefore no samples collected after October 30th, 2017 at W50. No adaptive management was required.

10.2 Surface Water Quality – McGinty Creek

Minto monitored the specific performance thresholds for surface water quality in McGinty Creek.

A summary of the MN-4.5 exceedances of the AMP are discussed below. Trend analysis and data has been presented in the monthly reports.

Not all threshold concentration exceedances result in the triggering of AMP responses.

Table 10-2: McGinty Creek Surface Water threshold exceedances, MN-4.5

Date	Parameter	Exceedance Threshold Triggered	Context
26-May-17	Cu	SPT1	1 out of 7 samples exceeded threshold concentration
21-Oct-17	Mo	SPT1	1 out of 7 samples exceeded threshold concentration
26-May-17	Ni	SPT2	1 out of 7 samples exceeded threshold concentration
26-May-17	NO3	SPT3	4 out of 7 samples exceeded threshold concentration
16-Sep-17		SPT3	
21-Oct-17		SPT3	
10-Nov-17		SPT2 / SPT3	
24-Jun-17	Se	SPT1	5 out of 7 samples exceeded threshold concentration
7-Jul-17		SPT1	
16-Sep-17		SPT3	
21-Oct-17		SPT3	
10-Nov-17		SPT3	
26-May-17	TSS	SPT1	1 out of 7 samples exceeded threshold concentration, single event likely due to freshet conditions

Ongoing events are addressed specifically as follows:

The 12-month average CTE for nitrates was an on-going threshold exceedance of the AMP Specific Threshold 3, however the monthly samples were below all thresholds, except for November. A consistent natural increase is observed during the summer months at both locations. The comparative examination of the results from MN-1.5 indicated mine loadings were not likely responsible for the exceedance, as MN-1.5 is closer to the mine than MN-4.5, yet values are consistently below all AMP thresholds. It was determined that the source of nitrates is not likely mine related and therefore does not trigger Specific Response Threshold 3.

The 12-month average CTE for dissolved selenium remained above the AMP Specific Threshold 3 at the end of 2017. The comparative examination of the results from MN-1.5 indicated mine loadings were not likely responsible for the exceedance, as Station MN-1.5 is closer to the mine than MN-4.5, the source of selenium does not appear to be mine related, therefore the Specific Response Threshold 3 is not triggered. No further investigation is required at this time.

10.3 Groundwater Quality – Minto Creek

Various exceedances of AMP levels triggered a review of the groundwater data by the qualified professional. All groundwater data was forwarded to SRK Consulting for review and recommendations. See Appendix H, *2017 Minto Groundwater Quality AMP Review Memo - SRK,* for details.

10.4 Groundwater Quality - McGinty Creek

Minto monitored the specific performance thresholds for McGinty Creek groundwater. Various exceedances of AMP levels triggered a review of the groundwater data by the qualified professional. All groundwater data was forwarded to SRK Consulting for review and recommendations. See Appendix H, *2017 Minto Groundwater Quality AMP Review Memo - SRK,* for details.

10.5 Water Management AMP

Water storage capacity in the Main Pit Tailings Management Facility and the Area 2 Pit Tailings Management Facility exceeded 1,000,000 m^3 during the operational period and as such, no responses from the adaptive management plan were applied.

10.6 Physical Monitoring Program AMP

The results of the Physical Monitoring Program are compared to the thresholds set out in the 2017 Adaptive Management Plan (AMP) on a weekly basis by the Geotechnical EIT. Table 10-3 and 10-4 below, summarize the threshold statuses for the Category 1 and Category 2 facilities.

Category 1 facilities are those found in areas of ice-rich periglacial foundations that have previously experienced deep seated foundation movement and include the Dry Stack Tailings Storage Facility, Mill Valley Fill Extension (Stages 1 and 2), Southwest Waste Dump, and South Wall Buttress/Main Pit Dump. Category 2 facilities are all other waste rock dumps, including the Main Waste Dump and Main Waste Dump Expansion, Reclamation Overburden Dump, and Ice-rich Overburden Dump.

Table 10-3: Category 1 Facilities – Threshold Status, December 2017

Specific Performance Thresholds	Thresholds Exceeded	Response
Specific Threshold 1 • Observation of unusual occurrence including: o tension cracks, settlement, or sloughing; o a seismic event that exceeds the 1:475 return period event[1]; o abnormal seepage from any area of the slopes; o increased turbidity from seepage; • Physical damage.	Main Pit In-Pit Dump/Main Pit Dump (MPD)	Tension cracking and settling has propagated for several years across the in-pit dump. The engineer of record (SRK) has reviewed and determined that the cracking is not a stability concern for the buttress. Cracking along NW corner noted on August 19, 2017, design engineer notified and monitoring plan put into place. SRK has reviewed and determined that the cracking is not a stability concern. Current conditions: Cracking is now covered in snow, no new cracking observed. The engineer of record (SRK) was notified and monitoring plan put in place
Specific Threshold 2 • One survey hub or inclinometer reading indicating an increase in the movement rate greater than the long-term trend and outside the range of instrumentation error.	M82, M84	April 2016: Main Pit survey hubs M82 and M84 showing increase in long-term trend. SRK notified. M84 reading frequencies initially increased to daily, and have since been reduced to weekly. Inspections of the area daily during SAT dump construction. Current conditions: movement rate for M84 has decreased back to the long-term trend. Movement rates for M82 are greater than the long-term trend.
Specific Threshold 3 • For DSTSF and MVFE piezometers 13-DSP-05a, 13-DSP-06, 15-DSP-07, and 15-DSP-08, an increase in piezometric pressures under unfrozen or thawing conditions such that Ru[2] exceeds 0.44. • For MVFE2 piezometer 15-DSP-10, an increase in piezometric pressures under unfrozen or thawing conditions such that the equivalent water elevation is 3 m above the original ground surface.	DSP-07 (2, 3, 4, 5, and 6)	December 2015: DSP-07 has displayed Ru values higher than 0.44 for sensors 2, 3, 4 and 5 since installation. This piezometer is outside the MVFE2 footprint and is not considered a stability concern. Reading frequency was increased to every two weeks (from monthly). High initial values may have been due to grout curing. Current conditions: Readings have been slowly increasing, sensor 2-6 have an Ru >0.44.

---

[1] This size of a seismic event would be felt by most people on site. It would shake buildings, and rattle or break dishes, hanging objects, etc. Earthquake information may also be found online at: http://www.earthquakescanada.nrcan.gc.ca/index-eng.php

[2] Ru is the pore water pressure coefficient which is the ratio of piezometric pressure to the overburden pressure. A pore water pressure ratio of 0.5 would be similar to the effect of a groundwater table at surface. Conversions from Ru to equivalent water elevation are contained in Table 2-15 of the 2017 AMP.

Specific Performance Thresholds	Thresholds Exceeded	Response
Or Temperature greater than zero at a depth of 2 m below original ground *(all SWD ground temperature cables, and DSTSF ground temperature cables DST-10, DST-11, and DST-14 only)*	DSP-08 (1)	April 2016: DSP-08 displayed Ru values higher than 0.4 for sensor 1 (@5m depth). The design engineer was notified. No instability was noted during inspections. Reading frequency was increased to bi-weekly (from monthly), and increased to daily while dumping in the immediate vicinity. Current conditions: Ru value is still >0.44, however, has been decreasing since June 30, 2016.
	DSP-08 (2, 3, 5 and 6)	May 31, 2016: An additional spike was noted on sensors 2, 3, 5 and 6. Again, the design engineer was notified and no instability was noted on inspection. Current conditions: no change, readings have been slowly increasing. Sensors 2, 3, 5, and 6 have Ru values >0.44.
	DSP-10	DSP-10 has displayed a water elevation >1m above ground surface depth since March 8th, 2016. The design engineer was contacted, and reading frequencies were immediately increased to weekly. Reading frequency was further increased to daily on March 14. On Sept 1, 2016 reading frequency was reduced to weekly, see response to Specific Threshold 4 for more details. Current conditions: equivalent water level is >3m.
Specific Threshold 4 • For DSTSF and MVFE piezometers 13-DSP-05, 13-DSP-06, 15-DSP-07, and 15-DSP-08, an increase in piezometric pressures under unfrozen or thawing conditions such that Ru exceeds 0.6. • For MVFE2 piezometer 15-DSP-10, an increase in piezometric pressures under unfrozen or thawing conditions such that the equivalent water elevation is 10 m above the original ground surface	DSP-07 (2, 3, 4, 5, and 6)	February 3, 2016: DSP-07 sensors 2 and3 are above the 0.6 threshold. May 15, 2016: DSP-07 sensor 5 is above the 0.6 threshold. January 14, 2017: DSP-07 sensor 4 is above the 0.6 threshold. December 5, 2017: DSP-07 sensor 6 is above the 0.6 threshold. This piezometer is outside the MVFE2 footprint and is not considered a stability concern. Current conditions: no change, readings have been slowly increasing.
	DSP-08 (1)	April 29. 2016: DSP-08 sensor 1 is above 0.6 threshold. Review of conditions by the Geotechnical EIT and engineer of record, SRK Consulting. Conditions have stabilized. Construction complete, inspections reduced to monthly. Reading frequency maintained at bi-weekly. No stability concerns identified.

Specific Performance Thresholds	Thresholds Exceeded	Response
		Current conditions: Ru value is still >0.6, however, has been decreasing since June 30, 2016.
	DSP-08 (2)	July 1, 2016: DSP-08 sensor 2 is above 0.6 threshold. Review of conditions by the Geotechnical EIT and engineer of record, SRK Consulting. Conditions have stabilized. Construction complete, inspections reduced to monthly. Reading frequency maintained at bi-weekly. No stability concerns identified. Current conditions: no change, readings have been slowly increasing.
	DSP-08 (3)	February 25, 2017: DSP-08 sensor 3 is above 0.6 threshold. Construction complete, inspections reduced to monthly. Reading frequency maintained at bi-weekly. No stability concerns identified. Current conditions: no change, readings have been slowly increasing.
	DSP-08 (5)	December 17, 2017: DSP-08 sensor 5 is above 0.6 threshold. No stability concerns identified. Current conditions: no change, readings have been slowly increasing.

Specific Performance Thresholds	Thresholds Exceeded	Response
	DSP-10	DSP-10 has displayed an equivalent water level >3m above ground surface depth since April 1st, 2016. Since September 2016 the equivalent water level has been >10m above ground surface. Summary of actions below: • April 1, 2016: Design engineer notified. Inspection frequency increased to daily. Dumping on the lower tier was suspended. • April 4, 2016: Two survey hubs were installed on the eastern slope to monitor for movement with a daily reading frequency. • April 5, 2016: The lower tier was re-opened for dumping after stabilization of piezometer values. Going forward, piezometer data was reviewed prior to dumping each subsequent lift. • May 3, 2016: Inspections were reduced to weekly, with a daily review of monitoring data. • When working along the eastern edge of the final lift, a daily inspection was conducted. • August 25, 2016: Survey hub reading frequency reduced to weekly as construction was complete. • Sept 1: Piezometer reading frequency was reduced to weekly as the data had stabilized and construction was complete. • Once the facility construction was complete, the inspections were reduced back to monthly. Piezometer readings remain on a weekly schedule. Current conditions: equivalent water level is >10m.
Specific Threshold 5 • Three consecutive survey hub or inclinometer readings indicating an increase in the movement rate movement greater than the long-term trend. Or • Three consecutive survey hub readings indicating a change in horizontal direction of movement greater than 15 degrees from the long-term trend,	M82, M84	April 2016: Main Pit Dump survey hubs M82 and M84 showing increase in long-term trend. SRK notified. M84 reading frequencies initially increased to daily, and have since been reduced to weekly. Inspections of the area daily during SAT dump construction. Current conditions: movement rate for M84 has decreased back to the long-term trend. Movement rates for M82 are greater than the long-term trend
	M82, M83, M88, M91, M93, M94	August 2017: High rates in both M82 and M83. SRK notified, reading frequency for all Main Pit hubs increased to daily. Six new survey hubs installed. There is some indication that rates are now decreasing. SRK has reviewed the current conditions and determined that the movement rates are not an immediate stability concern. Current conditions: Moderate movement rate for M82, M83, M88, M91, M93, and M94. Rates are

Specific Performance Thresholds	Thresholds Exceeded	Response
		greater than 1 mm/day but are significantly less than rates seen prior to the South wall failure (>20 mm/day).
	M81, M82, M83, M84	M81, M82, M83 and M84 have all displayed a change in horizontal movement greater than 15 degrees from the long-term trend. These directional changes occurred in January 2013 (M81), April 2016 (M82 and M83) and May 2016 (M84). Inspection of all hubs conducted with no change in conditions noted. Reading frequency increased to weekly. Increase in movement for M82 and M83 observed in May 2017. The engineer of record (SRK) was notified and monitoring plan has been put in place. Current conditions: no further change in the direction of movement observed. Movement rates for M82 and M83 have remained steady.
	SWD-06	SWD-06 has displayed a change in horizontal movement greater than 15 degrees from the long-term trend. • September 2016: the long-term trend changed from 132 degrees to 171 degrees. An inspection was conducted, and the change is likely due to differential settlement of the hub during spring thaw. • November 2016: the long-term trend changed from 171 to 85 degrees. An inspection was conducted, and the change is likely due to frost heave along the western edge of the survey hub; similar trend in movement was observed during the previous winter. • June 2017: the long-term trend changed from 085 to 180 degrees as glaciated ice melted below the western edge of the survey hub. Current conditions: no further change in the direction of movement observed.

Table 10-4: Category 2 Facilities – Threshold Status, December 2017

Specific Performance Thresholds	Thresholds Exceeded	Response
Specific Threshold 1 • Observation of unusual occurrence including: • tension cracks, settlement, or sloughing; • a seismic event that exceeds the 1:475 return period event; • abnormal seepage from any area of the slopes; • increased turbidity from seepage; • physical damage.	MWD	1m-deep depression formed in May 2016 in on the 905m-elevation pad of the MWD, currently being used as a POX stockpile. No bulging noted at toe and no other stability concerns noted. Monthly inspections continued during active MWDE construction. MDI-2 showing no change in trend. Current conditions: no further changes observed. MWDE construction is now complete and progressive reclamation activities are underway.
Specific Threshold 2 **WSP Dam:** • One survey hub reading indicating an increase of movement outside range of instrumentation error. **All other Category 2 Facilities:** Survey hub cumulative displacements between 150 mm and 500 mm.	None	N/A
Specific Threshold 3 **WSP Dam:** • One piezometer reading outside of its long-term trend (in comparison to the reservoir pond elevation). **All other Category 2 Facilities:** Survey hub cumulative displacements greater than 500 mm.	None	N/A
Specific Threshold 4 **WSP Dam:** • Three consecutive survey hub readings indicating increase in movement outside range of instrumentation error.	None	N/A

11 Aquatic Environmental Monitoring Program

The Aquatic Environmental Monitoring Program (AEMP) is composed of Minto's requirements under the MMER and biological monitoring of sediment, benthic invertebrates, fish and fish habitat. Monitoring under the MMER is presented in Section 11.1 and the biological monitoring of sediment, benthic invertebrates, fish and fish habitat is presented in Section 11.2.

11.1 Metal Mine Effluent Regulations Monitoring Programs

The Metal Mine Effluent Regulations (MMER) outline requirements for monitoring and reporting of discharged effluent volume and quality under the MMER to Environment Canada. Details of the Metal Mine Effluent Program, including sampling station locations and monitoring frequency, are outlined in the EMSRP and the results are submitted on a quarterly and annual basis to Environment Canada.

11.1.1 Effluent Monitoring Program

The MMER Program requires effluent monitoring and sampling at the final discharge point (FDP) station W3, downstream of the end of pipe discharge. The W3 sampling station is collected when there is a discharge of water at W3; testing occurs weekly for deleterious substances.

Weekly effluent monitoring samples are tested for the deleterious substances as described in the MMER including total metals (arsenic, copper, lead, nickel and zinc), total suspended solids (TSS), and pH. Weekly samples are collected at least 24 hours apart and not more than 7 days apart. Minto is striving for consistency and has internally scheduled MMER sampling to occur on Tuesdays.

Radium 226 and acute lethality tests are conducted quarterly due to the reduced frequency guidelines outlined in the MMER.

The Effluent Monitoring Program results are submitted to Environment Canada quarterly and are presented in Appendix I.

11.1.2 Environmental Effects Monitoring Water Quality Monitoring

The EEM Water Quality Monitoring Program is designed to characterize water quality at the exposure area, the receiving environment and in reference (un-impacted) area. Water quality samples must be collected four times a year, not less than one month apart, while the mine is discharging effluent at the Final Discharge Point (FDP) of W3. Samples are collected at the exposure area (W3), receiving environment station (W2) and reference station (W7). Effluent toxicity testing is required annually using a total of four tests; one each of a fish, invertebrate, algae and plant species.

The EEM Water Quality Monitoring Program results submitted to Environment Canada annually, are presented in Appendix I.

11.1.3 Environmental Effects Monitoring Biological Monitoring

The EEM Biological Monitoring Program outlines fish population, fish tissue and benthic invertebrate tests conducted under Schedule 5, Part 2 of the MMER. Minto Mine has submitted the results of the Phase 4 EEM Study Design Report as required to Environment Canada in January 2018. The *Phase 4 EEM Interpretive Report* is included in Appendix J.

11.2 Biological Monitoring Program

Clause 71 and 72 of the WUL requires an Annual Biological Monitoring Program that includes monitoring of sediment, periphyton, benthic invertebrates, fish, and fish habitat. The following sections summarize the monitoring programs and more detailed reports can be found in Appendix K and Appendix L. Appendix K contains information with respect to the sediment, periphyton, and benthic invertebrate monitoring programs and Appendix L contains information relative to the fish monitoring programs.

11.2.1 Sediment Monitoring Program

The objectives of the sediment monitoring program were to characterize particle size, total organic carbon content, and concentrations of metals, metalloids, and nutrients in sediments. A 10-day *Chironomus dilutus* and a 14-day *Hyalella azteca* sediment toxicity test were conducted in 2017 to evaluate survival and growth.

Sediments collected in 2017 were largely composed of fine particles in the silt and sand size categories (Table 11-1). Mean total organic carbon (TOC) content of sediment collected from upper Minto Creek (2.8%) was slightly higher than at the upper McGinty Creek (2.6%) reference area (Table 11-1). Lower Minto Creek had lower TOC (5.2%) than the reference area, lower Wolverine Creek (6.5%; Table 11-1). Arsenic and copper were the only analytes with mean concentrations greater than Interim Sediment Quality Guidelines (ISQG) for the protection of aquatic life (CCME 1999) in an effluent-exposed area (upper and/or lower Minto Creek; Table 11-1). However, mean arsenic concentrations in upper Minto Creek were below ISQG and lower than the reference area, upper McGinty Creek (which was greater than ISQG). This suggests that arsenic concentrations were unrelated to the mine. Mean copper concentrations in upper and lower Minto Creek were greater than the ISQG, and maximum copper concentration at upper Minto Creek was above the Probable Effect Level (PEL). Both areas had higher concentrations than the corresponding reference areas, which were lower than the ISQG (Figure 11-1). With progression from upper to lower Minto Creek, sediment copper concentrations decreased from a mean of 155 to 49 mg/kg, indicating improvement with distance downstream. Due to the predominantly erosional habitat in upper Minto Creek, relatively few areas had deposited sediment and even this occurred only in small quantities that likely wash away each year during freshet. Therefore, elevated sediment copper in fine sediment in the upper reaches of Minto Creek may be of limited importance in terms of exposure and potential effects to biota. In lower Minto Creek, fine sediment deposits are somewhat more common and therefore more relevant to aquatic life.

No effects to *H. azteca* survival or growth were observed during the sediment toxicity testing (Table 11-2). Survival of *C. dilutus* was significantly lower in sediment collected from lower Minto Creek than in laboratory control sediment (sand) and field reference sediment (lower Wolverine Creek; Table 11-2). Growth of *C. dilutus* was significantly greater in lower Minto Creek sediment compared to the reference sediment. In 2016, growth of *C. dilutus* was greater at lower Minto Creek but not significantly so. *H. azteca* results (no effects in 2017) were similar to those of 2011, 2015, and 2016 (Minnow 2012, 2016, 2017). Differences from previous years observed at lower Minto Creek in *C. dilutus* survival and growth suggest a possible adverse effect, but are not consistent with the results of previous years despite similar sediment chemistry.

Table 11-1: Sediment Chemistry Data Collected at Exposed and Reference Areas, Minto Mine (2017)

	Analytes	Units	CSQG [a]		Upper McGinty Creek (Reference)				Upper Minto Creek (Exposed)				Lower Wolverine Creek (Reference)				Lower Minto Creek (Exposed)			
			ISQG	PEL	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Particle size, TKN, carbon analytes and pH	Loss on Ignition	%	-	-	5.8	2.5	4.0	10	5.6	2.6	2.0	9.0	14	2.8	10	17	10	2.3	8.0	14
	pH (1:2 soil:water)	pH units	-	-	7.09	0.45	6.63	7.69	7.88	0.26	7.46	8.16	6.92	0.19	6.69	7.18	7.86	0.12	7.70	8.02
	% Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	<1.0	-	<1.0	<1.0	1.0	-	<1.0	1.2
	% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	-	-	-	30	18	11	57	15	12	3.3	33
	% Silt (0.063mm - 4µm)	%	-	-	-	-	-	-	-	-	-	-	65	17	40	84	75	13	55	87
	% Clay (<4µm)	%	-	-	-	-	-	-	-	-	-	-	5.1	1.0	3.4	6.0	10	0.85	9.1	11
	Total Kjeldahl Nitrogen	%	-	-	0.13	0.042	0.096	0.20	0.13	0.058	0.049	0.19	0.31	0.073	0.21	0.39	0.26	0.044	0.22	0.33
	Inorganic Carbon	%	-	-	0.081	0.019	0.055	0.11	0.12	0.041	0.064	0.16	0.14	0.024	0.11	0.16	0.16	0.021	0.14	0.19
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%	-	-	0.68	0.16	0.46	0.91	1.0	0.34	0.54	1.3	1.1	0.20	0.93	1.4	1.4	0.17	1.2	1.6
	Total Carbon by Combustion	%	-	-	2.7	0.99	1.8	4.4	2.9	1.5	0.99	4.6	6.7	1.7	5.1	9.4	5.4	1.5	4.0	7.6
	Total Organic Carbon	%	-	-	2.6	0.97	1.8	4.3	2.8	1.5	0.93	4.4	6.5	1.7	5.0	9.2	5.2	1.5	3.9	7.4
Total Metals	Aluminum (Al)	mg/kg	-	-	8,100	1,733	6,050	10,700	10,658	1,133	9,060	11,800	15,540	1,989	13,000	18,500	13,820	1,152	12,300	15,200
	Antimony (Sb)	mg/kg	-	-	0.30	0.052	0.26	0.39	0.49	0.13	0.38	0.71	0.49	0.031	0.46	0.54	0.52	0.056	0.45	0.58
	Arsenic (As)	mg/kg	5.9	17	6.5	1.6	4.1	8.1	5.8	0.32	5.5	6.3	5.6	0.98	4.3	6.7	7.3	0.67	6.6	8.2
	Barium (Ba)	mg/kg	-	-	141	46	87	213	202	70	127	281	202	12	187	220	236	20	214	257
	Beryllium (Be)	mg/kg	-	-	0.26	0.049	0.21	0.34	0.41	0.037	0.36	0.45	0.80	0.031	0.77	0.85	0.48	0.049	0.41	0.53
	Bismuth (Bi)	mg/kg	-	-	<0.20	-	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	-	<0.20	<0.20
	Boron (B)	mg/kg	-	-	<5.0	-	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	-	<5.0	<5.0
	Cadmium (Cd)	mg/kg	0.60	3.5	0.11	0.056	0.076	0.21	0.20	0.086	0.10	0.30	0.26	0.036	0.23	0.31	0.22	0.036	0.17	0.25
	Calcium (Ca)	mg/kg	-	-	6,150	1,938	4,850	9,560	7,754	1,393	5,770	9,120	10,776	908	9,580	11,700	10,830	1,372	8,650	12,100
	Chromium (Cr)	mg/kg	37	90	16	3.2	12	21	26	1.9	25	29	48	4.7	42	55	32	2.2	29	34
	Cobalt (Co)	mg/kg	-	-	7.2	1.9	5.8	10	10	1.1	9.2	12	13	0.33	13	13	11	0.53	10	12
	Copper (Cu)	mg/kg	36	197	14	3.6	11	20	155	96	46	274	30	4.3	28	38	49	5.5	44	57
	Iron (Fe)	mg/kg	-	-	19,820	3,175	15,400	23,800	23,080	1,361	21,700	25,200	27,000	587	26,200	27,700	25,140	1,563	23,800	27,700
	Lead (Pb)	mg/kg	35	91	3.4	0.61	2.8	4.5	5.6	0.56	4.9	6.3	6.5	0.47	6.0	7.3	6.0	0.47	5.5	6.6
	Lithium (Li)	mg/kg	-	-	5.3	0.77	4.4	6.5	7.7	1.0	6.6	8.6	11	1.5	9.4	14	11	0.96	9.2	12
	Magnesium (Mg)	mg/kg	-	-	3,384	515	2,760	4,190	6,356	521	5,660	6,880	9,674	825	8,760	11,000	7,118	413	6,600	7,610
	Manganese (Mn)	mg/kg	-	-	519	312	245	1,050	2,085	1,506	491	3,690	410	174	204	549	975	140	813	1,120
	Mercury (Hg)	mg/kg	0.17	0.49	0.039	0.020	0.017	0.060	0.022	0.0064	0.012	0.028	0.044	0.0026	0.041	0.047	0.035	0.0058	0.028	0.041
	Molybdenum (Mo)	mg/kg	-	-	0.44	0.12	0.32	0.65	1.5	0.73	0.76	2.4	0.59	0.058	0.54	0.68	0.68	0.071	0.59	0.76
	Nickel (Ni)	mg/kg	-	-	13	2.0	11	16	26	2.3	24	29	38	2.5	35	42	28	1.3	28	30
	Phosphorus (P)	mg/kg	-	-	771	79	687	882	892	30	861	933	1,050	36	988	1,080	870	43	832	937
	Potassium (K)	mg/kg	-	-	548	97	440	690	1,298	147	1,140	1,510	1,134	110	1,020	1,300	1,196	86	1,100	1,330
	Selenium (Se)	mg/kg	-	-	0.35	0.078	0.24	0.45	0.51	0.24	<0.20	0.78	0.39	0.044	0.34	0.44	0.57	0.11	0.44	0.70
	Silver (Ag)	mg/kg	-	-	<0.10	-	<0.10	<0.10	0.13	0.063	<0.10	0.24	0.10	0.0057	<0.10	0.11	0.10	0.0057	<0.10	0.11
	Sodium (Na)	mg/kg	-	-	173	20	147	198	326	18	308	350	458	33	417	500	317	22	281	335
	Strontium (Sr)	mg/kg	-	-	50	10	39	66	91	22	62	116	103	10	91	114	108	16	83	125
	Thallium (Tl)	mg/kg	-	-	0.053	-	<0.05	0.063	0.082	0.010	0.071	0.10	0.093	0.012	0.080	0.11	0.10	0.010	0.087	0.11
	Tin (Sn)	mg/kg	-	-	<2.0	-	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	-	<2.0	<2.0
	Titanium (Ti)	mg/kg	-	-	525	112	355	645	622	47	573	683	762	187	436	916	747	84	648	867
	Uranium (U)	mg/kg	-	-	0.87	0.33	0.56	1.4	0.89	0.25	0.54	1.2	3.2	0.44	2.7	3.8	1.2	0.25	0.94	1.5
	Vanadium (V)	mg/kg	-	-	37	6.3	31	48	52	4.0	50	59	70	2.1	67	73	54	3.6	51	60
	Zinc (Zn)	mg/kg	123	315	34	6.4	27	44	59	9.5	48	68	63	6.8	55	74	60	5.2	55	68

🟦 Indicates sediment concentration exceeding CSQG ISQG.
🟩 Indicates sediment concentration exceeding CSQG PEL.
☐ Indicates sediment concentration exceeding higher reference mean by more than two times.

[a] Canadian Sediment Quality Guidelines: ISQG = interim sediment quality guideline; PEL = probable effect level (CCME 1999).

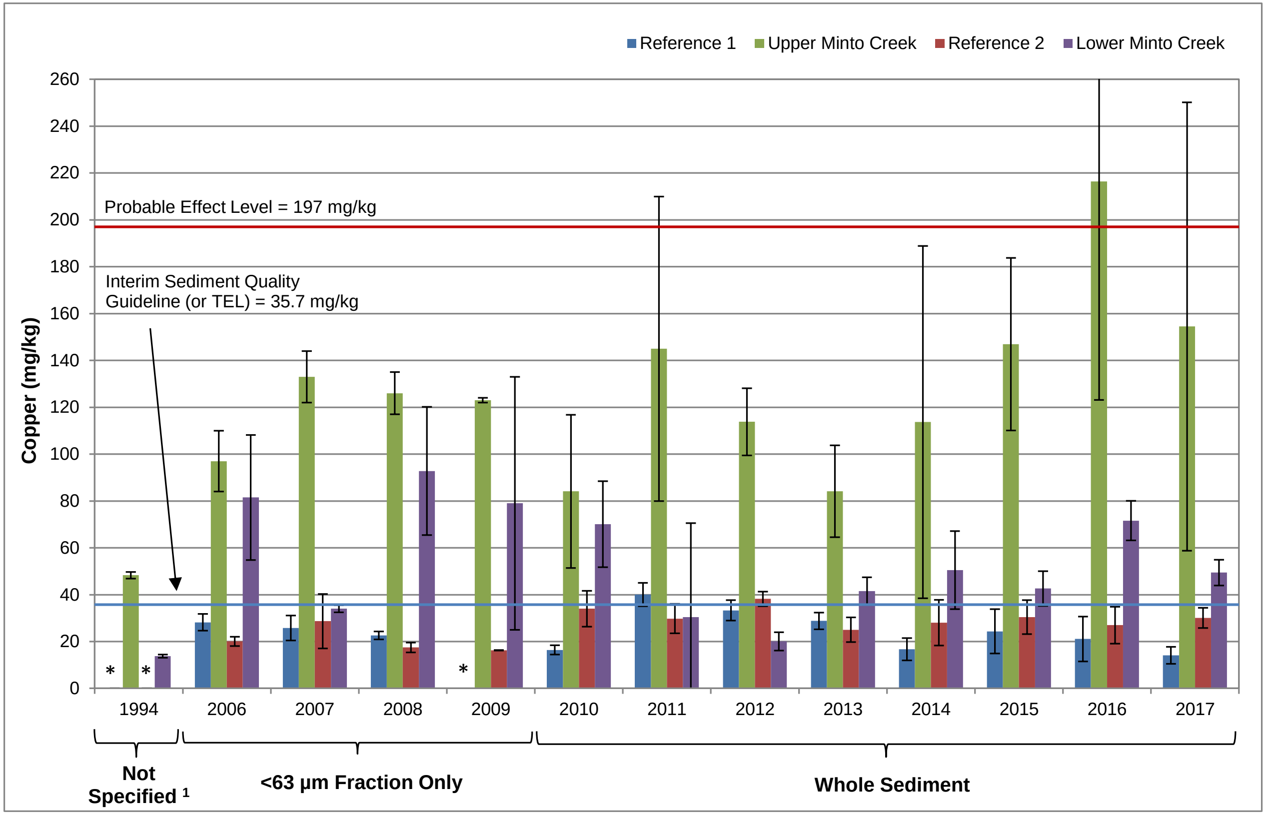


Figure 11-1: Mean Copper Concentrations in Sediment Collected in Minto Creek and Reference Locations (mean ± standard deviation) (1994-2017)

Notes:

[1] Methods were not specified, fine sediment was collected in triplicate in the mainstem of Minto Creek (HKP 1994).

[2] Reference 1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2017; Reference 2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2017.

* = no data.

TEL = Threshold Effect Levels.

Table 11-2: Minto Mine Sediment Toxicity Test Results Collected for Lower Wolverine and lower Minto Creeks, September 2017

Area	*Hyalella azteca*		*Chironomus dilutus*	
	Survival (%)	**Dry Weight (mg)**	**Survival (%)**	**Dry Weight (mg)**
Control Sediment	96 ± 5.5	0.11 ± 0.020	86 ± 8.9	1.2 ± 0.25
Lower Wolverine Creek (Reference)	94 ± 5.5	0.13 ± 0.030	90 ± 17	2.0 ± 0.24
Lower Minto Creek (Exposed)	92 ± 13	0.11 ± 0.020	🟦 48 ± 38	🟩 1.6 ± 0.32

▨ Significantly different than control sediment.
🟩 Significantly different than reference sediment.
🟦 Significantly different than reference and control sediment.
Note: Data presented as mean ± standard deviation.

11.2.2 Periphyton Monitoring

Periphyton production and community data were collected at lower Minto and lower Wolverine creeks. Productivity was assessed through measurements of chlorophyll-a in periphyton (used as a surrogate for the productivity of photosynthetic organisms).

Concentration of chlorophyll-a in periphyton was significantly higher at lower Minto Creek than at lower Wolverine Creek but both areas had concentrations below the British Columbia Water Quality Guideline (BCWQG) of 100 mg/m^2 for the protection of aquatic life (BCMOE 1985; Figure 11-2). In most years, production of both creeks was classified as low (oligotrophic), except in 2016 when lower Minto Creek was eutrophic and lower Wolverine Creek was mesotrophic. Production was classified based on the system of Dodds et al. (1998), which sets the oligotrophic-mesotrophic boundary for benthic chlorophyll-a at 20 mg/m^2 and the mesotrophic-eutrophic boundary was set at 70 mg/m^2. In 2017, production was classified as mesotrophic at lower Minto Creek (51 mg/m^2) and oligotrophic at lower Wolverine Creek (13 mg/m^2). Based on only total phosphorus, both creeks would be defined as oligotrophic as was observed in previous years (Dodds et al. 1998).

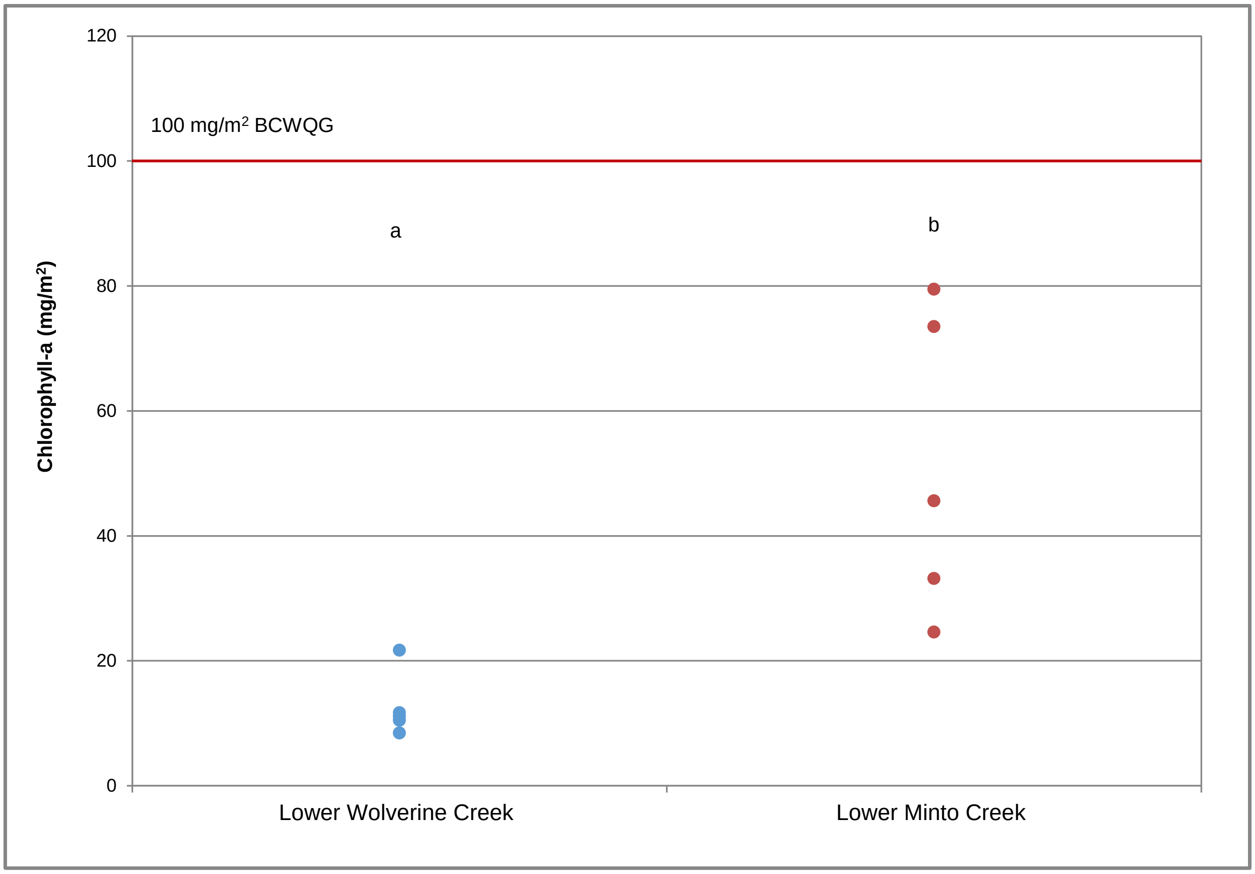
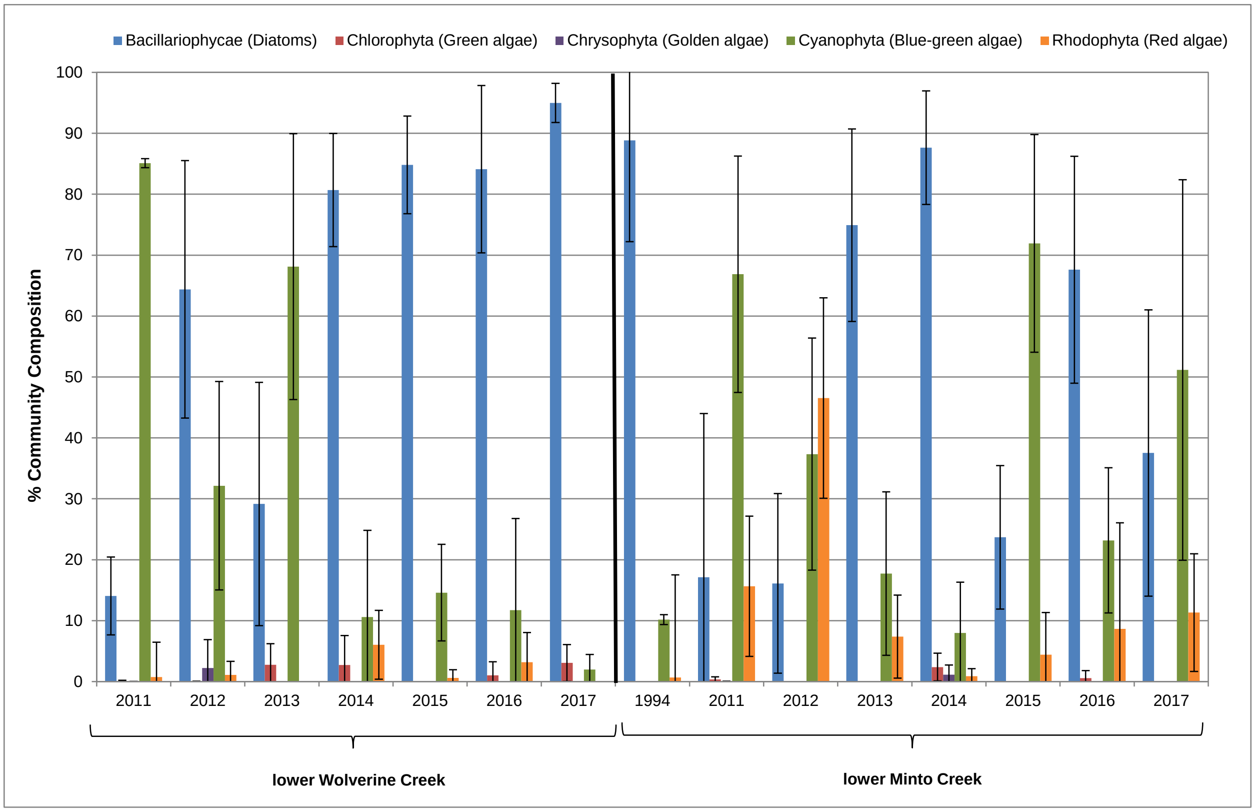


Figure 11-2: Concentration of Chlorophyll a in Periphyton Measured at Five Benthic Invertebrate Stations in Lower Wolverine and lower Minto Creeks, Minto Mine WUL, 2017

*Different letters represent significant differences between sites.

The periphyton community of lower Minto Creek was evaluated and compared to that of lower Wolverine Creek in order to evaluate any potential mine-related effects. Dominant phyla in lower Minto and Wolverine creeks were Bacillariophycae (diatoms) and Cyanophyta (blue-green algae). Cyanophyta was dominant at lower Minto Creek (51% of community) and Bacillariophycae was dominant at lower Wolverine Creek (95% of the community). Temporal variability in community composition has been high in both exposure and reference areas (Figure 11-3). For example, at lower Minto Creek, Bacillariophycae were dominant in 1994, 2013, 2014, and 2016; Rhodophyta (red algae) in 2012 and Cyanophyta in 2011, 2015, and 2017 (Figure 11-3). This lack of temporal consistency was also observed at lower Wolverine Creek, with Cyanophyta dominant in 2011 and 2013 and Bacillariophycae in 2012, 2014 to 2017 (Figure 11-3; Minnow 2013, 2014, 2015, 2016, 2017).



Note: Data presented as mean ± standard deviation

Figure 11-3: Periphyton Community Composition in Lower Minto Creek (1994, 2011 to 2017) and Lower Wolverine Creek (2011 to 2017), Minto Mine WUL, 2017

11.2.3 Benthic Invertebrate Community Monitoring

Benthic invertebrate communities at erosional areas of lower Minto Creek were summarized and compared to erosional areas of lower Wolverine Creek and lower Big Creek in order to evaluate any potential mine-related effects.

Benthic invertebrate community metrics of density, Simpson's diversity, and Simpson's evenness were not significantly different among areas (Table 11-3). Number of taxa and Bray-Curtis index showed significant differences among areas, but lower Minto Creek was intermediate between the reference areas (Table 11-3). This suggests a limited mine influence. Percent EPT did not differ significantly among areas but differences were seen with abundances of chironomids and oligochaetes (Table 11-3). The higher proportion of chironomids suggest a mine influence, but in combination with the lower proportion of oligochaetes and similar percent EPT taxa suggest limited influence of the mine on the benthic invertebrate community (Chapman et al. 1982a,b; Rosenberg and Resh 1993; Taylor and Bailey 1997). A potential decrease in number of taxa from 2012 to 2014 was not supported by the 2015 to 2017 data and appears to represent natural variability (Minnow 2015, 2016, 2017). The similarity of the benthic community of lower Minto Creek to reference communities and the temporal stability in the benthic community of lower Minto Creek suggest limited mine influence.

Table 11-3: Statistical comparisons of Benthic Invertebrate Community Metrics, Minto Mine WUL, 2017

Metric	Comparison		Area Means		Statistical Contrasts		
	Exposure Site	Reference Site			Significant Difference between areas?	Direction	P-value [a]
Density (organisms/m^2)	lower Minto Creek	lower Wolverine Creek	345	174	NO	-	0.208
		lower Big Creek		229	NO	-	
Number of Taxa	lower Minto Creek	lower Wolverine Creek	18	16	NO	-	0.813
		lower Big Creek		24	NO	-	0.213
Simpson's Diversity [b]	lower Minto Creek	lower Wolverine Creek	0.70	0.48	NO	-	0.105
		lower Big Creek		0.78	NO	-	
Simpson's Evenness [b]	lower Minto Creek	lower Wolverine Creek	0.22	0.18	NO	-	0.555
		lower Big Creek		0.20	NO	-	
BC Index to Combined Reference Median	lower Minto Creek	lower Wolverine Creek	0.79	0.82	NO	-	0.847
		lower Big Creek		0.67	NO	-	0.192
EPT (%) [c]	lower Minto Creek	lower Wolverine Creek	48	25	NO	-	0.161
		lower Big Creek		47	NO	-	
Chironomids (%)	lower Minto Creek	lower Wolverine Creek	31	4.7	YES	Minto > Wolverine	0.004
		lower Big Creek		27	NO	-	0.800
Oligochaetes (%)	lower Minto Creek	lower Wolverine Creek	6.8	65	YES	Minto < Wolverine	0.001
		lower Big Creek		15	NO	-	0.389
CA Axis-1 (34.8%)	lower Minto Creek	lower Wolverine Creek	224	-212	YES	Minto > Wolverine	0.011
		lower Big Creek		-214	YES	Minto > Wolverine	0.006
CA Axis-2 (28.9%)	lower Minto Creek	lower Wolverine Creek	10	190	YES	Minto < Wolverine	0.007
		lower Big Creek		-169	YES	Minto < Wolverine	0.007

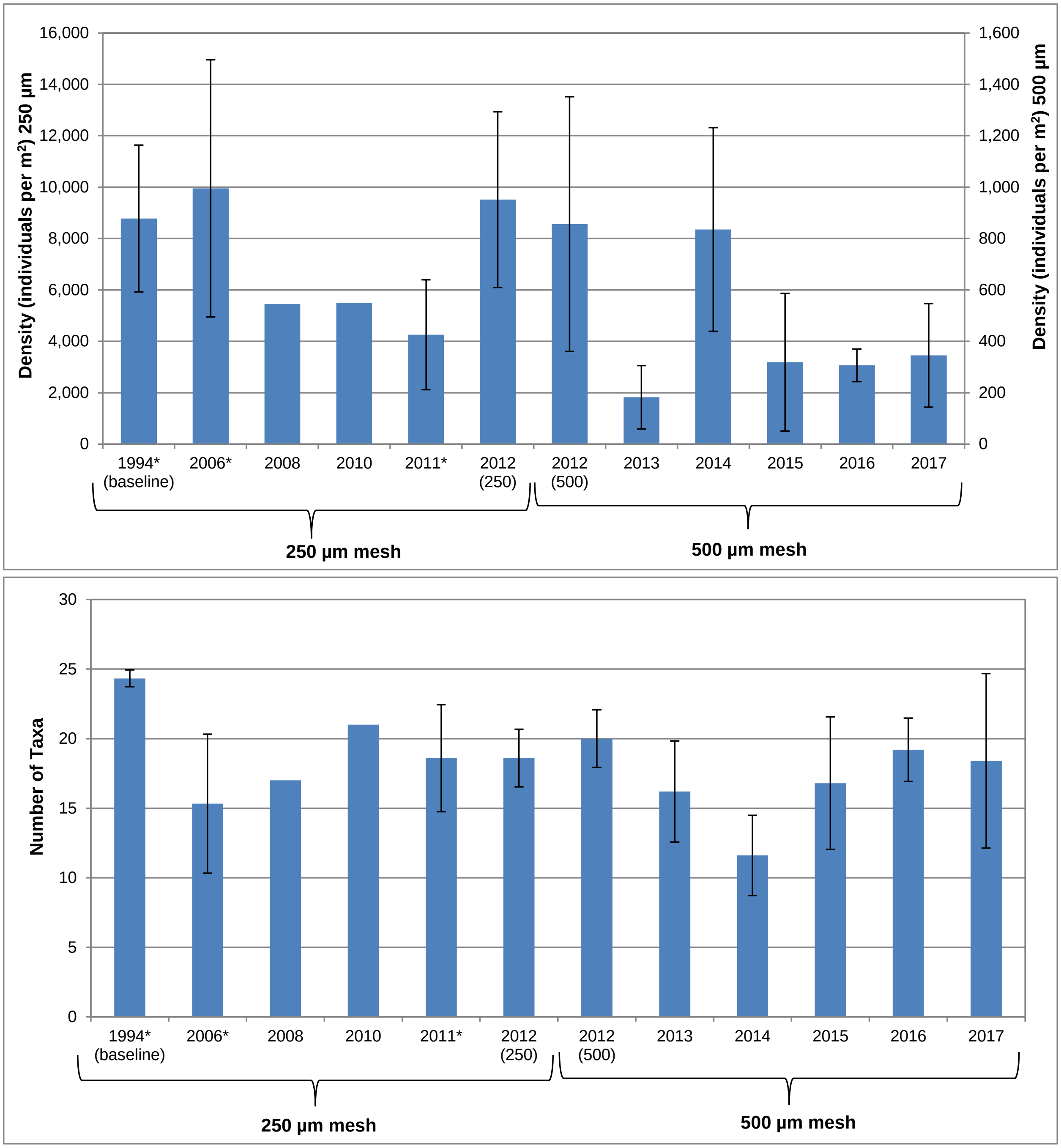
▨ Indicates a statistically significant difference between exposed and reference areas, p = 0.10.

[a] The overall p-value of the 3 group comparison used if there were no significant differences between all areas.

[b] Calculated as recommended by Environment Canada 2012.

[c] Percent Ephemeroptera (mayfly), Plecoptera (stonefly), Trichoptera (caddisfly).

Comparisons of benthic invertebrate community metrics in 2017 to those documented in previous years indicated substantial temporal variability (also observed with periphyton communities) at both the receiving environment and reference areas. Benthic invertebrate density in 2017 was lower than or similar to densities in 2012 (500 µm) and 2014 to 2016 but higher than in 2013 (Figure 11-4). Number of taxa at lower Minto Creek in 2017 was lower than in 1994 and within the historical range from 2006 onwards (Figure 11-4).



Notes: Data presented as mean ± standard deviation where replicated. Asterisk (*) indicates a year the mine was not discharging.

Figure 11-4: Primary Benthic Invertebrate Community Density and Taxon Richness at Lower Minto Creek, 1994 to 2017

11.2.4 Fisheries Monitoring Program

The objectives of the 2017 Fisheries Monitoring Program were to monitor, assess and characterize fish usage in Minto Creek during open water season, and to provide data allowing interpretation of the potential role and influence of the Minto Mine on the fish community. The 2017 fisheries program was a continuation of the previous year's components, and targeted all species that have previously been encountered as well as any new species. As part of the 2017 monitoring program, assessments at Big Creek were made concurrently with sampling in Minto Creek, to compare fish use in a neighbouring system relative to Minto Creek. Fish monitoring studies were conducted as per the EMSRP.

Fish monitoring of Minto Creek and Big Creek was conducted monthly during open water season, from June to September 2017, at trapping sites consistent with the 2010 mark-recapture study and the 2011 to 2016 fish monitoring programs. Capture effort included the use of Gee-type Minnow traps with 0.635 cm wire mesh size baited with Yukon River origin Chinook salmon roe. A total of six to fourteen minnow traps were set each time in Minto Creek, depending on water levels and availability of pools and backwater areas. Three to four traps were set each time in Big Creek, near the Minto road bridge.

All fish captured were identified, enumerated and measured for fork length or total length (± 1 mm), inspected for abnormalities, and released near their trapping location. Juvenile Chinook Salmon were also weighed (± 0.1g) prior to being released.

Additional supporting information collected included photo documentation of the creek, water level readings at W1 staff gauge, in situ water parameters in Minto Creek, Big Creek and the Yukon River (temperature, dissolved oxygen, conductivity, pH, Oxidation-Reduction Potential), discharge at W1, as well as weather conditions at time of sampling. Supporting variables also included monitoring of the previously identified fish barrier (1.2 km upstream of the Yukon River confluence) and/or any new barriers that may have developed.

For details on the 2017 results of Fisheries Monitoring Program see Appendix L.

11.3 Copper Toxicity Study

The copper toxicity study was initiated in 2015, due to a mild freshet and no major rainfalls, a turbid flow sampling could not be completed in 2016. The turbid flow sample was successfully collected in 2017. See Appendix M for a letter regarding the status of the program and the report on the copper toxicity for a turbid flow stream.

11.4 Aquatic Environmental Monitoring Program (AEMP) Review

As required by clause 102 of the WUL, a review and evaluation of the AEMP program was conducted in 2016. The next review is not required until 2019.

12 Meteorological Monitoring Program

Meteorological monitoring at the Minto Mine consists of data collection for the following parameters: rainfall, snowfall, temperature, evaporation, wind speed and direction, barometric pressure, relative humidity, and solar radiation (incoming and reflected). The Meteorological Monitoring Program includes the Climate Monitoring Program (EMSRP Section 4.1) and the Snow Survey Program (EMSRP Section 4.2). Data collected under the Meteorological Monitoring Program, along with baseline climatic data, provides input for the following mine projects:

- Site water management;
- Prediction for yearly water events (e.g. freshet);
- Design of water storage, conveyance and discharge systems; and
- Design of flood control structures on the road network.

12.1 Climate Monitoring Program

The 2017 Climate Monitoring Program data are presented below in Figure 12-1 through Figure 12-7. During 2017, Minto Mine had one meteorological station located approximately 70 m northeast of the north end of the airstrip, in an area that allows ample meteorological exposure from all directions. Trees are cleared for a radius of 30 m from the meteorology station and beyond that radius is a sparse growth of 2 m tall conifers.

The meteorology station is a research grade Campbell Scientific station that records the following parameters: maximum wind speed, minimum wind speed, average wind speed, wind direction, precipitation (rain and snow), temperature, relative humidity, pan evaporation, barometric pressure, solar radiation, and calculated evapotranspiration. Data are averaged over the one-hour archiving period and then saved to the datalogger.

The outgoing short wave radiation sensor and evaporation pan were operational in 2017.

At some point during February 2017 the power supply to the meteorology station became disconnected. It is uncertain how this occurred. The issue was not discovered until February 17th, 2017 as an intermittent communications error was thought to be the cause of the inability to communicate with the station. When the power supply was reconnected on February 17th, 2017, all data from January 25th to February 16th was lost, and partial data was lost from January 26th and February 17th.

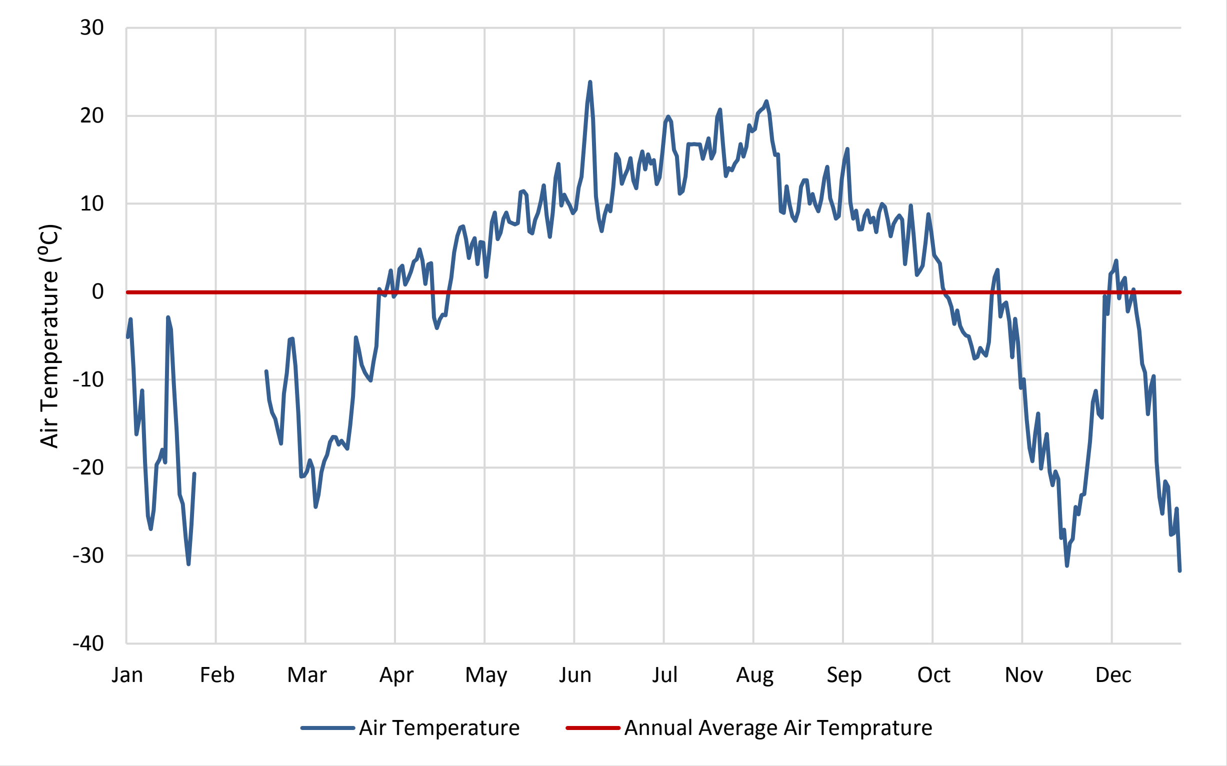


Figure 12-1: Annual Air Temperature (2017)

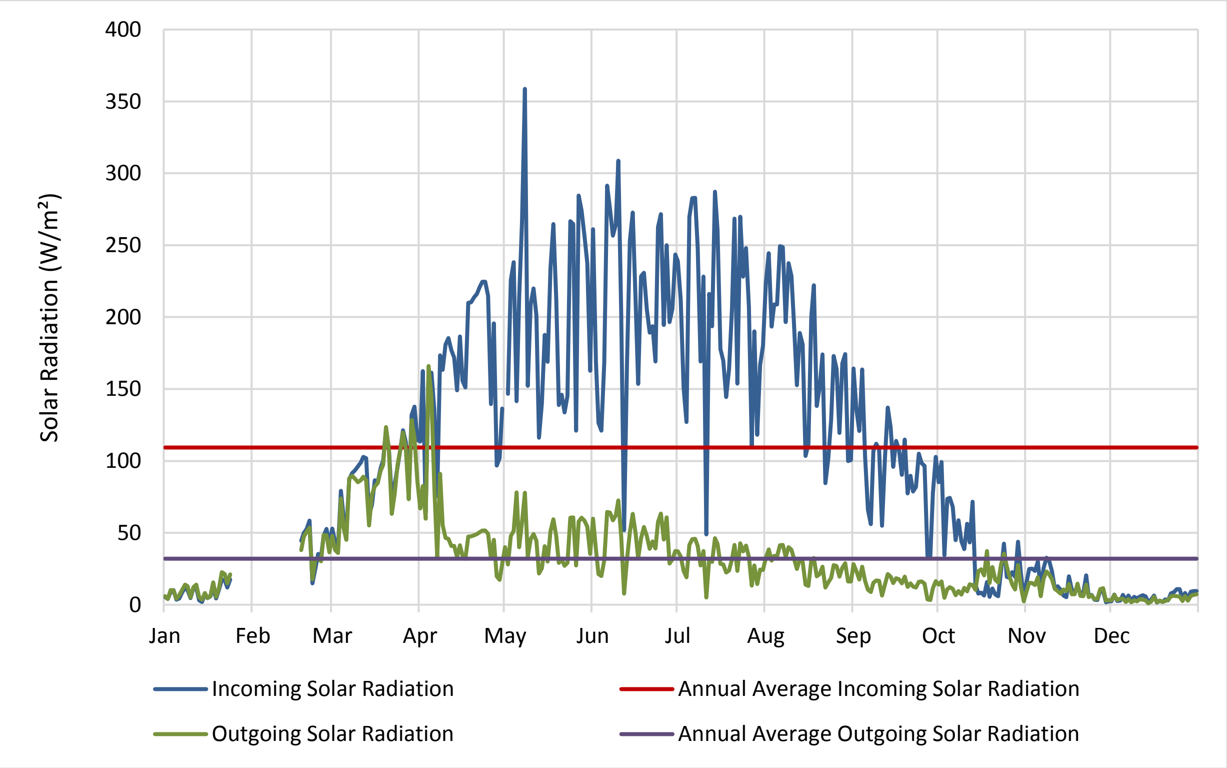


Figure 12-2: Annual Solar Radiation (2017)

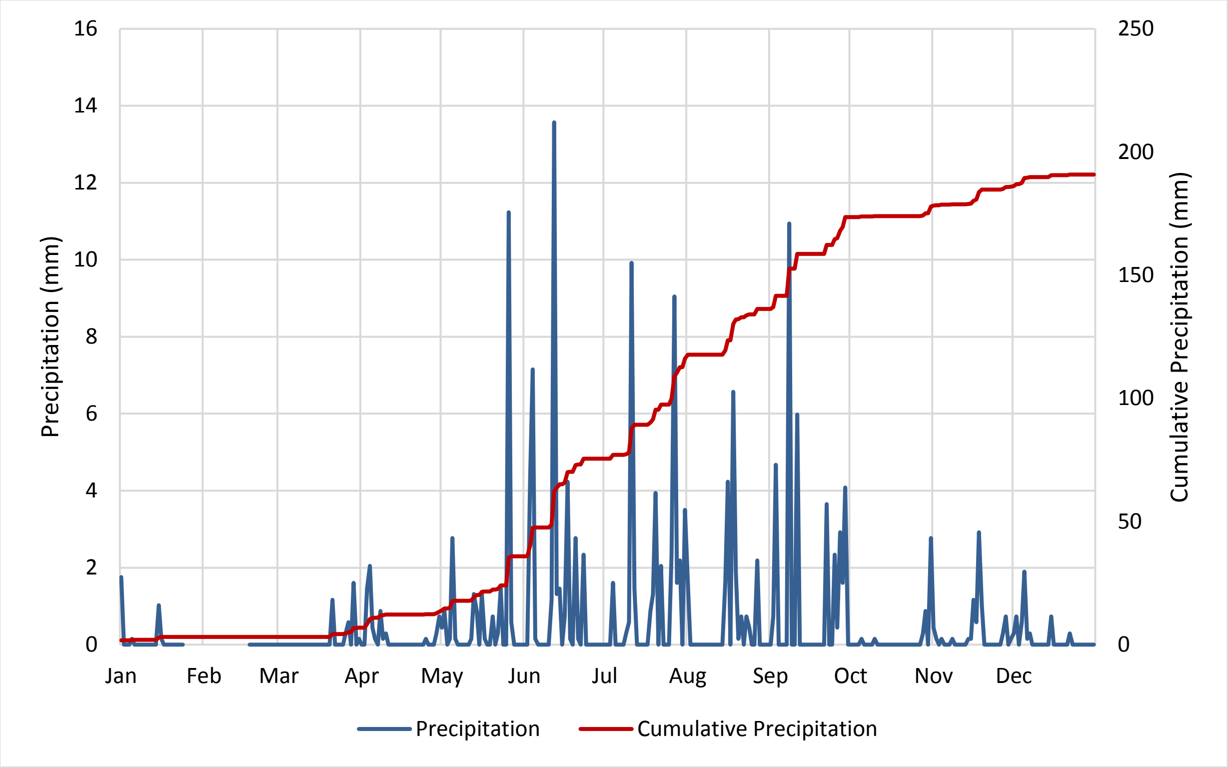


Figure 12-3: Annual Precipitation (2017)

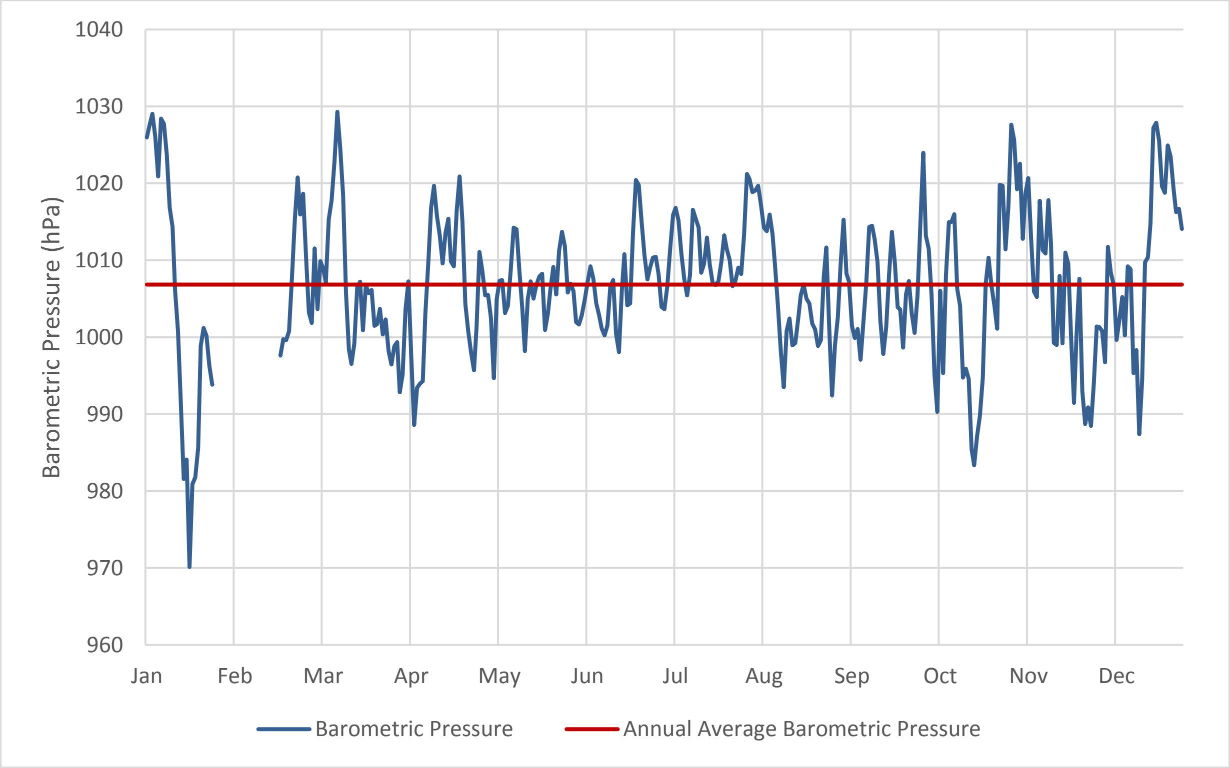


Figure 12-4: Annual Barometric Pressure (2017)

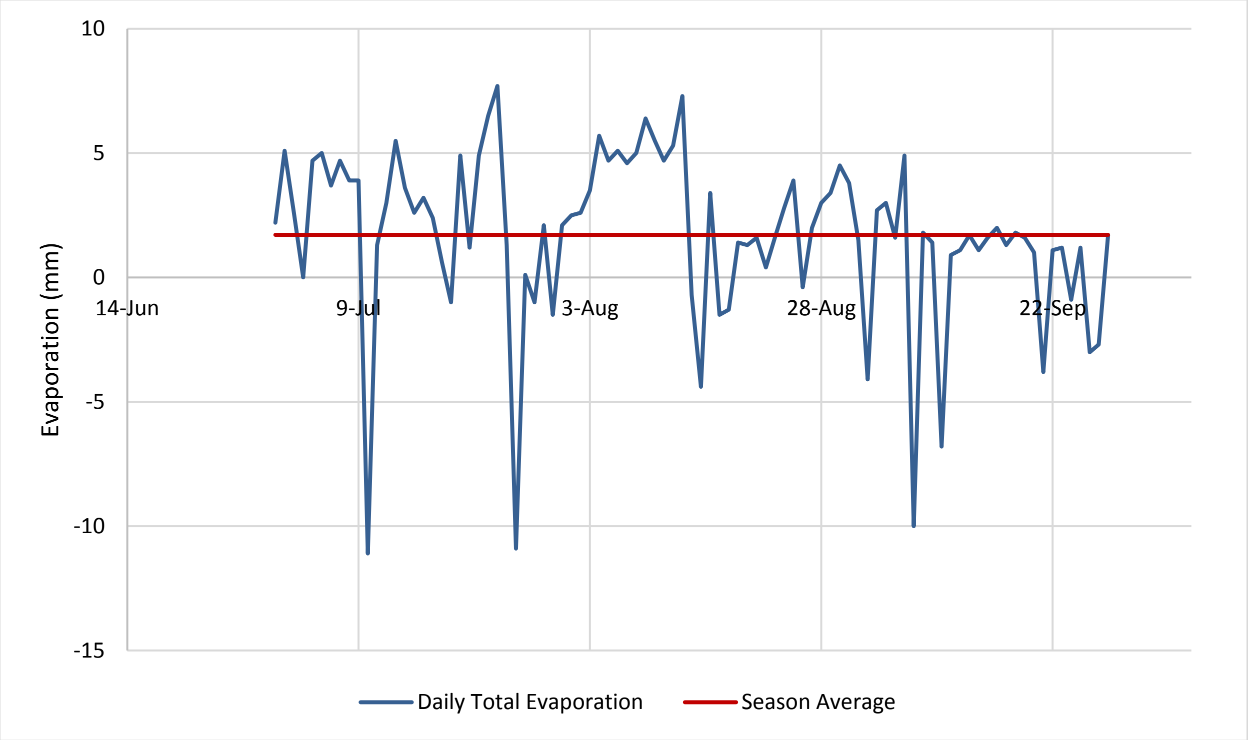


Figure 12-5: Evaporation (June 30th- September 28th 2017)

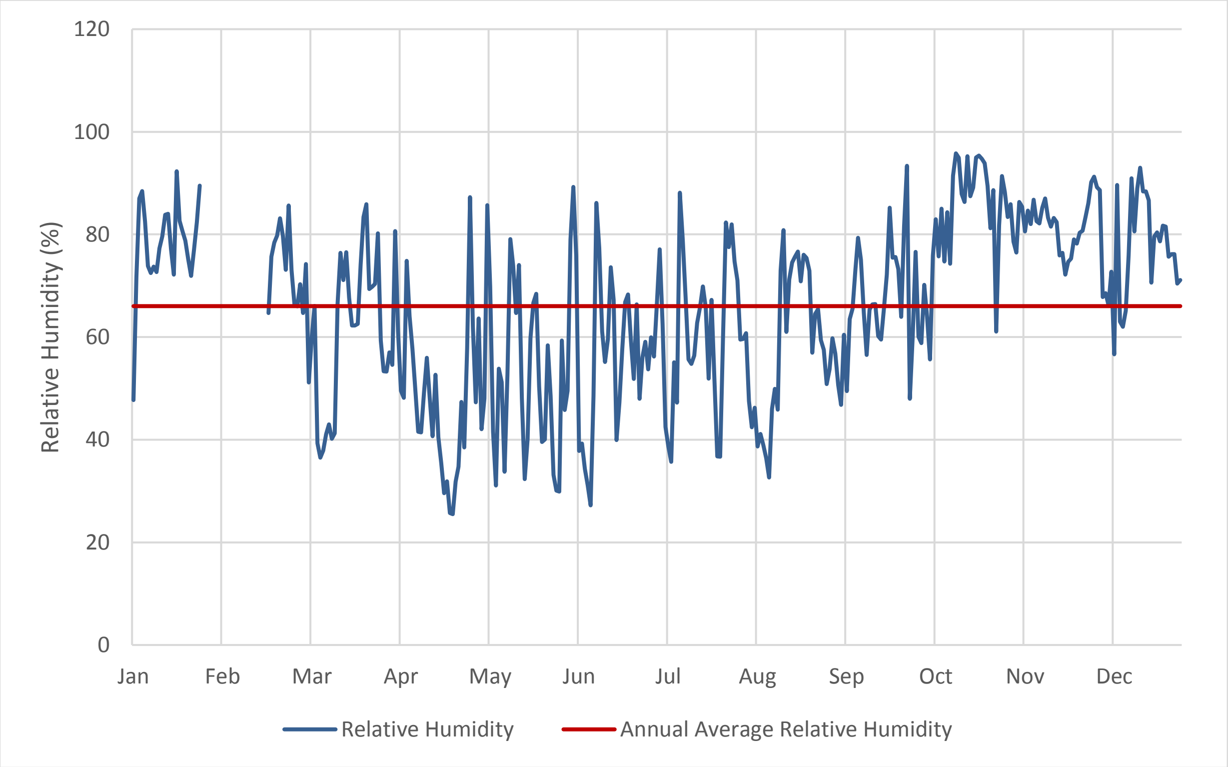
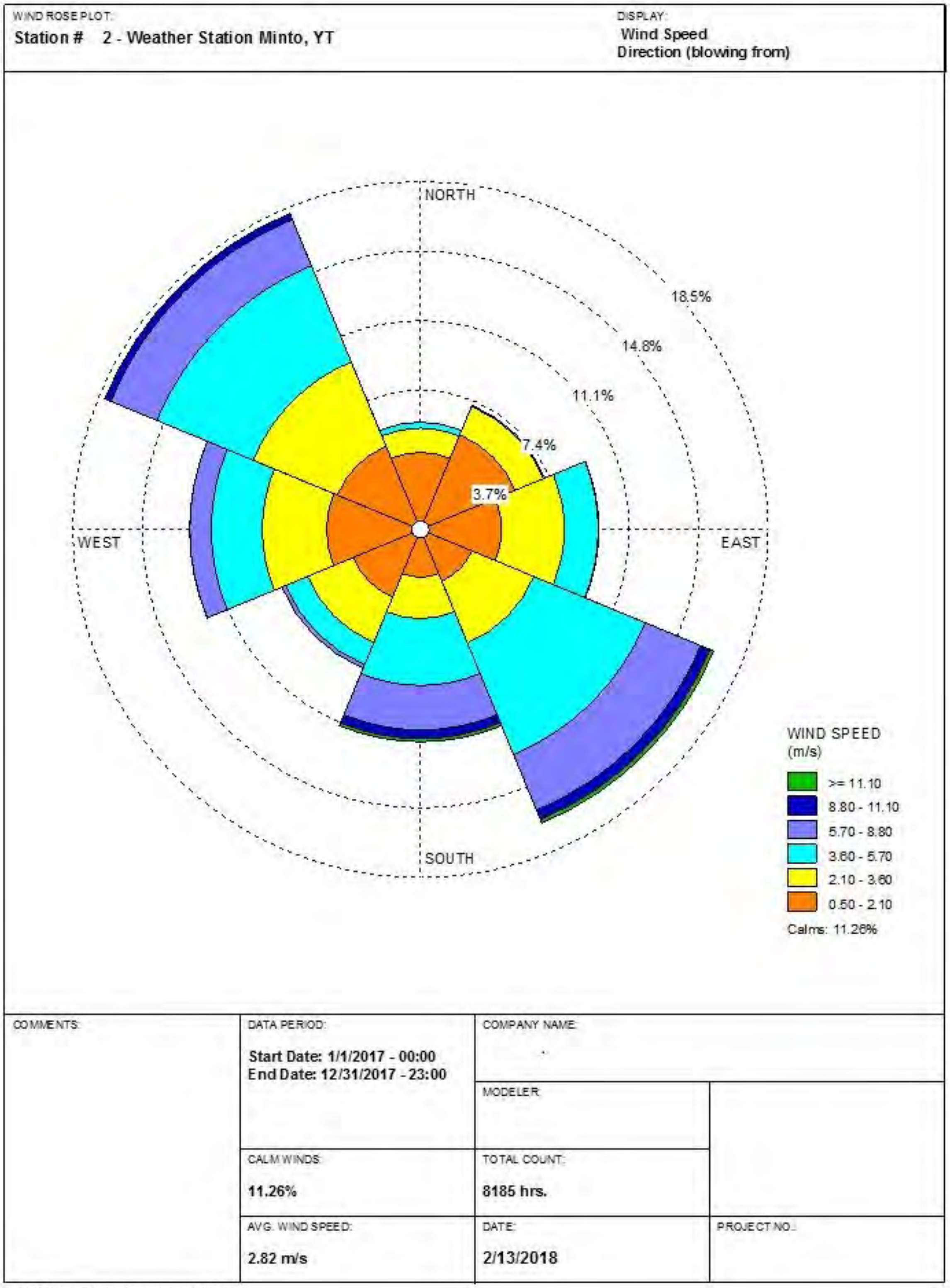


Figure 12-6: Annual Relative Humidity (2017)



WIND ROSE PLOT:
Station # 2 - Weather Station Minto, YT

DISPLAY:
Wind Speed
Direction (blowing from)

COMMENTS:

DATA PERIOD:
Start Date: 1/1/2017 - 00:00
End Date: 12/31/2017 - 23:00

COMPANY NAME:

MODELER:

CALM WINDS:
11.26%

TOTAL COUNT:
8185 hrs.

AVG. WIND SPEED:
2.82 m/s

DATE:
2/13/2018

PROJECT NO.:

Figure 12-7: Wind Speed and Direction Events (2017) – WRPLOT View – Lake Environmental Software

12.2 Snow Survey Program

As required by the WUL Clause 96 and as part of the EMSRP, Minto collects snow data at the mine. The objective of the Snow Survey Program is to collect data used for calculating the snow water equivalent at the Minto Mine site. Snow water equivalents are inputs for the Minto Mine Site Water Balance models. Three courses are surveyed during the first week of February, March & April each year, a new course was added on the Dry Stack Tailings facility in 2017. If conditions permit, Minto will additionally survey the snow courses in May. These courses are East-facing (near the Dyno compound), North-facing (near the airstrip) and South-facing (above the Tank Farm), as detailed in Table 12-1. Along each course, ten stations are sampled using a machined core tube with cutting end and scale assembly. The parameters collected during the surveys include snow depth, core length, core weight, snow density, weather, site conditions, snowpack conditions, crust layers, and snow temperature. Multi-year results to 2017 (averaged across the three snow courses) are presented in Appendix E – 2017 Water Balance and Water Quality Model Summary for the Minto Mine.

Table 12-1: Snow Survey Course Locations

Course Location	Description	Aspect	UTM	
			Easting	Northing
Dyno	East of the Dyno compound on an east facing slope along a cut line surrounded by moderately densely tree area.	East Facing	8V 383 594	694 3377
Fuel Farm	North of the Minto Mine fuel farm on a south facing slope in a sparse to moderately densely treed area.	South Facing	8V 385 061	694 5318
Airstrip	Northeast of the Minto Mine airstrip on a north facing slope in a sparsely treed area.	North Facing	8V 386 255	694 4284
Dry stack Tailings facility	Directly on top of the Dry stack storage facility.	Flat	8V 385 525	694 4786

12.3 Meteorology QA/QC

Procedures for meteorology monitoring at the Minto Mine are detailed in the Meteorology Station Standard Operating Procedures. Minto has installed a satellite connection to the Met Station 2 to enable real time viewing of the weather station data. The meteorology data is downloaded and reviewed twice monthly by Environmental Department staff and routine visual inspections of the monitoring stations occur on a weekly basis.

13 Geochemistry

13.1 Waste Rock Verification Program

The Waste Rock Verification Program was initiated in 2014 to support and monitor waste rock handling procedures at the Minto Mine. The program was developed to address Clause 95 of the WUL, with the results of the program to be included in the Annual Report. The program consists of detailed record keeping on the type and quantity of waste rock placed at each location, and monitoring and verification of the characteristics of the waste rock stored at each location as per the Waste Rock and Overburden Management Plan.

Minto's Technical Services Department tracks all waste dispatched between the source and the destination using the mine's computer database system. The dispatch data are based on load count sheets compiled by the mining contractor.

Samples are taken by Minto geology personnel on dump crests that had been active in the previous month as determined by the production tracking database. The grab sample consists of one shovel full of material taken at twenty-five individual one meter intervals over the distance of the recently placed waste. Particles greater than a pebble (64-80 mm) in size are manually rejected, the sample is then labelled and delivered to Minto's onsite assay lab.

Each sample is analyzed for total copper (Cu (T)), total sulfur (S (T)), and total carbon (C (T)) content using an Eltra CS-800 induction furnace. S (T) and C (T) values are converted into equivalent Acid Potential (AP-S (T)) and Neutralization Potential (NP-C (T)) values, and NP-C (T): AP-S (T) ratios (NP/AP) are calculated for each sample. The resulting (NP-C (T)): (AP-C (T)) ratios are compared to the segregation criteria and assigned "pass" or "fail" designations, which is a 3:1 ratio at Minto.

During the year 2017, seventy-four grab samples of waste (WST) were collected from the Main Pit Waste Dump (MPD), twenty-four samples were collected from the Main Waste Dump Wrap (MWDW) and twenty-one samples from the 118-overburden dump. All the overburden and rock placed in these dumps during this period consisted of waste material from the Area 2 Stage 3 pit and the expansion.

Of the one hundred and nineteen sample taken from the three destinations, one hundred and eighteen met the pass criteria based on the NP/AP segregation criteria. The one failure, which occurred in June in the MPD, was determined to be an isolated event and therefore no additional sampling was required. The average monthly values of the Acid-Base Accounting (ABA) parameters for each dump location are summarized in Table 13-1, below. For a complete summary of the sample results, please refer to Appendix N.

Table 13-1: Waste Rock Management Verification Program Summary (2017)

Average ABA Parameter Values: Month By Location								
Location	Month	Waste Type	Cu%	C% (Tot)	S% (Tot)	NP	AP	NP/AP
MPD	Jan	WST	0.010	0.216	0.011	17.97	0.34	52
	Feb	WST	0.119	0.230	0.014	19.18	0.44	44
	Mar	WST	0.204	0.201	0.039	16.73	1.23	14
	Apr	WST	0.018	0.202	0.008	16.81	0.25	67
	May	WST	0.067	0.458	0.022	38.13	0.69	55
	Jun	WST	0.224	0.218	0.092	18.19	2.88	6
	Jul	WST	0.375	0.478	0.142	39.83	4.43	9
	Aug	WST	0.176	0.403	0.085	33.61	2.64	13
	Sep	WST	0.072	0.215	0.034	17.87	1.07	17
	Oct	WST	0.138	0.253	0.043	21.07	1.33	16
	Nov	WST	0.388	0.124	0.011	10.36	0.34	30
118	Apr	WST	0.127	0.205	0.003	17.09	0.10	171
	May	WST	0.093	0.232	0.005	19.33	0.17	116
	Jun	WST	0.110	0.078	0.007	6.52	0.21	31
MWDW	Nov	WST	0.368	0.102	0.019	8.48	0.60	14
	Dec	WST	0.114	0.503	0.070	41.91	2.19	19

13.2 Acid-Base Accounting Program

The EMSRP commits to the submission of results of the ABA Program that was conducted during the reporting year. The ABA program determines the Neutralizing Potential Ratio ((defined as Neutralizing Potential divided by Acid Potential [NP/AP]) (NPR)) for overburden and waste rock to confirm that the NPR is greater than three. An NPR value of three or greater is generally considered indication of non-acid generating material. A separate, parallel program was initiated to determine the NPR of the tailings solids.

The following is a summary of results from the ABA program for the monitoring period of January to December 2017.

A total of 284 samples were collected from the Area 2 Stage 3 (A2S3), Area 2 Underground (A2 UG) and the Minto East Underground (ME UG) deposits and sent to an accredited laboratory (ALS Minerals) during the 2017 monitoring period. The samples were analyzed according to the MEND Modified NP Method as noted in the EMSRP.

The mean NP:mean AP results for waste rock samples was 15.26 for the duration of the monitoring period. 33 samples during the 2017 monitoring period were below the NPR threshold of 3 for waste rock. The mean paste pH values for all samples tested in 2017 was 8.50. The mean sulfide sulfur ($S(S^{-2})$) content for waste rock samples during the 2017 monitoring period was 0.082%. In 2017, 17 samples exceeded the $S(S^{-2})$ content threshold of 0.30% for construction grade waste rock.

15 tailings samples were analyzed in this period and had a mean NP:mean AP of 10.66. All tailings samples were well above a NPR of 4. All 15 samples of tailings were also below 0.30% $S(S^{-2})$ content and had a paste pH between 7.8 and 8.2.

A full report including lab results and analysis can be found in Appendix O.

13.3 Leach Pads

In 2017, two field scale leach pads were constructed and filled with Partially Oxidized Ore (POX – Leach Pad #1) and Low Grade Sulfide Ore (Green sulfide ore – Leach Pad #2), as per the EMSRP. The Pads were constructed in October, and the first leachate samples are expected to be collected in the spring of 2018.

14 Terrestrial Monitoring Programs

14.1 Wildlife Monitoring Program

The *Minto Mine Wildlife Protection Plan* (a component of the EMSRP) establishes guidelines for minimizing wildlife disturbance at the Minto Mine site and along the development corridor and includes a monitoring program to yield information about wildlife use in the area. The 2017 activities under the Wildlife Monitoring Program including the area and frequency of monitoring, are summarized in Table 14-1, below.

Table 14-1: Wildlife Monitoring Activities (2017)

Area Monitored	Monitoring Activities	Frequency
Wildlife Monitoring	Wildlife monitoring consisted of maintaining a wildlife observation log onsite and reporting wildlife encounters. Environmental personnel on site monitored project activities in order to address wildlife concerns.	Ongoing
Migratory Birds	Monitoring to determine if waterfowl and shorebirds settle on impacted water bodies, such as the Main or Area 2 Pits. Environmental personnel on site monitor project activities and modify operations to address wildlife concerns.	Seasonal, Daily during migratory periods
Species at risk/ of concern	Any caribou observations are reported to the Conservation Officer in Carmacks. Bank swallows have been observed to nest in residuum piles in the summer months, in which case these piles are cordoned off and left undisturbed until after the late summer migration.	As necessary

In addition to the Wildlife Monitoring Activities listed in Table 14-1, the Minto Environmental Department gathered observations from mine site staff with Wildlife Observation forms. These forms were posted at many accessible locations around site and employees were encouraged to record all wildlife observations. The forms were collected periodically and the sightings entered in a wildlife tracking sheet, which is included in Appendix P.

In 2017, 209 wildlife sightings were recorded. The majority of these sightings were comprised of mammals: 106 individual bear sightings, 31 foxes, 28 deer, 5 moose, 10 wolves, 9 lynxes, and 6 porcupines. Other animals observed on site included but were not limited to, hares, ermine, grouse, ptarmigan, sheep, dunlin, eagles, ducks and geese.

The most active animal observation month was August and the most common sighting was bears. Most the animal hazing activities occurred between June and August.

Additional activities that took place on site included wildlife education (including bear awareness training) and safety flashes concerning the prevention of wildlife habituation on site.

14.2 Erosion and Sedimentation Monitoring Program

As part of the EMSRP, Minto has developed and implemented a *Sediment and Erosion Control Plan* (SECP). The objective of the SECP is to minimize local site impacts from erosion and prevent sedimentation to the receiving environment of Minto Creek. The 2017 activities associated with the Erosion and Sedimentation Monitoring Program are identified in Table 14-2, below. There were no significant issues in 2017.

Table 14-2: Erosion and Sedimentation Monitoring Activities (2017)

Activity	Location	Frequency
Visual inspections	Bottoms of slopes and depressions of large structures.	As needed following heavy rain events, and during freshet.
	Road routes: ditches and outlets of culverts and pipes.	As needed following heavy rain events, and during freshet.
Water quality monitoring for total suspended solids (TSS)	Water quality monitoring stations W2, W3, W50 and W17	Weekly and during heavy runoff periods.
Physical inspection of surface facilities by a Yukon registered Engineer.	Water Storage Pond Dam, Mill Water Pond, all waste rock and overburden dumps, all water diversion and conveyance structures and the dry stack tailings storage facility.	After the spring thaw period in May/June of each year and again prior to the on-set of winter in September of each year

14.3 Invasive Plant Species Monitoring Program

As part of the EMSRP, Minto developed an *Invasive Species Monitoring Standard Operating Procedure* in 2015. The Invasive Species Monitoring Plan, created in 2014, was the basis for the SOP. The SOP details how the monitoring program will be conducted.

The 2017 invasive species program focused primarily on the site access road. The Minto Environmental Department completed an invasive plant survey of the twenty-seven kilometer access road, focusing primarily on the high-risk species as listed by the Yukon Invasive Species Council (YISC) (Table 14-3). During the access road survey, one high-risk species (Common Tansy, *Tanacetum* vulgare) was observed growing along the access road. As per the EMSRP, the observed high-risk species was reported to the Yukon Invasive Species Council (YISC) Spotter's Network. For a summary of the access road invasive species survey results, please refer to Table 14-4, below.

In accordance with the EMSRP, invasive plant surveys will continue through 2018, particularly along invasive species pathways such as roads with high visitor traffic, recently exposed areas, and areas that have been recently reclaimed.

Table 14-3: High Priority Invasive Species as determined by the Yukon Invasive Species Council, 2017

Common Name	Latin Name
Leafy Spurge	*Euphorbia esula*
Orange Hawkweed	*Hieracium aurantiacum*
Tall Hawkweed	*Hieracium piloselloides*
Perennial Sow Thistle	*Sonchus arvensis*
Scentless Chamomile	*Tripleurospermum inodorum*
Oxeye Daisy	*Leucanthemum vulgare*
Spotted Knapweed	*Centaurea stoebe*
Creeping Thistle	*Cirsium arvense*
Common Tansy	*Tanacetum vulgare*
Bird Vetch	*Vicia cracca*

Table 14-4: Minto Mine Invasive Species Monitoring Program Results, 2017

Survey Date	Location	Observed Species and Occurrence
19-Jul-17	Access Road, Right Side, km 0.5-0.75	Hawksbeard, Sporadic
19-Jul-17	Access Road, Right Side, km 1.5-2.5	Hawksbeard, Sporadic
19-Jul-17	Access Road, Right Side, km 2.5	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 3.25-3.5	Hawksbeard, Sporadic
19-Jul-17	Access Road, Right Side, km 3.5-4.0	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 4.25-5.0	Hawksbeard, Continuous
19-Jul-17	Access Road, Right Side, km 5.75	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 6.75-7.0	Hawksbeard, Sporadic

Survey Date	Location	Observed Species and Occurrence
19-Jul-17	Access Road, Right Side, km 6.75-7.25	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 7.75-10.0	Toadflax, Sporadic
19-Jul-17	Access Road, Right Side, km 10.0	Common Tansy, Rare
19-Jul-17	Access Road, Right Side, km 10.5-10.75	Toadflax, Sporadic
19-Jul-17	Access Road, Right Side, km 11.5	Common Tansy, Rare
19-Jul-17	Access Road, Right Side, km 12.25-15.5	Hawksbeard, Sporadic
19-Jul-17	Access Road, Right Side, km 12.25	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 12.25	Common Tansy, Rare
19-Jul-17	Access Road, Right Side, km 13.5	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 15.0-17.25	Sweet Clover, Continuous
19-Jul-17	Access Road, Right Side, km 15.75-16.5	Hawksbeard, Rare
19-Jul-17	Access Road, Right Side, km 18.25-18.5	Hawksbeard, Rare
19-Jul-17	Access Road, Right Side, km 18.25	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 19.0-20.0	Toadflax, Sporadic
19-Jul-17	Access Road, Right Side, km 19.5-19.75	Hawksbeard, Sporadic
19-Jul-17	Access Road, Right Side, km 20.0	Common Tansy, Rare
19-Jul-17	Access Road, Right Side, km 20.25-23.0	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 23.25-23.5	Hawksbeard, Rare
19-Jul-17	Access Road, Right Side, km 23.25-24.0	Toadflax, Sporadic
19-Jul-17	Access Road, Right Side, km 24.25-27.0	Toadflax, Rare
19-Jul-17	Access Road, Right Side, km 25.0	Common Tansy, Rare
19-Jul-17	Access Road, Right Side, km 25.75	Common Tansy, Sporadic
19-Jul-17	Access Road, Right Side, km 26.0	Hawksbeard, Rare
19-Jul-17	Access Road, Right Side, km 27.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 0.5	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 1.25-2.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 1.5	Sweet Clover, Rare
20-Jul-17	Access Road, Left Side, km 2.5-2.75	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 2.5-2.75	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 3.25-3.75	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 4.75-5.75	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 5.0	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 6.25-6.75	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 6.25	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 7.0-8.75	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 8.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 8.5	Hawksbeard, Sporadic
20-Jul-17	Access Road, Left Side, km 9.0	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 9.25-10.0	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 9.25-9.5	Toadflax, Rare

Survey Date	Location	Observed Species and Occurrence
20-Jul-17	Access Road, Left Side, km 9.75-10.25	Toadflax, Sporadic
20-Jul-17	Access Road, Left Side, km 10.5-11.5	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 12.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 11.5-12.0	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 12.25-12.75	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 13.0-14.75	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 14.0	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 14.0-14.75	Sweet Clover, Sporadic
20-Jul-17	Access Road, Left Side, km 15.5-16.75	Sweet Clover, Continuous
20-Jul-17	Access Road, Left Side, km 16.25-16.75	Hawksbeard, Sporadic
20-Jul-17	Access Road, Left Side, km 18.25	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 18.75-19.0	Toadflax, Sporadic
20-Jul-17	Access Road, Left Side, km 19.0-19.5	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 19.25	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 20.0-20.5	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 20.0	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 21.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 21.25	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 21.75-22.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 21.75	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 22.5-23.0	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 23.0-23.25	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 23.5-24.0	Toadflax, Rare
20-Jul-17	Access Road, Left Side, km 24.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 24.75	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 25.25-25.5	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 25.5-27.0	Toadflax, Sporadic
20-Jul-17	Access Road, Left Side, km 25.5	Common Tansy, Rare
20-Jul-17	Access Road, Left Side, km 25.5	Sweet Clover, Rare
20-Jul-17	Access Road, Left Side, km 26.25	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 27.0	Hawksbeard, Rare
20-Jul-17	Access Road, Left Side, km 27.0	Sweet Clover, Sporadic

14.4 Vegetation Metal Uptake Plan

The Vegetation Metal Uptake (VMU) program was not required in 2017. The next scheduled program is in 2019.

15 Site Characterization Report

The Site Characterization Report was submitted to EMR in January 2018. As per Clause 13.1 of the QML, the report will be updated in three years from the effective date of the licence. The submission date for the update was December 2017. An extension was granted to January to ensure a comprehensive report was completed. This report was also submitted to the Yukon Water Board in January 2018.

16 Reclamation

Reclamation activities at Minto Mine progressed throughout the monitoring period with the primary progressive reclamation focused on the following facilities:

- Mill Valley Fill Stage 2 (MVFES2);
- Dry Stack Tailings Storage Facility (DSTSF);
- Main Waste Dump Expansion (MWDE); and
- Southwest Waste Dump (SWD)

Reclamation research regarding the use of constructed wetland treatment systems as a closure water treatment option continued throughout the year. Details regarding the program for 2017 can be found in Section 16.2 or Appendix Q.

16.1 Recontouring and Overburden Placement

Recontouring continued from 2016 with the primary efforts for recontouring spent on the MWDE and the SWD. SRK continued to work on refining the closure designs with Minto engineers to guide the construction of the final closure landform designs for facilities that are no longer required by the operation.

The MWDE recontouring started again in April after the waste rock thawed and could be pushed to final slope angle. The upper west slopes were the primary targeted and largely completed by the end of August. The recontouring at the SWD was primarily focused on the Ice Rich Overburden Dump and the overburden area, north of the medium grade waste pile. The Ice Rich Overburden Dump was recountoured and blended into west side of the SWD and is now full integrated with the SWD. The overburden area was backfilled and recontoured to allow for positive drainage in the area.

The stripping of the Area 2 Stage 3 released a total volume of 1.14M BCM (unreconciled) of overburden that met the soil cover specification. That material was directly hauled and placed on the four facilities throughout the entire year. Figure 16-1 to 16-6 show the extent of the overburden placement on the targeted facilities. The reclamation overburden was dispatched from the pit using the soil cover material criteria outlined in the Reclamation and Closure Plan (2016-01). The overburden was visually inspected by Minto environment and mine operations personnel, who were familiar with the cover material criteria. Overburden material that did not meet the soil cover criteria was hauled to the Area 118 backfill dump while the material that met the reclamation cover specification was directly hauled to one of the four targeted facilities.

After spring thaw the majority of the soil cover material was spread out at a targeted thickness of 0.50cm. The spreading was focused on the flat sections of the facilities as well as the slopes of the DSTSF and the MVFE. Near the end of August, after all the overburden was placed it was determined that addition overburden would be required and so additional material was hauled to the targeted facilities in October through December. The additional material will have to be spread out in the spring/summer of 2018.

Figure 16-1: Minto Mine – Mill Valley Fill Extension Stage 2 completed in 2016.

Figure 16-2: Minto Mine – Overburden cover pushed into place on the MVFE and DSTSF.

Figure 16-3: Minto Mine - MVFE and DSTSF progressive reclamation, overburden cover placement (2017 overburden placement highlighted in red).

Figure 16-4: Minto Mine – Southwest dump progressive reclamation, overburden placement and stockpiling (highlighted in red).

Figure 16-5: Minto Mine – MWDE and Low Grade Waste progressive reclamation, overburden cover placement (highlighted in red).

Figure 16-6: Minto Mine – Site overview, all facilities.

16.1 2017 Reclamation Research

Reclamation research in 2017 focused primarily on carryover research of passive treatment technologies which started in 2014 and carried through 2017.

16.1.1 Passive Water Treatment

The demonstration-scale constructed wetland treatment system (CWTS) was constructed at Minto in 2014 and commissioned from 2015 through mid-2017 during which time the system matured and operational adjustments were made. Commissioning successfully established plant and microbial populations and achieved conditions conducive for treatment of constituents of concern. The demonstration-scale CWTS operational period ran for 35 days from mid-August to mid-September 2017.

Various aspects of the system were measured in 2017 and have been detailed under a separate report including operating conditions, water treatment performance, fate and distribution of treated metals, evapotranspiration, detritus decomposition rates, microbial community characterization (catalyzing treatment reactions), and pest control. The key findings of each phase of this research project are presented in table 16-2 below. A full detailed report can be found in Appendix Q.

Table 16-1: Demonstration Scale Constructed Wetland 2017 Work Summary

Item	Date	Activities	Actual
Construction	June 1-14 2014	Identify potential location for demonstration scale CWTS (Contango site visit – 1 scientist)	Completed
	June - July 2014	Engineering and geotechnical (Minto)	Completed
	July 2014	Construction (Minto)	Completed
	August 2014	Planting and bringing system online (Contango site visit – 1 scientist, 1 technologist), coordinate for local students to assist	Completed (no students available, brought 2 technologists)
Commissioning A	2014	Acclimation and maturation at constant flow rate, ~20 hr HRT	Completed
		September - Contango site visit/checkup (1 technologist, 1 scientist)	Did not occur because construction was last week of August
	2015	Continued commissioning. Operation at constant flow rate, ~20 hr HRT	Completed (at shorter HRT)
		Spring – Contango site visit/checkup (1 technologist, 1 scientist), includes micro sampling	Completed
		Summer - Increase depth from 10 cm to 20 cm (1 technologist), includes micro sampling	Completed (scientist)
		Fall – Contango site visit/checkup (1 technologist), includes micro sampling	Completed (scientist)
	2016	Minto to add sandbags prior to first site visit and begin W15 creek monitoring	Completed May/June 2016
		Spring – Contango site visit (1 scientist, 1 technologist), includes microbial sampling and tasks outlined in Table 2 of report. HRT tracer study completed, outlined in section 7 of report.	Completed June 2016
		Summer - Contango site visit/checkup (1 scientist, 1 technologist), includes microbial sampling and tasks outlined in Table 2 of report. Evapotranspiration study completed as outlined in section 5.5 of report. Organics were added to the CWTS as outlined in section 5.2.3 of report.	Completed July 2016
Commissioning B[1]		Fall - Contango site visit/checkup (1 technologist), includes microbial sampling and tasks outlined in Table 2 of report	Completed September 2016
	2017	Spring – Minto established low flow steady state in May. Contango site visit (1 scientist, 1 technologist), includes microbial sampling and tasks outlined in Table 2 of report. Continued commissioning/testing of CWTS including evapotranspiration and salt tracer studies.	Completed June 2017
		Summer – Contango site visit (1 scientist), includes microbial sampling and tasks outlined in Table 2 of the report., detritus collections	Completed July 2017
Operational	2017	Fall – Operational testing completed by Minto: Water sampling, microbial, soils, water, biomass, detritus.	Completed September 2017

Table 16-2: Passive Water Treatment Research Key Findings (2015-2017)

Objective	Purpose	Key Findings or Changes for Full-scale
Monitor explanatory parameters and performance	Determine when commissioning is complete and the operational period has begun	- Dissolved oxygen (DO) decreased from an average of 8.4 mg/L during commissioning- B in 2016, to an average of 5.3 mg/L during operations in 2017. The DO in the water column is likely the result of photosynthesis of algae and mosses. - Despite this DO level in the water column being in oxidizing ranges, stable reducing conditions were achieved in the CWTS soils within the targeted soil redox range (-100 to -250 mV).
Assess removal of constituents from the water	Develop Removal Rate Coefficients for application to Reclamation Closure Plan and Full-Scale treatment system	- Copper treatment in the CWTS was masked by leaching from the soils used in construction of the CWTS into the water, but this has mostly been remedied now by the wetland treating this copper and turning it into more stable sulfide forms in the soil. - During the operational period the demonstration-scale CWTS successfully achieved an average decrease in concentrations of 0.0169 µg/L for cadmium (from 0.0261 µg/L to 0.0092 µg/L), 31.8 µg/L for copper (from 49.1 µg/L to 17.3 µg/L), 3.6 µg/L for molybdenum (from 6.3 µg/L to 2.7 µg/L), 3.5 µg/L for selenium (from 4.0 µg/L to 0.5 µg/L), and 47.3 µg/L for zinc (from 49.2 µg/L to 1.9 µg/L). - Molybdenum and selenium treatment in the operational period is notable as the removal rates were negligible within the margins of error of the testing method in the commissioning-A period.
Determine the hydraulic retention time (HRT)	Use tracer trial and associated correction factor to apply to the nominal (calculated) HRT	- The tracer study effectively demonstrated the HRT (2.25 days) and flow symmetry through the CWTS. - There was a single flow path in the CWTS (shown by a single peak in the tracer study) - Water is incorporating into the CWTS soils (shown by the long tail for depletion of the tracer). - The nominal HRT is calculated from the area of the CWTS and the depth at the in-situ measuring points. This nominal HRT does not account for depth variations, embankment slopes, vegetation (using space in the water), or substrate pore space involvement. It was found that once all of these factors are in play, the correction factor from nominal to actual is only 0.01 added to the depth of the CWTS, which is incorporated into the HRT calculation as expressed in Equation 3.
Evaluate CWTS performance	determine achievable concentrations of contaminants of concern (thermodynamic minimums)	- Constituents are being treated by mineralization and sequestered to the soils (minimal plant uptake). - The lowest concentrations consistently achievable for the treatment design (thermodynamic minimums) were reached by the end of the A cells for cadmium and copper. - RRCs for cadmium and zinc in the 2017 demonstration-scale CWTS were artificially low because low flow rates did not provide the resolution needed to determine a RRC. - Removal rate coefficients (RRCs, *k*) have been developed that can be used for fullscale sizing. - Copper leaching from soils has decreased but is still likely making the RRC artificially low in this CWTS; however, the RRC is expected to improve once copper leaching has subsided.

Objective	Purpose	Key Findings or Changes for Full-scale
Update site-specific removal rate coefficients (from commissioning period) with data from operational period	Apply information to Reclamation Closure Plan and Full-Scale treatment system	- In pilot-scale testing specific for the Minto CWTS, the RRC for selenium was a zero-order reaction kinetic, however, optimizations of the operation of the system through the demonstration-scale commissioning have enabled a first-order RRC to be maintained. Therefore, cadmium, copper, selenium, zinc, and nitrate are calculated as first-order kinetics, but molybdenum followed a zero-order kinetic. In other words, the reaction rate for molybdenum is a constant rate and does not depend on concentration, whereas the reaction rates for cadmium, copper, selenium, zinc, and nitrate are proportional to concentration (a half-life type of reaction).
Determine amount of water loss due to evapotranspiration and effect on outflow concentrations	Design considerations for Full-Scale system	- The evapotranspiration studies revealed a significant loss of water, which will impact calculations of loads to the receiving environment (making them lower than previously estimated). - In May and June, an average water loss of 5.3 L/day/m2 was observed, which is equivalent to 18-20% of water (~700 L/day lost in the demonstration CWTS). - During the evapotranspiration trials, copper leached into the water as it was transformed from an oxide mineral to a sulfide mineral (because of the copper in the soils used for construction). This is not representative of what would occur during periods with no flow in a full-scale CWTS, where soils with minimal leachable copper are used and copper is deposited in sulfide form (fraction 4) by the biogeochemical activity of the CWTS (Section 5.6).
Assess stability of constituents of concern in soils	Affects overall theoretical treatment capabilities of Full-Scale system	- In 2017, leachable copper concentrations in soils decreased in the top 0-10cm while total copper concentrations increased. - Most constituents, including copper, have shifted primarily into stable reduced and residual minerals fractions in the soil. - Acid volatile sulfides (AVS) were non-detectable in the CWTS in 2016. In 2017 small amounts of AVS were detected in cells 1A and 2A which indicates that residual sulfides are starting to become available for metal treatment and that copper in the soils are becoming rendered inert through sulfide mineralization.
Determine the rate and extent of detritus decomposition (*C. aquatilis* leaves) in the CWTS over time	Design considerations for Full-Scale system	- The detritus study suggested that algae growth on the assay devices had reached a steady state (growth vs decomposition) by ~23 days of the study. - After 83 days submerged in the CWTS, *C. aquatilis* decomposed on average 64%.
Assess treatment mechanisms (including microbes)	Apply information to Reclamation Closure Plan and Full-Scale treatment system	- Establishment of sulfide-producing bacteria (SPB) increased throughout 2017 and was highest after commissioning was completed. - SPB were found in highest abundance in root and soil samples. - The average number of different types of sulfide-producing bacteria increased over time in all sample types tested (root, soil, detritus, and moss). - Selenium-reducing and nitrate-reducing bacteria increased over time with the highest abundances found in *C. aquatilis* roots.

Objective	Purpose	Key Findings or Changes for Full-scale
Determine an appropriate method for insect pest control (aphids) in the CWTS	Optimize Operational success of Demonstration-Scale CWTS.	- Aphids were again found in abundance on *C. aquatilis* in 2017. - Efforts to control the aphid population on-site were made but an ongoing spraying regiment was not maintained and, therefore, aphids remained. However, no short term detrimental effect on *C. aquatilis* viability was observed, despite the persistence of aphids. - Damage to the above water vegetation was observed however new shoots were emerging in the CWTS and treatment COCs was not impacted by damage to the above water vegetation. - Effects of aphids on *C. aquatilis* did not affect treatment. - These issues with aphids are likely owing to the isolated nature of the demonstration scale CWTS and not expected to affect the full-scale CWTS.

16.2 Proposed Reclamation for 2018

Proposed reclamation for 2018 includes the following:

- Contouring work on soil cover on the Mill Valley Fill Stage 2 Extension;
- Contouring work on soil cover on the Dry Stack Tailings Storage Facility;
- Contouring work on soil cover on the Southwest Waste Rock Dump;
- Contouring work on soil cover on the Main Waste Dump Expansion;
- Completion of Main Waste Dump Wrap;
- Minor recontouring work as required;
- Phase 1 seeding of soil cover; and
- Continuation of the Passive Water Treatment Research.

17 Socio-Economic Monitoring Program

The Minto Mine Socio-Economic Monitoring Program defines a framework for monitoring direct and indirect socio-economic effects from the Minto Mine. In 2017, as per the framework, Minto tracked and collected administrative data and other information relating to the mine's direct employment, training and procurement; worker safety; and Minto contributions to cultural well-being and community wellness. The 2017 socio-economic data which Minto tracked is summarized in Appendix R.

18 Closure

Minto trusts this document fulfills the 2017 annual reporting requirements of Minto Mine's WUL and QML.

19 References

Dodds, W.K., J.R. Jones and E.B. Welch. 1998. Suggested Classification of stream trophic state: Distribution of temperate stream types by chlorophyll, total nitrogen, and phosphorus, Water Research, 32(5):1455-1462.

BCMOE (British Columbia Ministry of Environment). 1985. Water Quality Criteria for Nutrients and Algae: Technical Appendix. Prepared by Richard Nordin, Water Quality Unit, Resource Quality Section, Water Management Branch. October 1985.

CCME (Canadian Council of Ministers of the Environment). 1999 (plus updates). Canadian Environmental Quality Guidelines. CCME, Winnipeg.

Chapman, P.M., M.O. Farrell and R.O. Brinkhurst. 1982a. Relative tolerances of selected aquatic oligochaetes to combinations of pollutants and environmental factors. Aquat. Toxicol. 2: 47–67.

Chapman, P.M., M.O. Farrell and R.O. Brinkhurst. 1982b. Relative tolerances of selected aquatic oligochaetes to combinations of pollutants and environmental factors. Aquat. Toxicol. 2: 69-78.

Dodds, W.K., J.R. Jones and E.B. Welch. 1998. Suggested Classification of stream trophic state: Distribution of temperate stream types by chlorophyll, total nitrogen, and phosphorus, Water Research, 32(5):1455-1462.

Environment Canada. 2012. 2012 Metal Mining Environmental Effects Monitoring (EEM) Technical Guidance Document. Environment Canada Report.

HKP (Hallam Knight Piesold). 1994. Minto Explorations Limited Minto Project: Volume II Environmental Setting. Prepared for Minto Explorations Limited. December 1994.

Minnow (Minnow Environmental Inc.). 2012. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2011. Prepared for Minto Explorations Ltd, March 2012.

Minnow (Minnow Environmental Inc.). 2013. Periphyton Community Monitoring in Minto Creek - September 2012. Letter report prepared for Minto Explorations Ltd., November 19, 2013.

Minnow (Minnow Environmental Inc.). 2014. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2013. Prepared for Minto Explorations Ltd, March 2014.

Minnow (Minnow Environmental Inc.). 2015. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2014. Prepared for Minto Explorations Ltd, March 2014.

Minnow (Minnow Environmental Inc.). 2016. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2015. Prepared for Minto Explorations Ltd, March 2016.

Minnow (Minnow Environmental Inc.). 2017. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment – 2016. Prepared for Minto Explorations Ltd, March 2017.

Rosenberg, D.M., and V.H. Resh. (Ed). 1993. Freshwater Biomonitoring and Benthic Invertebrates. Routledge, Chapman and Hall, Inc. New York, NY. 488 p.

SRK Consulting Inc. (2017) A2S3 Diversion Overflow Spillway

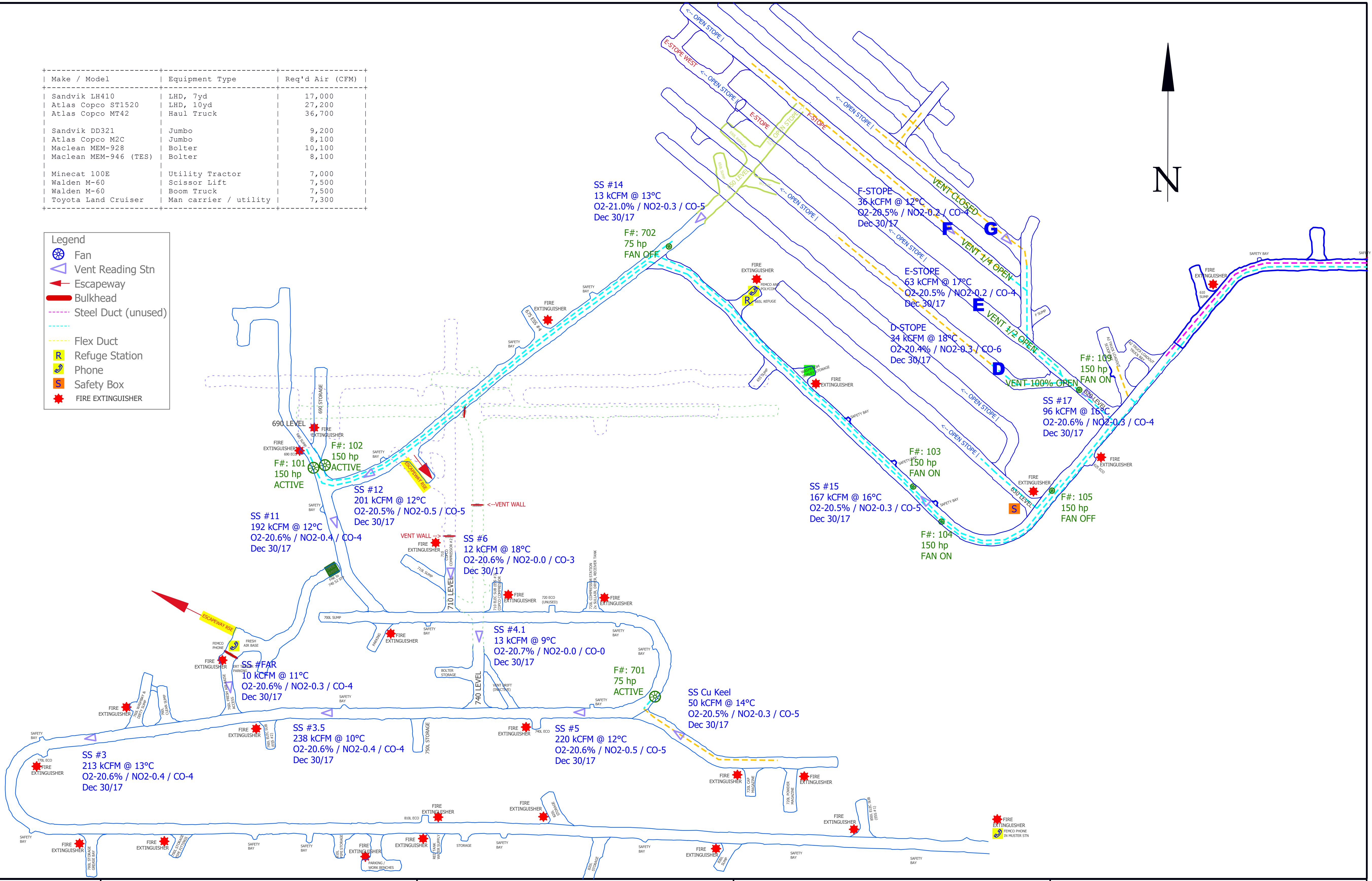
Taylor, B.R. and R.C. Bailey. 1997. Aquatic Effects Technology Evaluation (AETE) Program: Technical Evaluation on Methods for Benthic Invertebrate Data Analysis and Interpretation. AETE Project 2.1.1. 93 p

Appendix A – Minto Mine Underground Development Map

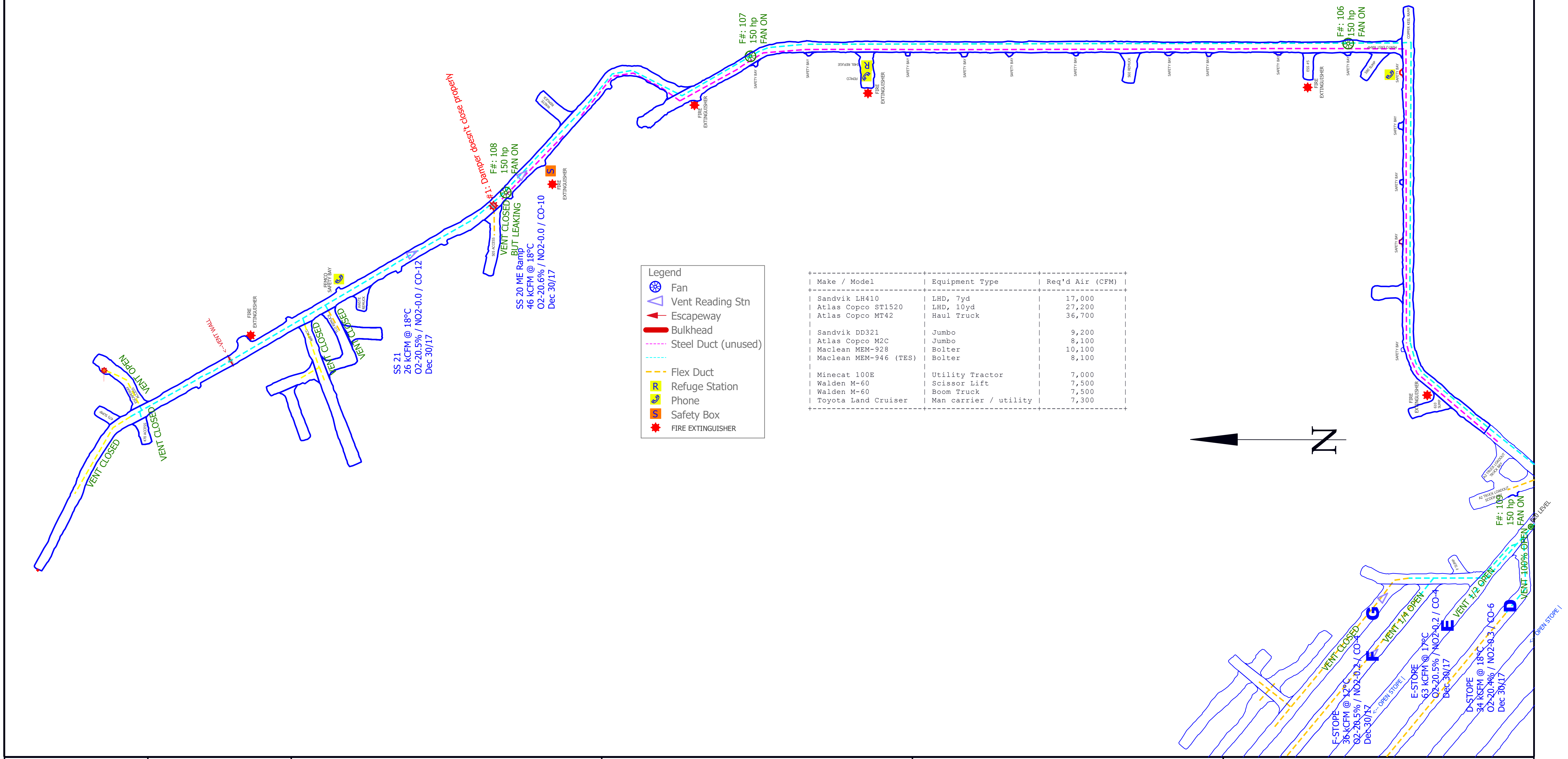
Make / Model	Equipment Type	Req'd Air (CFM)
Sandvik LH410	LHD, 7yd	17,000
Atlas Copco ST1520	LHD, 10yd	27,200
Atlas Copco MT42	Haul Truck	36,700
Sandvik DD321	Jumbo	9,200
Atlas Copco M2C	Jumbo	8,100
Maclean MEM-928	Bolter	10,100
Maclean MEM-946 (TES)	Bolter	8,100
Minecat 100E	Utility Tractor	7,000
Walden M-60	Scissor Lift	7,500
Walden M-60	Boom Truck	7,500
Toyota Land Cruiser	Man carrier / utility	7,300

Legend

⊛	Fan
◁	Vent Reading Stn
◄—	Escapeway
▬	Bulkhead
- - -	Steel Duct (unused)
- - -	
- - -	Flex Duct
R	Refuge Station
☎	Phone
S	Safety Box
✸	FIRE EXTINGUISHER



DRAWN BY: DP	SCALE: 1:2000	VENT SURVEY - 171230	Appendix A - 2017 Underground Development	capstone MINTO MINE
	DATE PLOTTED: 30-Dec-2017			



```
+----------------------+----------------------+------------------+
| Make / Model         | Equipment Type       | Req'd Air (CFM)  |
+----------------------+----------------------+------------------+
| Sandvik LH410        | LHD, 7yd             |     17,000       |
| Atlas Copco ST1520   | LHD, 10yd            |     27,200       |
| Atlas Copco MT42     | Haul Truck           |     36,700       |
|                      |                      |                  |
| Sandvik DD321        | Jumbo                |      9,200       |
| Atlas Copco M2C      | Jumbo                |      8,100       |
| Maclean MEM-928      | Bolter               |     10,100       |
| Maclean MEM-946 (TES)| Bolter               |      8,100       |
|                      |                      |                  |
| Minecat 100E         | Utility Tractor      |      7,000       |
| Walden M-60          | Scissor Lift         |      7,500       |
| Walden M-60          | Boom Truck           |      7,500       |
| Toyota Land Cruiser  | Man carrier / utility|      7,300       |
+----------------------+----------------------+------------------+
```

DRAWN BY: DP	SCALE: 1:2000	VENT SURVEY - 171230
	DATE PLOTTED: 30-Dec-2017	

capstone
MINTO MINE

Appendix B – Minto Mine Spill Contingency Plan

capstone
MINTO MINE

Minto Mine

2018 Spill Contingency Plan

Prepared by:

Minto Explorations Ltd.

Minto Mine

January 2018

Summary of Revisions (2018)

Section Revised	Description of Revision	Reason for Revision
All	• Updated dates and references to previous years SCP.	• Annual review and update
4.2	• Updated internal and external contact information	• Contact info changes
7.0	• Changes to training ("Big 6" updated to "Big 7")	• Annual Review and update
App. C	• Updated format – searchable. Included updated information	• Annual Review and update

Table of Contents

List of Tables

List of Figures

List of Appendices

1 Introduction

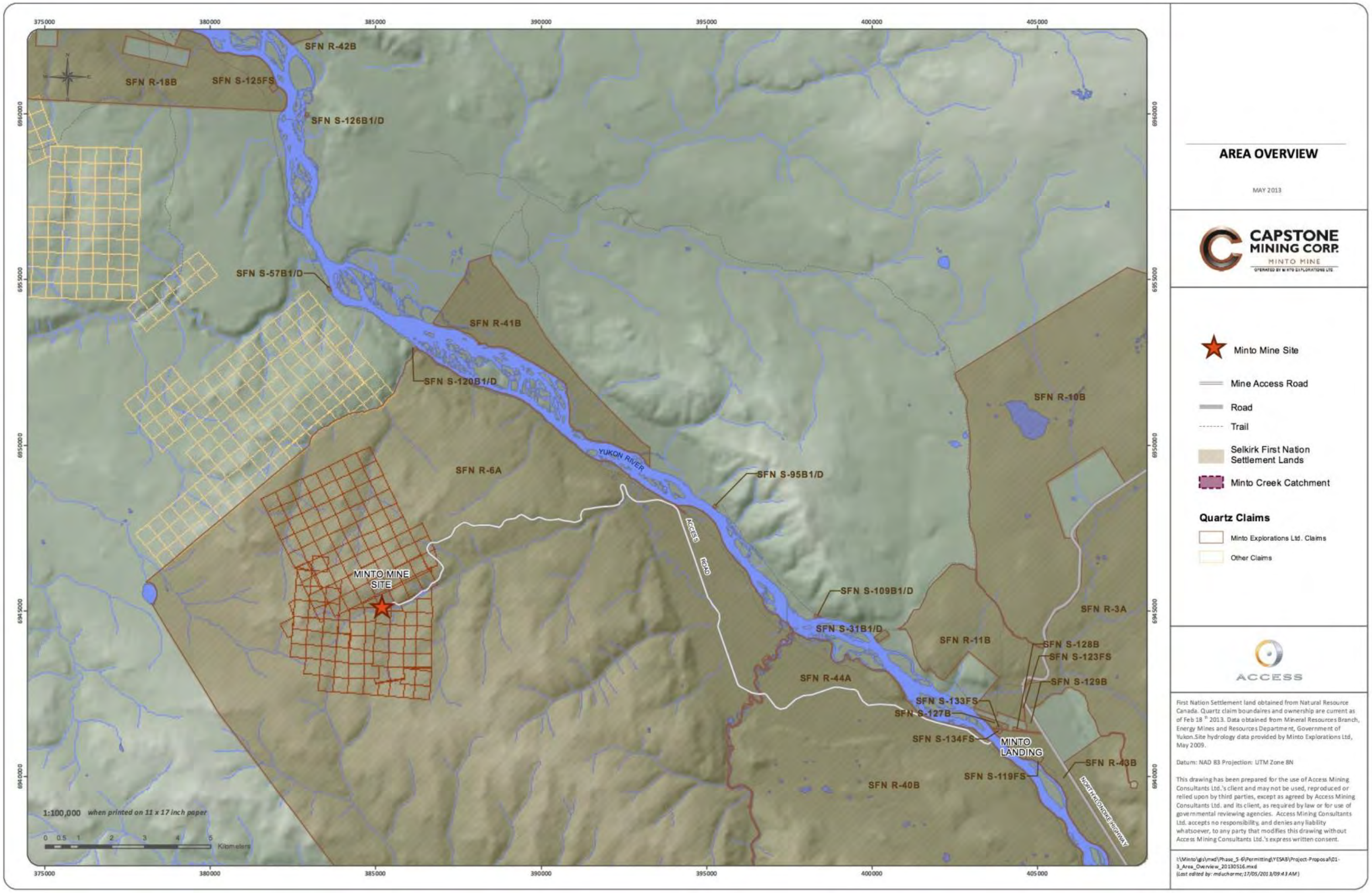
Minto Mine (administered by Minto Explorations Ltd. (Minto)) is a high-grade copper and gold mine that is located 240 km north of Whitehorse, Yukon. Operations started in October 2007. The mineral deposits mined at the site were identified during exploration programs occurring in the area in the 1970's; exploration activities occurred sporadically since that time until construction of the mine and related facilities began in earnest in 2006.

This Spill Contingency Plan (SCP) is an update to the previous SCP, drafted in February 2017. The content of this SCP is derived from the *Plan Requirement Guidance for Quartz Mining Projects* (Yukon Government, 2013). The SCP has been updated annually and submitted as part of Minto's Water Use Licence and Quartz Mining Licence annual reports.

The purpose of the SCP is to establish guidelines for staff, contractors and suppliers working at the site with a formal framework of actions to be taken when responding to spills during mine operation. The SCP includes practices and planning of future efforts to further reduce the potential for environmental contamination and other spill-related impacts. The SCP describes the fuels, chemicals and other materials used at the Minto Mine, reporting thresholds for those materials, a spill action plan for responding to unintentional spills of those materials, reporting sequences and forms, training requirements, spill prevention activities and routine monitoring and maintenance.

1.1 Project Description

Minto Explorations Ltd. (Minto), a wholly owned subsidiary of Capstone Mining Corporation (Capstone), owns and operates the Minto Project located 240 km (150 miles) northwest of Whitehorse, Yukon. The Minto Mine is a high-grade copper and gold mine with ongoing operations since October 2007. The Project area encompasses the Minto Creek Valley which collects and drains in to the Yukon River (Figure 1-1). The Minto Mine is currently in Phase V/VI of surface operations. An overview of major infrastructure at the Minto Mine and the expansion of Phase V/VI is shown on Figure 1-2.



First Nation Settlement land obtained from Natural Resource Canada. Quartz claim boundaires and ownership are current as of Feb 18 th 2013. Data obtained from Mineral Resources Branch, Energy Mines and Resources Department, Government of Yukon.Site hydrology data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

This drawing has been prepared for the use of Access Mining Consultants Ltd.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Access Mining Consultants Ltd. and its client, as required by law or for use of governmental reviewing agencies. Access Mining Consultants Ltd. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Access Mining Consultants Ltd.'s express written consent.

I:\Minto\gis\mxd\Phase_5-6\Permitting\YESAB\Project-Proposal\01-3_Area_Overview_20130516.mxd
(Last edited by: mducharme;17/05/2013/09:43 AM)

Figure 1-1: Minto Mine Area Overview

Figure 1-2: Minto Mine Area Overview – Existing and Phase V/VI Proposed Infrastructure

2 Definitions

The following definitions apply to the components of the SCP outlined herein.

Dangerous Good - A product, substance or organism included by its nature or by the regulations in any of the classes listed in the schedule to the act (*Yukon Transportation of Dangerous Goods Act)*.

Deposit out of the normal course of events - A deposit that can reasonably be expected to occur at the mine and that can reasonably be expected to result in damage or danger to fish habitat or fish or the use by man of fish, and the identification of the damage or danger (*Metal Mining Effluent Regulations, Part 3, SOR/2002-222)*.

Discoverer - The person that discovers an incident that could possibly result in a spill or has resulted in a spill.

Spill - A release of a substance in to the natural environment that is abnormal in quantity or quality in light of all circumstances of the release; or is in excess of an amount specified in the regulations (*Yukon Environment Act, Part 11*):

> **Emergency Spill -** A release of a hazardous product where there is potential for that product to enter a waterway or cause significant danger to life, health or environment.
>
> **Non-Emergency Spill -** All spills that do not meet criteria of an *emergency spill* and that the responsible party is competent to manage safely and efficiently in terms of assessment, prevention, containment and clean-up.

Substance - A hazardous substance, pesticide, contaminant or special waste often referred to as a "**deleterious substance".**

3 Purpose and Scope

Minto will ensure that all requirements related to Spill Response and reporting within these documents are implemented throughout the property for the life of mine. If statutory and regulatory responsibilities change over time updating of this Plan will result.

This SCP is prepared in support of:

- Minto's Type "A" Water Use License QZ14-031 (WUL) and Type "B" Water Use License MS15-094, which state that:

  > *"The Licensee shall apply the relevant procedures in the Spill Contingency Plan. The Licensee shall review the spill contingency plan annually and shall provide a summary of that review, including any revisions to the plan, as a component of the annual report."*

- *Part 3 – Deposits Out of the Normal Course of Events*, Section 30 of the *Metal Mining Effluent Regulations* (MMER), which indicates that:

> *"The owner or operator of a mine shall prepare an emergency response that describes the measures to be taken in respect of a deleterious substance within the meaning of subsection 34(1) of the Act to prevent any deposit out of the normal course of events of such a substance or to mitigate the effects of such a deposit."*

- *Part 7 – Emergency Response Assistance Plans and Security Plans of* the *Transportation of Dangerous Goods Act*:

> ***"****No person shall import, offer for transport, handle or transport dangerous goods in a quantity or concentration that is specified by regulation — or that is within a range of quantities or concentrations that is specified by regulation — unless the person has an emergency response assistance plan that is approved under this section."*

- Satisfying the requirements of the Quartz Mining License QML-0001 Schedule B, that requires:

> "A *plan that describes the measures designed to minimize the potential impact to the environment following a fuel or chemical spill."*

The SCP will apply to Minto Mine and the main access route for one year, whereby the owner or operator shall update and test the SCP to ensure it continues to meet the requirements of both the WUL, subsection 30(2) of the MMER, and the QML.

3.1 Purpose

The purpose of the SCP is to outline a general set of procedures to be followed to assess, prevent, contain and clean-up a spill at the Minto Mine. For procedures to be effective, Minto must ensure that employees and contractors, through experience and training, possess the skills necessary to safely assess, prevent, contain and clean-up a spill or potential spill. These procedures are necessary to ensure continuity and develop the foundation for a robust and effective SCP. The SCP is also designed to establish clear reporting and clean-up procedures as they apply to emergency and non-emergency spills and incidents.

This document also addresses opportunities to improve spill preparedness, response, and mitigation for deposits out of the normal course of events that have the potential to impact the Yukon River and its tributaries within the project site.

All Minto employees and contract staff must be familiar with the general spill reporting procedures outlined in this document and will be introduced to them as part of their site orientation.

3.2 Scope

The objectives of the SCP are to:

- identify potentially hazardous materials located on site;
- identify spill prevention measures;

- establish a high order of preparedness in the event that a spill occurs;
- ensure an orderly and timely decision-making, response and reporting process; and
- describe current and planned protective measures for all areas of the Mine Site

The *Minto Mine Emergency Response Plan* (Minto, 2017) contains other information that relates to Emergency spill procedures. The Emergency Response Team (ERT) and members of the Environmental Department have been trained on responding to Hazmat Spills. It is beyond the scope of this document to define the specific Spill Response Procedures and decision loops involved in an ERT response. Any details pertaining to a response from ERT to assess, prevent, contain and clean-up a spill at a spill incident is the responsibility of the Site Safety Department. General procedures for spill response procedures to emergency spills will be detailed herein.

3.2.1 Hardcopy Locations

Copies of the SCP are kept on-site at all times in the following locations: Mill Control Room; Site Safety Office; Environmental Office; General Manager's Office; Site Services Office; and on the Copper Queen Tug. Contact information is provided in

Table 4-2.

4 Communication and Spill Reporting

Any spill that occurs at the Minto Mine site must be reported through the internal reporting chain of command and follow the procedures for assessment, prevention, containment and clean-up and reporting. Should a spill exceed the thresholds set by the Yukon Government (Table 4-1) then it must be reported to external authorities.

A spill in excess of the thresholds outlined in Table 4-1 or any spill that is abnormal in quality or quantity is considered a "reportable spill" under the *Yukon Spill Regulations* (O.I.C. 1996/193), pursuant to the *Environment Act*.

Table 4-1: Reportable Spill Thresholds

Product	TDG[1.] Code	Threshold Quantity
Explosives	1	Any amount
Flammable gases	2.1	> 100 litres
Non-flammable gases	2.2	> 100 litres
Poisonous gases	2.3	Any amount
Corrosive gases	2.4	Any amount
Flammable liquids	3	> 200 litres
Flammable solids	4	> 25 kg
Spontaneously combustibles	4	> 25 kg
Dangerous when wet	4	> 25 kg
Oxidizers	5.1	> 50 kg or 50 litres
Organic peroxides	5.2	> 1 kg or 1 litre
Poisonous substances	6.1	> 5 kg or 5 litres
Corrosive materials	8	> 5 kg or 5 litres
Miscellaneous Dangerous Goods	9.1	> 50 kg or 50 litres
Special wastes	9.3	> 5 kg or 5 litres

1. TDG = *Transportation of Dangerous Good Regulations* (Government of Canada, 1985)

4.1 Internal Reporting (All Spills)

All spills (whether reportable externally or not) must be reported by the discoverer to their immediate supervisor and then to either Site Safety or the Environmental Department by radio or telephone following assessment of the scene. The supervisor of the responsible department will issue an Environmental Incident Notification, with assistance from the Environment department, to notify the site and its directors including senior management. This typically occurs concurrently with spill response (prevention, containment and clean-up) activities.

Following the spill response, responsible department supervisors are required to document the spill on an Environmental Incident Report, available through the Environmental Department, and provided in Appendix A. The report requires inclusion of photos, a description of clean-up activities, subsequent actions, identifies root cause and determines any required corrective actions.

4.2 External Reporting (Reportable Spills Only)

Under federal and territorial regulations, the environmental lead will call the 24-hour Yukon Spill Report line should a spill of a reportable quantity occur (Table 4-1). Although several government agencies at the federal, territorial and municipal levels may ultimately be informed, only the Yukon 24-Hour Spill Report line is required for reporting purposes. The environmental lead will ensure that the appropriate information is collected before reporting to the Spill Report line.

Any spill of an amount greater than those listed in Table 4-1 or a spill of any amount that enters the Yukon River or a tributary of the river is a "reportable spill".

The following information should be provided to the 24-Hour Spill Report line:

- Name
- Phone number
- Product spilled
- Quantity spilled
- Quality of product (thin, viscous etc.)
- Location of spill
- Distance to water
- Distance to drinking water wells
- What happened
- Responsible party
- Actions to contain the spill

When reporting the spill to the Spill Report line, the environment lead will obtain the Environment Yukon Spill Reporting Number and first/last name of the person whom the report has been made to (in the event of a reporting discrepancy).

Minto will also contact: the Selkirk First Nation Lands Director; and Energy Mines and Resources Client Services and Inspections via email or phone after discovery of a reportable spill. Should the spill enter a waterway or be categorized as a major spill, Minto will also contact Environment Canada. A detailed written report will be submitted to the regulatory authorities within 10 days after the event. The contact information for the various Minto employees, emergency response and external reporting personnel is provided in

Table 4-2.

Table 4-2: Contact Information for Minto Personnel and External Agencies

Resource	Email	Contact Number
Minto Internal Communications Contact Info		
Health and Safety Department	safety@mintomine.com	604 759-0860 ext. 4644
Environmental Department	minto_environment@mintomine.com	604 759-0860 ext. 4660
Yves Brouillette, General Manager	yvesb@mintomine.com	604 759-0860 ext. 4639
Ryan Herbert, Environmental Manager	ryanh@mintomine.com	604 759-0860 ext. 4634

Resource	Email	Contact Number
Emergency Phone Contacts		
Yukon 24- Hour Spill Line		867 667-7244
CANUTEC-Dangerous Goods Help (Transport Canada)		1-888-CANUTEC or 613 996-6666
Fire Department – Pelly Crossing (Emergency)		867 537-3000
Police – Pelly Crossing		867 537-5555
Health Centre - Carmacks		867 863-4444
Hospital – Whitehorse		867 667-8700
Fire Department – Whitehorse		867 668-8699 or 867 668-2462
Police – Whitehorse		867 667-5555
YG Department of Environment, Water Resources Branch		867 667-3227
YG Environmental Protection Branch		867 667-3436
Selkirk First Nation, Betty Baptiste, Lands Manager		867 537-3331
YG EMR, Client Services and Inspections		867 667-3199
External Reporting and Contacts for Submission of Spill Reports		
YG EMR, Matthew Jenner, Natural Resources Officer - Mining	Matthew.Jenner@gov.yk.ca	867 863-5271
Selkirk First Nation, Betty Baptiste, SFN Lands Manager	landsmgr@selkirkfn.com	867 537-3331 ext. 603
YG Environmental Health Services, Craig Van Lankveld, Environmental Health Officer	craig.vanlankveld@gov.yk.ca	867 667-8316
Environment Canada, Travis Teel, Enforcement Officer	Travis.Teel@ec.gc.ca	867-393-6705

5 Spill Action Plan

Implementation of the spill action plan requires knowledge of spill response supplies and locations, spill response procedures (Sections 5.1 and 5.2) and clean-up protocols (Section 5.3). In addition to the internal and external reporting requirements, spills must further be categorized as "emergency" or "non-emergency" incidents as the action plans and reporting requirements will differ according to the type of spill.

5.1 Spill Response Procedures: Non-Emergency

The majority of spills that are likely to occur on the Minto Mine Site will include a simple stepwise process initiated by the discoverer. If the safety at the scene is in doubt, then it is imperative that the Site Safety department is notified immediately. A "non-emergency" spill is defined as a spill of any product that the discoverer, or other personnel within close proximity of the incident can competently, safely, and efficiently manage in terms of assessment, prevention, containment and clean-up. This typically includes fuels, blasting agents, oils, lubricants or coolants and many of the reagents involved in mill operations. Once the scene is assessed for safety by the discoverer or supervisor and deemed non-emergency, they will prevent, contain and clean-up and contact the environmental team as soon as practical. If assistance is required to deal with the incident, the environmental team is to be notified by radio/telephone immediately.

A complete inventory of Dangerous Goods stored and used at the Minto Mine, including details on material handling and clean-up, reporting thresholds, special precautions, PPE requirements, and disposal methods is provided for reference during spill response activities (Appendix B).

5.2 Spill Response Procedures: Emergency

An "emergency spill" is a release of a hazardous product where there is potential for that product to enter a waterway or cause significant danger to life, health or environment. When a spill is discovered, the first step is to assess the scene for safety and **if safe to do so** immediately control and contain the spill by any means necessary. If the discoverer or other personnel within close proximity of the incident do not have the required training, resources or equipment to deal with the incident then the individual must report a "Code 1" callout. This protocol will initiate response of the Safety Department, Environmental Lead and the Emergency Response Team. The Emergency Spill Response Command Structure and General Spill Procedure are detailed in Figure 5-1 and Figure 5-2, respectively. If the scene is safe and the discoverer and the immediate supervisor have the means necessary to control, contain and recover the spill then they should proceed as such.

Once called via a "Code 1" the Safety Coordinator/Medic will respond to the scene and conduct an initial assessment and assume command of the scene. If the Safety Coordinator/Medic is required to treat patients, command is transferred to the Health and Safety Superintendent/Officer or Emergency

Response Team Captain. Unified Command Structure will be initiated once the General Manager, Area Manager, or Environmental Lead is on scene. The Unified Command Structure is a cooperative effort command between the General Manager, Health and Safety Superintendent/Officer, Area Manager of involved Department and the Environmental Lead. Transfer of command includes a detailed verbal report of the incident and activities conducted and underway.

A "Code 1" Protocol initiated by an emergency spill will trigger the specific spill response procedure based on the product type, quantity and environmental and safety conditions.

Initial spill response will be conducted in accordance to *Transport Canada's 2016 Emergency Response Guidebook* (Transport Canada, 2016). This Guidebook will assist Incident Command with information to identify the material, use the guide to reference potential hazards, public safety and emergency response information. The *Table of Initial Isolation and Protective Action Distances* will be used to dictate isolation and protection for large and small spills. However, this is not a comprehensive spill mitigation and response document and will only assist responders in making initial decisions upon arriving at the scene of a dangerous goods incident. It should not be considered as a substitute for emergency response training, knowledge or sound judgment. The *Emergency Response Guidebook* does not address all possible circumstances that may be associated with a dangerous goods incident. The *Minto Mine Emergency Response Plan* (Appendix C) has additional specific procedures for responding to the most commonly transported and hazardous materials including Nitric Acid, Gasoline, Diesel, Ammonium Nitrate, Sodium Sulfide and Propane.

In addition to on-site response, Minto, through its carriers of dangerous goods, has contracts in place with spill responders. These are full service response agencies that have commitments to mobilize fully trained emergency response teams and equipment 24 hours a day, 7 days a week.

5.2.1 CANUTEC Transport Canada

In the event that a spill requires additional technical resources Minto is registered with CANUTEC, a division of Transport Canada, for 24-hour Spill Response support and information to deal with emergency situations. If a spill occurs beyond the boundaries of the Minto property, the owner of the transportation firm and the owner or consignor of the dangerous goods will communicate with the regulators. For incidents that occur on the Minto property, the Environmental Department will ensure reporting to regulators is performed accordingly.

5.2.2 Surrounding and Downstream Communities

Notification of downstream water users of a spill, if required, is the responsibility of the Yukon Government, Environmental Protection Branch. Minto will additionally notify the authorities including police and fire departments and the Selkirk First Nation community of Pelly Crossing.

5.2.3 Public Relations

The General Manager is the designated spokesman for Minto. The General Manager may delegate his responsibility for public relations if required to do so by the scale of the incident.

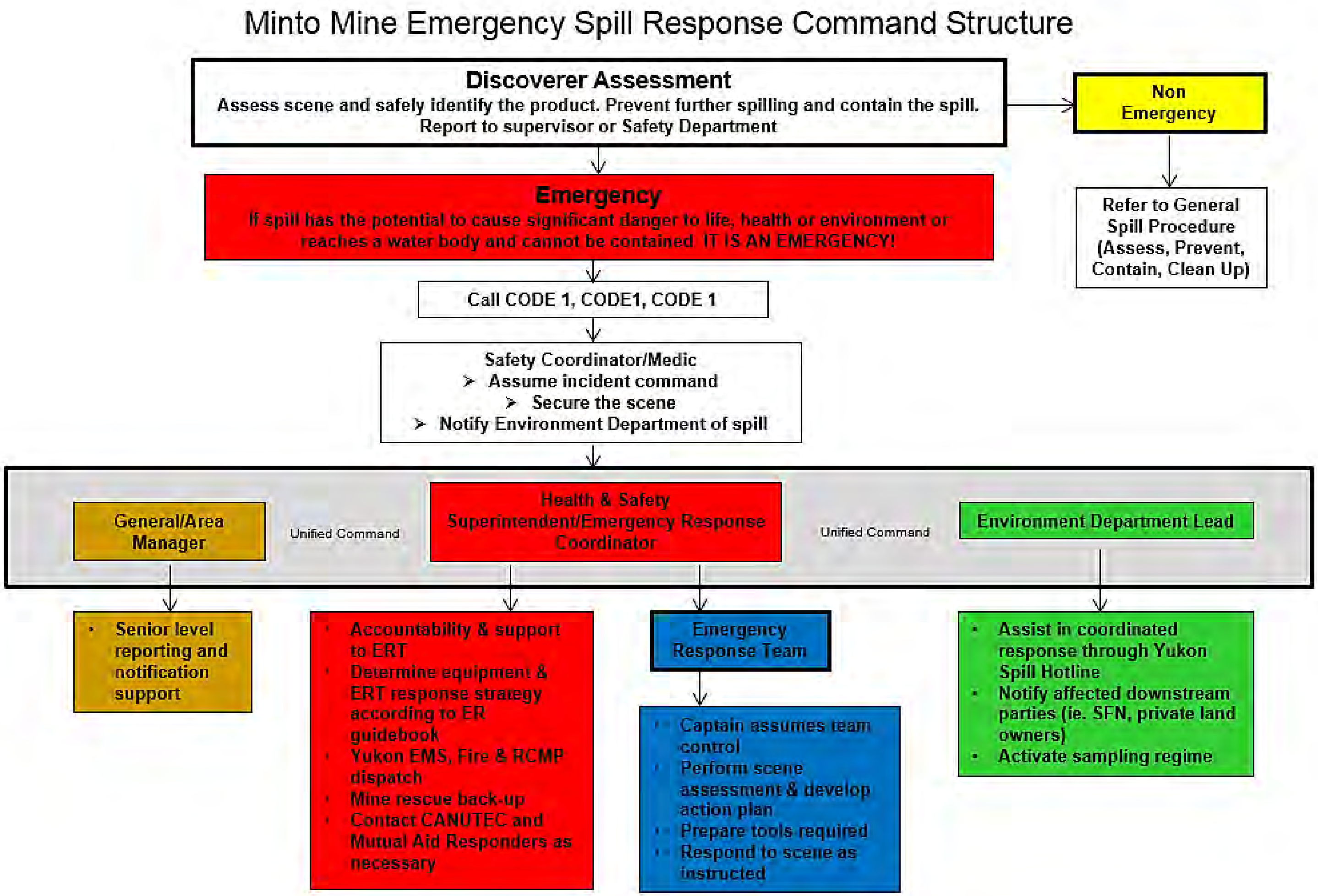


Figure 5-1: Minto Mine Emergency Spill Response Command Structure

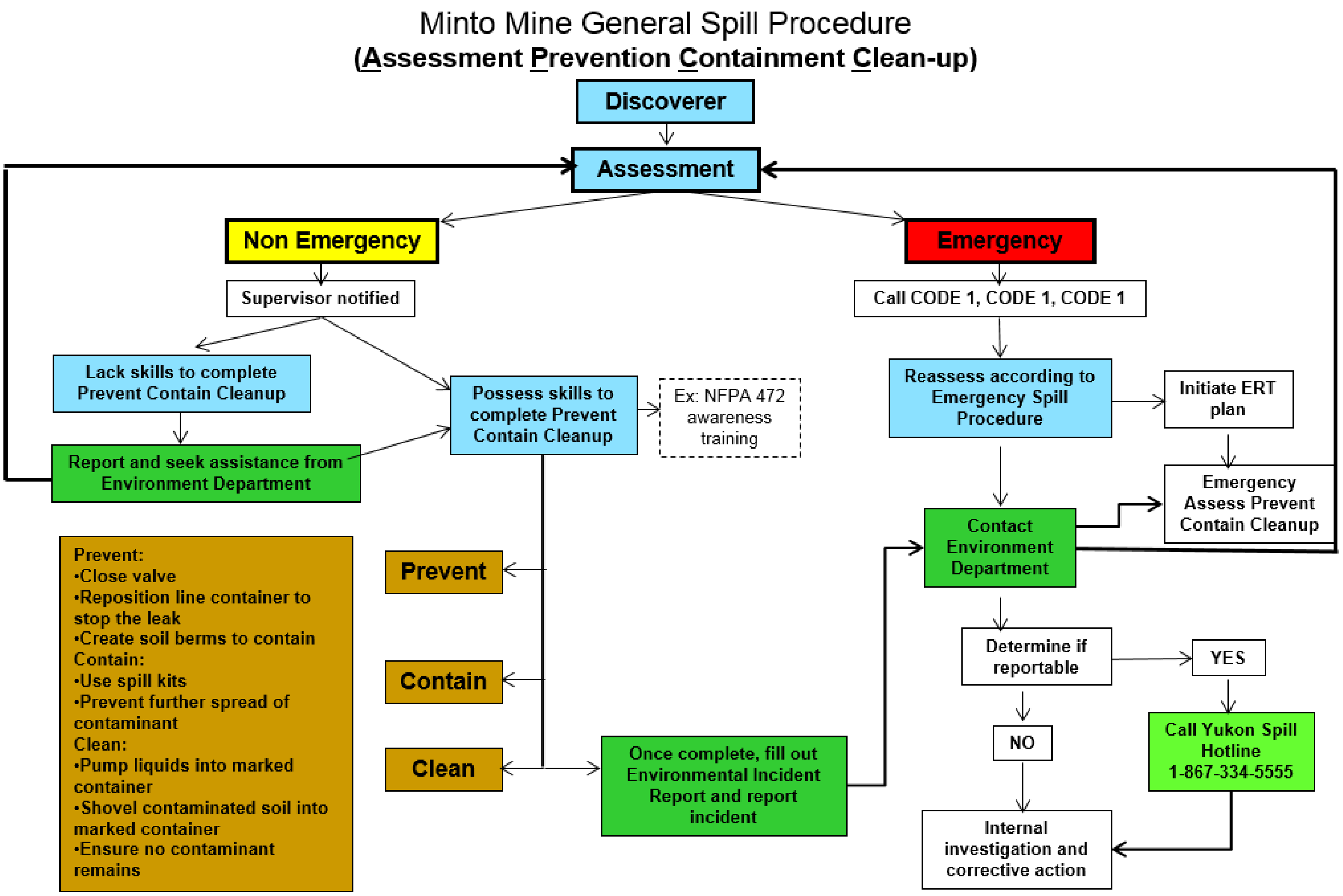


Figure 5-2: Minto Mine General Spill Procedure

5.3 Disposal and clean-up

Disposal and treatment methods of contaminated material are outlined below, and are further detailed in the *Minto Mine Spill Response Procedure: Non-emergency spills on soil* and the *Minto Mine Land Treatment Facility Standard Operating Procedure* documents. The Minto Mine Site has a Land Treatment Facility to accept incoming contaminated material from petroleum hydrocarbon and ethylene glycol spills. Depending on the state and substrate of the surface material, the clean-up and disposal location will differ. Brief practical descriptions of the clean-up procedures are summarized in Table 5-1.

Table 5-1: Disposal and Movement of Contaminated Material from Spill Sites

WASTE TYPE	DESCRIPTION	MOVEMENT OF MATERIAL FROM SPILLS
Oil or Glycol Contaminated Soil	Soil, Organics, and granular material (avoid coarse rock) contaminated as a result of a hydrocarbon or glycol spill	Contaminated soil will be transferred to the Land Treatment Facility. Contaminated soil will first be placed in the staging cell and labelled to be later categorized and treated. Contact Environment dept. before dropping off material in the Land Treatment Facility. Small spills will be stored in a composite pile in the staging area. Larger spills will be stored separately in staging while waiting for lab results.
Oil or Glycol Contaminated Rock	Blasted rock and coarse material and/or bedrock, contaminated as result of a hydrocarbon spill or glycol spill	If blasted rock contains ore and has been cleared by Mill operations ore will be processed through the mill. Non-ore containing rock will be placed in the main pit and in-situ bioremediation will be applied to the pile.
Oil or Glycol Contaminated Snow/ Ice/Water	Snow, Ice, and/or Water that has been contaminated as a result of a hydrocarbon spill or glycol spill	Contaminated snow/water will be transferred to the Land Treatment Facility. The contaminated product will be placed in a separate pile in the cell.

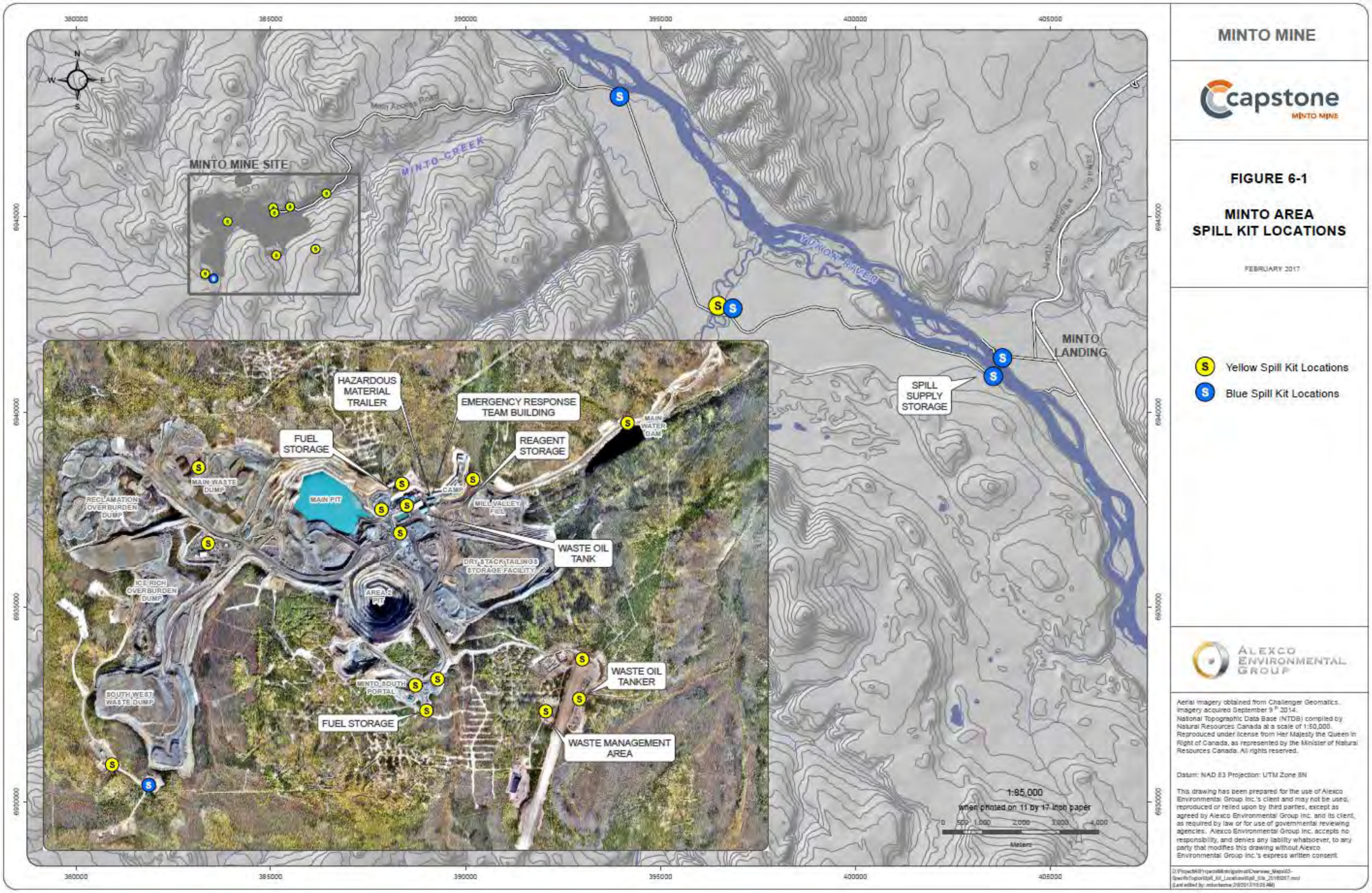
**** Any amount of material that has more than 30,000 ppm oil or glycol is considered special waste and must be disposed of off-site to a Special Waste Facility**

6 Spill Response Supplies

Spill kits (yellow and blue drums) are located throughout the Minto Mine Property at locations indicated in Figure 6-1. Additionally, there are blue drums located at the km 12 gravel pit, Big Creek and at the east and west terminals of Minto Landing. The contents of the yellow and blue barrels are summarized in Table 6-1. Spill kits are also supplied for each heavy and light truck at the Minto Mine. Contractor supervisor trucks have spill kits permanently affixed to the truck body. All contract trucking agencies coming to the mine are required to carry spill kits within or affixed to the truck. Spill kits are loaned to short term visitors if required.

Table 6-1: Spill Kit Contents

Spill Kit Item	Yellow Barrel	Blue Barrel	Yellow Truck Bag	Loaner Spill Kit (20 L Pail)
Tyvek splash suits	2	2		
Chemical master gloves	2	2	1	2
Garbage bags with ties	5	5	3	1
Oil only booms (5” x 10’)	2	4	1	
Oil only mats (16” x 20”)	50	50		10
Universal sorbent mat	20	20	10	5
Sorbent socks	10	10		1
Tarp	1	1		
Duct tape	1	1		
Utility knife	1	1		
Field notebook and pencil	1	1		
Instruction sheet (laminated)	1	1	1	1



Aerial imagery obtained from Challenger Geomatics. Imagery acquired September 9th 2014.
National Topographic Data Base (NTDB) compiled by Natural Resources Canada at a scale of 1:50,000. Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.

Datum: NAD 83 Projection: UTM Zone 8N

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent.

Figure 6-1: Minto Mine Area Overview – Hazmat Storage and Spill Supplies

Heavy machinery at the mine site is available for use in spill response and clean-up, as required under contract. Additionally, Minto has a 1991 Chevrolet Top Kick Fire truck with a 3200 litre/minute pump with 3800 litre supply tank and 3000 litre drop tank. This truck can support all spill response activities with SCBA, Class A and B foam capabilities, decontamination needs, as well as fire suppression/protection tools and equipment common to a truck of this nature. All ERT members are competent with the operation of this fire truck and related equipment in accordance with NFPA standards.

In 2013, Minto, on advice from Emergency Response Action Plan providers, procured a 20 foot Hazmat trailer and a helicopter-portable In-Viro-Drum vacuum unit (Figure 6-2) capable of being transported to locations not reachable with a vacuum truck. It has a liquid cooled three cylinder Kubota diesel engine and 250 CFM non-sparking blower, which makes it safe to vacuum flammable liquids and solids from water or dry land. It comes with a Double Port Vac Drum that allows for transfer of product from the drum to one of our 9500 litre bladders, while the drum continues to be filled. This system allows for quick, efficient and effective clean-up of hazardous products from hard to reach locations.

In 2016, Minto purchased a S.S. Alpha Adjustable Folding Weir Skimmer. Weir skimmers float on the surface of water and are designed to remove pollutants from the surface of calm or sheltered waters and shore line areas. Connected to a shore-based portable pump (e.g. Honda), contaminants can be removed from the water surface and transferred to a drum or other container for proper disposal.

Figure 6-2: In-Viro Drum and vacuum unit, 24’ Packman vessel, and Alpha Skimmer for spill response operations.

Minto Mine also acquired a 24-foot Packman man boat, which is described, further in the “Barge Emergency Contingency Plan” (Appendix D).

Spill contingency equipment and earth moving equipment located at Minto Mine are listed in Table 6-2. All contractor equipment is available for use in spills and clean-up operations.

Table 6-2: Spill contingency equipment located at Minto Mine

Quantity of Units	Equipment		Quantity of Units	Equipment
1	416 Backhoe		1	Assorted Wooden Plugs
1	3800 Litre Vacuum Truck		4	773DTruck
Various	Dozers, Excavator, Loaders		9	777 Truck
1	In-Viro Drum Portable Vacuum unit		1	Hazmat trailer 20’
2	9500 Litre bladders		1	Top Kick fire truck
1	24’ Packman Response Vessel		500’	Sorbent Boom (various sizes)
2	10,000 Litre Fuel Trucks		1	Storage Sea Can at Landing
1	Roll Over Kit		3	Trash pumps
1	Pipe Plug kit		1	S.S. Alpha Adjustable Folding Weir Skimmer Pump

7 Spill Prevention and Response Training

Education and training are critical to the success of any site-wide initiative, and the most important tool to ensuring the success of the SCP. Minto has a comprehensive training program in place that ensures all workers and supervisors are aware of their responsibilities and the practices that personnel and contractors must adhere to. Records are kept of the names of all employees or contractors that receive training, tracked though the either the Simply Safety software program or in the Environmental Department tracking sheets. Annual re-training is scheduled for all Minto and major contractor employees.

7.1 Existing Spill Prevention and Response Training

Employees are trained to understand the potentially hazardous situations that spills can create with respect to the health and safety of workers and the environment. They are trained to understand responsibilities as employees to Assess, Prevent, Contain, and Clean-up as well as to report any spills. The SCP is made available to all employees and employees will be advised of revisions or changes to the SCP.

7.1.1 Orientation

Employees and visitors are required to sign off on the environmental policy as part of the employee, contractor and visitor orientations that include a summary of the response required when a spill has occurred. The orientation has a strong focus on ensuring proper reporting of spills, so that the appropriate response and clean-up can occur.

7.1.2 “Big 7” Training

As part of the orientation, all Minto employees and major contractors receive training that is a computer based PowerPoint presentation, followed by a written test. The “Big 7” package focuses on some of the most common safety training required for site, which includes WHMIS (Workplace Hazardous Material Information System), fall protection, confined spaces, lock out, hot work, Explosives awareness training and Environmental Awareness. The Environmental Awareness portion of the training is comprised of four modules, with one module dedicated to Spill Response covering reporting and basic steps for assessing, preventing, containing and cleaning-up spills.

7.1.3 Targeted Practical Training

Training sessions are put on by the Environmental Department, and efforts are made to tailor the training to the attending group (i.e. underground miners, surface contractors, site services, etc.). Smaller groups are identified and targeted for specialised spill prevention training that is more job-specific. These include, but are not be limited to; maintenance personnel (mechanics), waste and water truck operators, fuelling personnel, and warehouse workers. Training in smaller groups focusses on spill prevention techniques.

7.1.4 Training for Fuel Handling Employees

Currently there are Safe Work Practices (SWP) designed for bulk fueling at the fuel farm and for fueling of equipment in the field. These SWPs include descriptions of the stepwise procedure for safely performing the task and also includes steps to take for emergency shut-off. Both the procedure and the equipment are audited during Workplace Inspections and Planned Job Observations by immediate supervisors and the Environmental Department.

7.1.5 ERT Training

An Emergency Response Team (ERT) has been established to, among other duties, respond to emergency spills. The Emergency Response Team periodically receives training to the National Fire Protection Association (NFPA) 472 Hazardous Material awareness level, and are required to thoroughly understand this document in order to respond to spills or incidents of a specific nature. This training is required as a foundation to develop site specific contingency planning for response tactics in areas specific to the Minto Mine associated activities that present a risk to the Yukon River and its tributaries.

7.1.6 Emergency Spill Response Drills

Table top exercises and/or field drills will help to prepare the ERT and other mine staff to respond to a major spill safely by identifying any deficiencies in the equipment or processes in place. On October 26th, 2014, a combined field and table top exercise took place with the following objectives:

- Help individuals become more knowledgeable with the ERP and SCP;
- Identify gaps in the plan;
- Improve communication between stakeholders and departments; and
- Learn new ways and better ways to execute the plan.

The announced exercise was initiated to test part of the Emergency Response Plan as it applies to Spills and the SCP. It focused on the crisis, interaction and escalation of problems within:

- Administrative;
- Operational;
- Managerial; and
- Facilities.

The scenario was as follows:

- A tanker truck with pup and trailer of diesel overturns on Oct 26th on icy roads at 3:20pm at south end of Big Creek. It is still dark and it is a Sunday and roads are icy and snowing lightly.

The exercise lasted approximately 2 hours and involved management staff onsite and offsite, the ERT, major contractors, The Yukon Spill Hotline, CANUTEC, Transnorth Helicopters, WCB, Parkland Fuel, and

Quantum Murray. A post–incident debrief revealed both opportunities and successes at the field operations and management level.

7.1.7 Training KPI's

Individuals who receive training are tracked, and training numbers are used as a key performance indicator (KPI) with annual targets. In addition, tracking is used to ensure annual retraining is delivered and statistics measured against key performance indicators.

8 Routine Maintenance and Monitoring

The Fuel Farm is inspected twice monthly for any leakages and, through the Human Machine Interface (HMI) readout, regular inventory is tracked daily to identify any incidental losses. An overfill protection system is installed on the two main diesel tanks using a visual indicator and a relay to the control room that will alarm on the HMI to alert maintenance personnel. The area also receives inspections by a qualified engineer and recommendations are recorded and deficiencies corrected as per the *CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products* (Canadian Council of Ministers of the Environment, 2003).

The tug and barge receive frequent inventory inspections for spill equipment and have had major overhauls in the last few years to ensure that the operation is continually improving. Maintenance activities are also carried out regularly and systems are inspected as per Transport Canada Regulations. The daily start-up procedure includes checking for leaks and ensuring all systems are performing to specifications. Annual maintenance activities have included the following: propeller repairs, controls work, system checks and repairs. Substantive refits have included: cylinder heads, exhaust manifold seals, motor mounts, transmission mounts and replacement of water pumps. A new transmission, propulsion seals and propellers have been installed and aligned. Other improvements have included welding reinforcements on the bow of the barge for landings, electrical upgrades, and the installation of an anchor with hawser.

The open pit mining equipment is outfitted with Wiggins Fast Fuel Systems on newer contractor open pit equipment that is a fail-safe system for overflow protection. All fuel trucks receive a daily walk-around inspection to ensure emergency shutoffs and hatches and tank valves are operating properly and are free of leaks. These are recorded daily.

The Waste Management Area (WMA) is restricted to access between 10-3 pm every Sunday by an attendant familiar with the protocols for waste segregation, incineration, special waste handling and landfilling. The attendant will inspect all loads that come into the WMA to ensure that waste has been properly sorted before any material is off loaded. The Environmental Department is directly responsible for the administration, compliance and procedures associated with the management of waste. They are also responsible for providing support and manpower to prepare shipments for backhauling and to ensure the WMA is maintained in accordance with the Commercial Dump Permit (# 81-005). The Environmental Monitors are responsible for conducting weekly inspections to ensure that the WMA is in compliance.

9 References

Canadian Council of Ministers of the Environment. (2003). *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.* Winnipeg: CCME.

Government of Canada. (1985, January 18). Transporation of Dangerous Goods Act SOR/85/77.

Government of Yukon. (1996). Spills Regulation. *Environment Act: Spills Regulation O.I.C. 1996/193*.

Government of Yukon. (2002). Environment Act. *Revised Statutes of the Yukon: Environment Act, RSY 2002, c.76*.

Minto. (2017). *Emergency Response Plan.*

Transport Canada. (2016). 2016 Emergency Response Guidebook. *A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Transportation INcident*.

Yukon Government. (2013, August). *Plan Requirement Guidance for Quartz Mining Projects.* Retrieved from http://www.yukonwaterboard.ca/forms/quartz/Plan%20Requirement%20Guideline%20for%20Quartz%20Mining%20Projects%20-%20August%202013-kh.pdf

Appendix A: Spill Report and Environmental Incident Report Forms

Spill Report Form

capstone
MINTO MINE

Spill Name:	

General Report Information: **(To be completed by the supervisor of responsible department or company)**

EIR #:		Location of Incident:	
Date of Incident:		Time of Incident:	
Contaminant Type:		Volume of Spill (L):	
Equipment (Type):		Equipment (#):	
Company or Department:		Supervisor	
Hours since last PM:		Proximity to nearest waterbody:	
Previous indication of leak (i.e. Prior Drip) (Yes/No):		Estimated cost of spill:	

Failure of Mechanism: **(Check one box below)**

Blown Hose		Failed Hose Connection		Human Error	
Unforseen		Blown or Leaking Seal		Unknown	
Other					

Brief Description of Cause: **(conditions at time of spill, what was happening at the time, specific direct cause of spill, etc.)**

Clean Up Actions Undertaken:

Land Treatment Facility Information: **(To be filled out by Environment Department)**

Material Moved to LTF (Yes/No):		Material Sampled (Yes/No):		Quantity (m^3):	

Notes:	

Corrective Actions: **(Must fill out for all reportable and preventable spills)**

Action Item #	Responsible Department	Corrective Action	Due Date

Reporting Sequence:

First Observer: ______________________
Name Company Date/Time

Reported To: ______________________
Name Company Date/Time

Reported To Environmental: ______________________
Name Company Date/Time

Reported To General Manager: ______________________
Name Company Date/Time

Regulatory Tracking: (To be completed by Environment Department)

24 Hour Spill Hotline (867) 667-7244:

Reported By:		Reported To:		Date/Time:	

Selkirk First Nation Lands Director (867)-537-3331

Reported By:		Reported To:		Date/Time:	

EMR - Client services and Inspections (867) 456-3882: (or site inspectors)

Reported By:		Reported To:		Date/Time:	

Environment Canada in the event of a discharge to a waterway (867)-667-3400

Reported By:		Reported To:		Date/Time:	

Detailed written report and MSDS to YWB, EMR, EC and SFN (Required within 10 days of spill):

Submitted By:		Date of Submission:	

Photos:

Appendix B: Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Acetone	2-Propanone	Anachemia	Liquid	3	B-2, D-2B	1, 3, 0	200 L	Solvent	Extremely Flammable	Goggles, gloves. SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant foam. Do not allow into waterway or drains. Contain spread of spill and soak up with absorb all, absorbant pads. Clear up using non-sparking tools. Place liquid and absorbents into tighly sealed container, label clearly and dispose of as hazardous waste offsite.
Acetylene	C_2H_2	AIRGAS INC	Pressurized gas dissolved	2.1	A, B-1, F	1, 4, 3	any if container larger than 100 L	Welding/cutting gas	Extremely flammable, pressurized gas dissolved in an extremely flammable liquid (Acetone)	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition, if possible without risk, shut off bottles. If bottle is ruptured after the gas has been expelled, the bottle will release the Acetone. At that point treat as an Acetone spill.
AERO 6493 Promoter	Alkyl hydroxamate	Cytec Canada	Liquid above 15C	9		2, 1, 2	5 L	Metal flotation in mill			Soak up with absorbent (do NOT use sawdust. Use PLASTIC tools). In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Place recovered spilt liquid in labelled drums for disposal as Special waste. Incinerate used absorbent pads.
AERO MX-5149	Modified Thionocarbamate 15-40%Xanthate esther 40-70%	Cytec Canada	Liquid	3	B3, D-1B, D-2B	3,2,0	200 L	Metal flotation in mill	Flammable	Closed system, safety glasses, gloves	Remove sources of ignition. Cover spills with some inert absorbent material; sweep up and place in a waste disposal container. Flush spill area with water.
Aerodri 100 Dewatering Agent		Cytec Canada	Liquid	3	B3, B-2, D-2A	2, 3, 0	200 L		Avoid contact with strong oxidizers or acids.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste. Soak up with absorbent materials and dispose of offsite in clearly labeled containers
Alconox		Anachemia	solid	not regulated	D-2B	1, 0, 0	50 kg			Safety Glasses, Gloves	Clean up uncontaminated material for reuse. Incinerate waste.
ALIQUAT 336	Methytrioctyl-ammonium Chloride	Sigma-Aldrich Canada	Liquid	6	D-2B	2, 1, 1	5 kg		Toxic if swallowed. Very corrosive. Will burn skin and eyes. Avoid contact with strong oxidizers. Hygroscopic: avoid contact with moist air.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
AlphaSolve II	>50% Sodium Hydroxide <50% Silicate	Alpha Resources	Solid						Avoid contact with strong oxidizers.	Safety Glasses, Impervious Gloves.	Highly caustic. Will produce heat and steam on contact with water. May boil and spatter. May generate hydrogen gas on contact with metals. Sweep or vaccum and, if not re-useable, send offsite as hazardous waste, in tightly closed, well labeled containers.
Aluminex 5	Aluminum Chloride Hydroxide Sulphate 15%	NALCO	Liquid	8	E		5 L	Coagulant		Safety Glasses, Gloves	Soak up with absorbent materials. These can be incinerated. Any remaining spilt liquid should be stored in closed container, labelled and disposed of off-site as Special Waste.
Aluminum Standard - AA		Anachemia	Liquid	8	E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
AM28 Flotation Reagent	Mixture of Potassium Hydroxide Alkyl hydroxamate	Axis House (Pty) Ltd.	Liquid	not regulated	D-2B	2,1,0		Floatation Reagent	corrosive solid.	Safety Glasses, Gloves	Soak up with absorbent (do NOT use sawdust. Use PLASTIC tools). In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Place recovered spilt liquid in labelled drums for disposal as Special waste. Incinerate used absorbent pads.
Amco Clear Turbidity Standard		GFS Chemicals	Liquid	not regulated	not regulated					Safety Glasses, Gloves	Contain spill. Incinerate waste or place in landfill
Ammonia, Refrigerant	Ammonia, Anhydrous	GT&S, INC	Liquefied Gas	2.3, 8	does not appear classified??	3, 0, 0	any amount		Liquefied gas, will produce extreme cold when released. Death has occurred at 5000ppm exposure for 5 minutes. Evacuate release area upwind and avoid low areas.	Goggles, gloves. SCBA.	Toxic gas and will react with a large number of substances, many in a violent manner, Gas will dissipate quickly in air. Small spills can be dissolved in water at ratio of 1:10 Not very flammable. Do not attempt to neutralise.

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Ammonium Nitrate prill	Ammonium Nitrate	Agrium	solid	5.1	C, D-2B	1.0.3	50 kg		Oxidizing material, does not burn but may contribute to combustion of materials that can burn	Safety Glasses, Gloves	In case of fire, cool containing vessels with water jet in order to prevent pressure build-up/explosion. Use flooding quantities of water. Evacuate surrounding area. If fumes or gases present, fire fighters should wear self-contained breathing apparatus. In event of spill, prevent from entering waterways. Will dissolve and disperse in water.
Ammonium Nitrate Emulsion	Ammonium Nitrate Emulsion	on-site	Liquid	5.1		2,0,3	50 kg	Explosive	Oxidizing material, does not burn but may contribute to combustion of materials that can burn	Safety Glasses, Gloves, chemical suits, SCBA may be required	In case of fire, cool containing vessels with water jet in order to prevent pressure build-up/explosion. Use flooding quantities of water. Evacuate surrounding area. If fumes or gases present, fire fighters should wear self-contained breathing apparatus. In event of spill, prevent from entering waterways. Use non-combustible material to soak up.
Arsenic Standard - AA		Anachemia	Liquid	8	D-2A, E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Ascorbic Acid	L-Ascorbic Acid (Vitamin C)	Anachemia	solid	not regulated	not regulated	1, 1, 1	5 kg		also known as Vitamin C	Safety Glasses, Gloves	Contain spill. Incinerate waste or place in landfill
Brake & Electrical Parts Kleen	CO$_2$ aerosol of Heptane and Isopropyl alcohol	Kleen-Flo Tumbler Industries	aerosol	Limited quantity	Consumer commodity; A, B5, D2-B	1, 3, 0			Highly flammable	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Buffer Solution pH 10		Anachemia	Liquid	not regulated	D-2A	1, 0, 0		Analytical Lab use	Dilute Sodium Hydroxide	Safety Glasses, Gloves	Contain spill. Absorb with sand, vermiculite or sorbal. Incinerate waste.
Buffer Solution pH 4		Anachemia	Liquid	not regulated	not regulated	1, 0, 0		Analytical Lab use		Safety Glasses, Gloves	Contain spill. Absorb with sand, vermiculite or sorbal. Incinerate waste.
Buffer Solution pH 7		Anachemia	Liquid	not regulated	not regulated	1, 0, 0		Analytical Lab use		Safety Glasses, Gloves	Contain spill. Absorb with sand, vermiculite or sorbal. Incinerate waste.
Cadmium Standard - AA		Anachemia	Liquid	8	D-2A, E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use flooding quantities of water. Contributes to combustion of other materials. Neutralize with soda ash or lime. Contain spill, keep from entering ground water. Neutralized spill can be pumped to the pit or tailings system.
Calcium Chloride		J.T. Baker	solid	not regulated	D-2B	1, 0, 2, 3	any amount		Road Salt, will corrode metals	Safety Glasses, Gloves	Sweep up spilled material and it my be deposed of in dilute form to the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Carbon Dioxide in Argon		Mittler Supply Inc.	Pressurized gas	2.2	A, D-2B	1, 0, 0	any if container larger then 100 L		Non-Flammable but will replace the O$_2$ in confined space	Goggles, gloves. SCBA if in confined space	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Caustic Soda (solid)	Sodium Hydroxide	Fisher Scientific	solid	8	E	3, 0, 1	5 kg		very corrosive solid	Safety Glasses, Gloves	Sweep up spilled material for reuse. In case of fire use appropriate measures for the surrounding fire. Minimise direct water spray on material. This material melts and 318^{o}C and when molten reacts violently with water. Neutralize the residue with a dilute solution of acetic acid. Neutralized solution can be disposed of in the pit or tailings system.
Caustic Soda (solution)		DOW	Liquid	8	E	3, 0, 1	5 L		very corrosive liquid	Safety Glasses, Gloves	Contain spill and pump to plastic barrel for re-use. In case of fire use appropriate measures for the surrounding fire. Neutralize the residue with a dilute solution of acetic acid. Neutralized solution can be disposed of in the pit or tailings system.
Caustic Potash	Potassium Hydroxide	Brenntag Canada	Solid	8	D-1B, E	3,0,1	5 kg		water reactive, contact with metals may evolve flammable hydrogen gas.	Safety Glasses, Gloves, fume hood	Sweep up or vacuum spillage, collect in suitable container for disposal. Avoid dust formation.
Chevron 2-Cycle Oil		Chevron Lubricants Canada	Liquid	not regulated	B-3	1, 2, 0	100 L		flammable oil for 2-storke fuel	Safety Glasses, Gloves	contain spill and use absorbent and incinerate waste
Chevron ATF+3 Automatic Transmission Fluid		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Automatic Transmission Fluid MD-3		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Clarity Synthetic Machine Oil		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Chevron Compressor Oil 260		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Coupling Grease	Grease	Chevron Lubricants Canada	Semi-Solid	not regulated	not regulated	1, 1, 0	100 L or 100 kg			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chevron Delo 300 Motor Oil		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Delo Grease EP	Grease	Chevron Lubricants Canada	Semi-Solid	not regulated	not regulated	1, 1, 0	100 L or 100 kg			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chevron Diesel Engine Oil Delo 6170 CFO		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Drive Train Fluid HD		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron ECO Hydraulic Oil AW		Chevron Lubricants Canada	Liquid	not regulated	not regulated	0, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Gas Engine Oil 930 and 940		Chevron Lubricants Canada	Liquid	not regulated	not regulated	0, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Mid-grade unleaded gasoline		Chevron Products	Liquid	3	B-2, D-2A, D-2B	2, 3, 0	200 L		Extremely Flammable, Vapours are harmful and they may be explosive. Non-sparking tools required. Vapours will collect in low areas and travel along the ground to an ignition source.	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Dike the spill and pump to containers for recycling. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Allow waste absorbent to evaporate and then Incinerate waste.
Chevron NWS Manual Transmission Fluid 6044GR		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron RPM Universal Gear Lubricant		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Supreme Antifreeze/Coolant	Ethylene Glycol	Chevron Lubricants Canada	Liquid	not regulated under 5000 lb.	D-2A	1, 1, 0	25 L		may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chevron Ulti-Plex® Grease EP		Chevron Lubricants Canada	Semi-Solid	not regulated	not regulated	1, 1, 0	100 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chloramine T	Chloramine-T trihydrate	Fisher	solid	8	D-2A, E	3, 1, 1	5 kg		Container may explode under fire conditions. Will release toxic fumes with fire or when mixed with strong oxidizers or acids	Goggles, gloves. SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. In case of fire. Material by itself is non-flammable, may decompose violently >100°C, use dry chemical, CO_2 foam or water spray. DISPOSAL mix with flammable solvent and incinerate.
Chromium Standard - AA		Anachemia	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Citric Acid	Citric Acid, Monohydrate	Anachemia	solid	not regulated	E	2, 1, 0	5 L		Will cause severe eye damage. Avoid oxidizers, acids, bases and bleach.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. In case of fire, use flooding quantities of water. Will decompose at high temperatures and emit acrid smoke and fumes.
Copper Standard - AA		Anachemia	Liquid	8	E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Crystal 78	Sodium Silicate	Quadra Chemicals	Liquid	not regulated	D-2B		25 L		Caustic solution. Avoid mixing with strong acids. Contact with metals such as aluminum, tin, lead and zinc generates hydrogen gas.	Goggles, gloves. Respirator	solution can be pumped into plastic drum and possibly recycled in mill circuit, or shipped off site. In case of fire use appropriate measures for surrounding fire.
Cyquest DP-6	Sodium polyacrylate in water	Cytec Canada	Liquid	not regulated	not regulated	1,1,0		Mill reagent	Slippery	Goggles, Impervious gloves	Soak up with absorbent materials. These can be incinerated. Any remaining spilt liquid should be stored in closed container, labelled and disposed of off-site as Special Waste.

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Delo Diesel Fuel System Cleaner		Chevron Lubricants Canada	Liquid	3	B-3, D-2A, D-2B		200 L			Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Diesel Fuel No. 2		Chevron Products Company	Liquid	3	B-3, D-2A, D-2B	0, 2, 0	200 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
DIISOBUTYL KETONE	2,6-Dimethyl-4-heptanone	J.T. Baker	Liquid	3	B-2, D-2A	2, 2, 0	200 L		Avoid contact with strong oxidizers or acids.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Drierite, indicating		Anachemia	solid	not regulated	D-2A	1, 0, 1				Safety Glasses, Gloves	Eliminate all sources of ignition. In case of fire use measures dictated by surrounding fire. Will decompose at 1450^{o}C liberating Cl_2 and SO_2. This product can be dried and reused, recycled.
Envirobind KFZ		Power Chemicals Ltd.	Liquid	not regulated	not regulated	1, 0, 0		Dust Suppression	Avoid contact with oxidizing agents or strong acids.	Goggles, Gloves	Do not use absorbents. Contain spill using noncombustible materials such as vermiculite, earth or sand.
Envirobind KTF		Power Chemicals Ltd.	Liquid	not regulated	not regulated	1, 0, 0		Dust Suppression	Avoid contact with oxidizing agents or strong acids.	Goggles/Glasses, Gloves	Do not use absorbents. Contain spill using noncombustible materials such as vermiculite, earth or sand.
Envirobind PCW		Power Chemicals Ltd.	Liquid	not regulated	not regulated	1, 0, 0		Dust Suppression	Avoid contact with strong oxidizing materials.	Goggles/Glasses, Gloves	Dike or contain. Absorb irrecoverable material onto inert oil absorbent medium, package, and label for legal disposal. Wash hard surfaces with water. Contaminated absorbent material may be disposed of in an approved landfill
FLEET CHARGE 50/50 Antifreeze	Ethylene Glycol	OLD WORLD INDUSTRIES	Liquid	9	D-2A	1, 1, 0	25 L		may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Fleet Charge PG Antifreeze/Coolant	Propylene Glycol	OLD WORLD INDUSTRIES	Liquid	not regulated	not regulated	0, 1, 0	25 L			Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Flomin C 3505 Collector	Potassium amyl xanthate (PAX)	Flomin Inc.	solid	4	not regulated	2, 2, 1	25 kg		Product is spontaneously combustible. Avoid contact with heat, moist air, and water.	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. Solutions of product my be deposed of on the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Flomin F 500 Frother	4-METHYL-2-PENTANOL (Methyl isobutyl carbinol - MIBC)	Flomin Inc.	Liquid	3	B-2, D-2B	2, 2, 0	200 L		Acids, acid chlorides, alkalis, oxidizing agents. Will attack some forms of plastics, rubber and coatings	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Floran Catalyst	Proprietary Inorganic Peroxide Blend	Floran Technologies	Liquid	5	C, D-2B	2, 0, 1, OX	50 L		Non-Flammable but will aid combustion of other materials	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use flooding quantities of water. Contributes to combustion of other materials. Contain spill, keep from entering ground water. Absorbed pill can be disposed in the pit or tailings system.
Frost Killer (Tannergas)	Methyl alcohol	TANNER SYSTEMS, INC.	Liquid	3, 6.1	B-2, D-1B, D-2A,D-2B	1, 3, 0	200 L		Extremely Flammable, Vapours are harmful and solution is poisonous	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
FUEL INJECTOR CLEANER		Radiator Specialty Co	Liquid	3	B-3, D-2A, D-2B		200 L			Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Gasoline, Unleaded		Petro-Canada	Liquid	3	B-2, D-2A, D-2B	2, 3, 0	200 L		Extremely Flammable, Vapours are harmful and they may be explosive. Non-sparking tools required. Vapours will collect in low areas and travel along the ground to an ignition source.	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Dike the spill and pump to containers for recycling. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Allow waste absorbent to evaporate and then Incinerate waste.
Glycerin	IPAC	Power Chemicals Ltd.	Liquid	Not regulated	Not regulated				Avoid contact with reducing agents and oxidizing agents.	Goggles, gloves.	Dike spilled product to prevent runoff
Havoline DEX-COOL Extended Life 50/50 Anti-Freeze/Coolant	Ethylene Glycol	Chevron Lubricants Canada	Liquid	not regulated	D-1b, D-2A	2, 0, 0	25 L		may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
HAVOLINE DEX-COOL extended life anti-freeze/coolant-B	Ethylene Glycol	Chevron Lubricants Canada	Liquid	not regulated	D-1b, D-2A	2, 1, 0	25 L		may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Havoline Power Steering Fluid		Chevron Products	Liquid	not regulated	not regulated	0, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Hot 4-in-1 Heating Oil Treatment	Proprietary Blend	FPPF Chemical Company, Inc.	Liquid	3	B-3, D-1A, D-2A, D-2B	3, 2, 0	200 L		Fuel Additive, fumes will collect in low area's.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Hydrated Lime	$Ca(OH)_2$	Chemical Lime Company of Canada Inc.	Solid	not regulated	D-2A, E				Will cause severe caustic burns. Avoid strong acids, and aluminum	Safety Glasses, Gloves	sweep up uncontaminated material for reuse. Neutralize with dilute acid and may be disposed of in pit or tailings system.
Hydraulic Oil SAE 10W		EXXON MOBIL	Liquid	not regulated	not regulated	0, 1, 0	200 L			Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Hydrex 3223		Veolia	Liquid	8	E	1, 0, 0	5kg or 5L	Coagulant in the WTP		Safety glasses with side shields or goggles, face shield, chemical resistant gloves. Suitable respiratory equipment in poorly ventilated areas.	Contain spill. Ventilate area if required. Use absorbent. Place contaminated materials in sealed container for disposal and dispose of via a licensed waste disposal contractor.
Hydrex 6186		Veolia	Solid	not regulated	not regulated	0, 1, 0		Flocculant in the WTP		Safety glasses with side shields or goggles.	Sweep or vacuum spilled material. Do not get water on spilled material. Flush area with water after product recovery. Place recovered material in sealed container and dispose of via a licensed waste disposal contractor.
Hydrochloric Acid		Anachemia	Liquid	8	D-1A, E	3, 0, 1	5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind	Goggles, gloves. Respirator or SCBA if in confined space	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Hydrofluoric acid, 47 - 51%		Fisher	Liquid	8, 6.1	D-1A, D-2A, E	4, 0, 1	5 L		**Extremely corrosive and Toxic acid. Causes very severe acid burns with symptoms being delayed. Skin contact of <10% can be fatal from cardio-pulmonary problems. IMMEDIATE medical attention is required for all exposures.**	**Goggles, gloves. Respirator or SCBA if in confined space (Actually SCBA should be used anywhere unless spill is in a fumehood)**	Neutralize with soda ash. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to a plastic barrel and then disposed of in the pit or tailings system.
IPAC 6832		Quadra Chemicals	Liquid	not regulated	not regulated				water soluble	Safety Glasses, Gloves	No special clean up procedures,
Iron Standard - AA		Anachemia	Liquid	8	E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Isopropylxanthic acid sodium salt (SIPX)		Quadra Chemicals Ltd.	Solid	4.2	B-6, D-1B, D-2B		25 kg	Collector in Mill	Keep away from water - contact with water liberates extremely flammable gases. Keep away from heat, sparks and flame - fine dust clouds may form explosive mixtures with air. Use only with adequate ventilation.	Goggles, Gloves, Respirator (air-purifying or air-fed)	Move containers from spill area. Avoid allowing the spilled material to get wet or using water to clean up spillages or residues, unless the quantity remaining is very small. Vacuum or sweep up material and place in a designated, labeled waste container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.
Javex Liquid Bleach	NaOCl	Colgate Palmolive	Liquid	not regulated	E, D-2B, C				Self heating and may catch fire.	Safety Glasses, Gloves, SCBA	Ventilate area and allow qualified personnel to stop/control spill. Small spills: flush area with plenty of water and mop up. Large spills: dike the ingredient and transfer to appropiate containers. Consult Federal, Provincial and Municipal regulations for disposal. May be neutralized with sodium bisulphite or dilute hydrogen preoxide.
KAX 51	Proprietary Blend (mix of isoamyl alohol, potassium amyl xanthate, and potassium hydroxide)	Prospec Chemicals	Solid	4.2	B-6, D-1B, E		25 kg	Collector in Mill		Safety Glasses. Face Shield, Gloves, SCBA	If in the liquid state: Stop spill at source. Contain any spilled material to prevent discharge into the environment. Eliminate all sources of ignition. Persons not wearing protective equipment should be excluded from the area. Absorb with inert dry material. Put into an approved metal salvage drum for disposal. If in the solid state: Eliminate all sources of ignition. Restrict access to area until completion of clean-up. Ensure clean-up is conducted by trained personnel only. Do not touch spilled material. Do not use water on spilled material as heat will be generated. Put spilled material into approved salvage drums for disposal. Flush cleaned area with water, making sure no water enters xanthate containers.

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
KOPR-KOTE	Graphite, Cu & MoS_2 mixture	Jet-Lube of Canada	paste	not regulated	not regulated	1,1,1				Safety Glasses, Gloves	Wipe up spill with rages and incinerate waste.
Lead Standard - AA		Anachemia	Liquid	8	D-2A, E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Lime		Chemical Lime Company of Canada Inc.	powder	not regulated	E	3, 0, 1			Will cause severe caustic burns. Avoid strong acids, and aluminum	Safety Glasses, Gloves	sweep up uncontaminated material for reuse. Neutralize with dilute acid and may be disposed of in pit or tailings system.
Liquid Nitrogen	Nitrogen	Praxair Canada Inc.	Liquefied Gas	2.2 Non-flammable gas	A	3, 0, 2	any if container larger then 100 L		Use air supplied respirator when working in confined space, Loose-fitting cryogenic gloves, Metatarsal shoes for cylinder handling. Protective clothing where needed. Cuff less trousers should be worn outside of shoes	Extremely cold liquefied gas, Will cause severe frost bite Use SCBA when working in confined space,	Evacuate all personnel from danger area. Allow spilled liquid to evaporate. Use self-contained breathing apparatus where needed. Shut off flow if you can do so without risk. Ventilate area or move cylinder to a well-ventilated area. Test for sufficient oxygen, especially in confined spaces, before allowing re-entry
LIQUID WRENCH SUPER LUBRICANT (AEROSOL)	Proprietary Blend	Radiator Specialty Co	aerosol	2.1	A, B5, D-1A, D2-B		any if container larger then 100 L		containers may rupture if exposed to high temperatures.	Safety Glasses, Gloves	Allow container to completely discharge while eliminating ignitions sources. Wipe up spill with rages and incinerate waste.
Loctite Belt Dressing	Proprietary Blend t	Henkel Canada, Inc.	aerosol	2.2	A, D-2A, D-2B		any if container larger then 100 L		containers may rupture if exposed to high temperatures.	Safety Glasses, Gloves	Allow container to completely discharge Wipe up spill with rags and incinerate waste.
LPS 2 Spray Lubricant	Proprietary Blend	LPS Laboratories	aerosol	2.2	A, D-2A, D-2B		any if container larger then 100 L		containers may rupture if exposed to high temperatures.	Safety Glasses, Gloves	Allow container to completely discharge Wipe up spill with rages and incinerate waste.
Magnesium Nitrate Matrix Modifier		Spex CertiPrep	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
MAXGOLD™ 900 Promoter	Proprietary Blend	Cytec Canada	Liquid	3	B-3, D-2A	3, 2, 0	200 L		slightly yellow liquid that has a slight sulphur smell. In confined space use respirator with organic vapour cartridges	Goggles, gloves. Respirator or SCBA if in confined space	eliminate ignition sources, use absorbent on small spills, for large spill pump to plastic drum for shipment off site. In case of fire use dry chemical extinguisher, CO_2 or foam. Water likely not effective.
MERCSORB Mercury Amalgamation Powder		NPS Corporation	solid	4		0, 1, 1	25 kg		Dry zinc dust will not ignite spontaneously, but once ignited, it may burn readily in air	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. In case of fire use appropriate measures for surrounding fire.
Mercury Indicator Powder	Proprietary Blend	NPS Corporation	solid	not regulated		2, 1, 0			Odorless, yellowish-tan to gray powder. Dust may form a flammable or explosive mixture in air. When heated to decomposition, toxic fumes of sulfur oxides are produced	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. In case of fire use appropriate measures for surrounding fire. This product in itself is considered to be non-hazardous.
Mercury Standard - AA		Anachemia	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Mercury Vapor Suppressor	Proprietary Blend	NPS Corporation	solid	not regulated		2, 1, 0			Odorless, black, irregular, dry granular solid. Wet activated carbon removes oxygen from the air causing a severe hazard to workers in confined space.	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. Contaminated waste can be incinerated. In case of fire use appropriate measures for surrounding fire. This product in itself is considered to be non-hazardous.
Methanol		Anachemia	Liquid	3, 6.1	B-2, D-1B, D-2A,D-2B	1, 3, 0	200 L		Extremely Flammable, Vapours are harmful and solution is poisonous	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
MIBC	Methyl Isobutyl Carbinol	Flomin Inc.	Liquid	3		2, 2, 0	200 L	Frother in Mill	Product liquid and vapor are flammable. Keep away from heat and sources of ignition. Product vapors or mist may be irritating to eyes and respiratory system. Product liquid may cause eye and skin burns. Harmful if swallowed.	Googles or Face Shield, Gloves, Respirator (NIOSH/MSA)	Dike spill and collect for disposal or reuse. Use adsorbents on residual material. Flush spill area with water. Keep flush material out of waterways. Dispose of cleanup material in an approved manner.
MIBK	4-Methyl-2-pentanone	Fisher Scientific	Liquid	3	B-2	2, 3, 0	200 L		clear liquid that has a slightly sweet smell. In confined space use respirator with organic vapour cartridges	Safety Glasses, Gloves	Clear liquid that is immiscible with water. Use absorbent for small spills and incinerate waste. Large spills, eliminate ignitions sources and pump to plastic drum for shipment off site.
Molybdenum Standard - AA		Anachemia	Liquid	not regulated	not regulated	0, 0, 0				Safety Glasses, Gloves	Contain spill. Incinerate waste or place in landfill
Mucasol universal detergent		Sigma-Aldrich Canada	Liquid	not regulated	D-2B	2, 0, 0				Safety Glasses, Gloves	

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Nickel Standard - AA		Anachemia	Liquid	8	D-2A, E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Nitric Acid		Anachemia	Liquid	8	C, D-1A, E	4, 0, 0, OX	5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind. **Strong Oxidizer**	Goggles, gloves. Respirator or SCBA if in confined space	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Nitric Acid 40%		Quadra Chemicals	Liquid	8	C, D-1A, E	4, 0, 0, OX	5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind. **Strong Oxidizer**	Goggles, gloves. Respirator or SCBA if in confined space	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Oxygen		BOC Canada Limited (Linde)	Pressurized gas	2.2	A, C	0, 3, 0, OX	any if container larger then 100 L		Strong Oxidizer will Contribute to combustion of other materials.	Safety Glasses, Gloves	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Oxygen Refrigerant		Air Liquide Canada	Liquefied Gas	2.2	A, C	0, 3, 0, OX	any if container larger then 100 L		Strong Oxidizer will Contribute to combustion of other materials. Liquefied gas, will produce extreme cold when released.	Safety Glasses, Gloves	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Palladium Nitrate Matrix Modifier		Spex CertiPrep	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Phosphoric acid		Sigma-Aldrich Canada	Liquid	8	D-1A, D-2B, E		5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind.	Goggles, gloves. Respirator	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Pine Oil (Terpene SW Blend)		Quadra Chemicals Ltd.	Liquid	not regulated	B-3, D-2B			Frother in Mill	Combustible liquid and vapor. Causes respiratory tract, eye and skin irritation. Use only with adequate ventilation. Keep container tightly closed and sealed until ready for use. Wash thoroughly after handling. Avoid oxidizing materials.	Goggles, Gloves, Respirator (air-purifying or air-fed)	Stop leak if without risk. Move containers from spill area. Dilute with water and mop up if water-soluble or absorb with an inert dry material and place in an appropriate waste disposal container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.
PAX	Potassium Amyl Xanthate	Quadra Chemicals Ltd.	Solid	4.2	B-6, D-2B		25 kg	Collector in Mill	Keep away from water - contact with water liberates extremely flammable gases. Keep away from heat, sparks and flame - fine dust clouds may form explosive mixtures with air. Use only with adequate ventilation.	Goggles, Gloves, Respirator (air-purifying or air-fed)	Move containers from spill area. Avoid allowing the spilled material to get wet or using water to clean up spillages or residues, unless the quantity remaining is very small. Vacuum or sweep up material and place in a designated, labeled waste container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.
Polyclear A2501		Quadra Chemicals Ltd.	Solid	not regulated	not regulated			Tailings thickener flocculant	Keep away from heat, sparks and flame - fine dust clouds may form explosive mixtures with air. Take precautionary measures against electrostatic discharges.Use only with adequate ventilation. Avoid oxidizing materials.	Safety Glasses, Gloves	Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Use spark-proof tools and explosion-proof equipment. In case of fire use appropriate measures for surrounding fire. Place in sealed container and dispose of via a licensed waste disposal contractor.
Polyclear 2528	Polyclear Floc	Quadra Chemicals Ltd.	solid	not regulated	not regulated				concentrated solution is extremely slippery, use caution	Safety Glasses, Gloves, respiratory equipment if risk assesment deems necesarry	Sweep up spilled material and it my be deposed of in dilute form to the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Polyclear 31080C		Quadra Chemicals Ltd.	Liquid	9	D-2B			Dewatering Aid in Mill	Use only with adequate ventilation. Avoid contact with strong oxidizers or halogens	Goggles, Gloves, Respirator (air-purifying or air-fed)	Stop leak if without risk. Move containers from spill area. Dilute with water and mop up if water-soluble or absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.
Polyfroth W31		Quadra Chemicals Ltd.	Liquid	not regulated	not regulated			Frother in Mill	Harmful or fatal if swallowed. Can enter lungs and cause damage. May cause target organ damage	Goggles, Gloves, Respirator (air-purifying or air-fed)	Stop leak if without risk. Move containers from spill area. Dilute with water and mop up if water-soluble or absorb with an inert dry material and place in an appropriate waste disposal container. Dispose of via a licensed waste disposal contractor.
Potassium hydroxide	KOH	Science lab	Solid	8	D-1B	3, 0, 1	5 kg		very corrosive solid	Safety Glasses, Gloves	Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid.
Potassium Iodide		Anachemia	solid	not regulated	D-2A	1, 1, 1			light and water exposure will cause breakdown	Safety Glasses, Gloves	Eliminate all sources of ignition. In case of fire use measures dictated by surrounding fire. Will decompose at high temperatures and emit toxic I_2 fumes. Use appropriate SCBA.
Potassium permanganate		CAIROX	Solid	5.1	C, E	1, 0, 0, OX	50 kg		corrosive solid. Oxidizing solid	Safety Glasses, Gloves	Sweep up solid spill for possible reuse. If necessary reduce material in aqueous solution with sodium thiosulfate (hypo), In case of fire use flooding quantities of water, material will contribute to combustion.
Propane		Superior Propane	Liquefied Gas	2.1	A, B-1		any if container larger then 100 L		Extremely flammable. Liquefied gas, will produce extreme cold when released.	Goggles, gloves. SCBA if in confined space	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Selenium Standard - AA		Anachemia	Liquid	8	E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.

Minto Mine - Inventory of Dangerous Goods

Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Sodium Borohydride		Anachemia	solid	4.3	B-6, B-4, D-1B, E	3, 1, 2	25 kg		Flammable solid. Reacts violently with water and acids to produce flammable H_2 gas. Strong reducing agent.	Safety Glasses, Gloves	Eliminate ignition sources, sweep up dry material. In case of fire use only dry chemical extinguisher, DO NOT USE WATER OR CO_2
Sodium Hydroxide Solutions (various strengths)	NaOH (The Anachemia MSDS is current, treat all solutions in the same manner regardless of strength.)	Various Suppliers	Liquid	8	E	3, 0, 1	5 L		Caustic solution. Avoid mixing with strong acids. Contact with metals such as aluminum, tin, lead and zinc generates hydrogen gas.	Safety Glasses, Gloves	Neutralize the residue with a dilute solution of acetic acid. Neutralized solution can be disposed of in the pit or tailings system.
Sodium Nitrite		Anachemia	solid	5.1, 6.1	C, D-1B, D-2A	3, 0, 2, OX	50 kg		**Strong Oxidizer** will Contribute to combustion of other materials.	Safety Glasses, Gloves	Eliminate all sources of ignition. In case of fire, use flooding quantities of water. Will decompose at high temperatures and emit acrid smoke. Strong oxidizer, may form compound that are sensitive to shock, friction. Sweep up solid spill for disposal. Dispose of contaminated solution in the pit or tailings system.
sodium sulphide Flakes	Sodium sulphide Hydrated	Quadra Chemicals	solid	8	D-1B, E		5 kg		caustic, very corrosive solid	Goggles, gloves. And a respirator, avoid creating dust and avoid any acids. Contact with acids liberate toxic H_2S	Sweep up spilled material an place in plastic sealed container for shipment off site.
TMT 15%	trisodium salt	Quadra Chemicals	Liquid	not regulated (treated as Cl. 9 Miscellaneous)	D-2B		25 L		water soluble	Safety Glasses, Gloves	No special clean up procedures, treated as Class 9 Miscellaneous as product does not meet Class 6 Toxicity standards but is an environmental hazard.
Urea	Carbamide	Anachemia	solid	not regulated	not regulated	1, 0, 0			Avoid contact with strong oxidizers. In fire conditions it can produce oxides of nitrogen. Also ammonia, and HCN	Safety Glasses, Gloves	Sweep up spilled material and it my be deposed of in dilute form to the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Vitec 7000		Avista Technologies	Liquid	not regulated	2A	1, 0, 0		Antiscalant in WTP	Avoid mixing with strong bases, strong oxidizers, very strong acids, water reactive materials	SCBA or SABA in confined space, Safety goggles/glasses, Chemical impervious gloves	Soak up or wet vacuum spilled liquid. Neutralize residue with sodium bicarbonate or other neutralizing agent for very dilute acids.Decontaminate the area thoroughly. Place all spill residues in suitable container and dispose of via a licensed waste disposal contractor.
VARSOL 3139 SOLVENT	Petroleum Hydrocarbons	Imperial Oil Chemicals	Liquid	3	B-3, D-2B	1, 2, 0	200 L		Flammable solvent	Safety Glasses, Gloves	Clean up uncontaminated material for reuse. Incinerate waste.
VoltEsso 35		Imperial Oil Chemicals	Liquid	not regulated	not regulated	1, 1, 0			electrical insulating oil	Safety Glasses, Gloves	Clean up uncontaminated material for reuse. Incinerate waste.
Zinc Standard - AA		Anachemia	Liquid	8	E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.

Appendix C: ERT Response to HazMat Spills

ERT Response to Hazmat Spill

Spill Contact: Yukon Territory Spill Line 1-867-667-7244

Canutec: 1-613-996-6666 Cell: *666

TABLE OF CONTENTS

1.0 Overall HAZMAT Response Procedures

1.1 Site Management and Control

Initial responders will :

- Approach the scene from uphill and upwind.
- Establish command uphill and upwind of spill at an appropriate distance.
- Establish 2 isolation perimeters: one that separates the hot zone from the warm zone and another that separates the warm zone from the cold zone. Emergency Response Guide or Canutec shall be referenced for perimeter size.
- Evacuate affected area or ‘protect in place’, as req’d. Emergency Response Guide or Canutec shall be referenced for evacuation zone.
- Identify contaminated persons and ensure they remain isolated until they can be decontaminated.
- Establish a staging area.
- Designate an information officer.
- Possible unification of command.

1.2 Identification of the problem

I/C will identify the:

- Spilled product, as per witness testimony, placards, labels, bill of lading, type of container, etc. If product cannot be identified from command position, then a recon team will be tasked with identification.
- Size of container.
- Size and nature of release.
- Conditions and # of victims at accident site.
- Topography of area, and exposures threatened.

1.3 Hazard &Risk Evaluation

A risk evaluation will be conducted, taking into consideration:

- Product hazards
- Access & Egress
- Size of Spill
- Condition of container
- Proximity of exposures
- Personnel available to perform operations, and their level of training/experience
- Information from MSDS, ERG, Canutec, etc., minimum 3 sources

1.4 Personal Protective Equipment

PPE will be selected for Ops, RIT, and Decon teams, considering:

- Flammability/explosiveness of product
- Toxicity of product
- Route of entry of product
- Permeation rate of PPE
- Breakthrough time of PPE
- Availability of PPE
- Visibility and workability while wearing PPE

1.5 Information Management and Resource Coordination

The information officer will begin to gather information about the product once it has been identified. The information officer can use the MSDS, ERG, Canutec, or many other resources to gather information, such as:

- Properties of the product
- Hazards of the product
- Expected travel of product released
- Populations/ environment in jeopardy
- PPE req'd by responders
- Decontamination requirements

Command will prioritize the information and ensure that the correct people receive the correct information.

1.6 Implementing Response Objectives

Command will develop an overall strategy, which may be offensive (entry of hot zone to gain quick control), defensive (contain from the cold zone to prevent spread), or passive (isolate only, and wait for incident to run its course), considering:

- Life safety
- Incident stabilization
- Environmental protection
- Property salvage

Command will delegate tactics to operations teams, such as:

- Reconnaissance for unknown product
- Evacuation for toxic gas leak, fire, or explosive hazard
- Fire control for flammable gas, flammable liquid, or oxidizer
- Search and rescue
- Leak control
- Neutralization of corrosives
- Deployment of boom, drain covers, etc.
- Building of dams, dykes, etc.

To follow: specific tactic options will be discussed in more detail, pertaining to hazardous materials that are commonly found in large quantities at the Minto Mine.

Entry teams will enter with a clear objective, but must assess for the next team's objective. For example, the 1st entry team may be tasked with rescuing the driver of a fuel truck that rolled down a bank and is spilling fuel. Although their objective is to rescue, while they are on scene they should observe where the leak is, consider what could be used to stop it, where the fuel is going, and what is needed to contain it. They should bring a camera, so that pictures can be brought back to command. This will give command crucial information and better prepare the next team for their task.

1.7 Decontamination

Considerations for decontamination should begin at the outset of the incident. A decontamination construct will exist in the warm zone prior to any team entering the hot zone. It will typically consist of a large berm fashioned out of a large chemical resistant tarp, wrapped over a charged 2 ½” hose-line. There will be a charged 1 ½” hose-line nearby for emergency decontamination. Within the berm, there will be a series of smaller berms, in which, personnel will stand while being decontaminated. Personnel conducting the decontamination will be wearing the appropriate PPE (typically 1 class below ops) and will use detergent and water to gently scrub and rinse ops personnel and rescuees as they exit the hot zone. Tools and anything else exiting the hot zone will be decontaminated as well.

Once decontamination is complete, all product collected by the berms, will be handled as per the MSDS.

1.8 Termination

Once emergency operations are complete, the scene will be handed over to clean-up & recovery operations. Command will ensure that the hand-off includes all pertinent information about the spilled product:

- Properties
- Hazards
- Location
- Safe-handling
- Exposure signs and symptoms
- Req’d PPE
- Disposal procedures

Command will conduct an on-site debrief. As well, a more formal debrief will be conducted, with all parties involved, at a later time. The incident will be documented, including exposure records for all personnel that entered the warm and/or hot zones.

2.0 Specific Chemical Responses

2.1 Ammonium Nitrate

Site management and control

- Set up perimeter with at least 25m radius.
- Command, staging, & decon shall be positioned upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept, Dyno Nobel, product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1942.
- Solid state. Prills or granules.
- White.
- Odorless.
- Is there threat to a stream?

Hazard & risk evaluation

- Oxidizer .
- Exposure to high heat may evolve toxic, flammable gases.
- Explosive when confined and exposed to high heat.
- Ingestion and inhalation hazard.
- Toxic to aquatic life.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear with SCBA.

Otherwise

- Class C suit with long sleeves.
- Dust mask.
- Oil resistant gloves & boots

Information management and resource coordination

- See MSDS for product information.

- Work closely with Dyno.
- Standard decon set-up will be constructed.
- Have tools cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured personnel.
- Fire-fighting: If flame impingement on tank, use unmanned ground monitor to supply flooding quantities of water via straight-stream, to cool tank. Then, evacuate area 800m in all directions. If signs of imminent explosion are present prior to setting up ground monitor, do not attempt to set it up, just evacuate for 800m in all directions.
- Prevent from entering streams.
- Once in stream, may be unrecoverable. Underflow dams should be constructed, and surface can be skimmed.
- If possible, stop anymore product from being spilled.
- Follow Dyno's recommendations for recovery and clean-up of product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, vac-truck can be utilized to clean up solution contained with the decon berms.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief.

2.2 Emulsion

Site management and control

- Consider initial perimeter of 800m.
- Command, staging, & decon shall be positioned upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept, Dyno Nobel, product carrier (if spill occurs during delivery to mine).

Identification

- UN# 0332.
- Viscous liquid.
- Pink, opaque.
- Slight fuel oil odour.
- Shipped in bulk by tanker truck.

Hazard & risk evaluation

- Emulsion explosives.
- Stable under normal conditions.
- May explode under fire conditions.
- Eye & skin irritant.
- Slight ingestion & inhalation hazard.
- Avoid contact with corrosives.
- Is there threat to a stream?

PPE

- Class C suit with long sleeves.
- Standard PPE

Information management and resource coordination

- See MSDS for product information.
- Work closely with Dyno.
- Standard decon set-up will be constructed.
- Have tools cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.

- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured personnel.
- Fire-fighting: If fire reaches cargo, DO NOT ATTEMPT TO FIGHT FIRE. Cargo may explode. Evacuate in all directions for 1600m.
- Prevent from entering streams.
- If possible, stop anymore product from being spilled.
- Follow Dyno's recommendations for recovery and clean-up of product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, clean out berms under direction of Dyno.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief.

2.3 Diesel, Kerosene, CFE 150

Note: LEL sensor will not detect presence of long-chain hydrocarbon vapour. Photo-ionization detector (PID) should be used, if available.

Site management and control

- Set up perimeter with at least 50m radius.
- Command, staging, & decon shall be positioned uphill and upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept, Dyno Nobel (if spilled product is CFE 150), product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1202.
- Liquid state.
- Colour varies.
- Petroleum odour.
- Transported by B-train, tidy-tanks.
- Stored in 5 large tanks at fuel farm (total volume of 3,282,000 L), one 70,000 l Tank by UG portal, and one tank at Dyno (45,000 L).
- What is downhill from spill??
- Is there threat to life?
- Is there threat to a stream?

Hazard & risk evaluation

- Combustible liquid.
- Vapour could be ignited by any source of ignition.
- Extraction methods could create static if not bonded/grounded, and serve as an ignition source.
- Ambient temperature relevant.
- Irritant to eyes and skin
- Ingestion and inhalation hazard
- Toxic to aquatic life.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear with SCBA.

  Otherwise
- For offensive strategies, such as rescue or plugging, full turn-out gear with SCBA
- For defensive strategies, such as diverting, damming, booming, diking, class B suit.

- Respirator with OV cartridges.
- Oil resistant gloves & boots

Information management and resource coordination

- See MSDS for product information.
- Know the product's route of travel.
- Standard decon set-up will be constructed.
- Ensure tools are cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd.
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured personnel.
- Consider using fog stream to protect rescuers.
- Fire-fighting: Use dry chemical, CO2, Class B foam, or water with fog pattern.
- If using fog, considering increased run-off hazard
- Prevent from entering streams.
- If possible, stop the leak: close valves, use plugs, plug n' dyke, gaskets, straps, jacks, cribbing, etc.
- Containment berm at source, 'Surrey Condom'.
- If possible, contain by covering drains/culverts, diking, diverting to a berm, absorbing, etc.
- If product has entered a stream, use booms, hydrocarbon-only absorbent socks and pads, under-flow dams, diversion-booms, skimmers to contain and extract, as per instructions found later in this document.
- If transfer of product req'd, ensure entire system is bonded/grounded.
- Use non-sparking tools, such as pneumatics.
- Site Services Vac-truck is an option for cleaning up product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, vac-truck can be utilized to clean up solution contained with the decon berms.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief

2.4 Gasoline

Note: Minto gas detectors are calibrated to pentane and are suitable for use during gasoline spill mitigation

Site management and control

- Set up perimeter. Consider radius up to 800m depending on amount of product and level of explosion hazard.
- Command, staging, & decon shall be positioned uphill and upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1203.
- Liquid state.
- Colourless to slightly yellow.
- Recognizable odour.
- Transported by B-train, tidy-tanks.
- Stored in 2 tank at fuel farm (34,150 L combined).
- What is downhill from spill??
- Is there threat to life?
- Is there threat to a stream?

Hazard & risk evaluation

- Flammable liquid. Extremely flammable in presence of ignition source, at nearly any temperature.
- Vapour could be ignited by any source of ignition.
- Vapour is heavier than air and may travel considerable distance to an ignition source, and flash back.
- Product extraction methods could create static if not bonded/grounded, and serve as an ignition source.
- Explosion hazard where flame impingement on tank.
- Irritant to eyes.
- Ingestion and inhalation hazard
- Toxic to aquatic life.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear with SCBA.
  Otherwise
- For offensive strategies, such as rescue or plugging, full turn-out gear with SCBA
- For defensive strategies, such as diverting, damming, booming, diking, fire resistant class B suit.
- Respirator with OV cartridges, only if LEL's are being monitored, otherwise, do not dampen sense of smell. Rather, move upwind of product vapour.

Information management and resource coordination

- See MSDS for product information.
- Know the product's route of travel.
- Standard decon set-up will be constructed.
- Ensure tools are cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Offensive tactics for rescue of injured personnel only.
- Consider blanketing affected area with class B foam, prior to rescuers entering hot zone.
- Use fog stream to suppress vapours and protect rescuers.
- Rescuers will carry intrinsically-safe radios and gas-detector.
- Prevent from entering streams
- If possible, stop the leak.
- If possible, contain by covering drains/culverts, diking, diverting to a berm, absorbing, etc.
- If product can or has has entered a stream, use booms, hydrocarbon-only absorbent socks and pads, under-flow dams, diversion-booms, as per instructions found later in this document.
- Safe handling and disposal of all waste product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, safe disposal of decon berm contents
- Safe and proper disposal of all spent PPE
- Hand-over command of operation to Environmental Dept.
- Debrief

2.5 LPG (Propane)

Note: Minto gas detectors are calibrated to pentane, and require no correction prior to use during propane leak mitigation.

Site management and control

- Set up initial perimeter of at least 100m. For large tank where there is fire, set up perimeter of at least 1600m.
- Command, staging, & decon shall be positioned uphill and upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1075
- Colourless liquid and vapour while stored under pressure.
- Colourless and odourless gas in natural state at any concentration.
- Commercial propane has an odorant added which is commonly ethyl.
- Transported by tanker truck.
- Stored in 6 113,000L tanks West of the Main Pit, One 12,000L tank at the refill station near the airport, twin 3,000L tanks at Pelly, and twin 18,000L tanks at Km 0 of the access road.
- What is downhill from spill?
- Is there threat to life?
- Is there threat to a stream?

Hazard & risk evaluation

- Extremely flammable gas.
- Vapour could be ignited by any source of ignition.
- Vapour is heavier than air and may travel considerable distance to an ignition source, and flash back.
- Stored under pressure, as a liquid.
- Product extraction methods could create static if not bonded/grounded, and serve as an ignition source.
- Massive explosion hazard where flame impingement on tank.

PPE

- Full turn-out gear with SCBA.

Information management and resource coordination

- See SDS for product information.
- Consider contacting Canutec.
- Know the product's route of travel.
- Ensure tools are cribbed for entry teams.
- Have fire truck at scene and ambulance in staging area, as req'd

Implementing Response Objectives Leak in an enclosed space

- Evacuate structure.
- Close supply valve remotely if possible.
- Eliminate any source of ignition.
- Use positive pressure to ventilate space, ensure that it is exhausting to safe location.

If no remote isolation valve:

- Entry team (2 ERT members) & RIT team (2 ERT members) will don full turn-out gear & SCBA.
- Any electronic equipment being carried, such as radio or gas detector, must be intrinsically safe.
- Entry team will enter with charged 1 ½" hose-line and gas detector equipped with LEL sensor, while RIT stages in the cold zone .
- Once entry team is at 'reach of stream' distance from the leak, the nozzleman (Entry member 1) will set-up, with nozzle fixed on Entry member 2. Entry member 2 will continue toward valve, with gas detector.

If LEL sensor rises above 20%, entry team will retreat until ventilation can be made adequate.

- Once Entry member 2 reaches the valve, he will close the valve, then back away until he reaches entry member 1.
- Entry team will exit the structure, until it has been adequately ventilated.
- Once adequately ventilated, ERT members, wearing appropriate PPE, will sweep the structure with gas detector(s), to ensure there are no pockets of gas, before deeming the structure 'safe to enter'.

****** If no remote shut-off is available or accessible, the main propane lines can be shut off by cutting the Underground Power feed in the Tailings Building.***

2.5.1 LPG line on fire, with no impingement

Note: a propane leak that is burning is safer than one that is not burning, as long as there is no impingement on a tank or structure. Therefore, in this scenario, gas will be allowed to burn until the valve can be shut off.

- Evacuate immediate area.
- If possible, close isolation valve from remote location.

If no remote isolation valve:

- Eliminate any further source of ignition.
- 2 or more ERT members in full turn-out gear & SCBA will be on 1 ½” hose-line.
- Nozzle will be turned to full fog, which will create a water-curtain between the fire and the fire fighters.
- The fire team will approach the isolation valve, keeping the water-curtain between themselves and the fire at all times, being careful not to put the fire out with the stream
- When the valve is reached by the team, the 2nd member on the line will let go of the hose and approach the valve, while the nozzleman maintains the water-curtain between the fire and the valve/fire team.
- The 2nd member will close the valve then back away from the fire until he regains his position on the hose.
- The team will maintain the water-curtain while they back away from the damaged gas-line.
- Once the team is at a safe distance, a 45 degree pattern can be fixed on the broken gas-line to cool it, and disperse any residual gases.

2.5.2 LPG leak, not enclosed, not on fire

Note: LPG has a very high vapour pressure (1013 kPa) so it wants to be a gas, a high vapour density (1.52) so it’s heavier than air, and a low flash point (-103.4 C). This combination means that it can form an explosive gas cloud that will stay close to the ground, may linger in incident area, or migrate downwind and/or downhill, possibly settling in low lying areas.

- Evacuate immediate area as well as areas downwind/downhill as per ERG recommendations.
- If possible, close isolation valve from remote location.
- From ‘reach of stream’, set up ground monitor and fix a 45 degree fog pattern on area of concern. This will push gas cloud away from area and disperse it. Be sure to push it to a safe location.

If no remote isolation valve:

- Entry team (2 ERT members) & RIT team (2 ERT members) will don full turn-out gear & SCBA.
- Any electronic equipment being carried, such as radio or gas detector, must be intrinsically safe.
- Entry team will enter with charged 1 ½" hose-line and gas detector equipped with LEL sensor, while RIT stages in the cold zone.
- While ground monitor continues to 'make it rain' in the hot zone, nozzleman (entry member 1) will fix nozzle on entry member 2, as entry member 2 approaches the isolation valve, with gas detector.

If LEL sensor rises above 20%, entry team will retreat until water stream can be made more effective

- Once Entry member 2 reaches the valve, he will close the valve, then back away until he reaches entry member 1.
- Entry team will retreat to the cold zone until gases are adequately dispersed
- Once the gas is adequately dispersed, ERT members, wearing appropriate PPE, will sweep the area with gas detector(s), including low-lying areas where gas may have migrated to, before deeming the area 'safe to enter'.

2.5.3 Fire where there is flame impingement on LPG tank

- Evacuate all non-ERT members for at least 1,800 m where there is flame impingement on either the 12,000 L tank or the tandem 18,000 L tanks.
- Command will know and understand the signs of imminent BLEVE.
- If Command witnesses signs of imminent BLEVE from an upright tank, there shall be no attempt made to cool tanks, rather, all focus shall be on a rapid evacuation of all personnel, at least 1,800m.
- If tank has been knocked over, there may be little or no warning signs of BLEVE, therefore no attempt shall be made to cool, rather, all focus shall be on a rapid evacuation of all personnel, at least 1,800m.
- If a BLEVE is not imminent, an attempt will be made to connect a ground monitor to the stand-pipe at the Tailings bldg.
- A narrow fog stream will be fixed on the tank at the area of flame impingement.
- The monitor will be left unmanned and the remaining ERT will evacuate at least 1,800m.

Where a tanker truck carrying propane has over-turned on the access road, causing damage to the tank trailer and subsequent rapid release of propane, the strategy for the hazmat portion of the incident response, will be passive and conducted from an upwind/uphill location, at a safe distance, as per the ERG. Transfer of residual product for the scenario, will be conducted by outside resource.

Decontamination

- 1 ½" charged hose-line, as emergency decon

Termination

- Debrief

BW GasAlert Micro 5 is intrinsically safe, as per: *http://directories.csa-international.org/xml_transform.asp?xml=certxml%5C080259_0_000-4828-82.xml&xsl=xsl/certrec.xsl*

- GasAlert Micro 5 Portable Gas Detector, Model M5-xwt1t2-r-p-d-a-b-cc & M5PID-xwt1t2-r-p-d-a-b-cc; utilizing electrochemical, catalytic bead and photo-ionization sensors; Intrinsically Safe when powered by one of the following AA Size Batteries / Battery Pack
  - Duracell MN1500; T-Code T4; Ambient -20 to +40°C; T-Code 139.8°C (T3C); Ambient -20 to +50°C
  - Energizer E91; T-Code 153°C(T3C); Ambient -20 to +40°C; T-Code 163°C (T3B); Ambient -20 to +50°C
  - NiMH Rechargeable Battery Pack "M5-BAT01"; T-code T4; Ambient -20 to +50°C
  - Lithium Polymer Rechargeable Battery pack "M5-BAT07B"; T-Code T4; Ambient -20 to +50°C

2.6 Nitric Acid 40%

Note: when it comes to corrosives such as Nitric Acid, the solution to pollution is NOT dilution. For a spill of 1 45 gal drum, it would take over 450,000 gal of pure water to make the solution habitable for fish. It would take over 45,000,000 gal of pure water to neutralize it.

Site management and control

- Set up perimeter with at least 50m radius.
- Command, staging, & decon shall be positioned uphill.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product Carrier (if spill occurs during delivery to mine).

Identification

- UN# 2031
- Liquid state
- Colourless to yellow
- Transported in 45 gallon drums
- # of 45 gal drums possibly damaged will help estimate size of spill.
- What is downhill from spill? Could acid reach a stream?

Hazard & risk evaluation

- Strong acid, very corrosive.
- Severely hazardous to eyes and skin
- Ingestion could cause death
- Inhalation hazard, although low vapour pressure 1.3kPa (wants to be a liquid).
- Could be devastating to stream life.
- Strong oxidizer, could have explosive reaction with organic or combustible materials

PPE

- If there is a fire situation, PPE will consist of full turn-out gear and SCBA.
  Otherwise
- Know and heed permeability rate and breakthrough times of all PPE.
- Acid resistant, class B suit with hood.
- Full-face respirator with appropriate chemical cartridges.
- Chemical resistant gloves & boots
- Chemical resistant tape used to seal between boots/suit, gloves/suit, and mask/hood.

Information management and resource coordination

- See MSDS for product information.
- Know the product's route of travel.
- Was anyone exposed?
- Will non-human life be exposed?
- Standard decon set-up will be constructed.
- Have tools cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is enough neutralizing agent at the site to complete the task. ***See below for chart***
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured/exposed personnel.
- Prevent from entering streams
- Prevent from contacting combustibles and organics.
- If possible, stop the leak.
- If possible, contain by covering drains/culverts, damming, diverting to a berm, etc.
- Use over-pack to contain leaking drums that still contain product.
- Neutralize spilled product with weak caustic – primary neutralizing agent is Ansul Spill X-A, alternatively hydrated lime or baking soda (if available). Be cautious of chemical reaction.
- Use Litmus paper to test for pH when neutralizing with lime or baking soda.
- Site Services Vac-truck is an option for cleaning up product before or after neutralized, as necessary.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, vac-truck can be utilized to clean up solution contained with the decon berms.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief

2.6.1 Chart for Estimating Caustic Req'd to Neutralize 40% Nitric Acid

For **Spill X-A**, use 1:1 ratio by volume, or 10lbs Spill X-A per 1 gal Nitric Acid.

Amount of Nitric Acid Spilled (in Gal.)	Amount of Baking Soda Req'd (in Lbs.)
1	5.6
2	11
5	28
10	56
20	110
45	252
90	504
135	756
180	1,008

Amount of Nitric Acid Spilled (in Gal.)	Amount of Lime Req'd (in Lbs.)
1	2.4
2	4.8
5	12
10	24
20	48
45	108
90	216
135	324
180	432

Charts derived from formulas below

Specific Gravity Nitric Acid: 1.2455

Concentration: 40%

1 gal HNO_3 x 1.24 x 8.34 lbs/gal x 0.40 = 4.14 lbs HNO_3

$HNO_3 + NaHCO_3 \rightarrow NaNO_3 + H_2O + CO_2$ Therefore 1 mol Nitric Acid per 1 mol Sodium Bicarb (Baking Soda)

$2HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2H_2O$ Therefore 2 mol Nitric Acid per 1 mol Calcium Hydroxide (Lime)

HNO_3 = 63 amu

$NaHCO_3$ = 85 amu

$Ca(NO_3)_2$ = 74 amu

(4.14 lbs HNO_3/63 amu-HNO_3) x 85 amu-$NaHCO_3$ = 5.6 lbs $NaHCO_3$

Therefore 1 gallon of Nitric Acid req's 5.6 lbs of baking soda

(4.14 lbs HNO_3/2(63) amu-HNO_3) x 74 amu-$Ca(OH)_2$ = 2.4lbs $Ca(NO_3)_2$

Neutralization Formulas and Quick Access Charts Formulas

The key to effective and efficient neutralization, is knowing how to use the following formulas.

1. The first formula indicates how much acid is spilled in weight.

Step #1- Determine the quantity of acid spilled, usually in gallons.
Step #2- Determine the specific gravity of the acid usually provided in MSDS.
Step #3- Determine the concentration of the acid spilled usually in %.
Step #4- The weight of water is 8.34 pounds per gallon.

After the above figures are known plug them into the following formula:

Quantity of spill X *specific gravity* X *weight of water* X *concentration*
= *weight of the spill*

Example:
One gallon of sulfuric X 1.84 X 8.34 X 98% = 15.04 pounds of sulfuric

2. The second formula will determine the quantity of the neutralizer needed. The type of neutralizer needs to be selected based on costs and availability. Plug numbers into the following formula:

Weight of the acid spilled X *number in the chart for the selected neutralizer.*

Example :

15.04 pounds of sulfuric X 1.06 for Soda Ash = 15.94 pounds of Soda Ash

Determination through Chemistry

To calculate the amount of neutralization agent needed the balanced chemical reaction must be written and the equivalent weights of acid and base determined.

Example: 1,000 gallons of 38% hydrochloric acid will be neutralized with lime.

Step #1 – Write the complete balanced neutralization reaction:
$2HCl + CaO \rightarrow CaCl_2 + H_2O$
This equation shows that 2 moles of HCl are required in the reaction with one mole of calcium oxide (lime).

Step #2 – Calculate the molecular weight of each compound:
HCl – H = 1, Cl = 35.5, Total = 36.5 amu
CaO – Ca = 40, O = 16, Total = 56

Step #3 – Calculate the weight of the HCl spill:
1,000 gallons X 1.20 X 8.34 X 0.38 = 3,803.04 pounds of HCl
Step #4 – Calculate the amount of neutralizer needed:
From Step #1 it was found that 2 moles of HCl are needed to react with 1 mole of CaO. From Step #2 it was found that 1 mole of HCl weighs 36.5 amu's so 2 moles weigh 73.0 amu's. The formula is**; weight of acid/formula weight of acid X formula weight of base = pounds of the neutralizer needed.**
3,803.04/73 X 56 = 2,917.4 pounds of lime

Finer Points
The final amount is an approximation and in actual practice more neutralizing agent should be obtained. The neutralization process needs to be checked at several spots to assure pH levels are acceptable and uniform.

Neutralization Precautions
Remember, the neutralization process is exothermic and it may involve splashing of product. Safety is paramount and proper protective equipment is very important. Also, the neutralizer is hazardous in its own right and needs to be handled with care. Consider expense and availability in selecting neutralizer. Other weak bases that may be used and their molecular weights are; sodium bicarbonate ($NaHCO_3$)- 85, and magnesium hydroxide ($Mg(OH)_2$)-58.

Neutralization Chart Information
Acids

Hydrochloric Acid, HCl, MW = 36.5, density/specific gravity is 1.19, weight of a gallon is 3.77 pounds at 38% concentration. Synonyms are chlorohydric acid and muriatic acid.

Nitric Acid, HNO_3, MW = 63, density/specific gravity is 1.41, weight of a gallon is 8.23 pounds at 70% concentration. Synonyms are Aqua Fortis and Azotic Acid. (Aqua Regia is a mixture of nitric and hydrochloric acids).

Phosphoric Acid, H_3PO_4, MW = 98, density/specific gravity is 1.69, weight of a gallon is 11.98 pounds at 85% concentration. Synonyms are orthophosphoric acid.

Sulfuric Acid, H_2SO_4, MW = 98, density/specific gravity is 1.84, weight of a gallon is 15.04 pounds at 98% concentration. Synonyms are Oil of vitriol and “oleum” is fuming sulfuric acid.

Bases

Ammonium hydroxide, NH_4OH, MW = 35, clear solution, synonyms are ammonia solution and aqua ammonia. Strong ammonia odor evolves from liquid. High vapor pressure.
Calcium carbonate, $CaCO_3$, MW = 100, white powder, synonyms are crushed limestone and dolomite. Low heat of reaction that gives off carbon dioxide gas.
Calcium hydroxide, $Ca(OH)_2$, MW = 74, white powder, synonyms are slaked lime, hydrated lime, and calcium hydrate.
Calcium oxide, CaO, MW = 56, white powder, synonyms are quicklime, lime, and unslaked lime. Most economical, lowest cost, neutralizer. **Best choice!** Maximum pH is 12.45 at 25C.
Magnesium carbonate, $MgCO_3$, MW = 84, synonyms are magnesia alba and carbonate magnesium.
Magnesium hydroxide, $Mg(OH)_2$, MW = 58, white powder, synonyms are milk of magnesia and magnesia hydrate. Good neutralization agent. Maximum pH is 10.6 at 25C.
Potassium hydroxide, KOH, MW = 56, white flakes, synonyms are caustic potash. High heat of reaction with toxic fumes. Maximum pH is 14 at 25C.
Sodium bicarbonate, $NaHCO_3$, MW = 85, white powder, synonyms are baking soda and sodium acid carbonate. Low heat of reaction with carbon dioxide gas evolution.
Sodium Carbonate, Na_2CO_3, MW = 106, white powder, synonyms are soda ash. **Second most economical neutralization agent next to lime.** Maximum pH is approximately 11 at 25C.
Sodium hydroxide, NaOH, MW = 40, white powder, synonyms are caustic soda, soda lye, caustic, and lye. High heat of reaction with toxic fumes. Maximum pH is 14 at 25C.

2.6.2 Quick Access Charts for Neutralizing Various Acids with Baking Soda

2.6.2.1 Sulfuric Acid neutralization using Baking Soda (Sodium Bicarbonate)

Amount of Sulfuric Acid spilled	**Amount of Baking Soda needed in pounds**
1 gallon	25.6
2 gallons	51.2
3 gallons	76.8
4 gallons	102.4
5 gallons	128.0
10 gallons	256.0
50 gallons	1280.0
55 gallons	1408.0
100 gallons	2560.0

2.6.2.2 *Hydrochloric Acid neutralization using Baking Soda*

Amount of Hydrochloric Acid spilled	**Amount of Baking Soda needed in pounds**
1 gallon	5.5
2 gallons	11.0
3 gallons	16.5
4 gallons	22.0
5 gallons	27.5
10 gallons	55.0
50 gallons	275.0
55 gallons	302.5
100 gallons	550.0

2.6.2.3 *Nitric Acid neutralization using Baking Soda*

Amount of Nitric Acid spilled	**Amount of Baking Soda needed in pounds**
1 gallon	7.4
2 gallons	14.8
3 gallons	22.2
4 gallons	29.6
5 gallons	37.0
10 gallons	74.0
50 gallons	370.0
55 gallons	407.0
100 gallons	740.0

2.7 Sodium Sulphide

Site management and control

- Set up perimeter with at least 50m radius if water introduced, or 25m if solid.
- Command, staging, & decon shall be position upwind and uphill.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1849
- Solid state
- Yellow
- Smell sulfurous or like rotten eggs with introduction of moisture.
- Transported in 1000 Kg ‘Super-Sacks’.
- # of super-sacks possibly damaged, will help estimate size of spill.
- Is water being introduced to the spill? If so, what is downhill form the spill? Could run-off reach a stream?
- Are corrosives being introduced to spill? If so, what is downwind?

Hazard & risk evaluation

- Strong caustic.
- Severely corrosive to digestive tract, respiratory system, eyes, and skin.
- Dust is powerful systemic poison. Inhalation could cause headache, dizziness, unconsciousness, pulmonary edema, asphyxiation, death.
- Contact with acid releases toxic and flammable Hydrogen Sulfide.
- Routes of entry include absorption, inhalation, and ingestion.
- Keep spilled product dry
- If water introduced, avoid run-off, contact with soil, waterways.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear and SCBA.
  Otherwise
- Know and heed permeability rate and breakthrough times of all PPE.
- SCBA if significant H2S release, otherwise, full-face respirator & OV cartridges with pre-filter.
- Corrosive resistant, class B suit with hood.
- Chemical resistant gloves & boots
- Chemical resistant tape used to seal between boots/suit, gloves/suit, and mask/suit.

Information management and resource coordination

- See MSDS for product information.
- Was anyone exposed?
- Will non-human life be exposed?
- Standard decon set-up will be constructed.
- Have tools cribbed for entry team.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured/exposed personnel.
- Keep product dry.
- Monitor atmosphere for H_2S and SO_2.
- If water introduced, contain run-off by covering drains/culverts, damming, diverting to a berm, etc. Solution collected can be mixed with oxidizing agent, such as hydrogen peroxide or sodium hypochlorite to prevent evolution of H_2S.
- If product has entered a stream, consider using over-flow dams to contain product, for extraction.
- Vacuum or sweep up dry product
- Disposal as per Environmental Dept. recommendations

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, solution in decon berms to be disposed of, as per Environmental recommendations.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief

Appendix D: Tug and Barge Emergency Contingency Plan

capstone
MINTO MINE

Minto Mine

Tug and Barge Emergency Contingency Plan

2017-01

Prepared by:

Minto Explorations Ltd.

Minto Mine

February 2017

First Issue: January 15, 2013

Revision History

Revision Number	Issue Date	Description and Revisions Made
2013-01	January 2013	First Issue
2017-01	February 2017	Review, revision of document and update of information: • Revised format of document (added revision history and table of contents); • Section 2.0 and 3.1 - Removed references to JDS and mutual aid agreement (not in place); • Section 4.0 - updated level of NFPA training for ERT (472 HazMat awareness level); • Section 4.0 - updated reference to 2014 field and table top exercise.

Table of Contents

List of Appendices

Appendix A: Man Boat Specifications

Appendix B: Safe Job Procedure for Loading and Unloading the Barge.

1 Introduction

Minto Mine (Minto) a subsidiary of Capstone Mining Corporation is pleased to submit the following contingency plan (plan) as per requirements of the Selkirk First Nation Access and Land Use Permit "Minto Landing Ice Bridge and Marshalling Area and West Side Barge Landing and Marshalling Area" (the permit). It is Minto's intention that this plan will fulfill the requirement as stated in Schedule 2, Section 9.0 Contingency Plan of the permit. It is not Minto's objective for this plan to mitigate all possible accidents or malfunction in regards to the in stream operation of the Copper Queen tug and barge.

The plan as prepared is adaptive and will be amended as is practicable. This plan is intended to deliver the best possible means of mitigating an accident or malfunction of the loading/unloading or in-stream operation of the tug and barge with the resources available at Minto. Preventing such an occurrence requires a combination of: procedural and engineering controls, based on an awareness of at risk conditions. These documents exist in the form of the Spill Contingency Plan, Emergency Response Plan, and any procedures or plans on the tug or barge from Site Services. This document serves as a contingency plan in the event that an accident or malfunction occurs when loading, unloading, and in-stream operations of the Copper Queen tug and barge (CQTB).

2 General Procedures

Any Response to an Emergency condition will be based on a priority sequence of Life, Environment and Property. Therefore every event will be regarded with these priorities in mind. Initial on scene assessment of the accident or malfunction will be called out on channel one as a "Code 1". The Emergency Response Team will be dispatched, communication established and the barge operator and deckhand will respond to control the scene.

Deckhands will mitigate all emergencies on the barge to the best of their ability given the resources available. General procedure in the event of an emergency would have the barge move to the west landing if possible or practical unless otherwise communicated to the barge captain. To mitigate an emergency in offloading or loading vehicles onto the barge the deckhand will utilize the anchor points on both landings. Slack will be left in the rope to ensure the barge captain is able to maneuver when docked at the landing. Tying off to the anchor points will mitigate complete catastrophe if the barge loses power during loading and offloading and will be discussed further under the specific procedures section of this plan.

To mitigate the risk of losing control of the barge downstream Minto will be installing an anchor on the barge. In the event of an emergency the deckhand would be able to deploy the anchor allowing the barge a safety contingency if control was lost.

3 Specific Procedures

Below is a list of the current on site procedures for dealing with various emergencies in regards to the CQTB at Minto Mine.

1. Emergency Response to Sinking
2. Emergency Response to Loss of Power or Control
3. Emergency Response to Fire Onboard
4. Emergency Response to Man Overboard
5. Emergency Response to Freight or Vehicle Overboard
6. Emergency Response to Medical Emergency on Board of the Barge
7. Emergency Response to Spill Response

3.1 Emergency Response to Sinking of CQTB

1. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.

2. Captain and deckhand will deploy Canadian Coast Guard approved life rafts.

3. As per Emergency Response Plan, Incident command (IC) will communicate with Deckhand by radio to determine any further details of events, number of injured or trapped people, risks to property and environment.

4. IC will respond to scene in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs based on initial assessment and

evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.

5. Incident Accountability will be established and adhered to throughout the operation.
6. IC will determine the need for rescue of people downstream. Option to deploy rescue ropes via launcher considered for KM 12.
7. Alternate access to river to be determined by nature of incident, KM 20 provides a second potential access. All other access would require trail cutting which is possible but would take more time.
8. IC, ERT Captain, and Environmental Lead (Unified Incident Command Support) will assess ongoing situation and need for additional or fewer resources.
9. Alternate man boat (see Appendix A for details on man boat) will be deployed from landing as needed to support rescue and/or to gain more information regarding location of sunken vessel and determine possible plan for retrieval/securing. Man boat operator will work under the direction of IC.
10. Once rescued, all patients will be treated as per OFA3/EMR protocols transported as per Yukon EMS dispatch confirmation aligned with Minto Emergency Response Plan.

3.2 Emergency Response to Loss of Power or Control of CQTB

The tug operates on two engines so total loss of power is not likely; however, is still possible and below is the emergency procedure that would be activated in the event that total loss or control of the CQTB was to occur.

11. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response. Captain will also communicate freight details and passenger numbers on board.
12. Passengers and crew will follow instructions from Captain and remaining on board if deemed safe. The Captain and deckhand will follow MED protocol in decision making in regards to passenger safety.
13. Captain and deckhand will deploy Canadian Coast Guard approved life rafts if deemed unsafe to stay on board by Captain.

14. IC will respond to scene or as close to it, in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs and downstream communication and reporting requirements based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.
15. Incident Accountability will be established and adhered to throughout the operation.
16. Captain will navigate to the best of his ability to the safest downstream location possible. Under the direction of the Captain the deckhand may deploy the anchor to assist in stopping the barge and tug.
17. Captain will communicate to IC location and details of condition of vessel and people and assist in determining plans for action.
18. Once vessel is secured to shore or where landed in river, Man boat will be deployed to assist with additional securing and remove non-essential people to location where they can be transferred back to site or alternate safe location.
19. If available and a benefit, Minto would exercise the use of the mutual aid agreement with JDS.
20. Plan for retrieval will be based appropriate to the conditions and location of vessel. Plan to be developed cooperatively through Barge Captain, Minto ECC and Mutual Aid resources. Equipment and additional resources will be sourced through ECC as per Minto Emergency Response Plan.

3.3 Emergency Response to Fire on the CQTB

21. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
22. If safe to do so, deckhand will attempt to supress fire using equipment on board following Marine Emergency Duty (MED) protocol.

23. Captain and deckhand will deploy Canadian Coast Guard approved life rafts if vessel in immediate danger. If possible and practical the Captain will position barge so that wind is blowing port to star board, to keep smoke/flames away from life raft.
24. If able to do so Barge will cross to West Bank of crossing and continue to use barge supplied fire suppression equipment. All passengers will disembark under direction of deckhand.
25. IC will respond to scene in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.
26. Incident Accountability will be established and adhered to throughout the operation.
27. Once IC on scene and vessel safely secured, fire suppression will be conducted under the direction of the IC following NFPA 1081 standards. Industrial Fire Brigade.
28. Consideration of environmental sensitivity need to be considered by IC in cooperation with the Environmental Lead (unified incident command support).
29. Defensive spill containment methods to be utilized to control run off and releases from firefighting operations. This may include tactics such as extinguishing agent selection, damming and berming on barge, boom placement around vessel, removal of burning equipment once fire controlled, etc.

3.4 Emergency Response to Man Overboard

30. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
31. Captain and deckhand will throw out provided Canadian Coast Guard approved life-rings to all personnel overboard. The response from the barge crew will conducted as per their MED training.
32. If able to successfully rescue person overboard, deckhand will treat person based on marine first aid protocols awaiting response by ERT and site Medic.

33. If unable to successfully achieve rescue, vessel will continue to West landing and man boat deployed for downstream rescue. Communication to IC on Radio Channel 1 must be available at all times. Man boat operation will be conducted under the direction of IC once in place.
34. Captain will communicate to IC of possible downstream rescue requirement.
35. IC will instruct ERT to stage at KM 12 with option to deploy rescue ropes via launcher considered for KM 12.
36. Incident Accountability will be established and adhered to throughout the operation.
37. IC to stage ambulance for patient pick up.
38. IC will communicate the need for mutual aid to ECC who will follow the Minto ERP by contacting local agencies for assistance on East side of river.
39. Once rescued, all patients will be treated as per OFA3/EMR protocols transported as per Yukon EMS dispatch confirmation aligned with Minto Emergency Response Plan.

3.5 Emergency Response to Freight or Vehicle Overboard of the CQTB

40. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response. Captain will also communicate freight details and passenger numbers on board.
41. Passengers and crew will follow instructions from Captain (Captain will respond as per MED training) remaining on board if deemed safe.
42. Captain and deckhand will deploy Canadian Coast Guard approved life rafts if deemed unsafe to stay on board by Captain. If at landing passengers will be offloaded to safe location on shore.
43. IC will respond to scene or as close to it, in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs and downstream communication and reporting requirements based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.

44. Incident Accountability will be established and adhered to throughout the operation.
45. Captain will navigate to the best of his ability to the landing, preferably west landing.
46. Once vessel is secured to shore, man boat will be deployed by deckhand or ERT members to assist with additional securing of vessel and freight, and deployment of containment booms located at landing and on vessel. Man boat operation under the direction of IC once in place.
47. Plan for retrieval of freight will be determined appropriate to the condition and location of freight. Plan developed cooperatively through Barge Captain, Minto ECC and Mutual Aid resources.
48. Equipment and additional resources will be sourced through ECC as per Minto Emergency Response Plan including manpower, expertise, heavy equipment, etc.
49. Special considerations for support in the event of incident occurring on East side of river to include Yukon Emergency Measures Organization, local first responders and alternate equipment operations contractor.

3.6 Emergency Response to Medical Emergency on board CQTB

50. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
51. For serious injury as defined in the ERP, Yukon EMS will be notified immediately.
52. Deckhand will treat patient per Marine Emergency First Aid protocols.
53. Captain will navigate barge to west bank of Yukon River and all vehicles will offload on west bank, giving clear passage for Ambulance.
54. ERT response will include medic, ambulance, fire truck and compliment of team members to assist with patient transfer and packaging.
55. Incident Accountability will be established and adhered to throughout the operation.
56. Yukon EMS dispatch will be updated of situation once history and assessment confirmed.
57. Upon arrival, Minto Medic will take control of scene and advise ERT Captain of resources needed on scene.

58. Upon history and assessment, patient will be treated, packaged and transferred as per OFA3/ERM protocols transported as per Yukon EMS dispatch confirmation aligned with Minto Emergency Response Plan.

3.7 Emergency Response to a Spill

59. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
60. Deckhand will attempt to contain spill using on board spill kit, to prevent spill into Yukon River.
61. IC will respond to scene in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs, downstream communication, communication with CANUTEC and reporting requirements based on initial assessment and evaluation by IC will be communicated to the ECC as per Emergency Response Plan and Spill Contingency Plan.
62. Incident Accountability will be established and adhered to throughout the operation.
63. If practical the barge captain will navigate the barge to west landing.
64. All passengers will disembark vessel.
65. All vehicles and machinery that is not in the spill zone will disembark.
66. Deckhand and ERT members under the direction of IC will use the man boat to deploy containment booms around the barge.
67. IC with advice from the Environment Lead will develop and implement the SCP for stopping the spill if possible.
68. If the spill cannot be stopped a plan to mitigate the quantity of contaminant spilt to environment will be developed and implemented.
69. If safe and practical to do so Environment Lead will deploy environment staff to sample downstream of spill to measure contamination concentration.

70. IC with advice from the Environment Lead will oversee cleanup of the spill.
71. Special considerations for support in the event of incident occurring on East side of river to access the barge with ERT by man boat.

4 Minto Mine Training

The barge crew were trained and certified in Marine Emergency Duties (MED) A1 and A2 in 2012. The MED course meets the standards of training, certification and watch-keeping, and is run by Transport Canada. The A1 MED course covers basic safety with a focus on hazards and emergencies awareness, firefighting, emergency response, lifesaving appliances and abandonment, survival and rescue. The A2 MED course covers small passenger-carrying vessel safety with the same focus as A1 with the addition of maintenance and inspection of emergency equipment and passenger control. As well the barge crew is trained in Marine First Aid.

The ERT team has been trained to National Fire Protection Association (NFPA) 472 Hazardous Materials awareness level for responders. In 2014, Minto conducted a table top and field exercise in regards to Yukon River response. The table top and field exercise was held in conjunction with ERT, barge crew, environment department, management, major contractors, the Yukon Spill Hotline, CANUTEC, Transnorth Helicopters, WCB, Parkland Fuel, and Quantum Murray. A post–incident debrief revealed both opportunities and successes at the field operations and management level.

Appendix A: Man Boat Specifications

- Brand/Model: Munson Packman Landing Craft
- Hull Length: 24 feet (7.3 meters)
- Beam: 8 feet 6 inches (2.6 meters)
- Hull Type: Packman mono hull
- Power: Twin Yamaha 150hp
- Propulsion: Outboard (25” shaft)
- Outfitting: 52” bow door

Appendix B: Safe Work Procedure for Loading and Unloading the Barge.

Capstone Minto Safe Work Practice

Barge Loading and Offloading

Purpose: To ensure the safe practice of loading and offloading the barge at the Yukon River. To educate workers on the hazards of loading and offloading the barge, and working on landings.

Scope: This Safe Work Practice pertains to the Captain and the crew of the Minto Mine property who are exposed to operating the barge for transport across river.

Definitions:

Certified Flotation Device – Personal Flotation Devices marked "Approved by Department of Transport Canada" or "Approved by Canadian Coast Guard, Department of Fisheries and Oceans"

Hypothermia - A potentially fatal condition that occurs when the body core temperature falls below 95°F (35°C). This can occurs quickly when immersed in cold water.

Responsibilities

Employer / Supervisor Responsibilities

- Make sure appropriate training and assistance are provided to crew.
- Make sure appropriate rescue devices such as a life hook and floatation devices are available to workers

Safety Department Responsibilities

- Ensure this SWP is in alignment with the Yukon Health and Safety Act and Regulations

Worker Responsibilities

- Read, understand, and follow this safe work practice
- If unsure then stop work and ask for assistance
- Wear appropriate PPE defined to their work area.
- Provide training for proper use of PFD to passangers

Reference to Legislative and Site Requirements

- Yukon Occupational Health and Safety Regulations – Part 1 – section 1.34 – Each worker shall be provided with and be required to use an appropriate personal flotation device with the required buoyancy where a worker is employed in a situation where there is a risk of drowning

Safe Work Practice:

The captain and crew will give direction in regards to the following.

1. Landings.

1.1. Assess landing and vehicles to be loaded and unloaded. The use of wooden ramps may be needed. (For more information reference safe work practice for wooden ramps.)

1.2. Use gauge on apron ram to determine the need for landing to be rebuilt. This gauge is located on the ram closest to deckhand shed and has a max angle marked on the gauge. If the apron should go past the marked max angle stop and fix landing. (For more information reference safe work practice for landing maintenance and apron angle.)

2. Transportation.

2.1. Due to landing and vehicle loads ask driver to back on or drive on. This may be determined by many factors, such as:

- Angle and length of landing
- Apron angle and how it contacts the landing
- Underwater debris
- Drivers skill
- Extra low trailers
- Frozen or icy landings
- Load weights

2.2. Deckhand must communicate with captain any concerns about previously mention conditions. It is ultimately the captains' decision on how the barge is loaded.

3. Priority Boarding

3.1. Emergency vehicles on medical runs are given the top priority. Compassionate reasons or special circumstances are considered when loading vehicle traffic. The bus will also be given high priority along with con trucks. Loading priority will be determined by the Captain or the Supervisor.

3.2. Priority may change from day to day and we ask that drivers cooperate and be patient. Ultimately the captain will make the decision based on information available at the time.

4. Communication.

4.1. Drivers are given a handout of standard hand signals as endorsed by WCB and a signature logbook is maintained to who has received the handout and when.

4.2. The deckhand is in charge of directing and communicating with all traffic. Radios, hand signals, face to face communication are all used. An air horn is used as warning to stop the drivers quickly.

5. Hazards.

5.1. Working at or near water has its inherent risks. A JHA should be conducted for any new or unusual work being conducted on or near the water. Some hazards to be aware of are:

- Exposure to the environmental elements of the season
- Slips, trips and falls on uneven ground
- Slipping on slippery rocks and surfaces
- Eroding shore line sloughing or slipping on ice along shoreline
- Falling into cold water
- Ice flows and ice jams
- Swift current
- Drowning
- Hypothermia
- Wildlife
- Slippery deck

6. Emergency Equipment.

6.1. Life ring with rope and pole must be available on the barge. An emergency response container complete with first aid kit, oxygen therapy unit, spare dry coveralls and several blankets is located on the tug. This container is used to reduce the effects of hypothermia until emergency response arrives.

6.2. As the river is 27kms from the mine site emergency response will take at least 40 minutes to arrive at the scene. Deckhands should have marine first aid training and clear knowledge of where all safety equipment is and its condition.

6.3. Honda pump & fire hose along with fire extinguishers are also in place. Deckhands should be well train in this area and will instruct people as needed on what to do in case of an emergency.

7. Training.

7.1. All workers must be trained and competent to operate or run any equipment that pertains to their job.

7.2. At least one worker must have a valid marine first aid ticket in the event of an emergency due to the location of this worksite and the anticipated delay on response time by ERT.

SWP Development and Approval

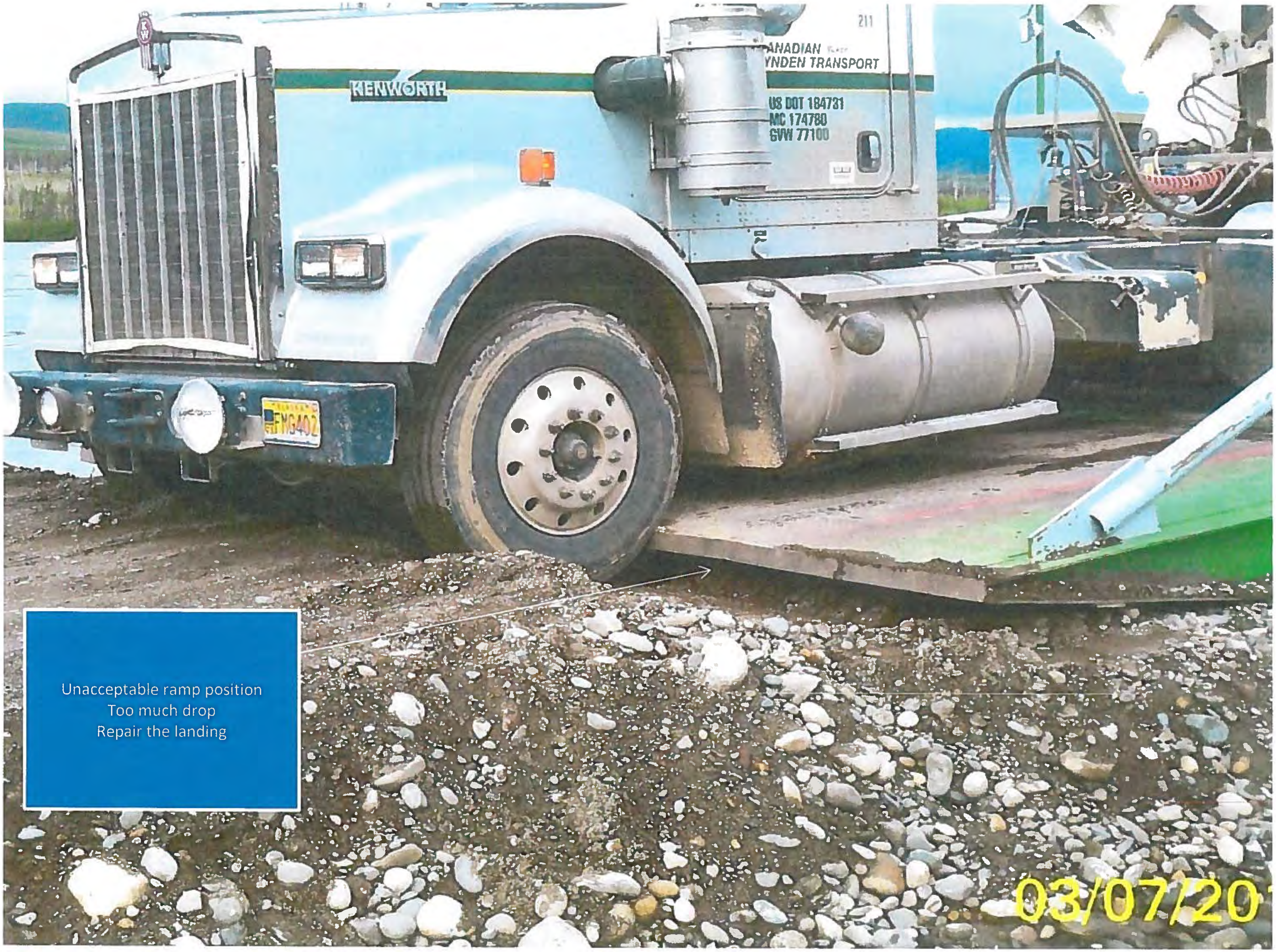
	Print: **Developed/ Revised by:**	**DD/MM/YYYY**
Worker:		**Date:**
Worker:		**Date:**
JOHSC Representative:	Siana mills	**Date:24/08/2012**
Supervisor:	Stephen Maunder	**Date:26/08/2012**
Supervisor:	Captain Dave Johnstone	**Date: :26/08/2012**
Supervisor:	Jeff Billings	**Date: :26/08/2012**
Supervisor:		**Date:**
JOHSC Representative:		**Date:**
Senior Supervisor:		**Date:**
Senior Supervisor:		**Date:**
Departmental Manager:		**Date:**
	Print & Sign: **Reviewed By:**	
Safety Department:	MARK GOEBEL	
Safety Department:		**Date:** Sept19/12
	Print & Sign: **Approved By:** **Determined by Safety Dept. Enter NA if not applicable.**	**Date:**
Departmental Manager:	stephen maunder	**Date:** 19/09/12
General Manager:		**Date:** 9.20.2012

Clarification of this safe work practice can be directed to the Safety Department.

Name of SWP:
Location: X:\Health & Safety\Safety Public\Procedures and Safe Work Procedures
Last revision date: April 21 2012

Ideal Ramp Position for Loading


Good Ramp Position



Unacceptable ramp position
Too much drop
Repair the landing


Ramp Angle Gauge
Minimum and Maximum Ramp Angle Indicators


Ramp Angle Gauge
Minimum and Maximum Ramp Angle Indicators

Appendix C – Groundwater Quality Monitoring Program Laboratory Results

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 04-JAN-18
Report Date: 16-JAN-18 17:50 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2041421

Project P.O. #: 224161
Job Reference:
C of C Numbers: 2018-01-03 C
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L2041421-1	L2041421-2	L2041421-3	L2041421-4	L2041421-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	31-DEC-17	31-DEC-17	31-DEC-17	31-DEC-17	31-DEC-17
	Sampled Time	11:15	11:50	13:30	13:50	14:15
	Client ID	MW12-06-01	MW12-06-02	MW12-06-03	MW12-06-04	MW12-06-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	702	955	970	966	966
	Hardness (as CaCO3) (mg/L)	290	518	533	530	529
	pH (pH)	7.81	7.70	7.90	7.93	7.92
	Total Suspended Solids (mg/L)	4.7	30.1	6.7	<3.0	<3.0
	TDS (Calculated) (mg/L)	406	664	671	651	635
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	389	356	379	400	400
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	389	356	379	400	400
	Ammonia, Total (as N) (mg/L)	0.0108	0.0252	0.0150	0.0062	0.0061
	Bromide (Br) (mg/L)	<0.050	<0.25 DLDS	<0.25 DLDS	<0.25 DLDS	<0.25 DLDS
	Chloride (Cl) (mg/L)	5.40	<2.5 DLDS	<2.5 DLDS	<2.5 DLDS	<2.5 DLDS
	Nitrate and Nitrite (as N) (mg/L)	0.133	0.158	0.391	0.052	0.069
	Nitrate (as N) (mg/L)	0.0348	0.033	0.077	<0.025 DLDS	<0.025 DLDS
	Nitrite (as N) (mg/L)	0.0981	0.125	0.314	0.0522	0.0688
	Sulfate (SO4) (mg/L)	1.14	222	221	197	182
	Anion Sum (meq/L)	7.96	11.7	12.2	12.1	11.8
	Cation Sum (meq/L)	8.43	12.3	12.5	12.4	12.4
	Cation - Anion Balance (%)	2.9	2.3	1.1	1.1	2.5
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0157	0.0013	0.0019	0.0024	0.0011
	Antimony (Sb)-Dissolved (mg/L)	0.00020	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00663	0.00380	0.00056	0.00242	0.00074
	Barium (Ba)-Dissolved (mg/L)	0.212	0.0249	0.0252	0.0174	0.0418
	Beryllium (Be)-Dissolved (mg/L)	0.000100	0.000052	0.000026	0.000028	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.144	0.084	0.071	0.059	0.058
	Cadmium (Cd)-Dissolved (mg/L)	0.0000104	0.0000076	<0.0000050	0.0000067	0.0000112
	Calcium (Ca)-Dissolved (mg/L)	84.6	144	120	112	105
	Chromium (Cr)-Dissolved (mg/L)	0.00402	<0.00010	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00151
	Copper (Cu)-Dissolved (mg/L)	0.00068	<0.00020	<0.00020	<0.00020	<0.00020
	Iron (Fe)-Dissolved (mg/L)	0.273	1.18	1.39	0.774	0.016
	Lead (Pb)-Dissolved (mg/L)	0.000051	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0091	0.0084	0.0077	0.0065	0.0061
	Magnesium (Mg)-Dissolved (mg/L)	19.1	38.5	56.7	61.0	65.0

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2041421-6	L2041421-7			
	Description	Water	Water			
	Sampled Date	31-DEC-17	31-DEC-17			
	Sampled Time	14:45				
	Client ID	MW12-06-06	DUP			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	817	961			
	Hardness (as CaCO3) (mg/L)	423	520			
	pH (pH)	7.98	7.96			
	Total Suspended Solids (mg/L)	<3.0	<3.0			
	TDS (Calculated) (mg/L)	527	640			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	314	398			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	314	398			
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050			
	Bromide (Br) (mg/L)	DLDS <0.25	DLDS <0.25			
	Chloride (Cl) (mg/L)	6.8	DLDS <2.5			
	Nitrate and Nitrite (as N) (mg/L)	1.10	0.025			
	Nitrate (as N) (mg/L)	1.02	DLDS <0.025			
	Nitrite (as N) (mg/L)	0.0773	0.0252			
	Sulfate (SO4) (mg/L)	155	190			
	Anion Sum (meq/L)	9.78	11.9			
	Cation Sum (meq/L)	9.99	12.1			
	Cation - Anion Balance (%)	1.0	0.7			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	<0.0010	<0.0010			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	<0.00010	0.00070			
	Barium (Ba)-Dissolved (mg/L)	0.0148	0.0431			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.054	0.060			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000104	0.0000095			
	Calcium (Ca)-Dissolved (mg/L)	82.8	109			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00119			
	Copper (Cu)-Dissolved (mg/L)	0.00025	<0.00020			
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.152			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0047	0.0063			
	Magnesium (Mg)-Dissolved (mg/L)	52.6	59.9			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2041421-1 Water 31-DEC-17 11:15 MW12-06-01	L2041421-2 Water 31-DEC-17 11:50 MW12-06-02	L2041421-3 Water 31-DEC-17 13:30 MW12-06-03	L2041421-4 Water 31-DEC-17 13:50 MW12-06-04	L2041421-5 Water 31-DEC-17 14:15 MW12-06-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0802	0.0267	0.0158	0.0444	0.396
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000996	0.00784	0.00400	0.00906	0.00993
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	0.00069
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.73	3.85	4.24	3.96	4.33
	Selenium (Se)-Dissolved (mg/L)	0.000622	0.000057	<0.000050	<0.000050	<0.000050
	Silicon (Si)-Dissolved (mg/L)	7.93	10.9	9.96	9.18	8.97
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	58.6	41.0	38.1	37.2	39.0
	Strontium (Sr)-Dissolved (mg/L)	3.51	10.7	4.93	3.16	2.55
	Sulfur (S)-Dissolved (mg/L)	5.06	76.3	77.1	67.6	66.6
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00015	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00293	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000699	0.00242	0.00269	0.00601	0.00417
	Vanadium (V)-Dissolved (mg/L)	0.0146	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0037	0.0058	0.0096	0.0114	0.0236
	Zirconium (Zr)-Dissolved (mg/L)	0.00122	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2041421-6 Water 31-DEC-17 14:45 MW12-06-06	L2041421-7 Water 31-DEC-17 DUP			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0373	0.366			
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00607	0.00948			
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00059			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	3.74	3.96			
	Selenium (Se)-Dissolved (mg/L)	0.000280	<0.000050			
	Silicon (Si)-Dissolved (mg/L)	7.32	8.92			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	33.0	36.4			
	Strontium (Sr)-Dissolved (mg/L)	1.62	2.90			
	Sulfur (S)-Dissolved (mg/L)	57.4	67.8			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00430	0.00613			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0356	0.0134			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2041421-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2041421-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2041421-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2041421-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2041421-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>ALK-TITR-VA</td><td>Water</td><td>Alkalinity Species by Titration</td><td>APHA 2320 Alkalinity</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.</td></tr>
<tr><td>ANIONS-N+N-CALC-VA</td><td>Water</td><td>Nitrite & Nitrate in Water (Calculation)</td><td>EPA 300.0</td></tr>
<tr><td colspan="4">Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).</td></tr>
<tr><td>BE-D-L-CCMS-VA</td><td>Water</td><td>Diss. Be (low) in Water by CRC ICPMS</td><td>APHA 3030B/6020A (mod)</td></tr>
<tr><td colspan="4">Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.</td></tr>
<tr><td>BR-L-IC-N-VA</td><td>Water</td><td>Bromide in Water by IC (Low Level)</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>CL-IC-N-VA</td><td>Water</td><td>Chloride in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>EC-PCT-VA</td><td>Water</td><td>Conductivity (Automated)</td><td>APHA 2510 Auto. Conduc.</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.</td></tr>
<tr><td>EC-SCREEN-VA</td><td>Water</td><td>Conductivity Screen (Internal Use Only)</td><td>APHA 2510</td></tr>
<tr><td colspan="4">Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.</td></tr>
<tr><td>HARDNESS-CALC-VA</td><td>Water</td><td>Hardness</td><td>APHA 2340B</td></tr>
<tr><td colspan="4">Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.</td></tr>
<tr><td>HG-D-CVAA-VA</td><td>Water</td><td>Diss. Mercury in Water by CVAAS or CVAFS</td><td>APHA 3030B/EPA 1631E (mod)</td></tr>
<tr><td colspan="4">Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.</td></tr>
<tr><td>IONBALANCE-VA</td><td>Water</td><td>Ion Balance Calculation</td><td>APHA 1030E</td></tr>
<tr><td colspan="4">Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.
Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:
Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]</td></tr>
<tr><td>MET-D-CCMS-VA</td><td>Water</td><td>Dissolved Metals in Water by CRC ICPMS</td><td>APHA 3030B/6020A (mod)</td></tr>
<tr><td colspan="4">Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.
Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.</td></tr>
<tr><td>NH3-F-VA</td><td>Water</td><td>Ammonia in Water by Fluorescence</td><td>J. ENVIRON. MONIT., 2005, 7, 37-42, RSC</td></tr>
<tr><td colspan="4">This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.</td></tr>
</table>

Reference Information

NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2018-01-03 C

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

cal

L2041421-COFC

COC Number: 2018-01-03 C

Page of

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)

4 day [P4] ☐

3 day [P3] ☐

2 day [P2] ☐

EMERGENCY

1 Business day [E1] ☐

Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-06-01	31-Dec-17	11:15	Water		R		R	R		R	R						4
	MW12-06-02	31-Dec-17	11:50	Water		R		R	R		R	R						4
	MW12-06-03	31-Dec-17	13:30	Water		R		R	R		R	R						4
	MW12-06-04	31-Dec-17	13:50	Water		R		R	R		R	R						4
	MW12-06-05	31-Dec-17	14:15	Water		R		R	R		R	R						4
	MW12-06-06	31-Dec-17	14:45	Water		R		R	R		R	R						4
	DUP	31-Dec-17		Water		R		R	R		R	R						4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐

Ice Packs ☐ Ice Cubes ☐

Cooling Initiated ☐

SIF Observations Yes ☐ No ☐

Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1°C.			3	5	6

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2018-01-03	Time: 11:00	Received by:	Date: JAN 4/18	Time: 10:45	Received by: JC	Date: JAN - 5 2018	Time: 1325

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 12-DEC-17
Report Date: 29-DEC-17 17:14 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L2034344
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-12-12 B
Legal Site Desc:

Comments:

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2034344-1				
	Description	Water				
	Sampled Date	09-DEC-17				
	Sampled Time	11:15				
	Client ID	MW17-DP03				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1140				
	Hardness (as CaCO3) (mg/L)	408				
	pH (pH)	8.20				
	Total Suspended Solids (mg/L)	<3.0				
	TDS (Calculated) (mg/L)	812				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	210				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	210				
	Ammonia, Total (as N) (mg/L)	4.70				
	Bromide (Br) (mg/L)	<0.25 DLDS				
	Chloride (Cl) (mg/L)	13.6				
	Nitrate and Nitrite (as N) (mg/L)	<0.025				
	Nitrate (as N) (mg/L)	<0.025 DLDS				
	Nitrite (as N) (mg/L)	<0.0050 DLDS				
	Sulfate (SO4) (mg/L)	403				
	Anion Sum (meq/L)	13.0				
	Cation Sum (meq/L)	13.2				
	Cation - Anion Balance (%)	0.9				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	2.48				
Total Metals	Aluminum (Al)-Total (mg/L)	0.0287				
	Antimony (Sb)-Total (mg/L)	<0.00010				
	Arsenic (As)-Total (mg/L)	0.00063				
	Barium (Ba)-Total (mg/L)	0.0254				
	Beryllium (Be)-Total (mg/L)	<0.000020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	0.105				
	Cadmium (Cd)-Total (mg/L)	0.000407				
	Calcium (Ca)-Total (mg/L)	97.8				
	Chromium (Cr)-Total (mg/L)	<0.00010				
	Cobalt (Co)-Total (mg/L)	0.00105				
	Copper (Cu)-Total (mg/L)	0.0543				
	Iron (Fe)-Total (mg/L)	0.057				
	Lead (Pb)-Total (mg/L)	<0.000050				
	Lithium (Li)-Total (mg/L)	0.0082				
	Magnesium (Mg)-Total (mg/L)	33.1				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2034344-1				
	Description	Water				
	Sampled Date	09-DEC-17				
	Sampled Time	11:15				
	Client ID	MW17-DP03				
Grouping	**Analyte**					
WATER						
Total Metals	Manganese (Mn)-Total (mg/L)	0.826				
	Mercury (Hg)-Total (mg/L)	<0.0000050				
	Molybdenum (Mo)-Total (mg/L)	0.0384				
	Nickel (Ni)-Total (mg/L)	0.00370				
	Phosphorus (P)-Total (mg/L)	<0.050				
	Potassium (K)-Total (mg/L)	36.6				
	Selenium (Se)-Total (mg/L)	0.00117				
	Silicon (Si)-Total (mg/L)	3.92				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	70.9				
	Strontium (Sr)-Total (mg/L)	9.78				
	Sulfur (S)-Total (mg/L)	136				
	Thallium (Tl)-Total (mg/L)	0.000022				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	DLM <0.0015				
	Uranium (U)-Total (mg/L)	0.00222				
	Vanadium (V)-Total (mg/L)	<0.00050				
	Zinc (Zn)-Total (mg/L)	<0.0030				
	Zirconium (Zr)-Total (mg/L)	<0.00030				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0018				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00067				
	Barium (Ba)-Dissolved (mg/L)	0.0274				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.096				
	Cadmium (Cd)-Dissolved (mg/L)	0.000424				
	Calcium (Ca)-Dissolved (mg/L)	99.4				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	0.00102				
	Copper (Cu)-Dissolved (mg/L)	0.0519				
	Iron (Fe)-Dissolved (mg/L)	<0.010				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0073				
	Magnesium (Mg)-Dissolved (mg/L)	38.9				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2034344-1				
	Description	Water				
	Sampled Date	09-DEC-17				
	Sampled Time	11:15				
	Client ID	MW17-DP03				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.942				
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.0383				
	Nickel (Ni)-Dissolved (mg/L)	0.00368				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	43.2				
	Selenium (Se)-Dissolved (mg/L)	0.00139				
	Silicon (Si)-Dissolved (mg/L)	3.80				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	81.8				
	Strontium (Sr)-Dissolved (mg/L)	10.5				
	Sulfur (S)-Dissolved (mg/L)	134				
	Thallium (Tl)-Dissolved (mg/L)	0.000018				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.00206				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0015				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Total (as CaCO3)	B	L2034344-1
Matrix Spike	Dissolved Organic Carbon	MS-B	L2034344-1
Matrix Spike	Dissolved Organic Carbon	MS-B	L2034344-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2034344-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2034344-1
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L2034344-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2034344-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2034344-1
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L2034344-1
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2034344-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2034344-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2034344-1
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2034344-1
Matrix Spike	Barium (Ba)-Total	MS-B	L2034344-1
Matrix Spike	Barium (Ba)-Total	MS-B	L2034344-1
Matrix Spike	Barium (Ba)-Total	MS-B	L2034344-1
Matrix Spike	Boron (B)-Total	MS-B	L2034344-1
Matrix Spike	Cadmium (Cd)-Total	MS-B	L2034344-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2034344-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2034344-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2034344-1
Matrix Spike	Copper (Cu)-Total	MS-B	L2034344-1
Matrix Spike	Copper (Cu)-Total	MS-B	L2034344-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2034344-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2034344-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2034344-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L2034344-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L2034344-1
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L2034344-1
Matrix Spike	Potassium (K)-Total	MS-B	L2034344-1
Matrix Spike	Potassium (K)-Total	MS-B	L2034344-1
Matrix Spike	Sodium (Na)-Total	MS-B	L2034344-1
Matrix Spike	Sodium (Na)-Total	MS-B	L2034344-1
Matrix Spike	Sodium (Na)-Total	MS-B	L2034344-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2034344-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2034344-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2034344-1
Matrix Spike	Sulfur (S)-Total	MS-B	L2034344-1
Matrix Spike	Sulfur (S)-Total	MS-B	L2034344-1
Matrix Spike	Sulfur (S)-Total	MS-B	L2034344-1
Matrix Spike	Nitrate (as N)	MS-B	L2034344-1
Matrix Spike	Sulfate (SO4)	MS-B	L2034344-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Reference Information

ALK-TITR-VA Water Alkalinity Species by Titration APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA Water Nitrite & Nitrate in Water (Calculation) EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA Water Diss. Be (low) in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA Water Total Be (Low) in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

BR-L-IC-N-VA Water Bromide in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CARBONS-DOC-VA Water Dissolved organic carbon by combustion APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et

Reference Information

al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-12-12 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

C[illegible] of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2034344-COFC

COC Number: 2017-12-12 B

Page of

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: SR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW17-DP03	9-Dec-17	11:15	Water	R	R	R	R	R	R	R	R						7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0			3		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Shaun Roberts	Date: 2017-12-12	Time: 11:00	Received by: EHF	Date: 12 Dec 2017	Time: 15:40	Received by: Cade	Date: Dec 13	Time: 1315

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form maydelay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 11-DEC-17
Report Date: 20-DEC-17 17:44 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2033487
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-12-08 B
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L2033487-1	L2033487-2	L2033487-3	L2033487-4	
	Description	Water	Water	Water	Water	
	Sampled Date	07-DEC-17	07-DEC-17	07-DEC-17	07-DEC-17	
	Sampled Time	15:00	15:30			
	Client ID	MW09-03-01	MW09-03-02	DUP1	DUP2	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	303	377			
	Hardness (as CaCO3) (mg/L)	151	198		201	
	pH (pH)	8.22	8.24			
	Total Suspended Solids (mg/L)	4.0	3.4			
	TDS (Calculated) (mg/L)	175	225			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	148	197			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	148	197			
	Ammonia, Total (as N) (mg/L)	0.0360	<0.0050	0.0356		
	Bromide (Br) (mg/L)	<0.050	<0.050			
	Chloride (Cl) (mg/L)	<0.50	0.66			
	Fluoride (F) (mg/L)	1.70	0.350			
	Nitrate (as N) (mg/L)	0.0231	3.72			
	Nitrite (as N) (mg/L)	0.151	0.136			
	Sulfate (SO4) (mg/L)	19.7	6.97			
	Anion Sum (meq/L)	3.46	4.39			
	Cation Sum (meq/L)	3.45	4.27			
	Cation - Anion Balance (%)	-0.1	-1.5			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD		FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD		FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0029	<0.0010		<0.0010	
	Antimony (Sb)-Dissolved (mg/L)	0.00012	0.00012		0.00015	
	Arsenic (As)-Dissolved (mg/L)	0.00075	<0.00010		<0.00010	
	Barium (Ba)-Dissolved (mg/L)	0.0643	0.0219		0.0200	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020		<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050		<0.000050	
	Boron (B)-Dissolved (mg/L)	0.165	0.146		0.170	
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000167		0.0000125	
	Calcium (Ca)-Dissolved (mg/L)	41.8	66.1		67.4	
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010		<0.00010	
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010		<0.00010	
	Copper (Cu)-Dissolved (mg/L)	<0.00020	0.00266		0.00260	
	Iron (Fe)-Dissolved (mg/L)	0.340	<0.010		<0.010	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050		<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0037	0.0011		0.0012	
	Magnesium (Mg)-Dissolved (mg/L)	11.2	7.96		7.90	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2033487-1	L2033487-2	L2033487-3	L2033487-4
	Description	Water	Water	Water	Water
	Sampled Date	07-DEC-17	07-DEC-17	07-DEC-17	07-DEC-17
	Sampled Time	15:00	15:30		
	Client ID	MW09-03-01	MW09-03-02	DUP1	DUP2
WATER					
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0802	0.00208		0.00134
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050		<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00442	0.00345		0.00357
	Nickel (Ni)-Dissolved (mg/L)	0.00073	<0.00050		<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050		<0.050
	Potassium (K)-Dissolved (mg/L)	2.04	2.61		2.50
	Selenium (Se)-Dissolved (mg/L)	<0.000050	0.000209		0.000248
	Silicon (Si)-Dissolved (mg/L)	5.33	5.35		5.46
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010		<0.000010
	Sodium (Na)-Dissolved (mg/L)	8.51	5.64		5.76
	Strontium (Sr)-Dissolved (mg/L)	0.944	0.384		0.388
	Sulfur (S)-Dissolved (mg/L)	5.98	2.22		2.09
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010		<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010		<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030		<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000876	0.00327		0.00334
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050		<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0103	0.0195		0.0185
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030		<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2033487-1, -2, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2033487-1, -2, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-12-08 B

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

of Custody (COC) / Analytical
ɑt Form

800 668 9878

L2033487-COFC

COC Number: 2017-12-08 B

Page of

Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
Company address below will appear on the final report	
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐

EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: SR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW09-03-01	7-Dec-17	15:00	Water		R		R	R		R	R						4
	MW09-03-01	7-Dec-17	15:30	Water		R		R	R		R	R						4
	DUP1	7-Dec-17		Water					R									1
	DUP2	7-Dec-17		Water		R												1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1°C			7.8		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-12-08	Time: 12:00	Received by:	Date: Dec 11/17.	Time: 09:35	Received by:	Date: Dec 12th 2017	Time: 12:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	21-NOV-17
Report Date:	28-NOV-17 14:16 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2025311

Project P.O. #:	224161
Job Reference:	
C of C Numbers:	2017-11-21 A
Legal Site Desc:	

Shane Stack
Account Manager

Grouping	Analyte	L2025311-1	L2025311-2	L2025311-3	L2025311-4	L2025311-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	20-NOV-17	20-NOV-17	20-NOV-17	20-NOV-17	20-NOV-17
	Sampled Time	11:30	13:30	13:45	14:00	15:55
	Client ID	MW17-08-01	MW17-08-02	MW17-08-03	MW17-08-04	MW17-10-01
WATER						
Physical Tests	Conductivity (uS/cm)	472	293	279		367
	Hardness (as CaCO3) (mg/L)	274	195	158	88.8	196
	pH (pH)	8.15	8.13	8.16		8.10
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		6.7
	TDS (Calculated) (mg/L)	281	180	160		233
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	230	154	151		120
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	230	154	151		120
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050		0.0275
	Bromide (Br) (mg/L)	0.149	<0.050	<0.050		4.21
	Chloride (Cl) (mg/L)	0.52	0.41	0.43		2.44
	Nitrate and Nitrite (as N) (mg/L)	0.378	0.684	0.851		3.14
	Nitrate (as N) (mg/L)	0.365	0.684	0.851		3.10
	Nitrite (as N) (mg/L)	0.0136	<0.0010	<0.0010		0.0484
	Sulfate (SO4) (mg/L)	43.1	11.7	5.7		61.9
	Anion Sum (meq/L)	5.55	3.40	3.23		4.03
	Cation Sum (meq/L)	5.84	4.16	3.35		4.49
	Cation - Anion Balance (%)	2.5	10.1	1.9		5.4
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0014	0.0027	0.0036	0.0038	0.0084
	Antimony (Sb)-Dissolved (mg/L)	0.00051	0.00017	0.00013	0.00036	0.00042
	Arsenic (As)-Dissolved (mg/L)	0.00026	0.00033	0.00023	0.00028	0.00064
	Barium (Ba)-Dissolved (mg/L)	0.00978	0.105	0.0959	0.0278	0.0290
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.028	0.013	<0.010	<0.010	0.015
	Cadmium (Cd)-Dissolved (mg/L)	0.0000635	0.0000258	0.0000131	0.0000910	0.0000884
	Calcium (Ca)-Dissolved (mg/L)	55.6	45.7	40.5	26.5	50.3
	Chromium (Cr)-Dissolved (mg/L)	0.00019	<0.00010	<0.00010	0.00017	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00029
	Copper (Cu)-Dissolved (mg/L)	0.00068	0.00240	0.00069	0.00053	0.00430
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0022	<0.0010	<0.0010	<0.0010	0.0021
	Magnesium (Mg)-Dissolved (mg/L)	32.9	19.7	13.8	5.50	17.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2025311-6	L2025311-7	L2025311-8		
	Description	Water	Water	Water		
	Sampled Date	20-NOV-17	20-NOV-17	20-NOV-17		
	Sampled Time	16:10	16:45			
	Client ID	MW17-10-02	MW17-10-03	DUP		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	388	405	382		
	Hardness (as CaCO3) (mg/L)	210	205	210		
	pH (pH)	8.07	8.10	8.09		
	Total Suspended Solids (mg/L)	7.3	<3.0	6.0		
	TDS (Calculated) (mg/L)	255	262	256		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	116	115	117		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	116	115	117		
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050		
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050		
	Chloride (Cl) (mg/L)	0.85	0.88	0.82		
	Nitrate and Nitrite (as N) (mg/L)	17.7	19.9	17.7		
	Nitrate (as N) (mg/L)	17.7	19.9	17.7		
	Nitrite (as N) (mg/L)	0.0016	0.0036	0.0022		
	Sulfate (SO4) (mg/L)	24.8	23.3	24.8		
	Anion Sum (meq/L)	4.14	4.25	4.16		
	Cation Sum (meq/L)	4.53	4.42	4.54		
	Cation - Anion Balance (%)	4.5	1.9	4.4		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0026	0.0032	0.0033		
	Antimony (Sb)-Dissolved (mg/L)	0.00011	0.00014	0.00011		
	Arsenic (As)-Dissolved (mg/L)	0.00021	0.00012	0.00015		
	Barium (Ba)-Dissolved (mg/L)	0.0332	0.0334	0.0332		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000365	0.0000561	0.0000369		
	Calcium (Ca)-Dissolved (mg/L)	55.9	55.9	56.7		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	0.00055	0.00071	0.00056		
	Copper (Cu)-Dissolved (mg/L)	0.00343	0.00295	0.00355		
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0013	0.0012	0.0013		
	Magnesium (Mg)-Dissolved (mg/L)	17.0	15.8	16.7		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2025311-1	L2025311-2	L2025311-3	L2025311-4	L2025311-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	20-NOV-17	20-NOV-17	20-NOV-17	20-NOV-17	20-NOV-17
	Sampled Time	11:30	13:30	13:45	14:00	15:55
	Client ID	MW17-08-01	MW17-08-02	MW17-08-03	MW17-08-04	MW17-10-01
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.00136	0.00310	0.00252	0.00129	0.0764
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00908	0.00372	0.00114	0.000714	0.0381
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00100	0.0136
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.91	1.10	1.01	0.73	2.22
	Selenium (Se)-Dissolved (mg/L)	0.000665	0.000729	0.000682	0.000659	0.00290
	Silicon (Si)-Dissolved (mg/L)	5.68	5.78	4.81	4.44	6.02
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000014
	Sodium (Na)-Dissolved (mg/L)	7.08	5.32	3.84	3.52	11.8
	Strontium (Sr)-Dissolved (mg/L)	7.94	1.38	0.919	0.209	1.35
	Sulfur (S)-Dissolved (mg/L)	14.6	4.80	2.30	0.90	22.4
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00025	0.00012
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000263	0.000182	0.000145	0.000076	0.00195
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00088	0.00065	0.00114	0.00080
	Zinc (Zn)-Dissolved (mg/L)	0.0336	0.0224	0.0209	0.137	0.0463
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2025311-6	L2025311-7	L2025311-8		
	Description	Water	Water	Water		
	Sampled Date	20-NOV-17	20-NOV-17	20-NOV-17		
	Sampled Time	16:10	16:45			
	Client ID	MW17-10-02	MW17-10-03	DUP		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.00642	0.00485	0.00649		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00910	0.00902	0.00942		
	Nickel (Ni)-Dissolved (mg/L)	0.00633	0.00592	0.00629		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	1.93	1.94	1.93		
	Selenium (Se)-Dissolved (mg/L)	0.00153	0.00145	0.00141		
	Silicon (Si)-Dissolved (mg/L)	5.99	5.72	5.91		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	6.73	6.33	6.75		
	Strontium (Sr)-Dissolved (mg/L)	1.04	0.906	1.06		
	Sulfur (S)-Dissolved (mg/L)	9.20	8.22	9.22		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00123	0.00112	0.00122		
	Vanadium (V)-Dissolved (mg/L)	0.00053	0.00058	0.00055		
	Zinc (Zn)-Dissolved (mg/L)	0.0365	0.0559	0.0370		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2025311-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2025311-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2025311-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2025311-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2025311-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-21 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2025311-COFC

COC Number: 2017- 11-21 A

Page 1 of 1

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	**Sampler:** CR/CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW17-08-01	20-11-2017	11:30	Water		R		R	R		R	R						4
	MW17-08-02	20-11-2017	13:30	Water		R		R	R		R	R						4
	MW17-08-03	20-11-2017	13:45	Water		R		R	R		R	R						4
	MW17-08-04	20-11-2017	14:00	Water		R												1
	MW17-10-01	20-11-2017	15:55	Water		R		R	R		R	R						4
	MW17-10-02	20-11-2017	16:10	Water		R		R	R		R	R						4
	MW17-10-03	20-11-2017	16:45	Water		R		R	R		R	R						4
	DUP	20-11-2017		Water		R		R	R		R	R						4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3°C			4	3	2

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Corey Roberts	Date:2017-11-21	Time:	Received by:	Date: NOV 21, 2017	Time: 15:40	Received by: Cale	Date: Nov 23	Time: 1300

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 20-NOV-17
Report Date: 28-NOV-17 12:17 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2024714

Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-11-20 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2024714-1	L2024714-2	L2024714-3	L2024714-4	L2024714-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-NOV-17	18-NOV-17	18-NOV-17	18-NOV-17	18-NOV-17
	Sampled Time	14:50	15:20	16:00	16:20	16:50
	Client ID	MW17-11-01	MW17-11-02	MW17-11-03	MW17-11-04	MW17-11-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	308	319	323	496	474
	Hardness (as CaCO3) (mg/L)	130	123	167	280	273
	pH (pH)	8.27	8.25	8.32	8.27	8.28
	Total Suspended Solids (mg/L)	28.7	20.0	3.3	10.0	4.0
	TDS (Calculated) (mg/L)	183	192	194	313	305
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	120	147	158	248	241
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	2.8	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	120	147	161	248	241
	Ammonia, Total (as N) (mg/L)	0.0067	<0.0050	<0.0050	0.0145	<0.0050
	Bromide (Br) (mg/L)	3.23	0.144	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)	1.85	3.19	0.39	0.89	0.82
	Nitrate and Nitrite (as N) (mg/L)	0.111	0.0801	0.374	9.12	9.23
	Nitrate (as N) (mg/L)	0.0674	0.0748	0.335	9.10	9.23
	Nitrite (as N) (mg/L)	0.0435	0.0053	0.0395	0.0181	0.0045
	Sulfate (SO4) (mg/L)	38.7	28.7	21.1	6.3	4.7
	Anion Sum (meq/L)	3.37	3.74	3.79	5.78	5.60
	Cation Sum (meq/L)	3.50	3.58	3.91	6.01	5.81
	Cation - Anion Balance (%)	2.0	-2.1	1.6	2.0	1.9
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0229	0.0047	0.0056	0.0035	0.0014
	Antimony (Sb)-Dissolved (mg/L)	0.00052	0.00029	0.00011	0.00052	0.00024
	Arsenic (As)-Dissolved (mg/L)	0.00063	0.00183	0.00046	0.00024	0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0426	0.0374	0.0719	0.126	0.211
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.050	0.022	0.012	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000538	0.0000187	<0.0000050	0.0000491	0.0000083
	Calcium (Ca)-Dissolved (mg/L)	36.0	32.5	44.1	95.3	96.2
	Chromium (Cr)-Dissolved (mg/L)	0.00017	<0.00010	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00018	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00052	0.00061	0.00033	0.00674	0.00229
	Iron (Fe)-Dissolved (mg/L)	0.026	0.069	<0.010	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.000082	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0052	0.0045	0.0053	0.0026	0.0019
	Magnesium (Mg)-Dissolved (mg/L)	9.75	10.1	13.7	10.3	7.95

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2024714-6				
	Description	Water				
	Sampled Date	18-NOV-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	320				
	Hardness (as CaCO3) (mg/L)	157				
	pH (pH)	8.27				
	Total Suspended Solids (mg/L)	13.3				
	TDS (Calculated) (mg/L)	196				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	151				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	151				
	Ammonia, Total (as N) (mg/L)	<0.0050				
	Bromide (Br) (mg/L)	0.092				
	Chloride (Cl) (mg/L)	0.85				
	Nitrate and Nitrite (as N) (mg/L)	0.0147				
	Nitrate (as N) (mg/L)	0.0127				
	Nitrite (as N) (mg/L)	0.0020				
	Sulfate (SO4) (mg/L)	29.5				
	Anion Sum (meq/L)	3.77				
	Cation Sum (meq/L)	3.87				
	Cation - Anion Balance (%)	1.4				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0070				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00130				
	Barium (Ba)-Dissolved (mg/L)	0.0450				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.017				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000073				
	Calcium (Ca)-Dissolved (mg/L)	43.4				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	<0.00020				
	Iron (Fe)-Dissolved (mg/L)	0.085				
	Lead (Pb)-Dissolved (mg/L)	0.000058				
	Lithium (Li)-Dissolved (mg/L)	0.0057				
	Magnesium (Mg)-Dissolved (mg/L)	11.7				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2024714-1	L2024714-2	L2024714-3	L2024714-4	L2024714-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-NOV-17	18-NOV-17	18-NOV-17	18-NOV-17	18-NOV-17
	Sampled Time	14:50	15:20	16:00	16:20	16:50
	Client ID	MW17-11-01	MW17-11-02	MW17-11-03	MW17-11-04	MW17-11-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0331	0.0532	0.102	0.0488	0.00650
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0257	0.00669	0.00615	0.00407	0.00114
	Nickel (Ni)-Dissolved (mg/L)	0.00102	0.00069	<0.00050	0.00136	0.00067
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.15	2.36	3.86	4.46	3.50
	Selenium (Se)-Dissolved (mg/L)	0.000596	0.00261	0.000586	0.000502	0.000349
	Silicon (Si)-Dissolved (mg/L)	4.98	5.35	5.47	7.26	6.98
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	0.000011	0.000011
	Sodium (Na)-Dissolved (mg/L)	18.9	24.5	11.1	6.68	6.13
	Strontium (Sr)-Dissolved (mg/L)	0.945	0.844	1.16	0.612	0.403
	Sulfur (S)-Dissolved (mg/L)	13.7	8.47	7.49	2.52	1.79
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00034	0.00025	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00165	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000399	0.000757	0.00190	0.00383	0.00338
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0240	0.0656	0.0112	0.0453	0.0450
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2024714-6 Water 18-NOV-17 DUP				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0588				
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00628				
	Nickel (Ni)-Dissolved (mg/L)	<0.00050				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	2.76				
	Selenium (Se)-Dissolved (mg/L)	0.000382				
	Silicon (Si)-Dissolved (mg/L)	5.58				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	15.3				
	Strontium (Sr)-Dissolved (mg/L)	1.13				
	Sulfur (S)-Dissolved (mg/L)	10.3				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.000729				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0159				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2024714-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-20 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2024714-COFC

COC Number: 2017-11-20 A

Page 1 of 1

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report).	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW17-11-01	18-11-2017	14:50	Water		R		R	R		R	R						4
	MW17-11-02	18-11-2017	15:20	Water		R		R	R		R	R						4
	MW17-11-03	18-11-2017	16:00	Water		R		R	R		R	R						4
	MW17-11-04	18-11-2017	16:20	Water		R		R	R		R	R						4
	MW17-11-05	18-11-2017	16:50	Water		R		R	R		R	R						4
	DUP	18-11-2017		Water		R		R	R		R	R						4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐ No ☐
Ice Packs	☑	Ice Cubes	☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated	☑				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0			1.1		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Corey Roberts	Date:2017-11-20	Time:	Received by: EHF	Date: 20 Nov 2017	Time: 16:22	Received by: Cade	Date: Nov 22	Time: 1130

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 16-NOV-17
Report Date: 27-NOV-17 15:06 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2023142
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-11-15 C
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L2023142-1	L2023142-2	L2023142-3	L2023142-4	L2023142-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	14-NOV-17	14-NOV-17	14-NOV-17	14-NOV-17	14-NOV-17
	Sampled Time	13:55	14:30	14:55	15:10	15:45
	Client ID	MW12-06-01	MW12-06-02	MW12-06-03	MW12-06-04	MW12-06-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	700	952	953	937	948
	Hardness (as CaCO3) (mg/L)	286	496	518	528	491
	pH (pH)	8.33	8.20	8.25	8.23	8.21
	Total Suspended Solids (mg/L)	<3.0	137	6.7	5.3	4.7
	TDS (Calculated) (mg/L)	400	647	641	634	622
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	387	358	377	399	406
	Alkalinity, Carbonate (as CaCO3) (mg/L)	6.2	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	394	358	377	399	406
	Ammonia, Total (as N) (mg/L)	0.0067	0.0427	0.0352	0.0068	<0.0050
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)	5.10	0.57	0.48	0.43	0.44
	Nitrate and Nitrite (as N) (mg/L)	0.0518	0.333	0.168	0.0783	0.0666
	Nitrate (as N) (mg/L)	0.0139	0.0668	0.0346	0.0160	0.0155
	Nitrite (as N) (mg/L)	0.0379	0.266	0.133	0.0623	0.0511
	Sulfate (SO4) (mg/L)	<5.0	211	202	182	181
	Anion Sum (meq/L)	8.07	11.7	11.8	11.8	12.0
	Cation Sum (meq/L)	8.08	11.7	12.0	12.2	11.2
	Cation - Anion Balance (%)	0.1	0.2	0.8	1.5	-3.2
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0150	0.0011	0.0028	0.0017	0.0018
	Antimony (Sb)-Dissolved (mg/L)	0.00013	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00590	0.00362	0.00052	0.00227	0.00058
	Barium (Ba)-Dissolved (mg/L)	0.205	0.0226	0.0226	0.0164	0.0344
	Beryllium (Be)-Dissolved (mg/L)	0.000088	0.000045	0.000028	0.000027	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.124	0.069	0.053	0.049	0.048
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	83.1	138	113	110	108
	Chromium (Cr)-Dissolved (mg/L)	0.00312	<0.00010	0.00019	0.00014	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00097
	Copper (Cu)-Dissolved (mg/L)	0.00057	<0.00020	<0.00020	<0.00020	0.00033
	Iron (Fe)-Dissolved (mg/L)	0.256	1.13	1.33	0.723	0.120
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0094	0.0074	0.0068	0.0055	0.0059
	Magnesium (Mg)-Dissolved (mg/L)	19.0	36.6	57.2	61.4	53.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023142-6	L2023142-7			
	Description	Water	Water			
	Sampled Date	14-NOV-17	14-NOV-17			
	Sampled Time	16:05				
	Client ID	MW12-06-06	DUP			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	816	946			
	Hardness (as CaCO3) (mg/L)	429	531			
	pH (pH)	8.30	8.29			
	Total Suspended Solids (mg/L)	<3.0	<3.0			
	TDS (Calculated) (mg/L)	529	639			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	316	402			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	4.8	2.2			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	321	404			
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0064			
	Bromide (Br) (mg/L)	<0.050	<0.050			
	Chloride (Cl) (mg/L)	6.62	0.36			
	Nitrate and Nitrite (as N) (mg/L)	1.10	0.0441			
	Nitrate (as N) (mg/L)	1.06	0.0089			
	Nitrite (as N) (mg/L)	0.0455	0.0352			
	Sulfate (SO4) (mg/L)	154	183			
	Anion Sum (meq/L)	9.92	12.0			
	Cation Sum (meq/L)	9.98	12.2			
	Cation - Anion Balance (%)	0.3	1.1			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	<0.0010	0.0021			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	<0.00010	0.00229			
	Barium (Ba)-Dissolved (mg/L)	0.0132	0.0167			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	0.000030			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.047	0.046			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	83.3	112			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	<0.00020	<0.00020			
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.707			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0044	0.0054			
	Magnesium (Mg)-Dissolved (mg/L)	53.6	61.0			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023142-1	L2023142-2	L2023142-3	L2023142-4	L2023142-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	14-NOV-17	14-NOV-17	14-NOV-17	14-NOV-17	14-NOV-17
	Sampled Time	13:55	14:30	14:55	15:10	15:45
	Client ID	MW12-06-01	MW12-06-02	MW12-06-03	MW12-06-04	MW12-06-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0731	0.0249	0.0149	0.0404	0.299
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000954	0.00791	0.00353	0.00865	0.00973
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.40	3.38	3.73	3.65	3.15
	Selenium (Se)-Dissolved (mg/L)	0.00374	0.000643	0.000422	0.000261	0.000168
	Silicon (Si)-Dissolved (mg/L)	7.79	10.5	9.42	8.92	8.63
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	52.5	38.2	34.8	35.1	30.2
	Strontium (Sr)-Dissolved (mg/L)	3.60	10.8	4.82	3.22	2.96
	Sulfur (S)-Dissolved (mg/L)	6.39	72.8	72.1	63.7	65.5
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00015	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.0030 DLM	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000637	0.00232	0.00253	0.00595	0.00594
	Vanadium (V)-Dissolved (mg/L)	0.0136	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0040 DLB	<0.0050 DLB	<0.0040 DLB	0.0084	0.0100
	Zirconium (Zr)-Dissolved (mg/L)	0.00111	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023142-6	L2023142-7			
	Description	Water	Water			
	Sampled Date	14-NOV-17	14-NOV-17			
	Sampled Time	16:05				
	Client ID	MW12-06-06	DUP			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0367	0.0410			
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00572	0.00876			
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	3.29	3.56			
	Selenium (Se)-Dissolved (mg/L)	0.000291	0.000074			
	Silicon (Si)-Dissolved (mg/L)	7.01	9.08			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	30.4	34.2			
	Strontium (Sr)-Dissolved (mg/L)	1.60	3.16			
	Sulfur (S)-Dissolved (mg/L)	54.1	64.5			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00411	0.00575			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0116	0.0065			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Zinc (Zn)-Dissolved	MB-LOR	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Boron (B)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2023142-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

Reference Information

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-15 C

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

C / Analytical

Canada Toll Free: 1 800 668 9878

L2023142-COFC

COC Number: 2017-11-15 C

Page of

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
Company address below will appear on the final report		
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact:

Sampler: SR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-06-01	14-Nov-17	13:55	Water		R		R	R		R	R						4
	MW12-06-02	14-Nov-17	14:30	Water		R		R	R		R	R						4
	MW12-06-03	14-Nov-17	14:55	Water		R		R	R		R	R						4
	MW12-06-04	14-Nov-17	15:10	Water		R		R	R		R	R						4
	MW12-06-05	14-Nov-17	15:45	Water		R		R	R		R	R						4
	MW12-06-06	14-Nov-17	16:05	Water		R		R	R		R	R						4
	DUP	14-Nov-17		Water		R		R	R		R	R						4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1°C.					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Shaun Roberts	Date:2017-11-15	Time: 12:00	Received by:	Date: NOV 16/17.	Time: 08:42.	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form maydelay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 16-NOV-17
Report Date: 27-NOV-17 15:57 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2023138
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-11-15 B
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L2023138-1	L2023138-2	L2023138-3	L2023138-4	L2023138-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	12-NOV-17	12-NOV-17	12-NOV-17	12-NOV-17	12-NOV-17
	Sampled Time	10:50	11:25	13:00	13:20	13:45
	Client ID	MW17-12-01	MW17-12-02	MW17-12-03	MW17-12-04	MW17-12-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	2530	2190	851	746	755
	Hardness (as CaCO3) (mg/L)	1100	865	361	388	393
	pH (pH)	7.93	7.98	8.21	8.19	8.21
	Total Suspended Solids (mg/L)	13.6	19.6	5.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	2160	1840	561	480	474
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	197	223	373	339	352
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	197	223	373	339	352
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	0.0060
	Bromide (Br) (mg/L)	DLDS <1.0	DLDS <1.0	DLDS <0.25	DLDS <0.25	DLDS <0.25
	Chloride (Cl) (mg/L)	13	12	DLDS <2.5	DLDS <2.5	DLDS <2.5
	Nitrate (as N) (mg/L)	DLDS <0.10	DLDS <0.10	0.274	0.261	0.336
	Nitrite (as N) (mg/L)	DLDS <0.020	DLDS <0.020	DLDS <0.0050	DLDS <0.0050	DLDS <0.0050
	Sulfate (SO4) (mg/L)	1370	1140	142	115	102
	Anion Sum (meq/L)	32.9	28.6	10.5	9.24	9.24
	Cation Sum (meq/L)	33.0	27.7	10.3	9.31	9.34
	Cation - Anion Balance (%)	0.1	-1.6	-1.2	0.3	0.5
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0023	0.0022	0.0024	0.0035	0.0037
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00232	0.00213	0.00104	0.00018	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.00783	0.0109	0.0189	0.0263	0.0410
	Beryllium (Be)-Dissolved (mg/L)	0.000077	<0.000040	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.147	0.144	0.056	0.036	0.033
	Cadmium (Cd)-Dissolved (mg/L)	0.0000087	<0.000010	<0.0000050	0.0000113	0.0000151
	Calcium (Ca)-Dissolved (mg/L)	342	269	84.8	69.9	69.2
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00020	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00020	0.00010	0.00012	0.00026
	Copper (Cu)-Dissolved (mg/L)	<0.00020	<0.00040	<0.00020	0.00374	0.00086
	Iron (Fe)-Dissolved (mg/L)	3.08	2.29	0.470	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0181	0.0134	0.0085	0.0069	0.0071
	Magnesium (Mg)-Dissolved (mg/L)	60.7	46.9	36.3	51.8	53.5
	Manganese (Mn)-Dissolved (mg/L)	0.108	0.0537	0.104	0.0149	0.0764

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2023138-6	L2023138-7	L2023138-8
	Description	Water	Water	Water
	Sampled Date	12-NOV-17	12-NOV-17	12-NOV-17
	Sampled Time	14:05	14:30	14:50
	Client ID	MW17-12-06	MW17-12-07	MW17-12-08
Grouping	**Analyte**			
WATER				
Physical Tests	Conductivity (uS/cm)	730	556	557
	Hardness (as CaCO3) (mg/L)	385	285	285
	pH (pH)	8.27	8.23	8.27
	Total Suspended Solids (mg/L)	3.4	<3.0	4.6
	TDS (Calculated) (mg/L)	462	333	337
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	348	251	255
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	348	251	255
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050
	Bromide (Br) (mg/L)	<0.25 DLDS	<0.050	<0.050
	Chloride (Cl) (mg/L)	<2.5 DLDS	4.03	4.00
	Nitrate (as N) (mg/L)	0.046	0.970	0.963
	Nitrite (as N) (mg/L)	<0.0050 DLDS	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	94.1	60.9	60.8
	Anion Sum (meq/L)	8.96	6.49	6.58
	Cation Sum (meq/L)	9.26	6.69	6.75
	Cation - Anion Balance (%)	1.7	1.5	1.3
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0028	0.0030	0.0024
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0511	0.0227	0.0240
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.032	0.024	0.024
	Cadmium (Cd)-Dissolved (mg/L)	0.0000223	<0.0000050	0.0000075
	Calcium (Ca)-Dissolved (mg/L)	67.6	50.0	50.5
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00054	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00077	0.00122	0.00151
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0095	0.0055	0.0056
	Magnesium (Mg)-Dissolved (mg/L)	52.5	38.8	38.6
	Manganese (Mn)-Dissolved (mg/L)	0.531	0.00558	0.00518

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2023138-1	L2023138-2	L2023138-3	L2023138-4	L2023138-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	12-NOV-17	12-NOV-17	12-NOV-17	12-NOV-17	12-NOV-17
	Sampled Time	10:50	11:25	13:00	13:20	13:45
	Client ID	MW17-12-01	MW17-12-02	MW17-12-03	MW17-12-04	MW17-12-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00748	0.00840	0.00601	0.00711	0.00780
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.0010	0.00069	0.00103	0.00136
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.10	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.75	3.32	2.94	3.34	3.78
	Selenium (Se)-Dissolved (mg/L)	0.000060	<0.00010	<0.000050	0.000569	0.000588
	Silicon (Si)-Dissolved (mg/L)	7.67	7.74	7.97	7.04	7.14
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000020	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	246	235	68.1	33.9	31.8
	Strontium (Sr)-Dissolved (mg/L)	10.5	10.9	3.79	1.49	1.67
	Sulfur (S)-Dissolved (mg/L)	522	391	44.7	37.7	33.7
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000020	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00051	<0.00020	0.00014	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00060	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000232	0.000530	0.00455	0.00434	0.00446
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.0010	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0385	0.0230	0.0286	0.0257	0.0372
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023138-6	L2023138-7	L2023138-8		
	Description	Water	Water	Water		
	Sampled Date	12-NOV-17	12-NOV-17	12-NOV-17		
	Sampled Time	14:05	14:30	14:50		
	Client ID	MW17-12-06	MW17-12-07	MW17-12-08		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.0448	0.00801	0.0110		
	Nickel (Ni)-Dissolved (mg/L)	0.00268	<0.00050	<0.00050		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	4.88	2.71	2.78		
	Selenium (Se)-Dissolved (mg/L)	0.000532	0.000345	0.000340		
	Silicon (Si)-Dissolved (mg/L)	6.59	6.66	6.84		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	32.8	21.5	22.6		
	Strontium (Sr)-Dissolved (mg/L)	1.92	1.01	1.01		
	Sulfur (S)-Dissolved (mg/L)	33.0	20.9	21.4		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00372	0.00270	0.00266		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00062	0.00066		
	Zinc (Zn)-Dissolved (mg/L)	0.0218	0.0180	0.0213		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Zinc (Zn)-Dissolved	MB-LOR	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Boron (B)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfate (SO4)	MS-B	L2023138-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-15 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2023138-COFC

COC Number: 2017-11-15 B

Page of

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	P	F/P	P	F/P	P	F/P								
					Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
	MW17-12-01	12-Nov-17	10:50	Water		R		R	R		R	R						4
	MW17-12-02	12-Nov-17	11:25	Water		R		R	R		R	R						4
	MW17-12-03	12-Nov-17	13:00	Water		R		R	R		R	R						4
	MW17-12-04	12-Nov-17	13:20	Water		R		R	R		R	R						4
	MW17-12-05	12-Nov-17	13:45	Water		R		R	R		R	R						4
	MW17-12-06	12-Nov-17	14:05	Water		R		R	R		R	R						4
	MW17-12-07	12-Nov-17	14:30	Water		R		R	R		R	R						4
	MW17-12-08	12-Nov-17	14:50	Water		R		R	R		R	R						4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2°C.					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Shaun Roberts	Date:2017-11-15	Time: 12:00	Received by:	Date: Nov 16/17	Time: 08:42	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form maydelay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using anAuthorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	16-NOV-17
Report Date:	28-NOV-17 11:32 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2023110

Project P.O. #:	224161
Job Reference:	
C of C Numbers:	2017-11-15 A
Legal Site Desc:	

Comments:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023110-1	L2023110-2	L2023110-3	L2023110-4	L2023110-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-NOV-17	11-NOV-17	11-NOV-17	11-NOV-17	11-NOV-17
	Sampled Time	10:45	11:15	11:35	11:55	13:35
	Client ID	MW12-05-01	MW12-05-02	MW12-05-03	MW12-05-04	MW12-05-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	2110	2060	1800	487	479
	Hardness (as CaCO3) (mg/L)	940	1000	818	221	250
	pH (pH)	7.89	8.06	7.95	8.14	8.15
	Total Suspended Solids (mg/L)	9.0	4.6	9.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	1780	1700	1430	273	286
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	133	184	234	245	220
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	133	184	234	245	220
	Ammonia, Total (as N) (mg/L)	0.0249	0.0175	0.0122	0.0173	0.0119
	Bromide (Br) (mg/L)	<0.50 DLDS	<0.50 DLDS	<0.50 DLDS	<0.050	<0.050
	Chloride (Cl) (mg/L)	13.0	11.7	9.7	5.18	5.17
	Nitrate and Nitrite (as N) (mg/L)	<0.051	<0.051	<0.051	0.0293	0.238
	Nitrate (as N) (mg/L)	<0.050 DLDS	<0.050 DLDS	<0.050 DLDS	<0.0050	0.194
	Nitrite (as N) (mg/L)	0.043	0.035	0.036	0.0293	0.0438
	Sulfate (SO4) (mg/L)	1170	1070	883	25.2	47.9
	Anion Sum (meq/L)	27.4	26.3	23.4	5.60	5.59
	Cation Sum (meq/L)	26.0	26.4	21.3	5.40	5.74
	Cation - Anion Balance (%)	-2.7	0.1	-4.7	-1.8	1.3
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0054	0.0048	0.0029	0.0049	0.0025
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00010	<0.00010	<0.00010	0.00011
	Arsenic (As)-Dissolved (mg/L)	0.00064	0.00030	0.00021	0.00014	0.00061
	Barium (Ba)-Dissolved (mg/L)	0.0369	0.0871	0.0438	0.0677	0.0696
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.110	0.104	0.093	0.065	0.063
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000081
	Calcium (Ca)-Dissolved (mg/L)	312	312	210	44.6	52.2
	Chromium (Cr)-Dissolved (mg/L)	0.00023	0.00029	<0.00010	0.00017	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00021	<0.00020	<0.00020	<0.00020	0.00117
	Iron (Fe)-Dissolved (mg/L)	0.032	0.071	0.531	0.101	0.012
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0086	0.0058	0.0047	0.0031	0.0036
	Magnesium (Mg)-Dissolved (mg/L)	38.9	54.0	71.5	26.7	29.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023110-6	L2023110-7			
	Description	Water	Water			
	Sampled Date	11-NOV-17	11-NOV-17			
	Sampled Time	13:55	14:15			
	Client ID	MW12-05-06	MW12-05-07			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	480	494			
	Hardness (as CaCO3) (mg/L)	250	258			
	pH (pH)	8.14	8.16			
	Total Suspended Solids (mg/L)	<3.0	<3.0			
	TDS (Calculated) (mg/L)	284	291			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	217	242			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	217	242			
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0238			
	Bromide (Br) (mg/L)	<0.050	<0.050			
	Chloride (Cl) (mg/L)	5.08	4.84			
	Nitrate and Nitrite (as N) (mg/L)	0.276	0.0087			
	Nitrate (as N) (mg/L)	0.229	<0.0050			
	Nitrite (as N) (mg/L)	0.0470	0.0087			
	Sulfate (SO4) (mg/L)	48.8	38.7			
	Anion Sum (meq/L)	5.55	5.81			
	Cation Sum (meq/L)	5.70	5.89			
	Cation - Anion Balance (%)	1.4	0.7			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0021	0.0018			
	Antimony (Sb)-Dissolved (mg/L)	0.00012	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00047	0.00044			
	Barium (Ba)-Dissolved (mg/L)	0.0613	0.333			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.062	0.027			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000142	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	52.6	55.3			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	0.00011	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00130	<0.00020			
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.365			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0037	0.0031			
	Magnesium (Mg)-Dissolved (mg/L)	28.8	29.2			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023110-1	L2023110-2	L2023110-3	L2023110-4	L2023110-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-NOV-17	11-NOV-17	11-NOV-17	11-NOV-17	11-NOV-17
	Sampled Time	10:45	11:15	11:35	11:55	13:35
	Client ID	MW12-05-01	MW12-05-02	MW12-05-03	MW12-05-04	MW12-05-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.148	0.827	2.31	0.500	0.132
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000125	0.000231	0.000229	0.00311	0.00371
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.82	4.17	4.15	2.26	1.89
	Selenium (Se)-Dissolved (mg/L)	0.000295	0.000222	0.000122	0.000107	0.000110
	Silicon (Si)-Dissolved (mg/L)	7.56	6.88	7.04	6.35	6.33
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	163	142	109	20.6	15.9
	Strontium (Sr)-Dissolved (mg/L)	8.51	11.2	7.83	0.833	0.758
	Sulfur (S)-Dissolved (mg/L)	479	425	277	12.5	15.6
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	0.00011	<0.00010	0.00019
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000892	0.000567	0.00123	0.00138	0.00265
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0030 DLB	<0.0045 DLB	<0.0040 DLB	<0.0035 DLB	0.0202
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2023110-6 Water 11-NOV-17 13:55 MW12-05-06	L2023110-7 Water 11-NOV-17 14:15 MW12-05-07			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0816	0.696			
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00379	0.00246			
	Nickel (Ni)-Dissolved (mg/L)	0.00060	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	1.82	1.71			
	Selenium (Se)-Dissolved (mg/L)	0.000161	0.000233			
	Silicon (Si)-Dissolved (mg/L)	6.17	6.46			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	15.2	14.6			
	Strontium (Sr)-Dissolved (mg/L)	0.748	0.756			
	Sulfur (S)-Dissolved (mg/L)	15.7	18.4			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	0.00011	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00287	0.00451			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0373	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Zinc (Zn)-Dissolved	MB-LOR	L2023110-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Boron (B)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2023110-1, -2, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L2023110-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Reference Information

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-15 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

78

L2023110-COFC

COC Number: 2017-11-15 A

Page of

o companyname below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☑ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: SR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Dissolved Bromide (Br-D)						Number of Containers
					P	F/P	P	F/P	P	F/P								
1	MW12-05-01	11-Nov-17	10:45	Water		R		R	R		R	R						4
2	MW12-05-02	11-Nov-17	11:15	Water		R		R	R		R	R						4
3	MW12-05-03	11-Nov-17	11:35	Water		R		R	R		R	R						4
4	MW12-05-04	11-Nov-17	11:55	Water		R		R	R		R	R						4
5	MW12-05-05	11-Nov-17	13:35	Water		R		R	R		R	R						4
6	MW12-05-06	11-Nov-17	13:55	Water		R		R	R		R	R						4
7	MW12-05-07	11-Nov-17	14:15	Water		R		R	R		R	R						4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1°C					

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts

Date: 2017-11-15

Time: 12:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by:

Date: NOV16/17

Time: 08:42

FINAL SHIPMENT RECEPTION (lab use only)

Received by:

Date:

Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

✓

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 14-NOV-17
Report Date: 28-NOV-17 16:38 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2021805
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-11-11 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2021805-1	L2021805-2	L2021805-3	L2021805-4	L2021805-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	08-NOV-17	08-NOV-17	09-NOV-17	09-NOV-17	08-NOV-17
	Sampled Time	15:30	16:20	10:10	10:55	
	Client ID	MW09-03-01	MW09-03-02	MW12-07-01	MW12-07-02	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	298	346	1180	1390	360
	Hardness (as CaCO3) (mg/L)	155	194	554	716	202
	pH (pH)	8.11	8.11	7.96	7.86	8.05
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	180	213	840	1150	217
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	150	183	374	102	184
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	150	183	374	102	184
	Ammonia, Total (as N) (mg/L)	0.0371	<0.0050	0.604	0.0340	<0.0050
	Bromide (Br) (mg/L)	<0.050	<0.050	DLDS <0.25	DLDS <0.25	<0.050
	Chloride (Cl) (mg/L)	0.37	0.67	1.30	1.12	0.60
	Nitrate and Nitrite (as N) (mg/L)	0.955	3.41	0.648	0.326	3.40
	Nitrate (as N) (mg/L)	0.0117	3.26	0.193	0.094	3.28
	Nitrite (as N) (mg/L)	0.944	0.155	0.455	0.232	0.112
	Sulfate (SO4) (mg/L)	20.3	6.4	311	747	6.5
	Anion Sum (meq/L)	3.49	4.06	14.0	17.7	4.08
	Cation Sum (meq/L)	3.60	4.19	15.0	17.7	4.35
	Cation - Anion Balance (%)	1.6	1.6	3.5	0.1	3.2
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0024	0.0016	0.0020	0.0019	0.0011
	Antimony (Sb)-Dissolved (mg/L)	0.00016	0.00010	<0.00010	<0.00010	0.00012
	Arsenic (As)-Dissolved (mg/L)	0.00077	<0.00010	0.00040	0.00135	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0617	0.0191	0.104	0.0103	0.0186
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	0.000039	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.260	0.126	0.568	0.296	0.158
	Cadmium (Cd)-Dissolved (mg/L)	0.0000066	0.0000201	<0.0000050	<0.0000050	0.0000163
	Calcium (Ca)-Dissolved (mg/L)	42.7	65.2	188	228	68.6
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00040	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	<0.00020	0.00250	<0.00020	0.00037	0.00249
	Iron (Fe)-Dissolved (mg/L)	0.350	<0.010	0.060	0.141	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0041	0.0012	0.0294	0.0330	0.0013
	Magnesium (Mg)-Dissolved (mg/L)	11.9	7.67	20.6	35.7	7.54

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2021805-1	L2021805-2	L2021805-3	L2021805-4	L2021805-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	08-NOV-17	08-NOV-17	09-NOV-17	09-NOV-17	08-NOV-17
	Sampled Time	15:30	16:20	10:10	10:55	
	Client ID	MW09-03-01	MW09-03-02	MW12-07-01	MW12-07-02	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0863	0.00190	0.111	0.117	0.00162
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00512	0.00382	0.000968	0.0194	0.00384
	Nickel (Ni)-Dissolved (mg/L)	0.00093	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.16	2.40	2.71	2.93	2.43
	Selenium (Se)-Dissolved (mg/L)	0.000112	0.000219	0.00128	0.000230	0.000244
	Silicon (Si)-Dissolved (mg/L)	5.62	5.59	8.38	5.98	5.53
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.45	5.51	88.4	75.8	5.63
	Strontium (Sr)-Dissolved (mg/L)	0.972	0.376	8.20	10.8	0.386
	Sulfur (S)-Dissolved (mg/L)	6.49	2.05	114	253	2.03
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00020	0.00020	<0.00010	<0.00010	0.00053
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000962	0.00316	0.000113	0.00185	0.00314
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00121	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0130	0.0266	0.0039	0.0120	0.0244
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2021805-1, -2, -3, -4, -5
Matrix Spike	Ammonia, Total (as N)	MS-B	L2021805-3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-11 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2021805-COFC

COC Number: 2017-11-11 A

Page of

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW09-03-01	8-Nov-17	15:30	Water		R		R	R		R							4
	MW09-03-02	8-Nov-17	16:20	Water		R		R	R		R							4
	MW12-07-01	9-Nov-17	10:10	Water		R		R	R		R							4
	MW12-07-02	9-Nov-17	10:55	Water		R		R	R		R							4
	DUP	8-Nov-17		Water		R		R	R		R							4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
-1.0				5°C	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Shaun Roberts	Date:2017-11-11	Time: 11:00	Received by: EHF	Date: 14 Nov 2017	Time: 09:15	Received by:	Date: Nov 15	Time: 2:30pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 25-OCT-17
Report Date: 15-NOV-17 18:36 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2012848

Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-10-24 B
Legal Site Desc:

Comments:

Shane Stack
Account Manager

	Sample ID	L2012848-1	L2012848-2	L2012848-3	L2012848-4	L2012848-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	20-OCT-17	20-OCT-17	20-OCT-17	20-OCT-17	20-OCT-17
	Sampled Time	14:05	14:40			16:45
	Client ID	MW09-03-01	MW09-03-02	DUP1	DUP2	MW12-07-01
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	297	371			1150
	Hardness (as CaCO3) (mg/L)	140	184			479
	pH (pH)	8.16	8.06			8.02
	Total Suspended Solids (mg/L)	<3.0	<3.0			7.6
	TDS (Calculated) (mg/L)	171	213			753
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	145	187			459
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	145	187			459
	Ammonia, Total (as N) (mg/L)	0.0327	<0.0050			0.587
	Chloride (Cl) (mg/L)	<0.50	0.81			<2.5 DLDS
	Nitrate and Nitrite (as N) (mg/L)	0.196	3.27			2.10
	Nitrate (as N) (mg/L)	<0.0050	3.21	3.11		0.623
	Nitrite (as N) (mg/L)	0.196	0.0596			1.47
	Sulfate (SO4) (mg/L)	20.4	6.96			193
	Anion Sum (meq/L)	3.42	4.15			13.4
	Cation Sum (meq/L)	3.30	4.07			13.7
	Cation - Anion Balance (%)	-1.8	-0.9			1.3
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD		FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0021	0.0015			0.0045
	Antimony (Sb)-Dissolved (mg/L)	0.00012	<0.00010			<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00074	<0.00010		0.00093	0.00271
	Barium (Ba)-Dissolved (mg/L)	0.0645	0.0200			0.112
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			0.000036
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			<0.000050
	Boron (B)-Dissolved (mg/L)	0.206	0.079			0.556
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000132			0.0000113
	Calcium (Ca)-Dissolved (mg/L)	37.7	61.3			160
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			0.00015
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			<0.00010
	Copper (Cu)-Dissolved (mg/L)	<0.00020	0.00271			0.00036
	Iron (Fe)-Dissolved (mg/L)	0.321	<0.010			0.045
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0039	0.0016			0.0239
	Magnesium (Mg)-Dissolved (mg/L)	11.1	7.53			19.4
	Manganese (Mn)-Dissolved (mg/L)	0.0805	0.00263			0.111

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2012848-6				
	Description	Water				
	Sampled Date	20-OCT-17				
	Sampled Time	17:15				
	Client ID	MW12-07-02				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1430				
	Hardness (as CaCO3) (mg/L)	661				
	pH (pH)	7.92				
	Total Suspended Solids (mg/L)	3.8				
	TDS (Calculated) (mg/L)	1140				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	104				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	104				
	Ammonia, Total (as N) (mg/L)	0.0220				
	Chloride (Cl) (mg/L)	DLDS <2.5				
	Nitrate and Nitrite (as N) (mg/L)	0.355				
	Nitrate (as N) (mg/L)	0.107				
	Nitrite (as N) (mg/L)	0.248				
	Sulfate (SO4) (mg/L)	752				
	Anion Sum (meq/L)	17.8				
	Cation Sum (meq/L)	16.7				
	Cation - Anion Balance (%)	-3.2				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0026				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00292				
	Barium (Ba)-Dissolved (mg/L)	0.0119				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.213				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000252				
	Calcium (Ca)-Dissolved (mg/L)	207				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	0.00056				
	Iron (Fe)-Dissolved (mg/L)	0.114				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0276				
	Magnesium (Mg)-Dissolved (mg/L)	34.8				
	Manganese (Mn)-Dissolved (mg/L)	0.109				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2012848-1 Water 20-OCT-17 14:05 MW09-03-01	L2012848-2 Water 20-OCT-17 14:40 MW09-03-02	L2012848-3 Water 20-OCT-17 DUP1	L2012848-4 Water 20-OCT-17 DUP2	L2012848-5 Water 20-OCT-17 16:45 MW12-07-01
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00461	0.00329			0.000840
	Nickel (Ni)-Dissolved (mg/L)	0.00102	<0.00050			0.00061
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			<0.050
	Potassium (K)-Dissolved (mg/L)	2.07	2.30			2.83
	Selenium (Se)-Dissolved (mg/L)	0.000056	0.000254			0.00348
	Silicon (Si)-Dissolved (mg/L)	5.25	5.40			8.70
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.81	7.64			92.9
	Strontium (Sr)-Dissolved (mg/L)	0.937	0.347			7.22
	Sulfur (S)-Dissolved (mg/L)	6.22	1.93			71.4
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	0.00184			0.00028
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000961	0.00301			0.000161
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			0.00144
	Zinc (Zn)-Dissolved (mg/L)	0.0174	0.0137			0.0127
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2012848-6				
	Description	Water				
	Sampled Date	20-OCT-17				
	Sampled Time	17:15				
	Client ID	MW12-07-02				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.0180				
	Nickel (Ni)-Dissolved (mg/L)	<0.00050				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	2.83				
	Selenium (Se)-Dissolved (mg/L)	0.000203				
	Silicon (Si)-Dissolved (mg/L)	5.73				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	78.8				
	Strontium (Sr)-Dissolved (mg/L)	10.7				
	Sulfur (S)-Dissolved (mg/L)	245				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.00164				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0051				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2012848-1, -2, -5, -6
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2012848-1, -2, -5, -6
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2012848-1, -2, -5, -6
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2012848-1, -2, -5, -6
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2012848-1, -2, -5, -6
Matrix Spike	Ammonia, Total (as N)	MS-B	L2012848-5
Matrix Spike	Sulfate (SO4)	MS-B	L2012848-1, -2, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-10-24 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2012848-COFC

COC Number: 2017-10-24 B

Page 1 of 1

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)

- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY

- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	P Total Metals(TM)	F/P Disolved Metals (DM)	P Total Mercury, Hardness	F/P Dissolved Mercury	P Ammonia (Total Nutrients)	F/P Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	NO3	Dissolved As					Number of Containers
1 1	MW09-03-01	20-Oct-17	14:05	Water		R		R	R		R							4
2 2	MW09-03-02	20-Oct-17	14:40	Water		R		R	R		R							4
3 3	DUP1	20-Oct-17		Water								R						1
4 4	DUP2	20-Oct-17		Water									R					1
5 5	MW12-07-01	20-Oct-17	16:45	Water		R		R	R		R							4
6 6	MW12-07-02	20-Oct-17	17:15	Water		R		R	R		R							4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐ No ☐
Ice Packs	☐	Ice Cubes	☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4°C			6		

SHIPMENT RELEASE (client use)

Released by:Chris Harry	Date:2017-10-24 9:00	Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: ②	Date: OCT 25/17.	Time: 11:02

FINAL SHIPMENT RECEPTION (lab use only)

Received by: JC	Date: 10/26/17	Time: 12pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form maydelay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 23-OCT-17
Report Date: 09-NOV-17 13:28 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2011870
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-10-20 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2011870-1	L2011870-2	L2011870-3		
	Description	Water	Water	Water		
	Sampled Date	19-OCT-17	19-OCT-17	19-OCT-17		
	Sampled Time	15:45	16:10	16:30		
	Client ID	MW17-DP01	MW17-DP02	MW17-DP03		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	868	1610	1180		
	Hardness (as CaCO3) (mg/L)		662	334		
	pH (pH)	8.32	8.14	8.20		
	Total Suspended Solids (mg/L)	7500	87.4	327		
	TDS (Calculated) (mg/L)	540	1190	798		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	218	231	166		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	5.4	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	223	231	166		
	Ammonia, Total (as N) (mg/L)	1.62	11.5	3.71		
	Chloride (Cl) (mg/L)	25.6	44.7	17.7		
	Nitrate and Nitrite (as N) (mg/L)	<0.025	24.2	0.039		
	Nitrate (as N) (mg/L)	<0.025 DLDS	23.8	0.030		
	Nitrite (as N) (mg/L)	0.0060	0.422	0.0093		
	Sulfate (SO4) (mg/L)	192	575	425		
	Anion Sum (meq/L)	9.37	19.6	12.8		
	Cation Sum (meq/L)	8.43	17.1	12.0		
	Cation - Anion Balance (%)	-5.3	-6.9	-3.0		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	9.56	5.76	5.03		
Total Metals	Aluminum (Al)-Total (mg/L)		6.76	3.76		
	Antimony (Sb)-Total (mg/L)		0.00033	0.00033		
	Arsenic (As)-Total (mg/L)		0.00178	0.00252		
	Barium (Ba)-Total (mg/L)		0.162	0.0903		
	Beryllium (Be)-Total (mg/L)		0.000224	0.000373		
	Bismuth (Bi)-Total (mg/L)		0.000072	0.000070		
	Boron (B)-Total (mg/L)		0.268	0.133		
	Cadmium (Cd)-Total (mg/L)		0.000992	0.00121		
	Calcium (Ca)-Total (mg/L)		168	92.7		
	Chromium (Cr)-Total (mg/L)		0.0225	0.0283		
	Cobalt (Co)-Total (mg/L)		0.00599	0.00625		
	Copper (Cu)-Total (mg/L)		0.628	2.43		
	Iron (Fe)-Total (mg/L)		13.0	12.6		
	Lead (Pb)-Total (mg/L)		0.00334	0.00681		
	Lithium (Li)-Total (mg/L)		0.0152	0.0097		
	Magnesium (Mg)-Total (mg/L)		65.8	31.4		
	Manganese (Mn)-Total (mg/L)		1.92	1.64		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2011870-1	L2011870-2	L2011870-3		
	Description	Water	Water	Water		
	Sampled Date	19-OCT-17	19-OCT-17	19-OCT-17		
	Sampled Time	15:45	16:10	16:30		
	Client ID	MW17-DP01	MW17-DP02	MW17-DP03		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)		<0.000025 DLM	0.000252		
	Molybdenum (Mo)-Total (mg/L)		0.107	0.0199		
	Nickel (Ni)-Total (mg/L)		0.0200	0.0285		
	Phosphorus (P)-Total (mg/L)		0.280	0.621		
	Potassium (K)-Total (mg/L)		33.0	42.7		
	Selenium (Se)-Total (mg/L)		0.00201	0.00132		
	Silicon (Si)-Total (mg/L)		15.9	9.64		
	Silver (Ag)-Total (mg/L)		0.000241	0.000055		
	Sodium (Na)-Total (mg/L)		50.2	89.4		
	Strontium (Sr)-Total (mg/L)		20.2	8.83		
	Sulfur (S)-Total (mg/L)		193	152		
	Thallium (Tl)-Total (mg/L)		0.000129	0.000091		
	Tin (Sn)-Total (mg/L)		0.00092	0.00031		
	Titanium (Ti)-Total (mg/L)		0.404	0.0721		
	Uranium (U)-Total (mg/L)		0.0103	0.00147		
	Vanadium (V)-Total (mg/L)		0.0279	0.0222		
	Zinc (Zn)-Total (mg/L)		0.0625	0.0554		
	Zirconium (Zr)-Total (mg/L)		0.00055	0.00077		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0149	0.0128	0.0103		
	Antimony (Sb)-Dissolved (mg/L)	0.00074	0.00021	0.00026		
	Arsenic (As)-Dissolved (mg/L)	0.00074	0.00072	0.00066		
	Barium (Ba)-Dissolved (mg/L)	0.0401	0.0277	0.0434		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.257	0.246	0.125		
	Cadmium (Cd)-Dissolved (mg/L)	0.000494	0.000599	0.000255		
	Calcium (Ca)-Dissolved (mg/L)	41.9	161	84.9		
	Chromium (Cr)-Dissolved (mg/L)	0.00098	0.00030	0.00055		
	Cobalt (Co)-Dissolved (mg/L)	0.00093	0.00236	0.00161		
	Copper (Cu)-Dissolved (mg/L)	0.0733	0.0518	0.0724		
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.013	0.012		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0054	0.0120	0.0078		
	Magnesium (Mg)-Dissolved (mg/L)	13.6	62.9	29.7		
	Manganese (Mn)-Dissolved (mg/L)	0.498	1.61	1.27		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2011870-1	L2011870-2	L2011870-3
	Description	Water	Water	Water
	Sampled Date	19-OCT-17	19-OCT-17	19-OCT-17
	Sampled Time	15:45	16:10	16:30
	Client ID	MW17-DP01	MW17-DP02	MW17-DP03
Grouping	**Analyte**			
WATER				
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000137
	Molybdenum (Mo)-Dissolved (mg/L)	0.0407	0.108	0.0328 DTMF
	Nickel (Ni)-Dissolved (mg/L)	0.0210	0.0136	0.0183
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	24.5	32.3	42.7
	Selenium (Se)-Dissolved (mg/L)	0.000710	0.00200	0.00162 DTMF
	Silicon (Si)-Dissolved (mg/L)	2.69	3.96	3.96
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000013	<0.000010
	Sodium (Na)-Dissolved (mg/L)	103	50.0	90.5
	Strontium (Sr)-Dissolved (mg/L)	3.15	20.3	8.52
	Sulfur (S)-Dissolved (mg/L)	60.7	193	145
	Thallium (Tl)-Dissolved (mg/L)	0.000013	0.000039	0.000041
	Tin (Sn)-Dissolved (mg/L)	0.00060	0.00026	0.00013
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00060 DLM	<0.00060 DLM
	Uranium (U)-Dissolved (mg/L)	0.000711	0.00962	0.000488
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0258	0.0103	0.0050
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L2011870-1, -2, -3
Matrix Spike	Dissolved Organic Carbon	MS-B	L2011870-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2011870-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2011870-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2011870-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2011870-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2011870-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2011870-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2011870-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2011870-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2011870-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2011870-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2011870-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2011870-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2011870-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2011870-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2011870-1
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2011870-1
Matrix Spike	Barium (Ba)-Total	MS-B	L2011870-2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L2011870-2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2011870-2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L2011870-2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L2011870-2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L2011870-2, -3
Matrix Spike	Sulfate (SO4)	MS-B	L2011870-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTMF	Dissolved concentration exceeds total for field-filtered metals sample. Metallic contaminants were likely introduced to dissolved sample during field filtration.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are

Reference Information

determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-VA Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-10-20 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2011870-COFC

COC Number: 2017-10-20 A

Page 1 of 1

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Number of Containers
					P	F/P	P	F/P	P	F/P		
	MW17-DP01	19-Oct-17	15:45	Water		R		R	R	R	R	5
	MW17-DP02	19-Oct-17	16:10	Water	R	R	R	R	R	R	R	7
	MW17-DP03	19-Oct-17	16:30	Water	R	R	R	R	R	R	R	7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
0° To 1°C			5.4		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-10-20 10:00	Time:	Received by: ②	Date: OCT 23/17	Time: 16:04	Received by:	Date: Oct 25/17	Time: 12:08

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 30-AUG-17
Report Date: 05-OCT-17 19:35 (MT)
Version: FINAL REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1983905

Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-08-30 B
Legal Site Desc:

Comments: 5-OCT-2017 Please note, this report has been revised to include additional bromide data.

Shane Stack
Account Manager

	Sample ID	L1983905-1	L1983905-2	L1983905-3	L1983905-4	L1983905-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	29-AUG-17	29-AUG-17	29-AUG-17	29-AUG-17	29-AUG-17
	Sampled Time	10:35	11:05	11:25	11:40	13:25
	Client ID	MW12-06-01	MW12-06-02	MW12-06-03	MW12-06-04	MW12-06-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	801	1040	1040	1020	1000
	Hardness (as CaCO3) (mg/L)	267	453	475	483	494
	pH (pH)	7.60	7.66	7.74	7.83	7.81
	Total Suspended Solids (mg/L)	3.3	80.0	5.3	4.0	6.0
	TDS (Calculated) (mg/L)	387	644	619	627	630
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	364	357	354	398	400
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	364	357	354	398	400
	Ammonia, Total (as N) (mg/L)	0.612	0.0519	0.0673	0.0110	0.0131
	Bromide (Br) (mg/L)					
	Chloride (Cl) (mg/L)	5.02	0.77	0.65	0.64	0.64
	Nitrate and Nitrite (as N) (mg/L)	1.19	0.343	0.169	0.153	0.151
	Nitrate (as N) (mg/L)	0.251	0.083	0.038	0.034	0.034
	Nitrite (as N) (mg/L)	0.936	0.259	0.131	0.118	0.117
	Sulfate (SO4) (mg/L)	<5.0	224	206	190	188
	Anion Sum (meq/L)	7.51	11.8	11.4	11.9	11.9
	Cation Sum (meq/L)	8.07	10.9	11.2	11.3	11.5
	Cation - Anion Balance (%)	3.6	-4.0	-0.7	-2.7	-1.7
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0182	0.0012	0.0017	0.0015	0.0015
	Antimony (Sb)-Dissolved (mg/L)	0.00042	<0.00010	0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00828	0.00403	0.00062	0.00238	0.00076
	Barium (Ba)-Dissolved (mg/L)	0.224	0.0305	0.0256	0.0176	0.0418
	Beryllium (Be)-Dissolved (mg/L)	0.000095	0.000039	0.000022	0.000028	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.989	0.182	0.108	0.101	0.101
	Cadmium (Cd)-Dissolved (mg/L)	0.0000112	<0.0000050	0.0000247	0.0000054	0.0000103
	Calcium (Ca)-Dissolved (mg/L)	79.0	127	107	103	102
	Chromium (Cr)-Dissolved (mg/L)	0.00314	<0.00010	0.00026	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00117
	Copper (Cu)-Dissolved (mg/L)	0.00337	<0.00020	<0.00020	<0.00020	0.00024
	Iron (Fe)-Dissolved (mg/L)	0.222	1.10	1.14	0.706	0.137
	Lead (Pb)-Dissolved (mg/L)	0.000064	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0090	0.0078	0.0072	0.0061	0.0062
	Magnesium (Mg)-Dissolved (mg/L)	17.0	32.8	50.7	54.8	58.2

	Sample ID	L1983905-6	L1983905-7	L1983905-8		
	Description	Water	Water	Water		
	Sampled Date	29-AUG-17	29-AUG-17	29-AUG-17		
	Sampled Time	13:40		16:28		
	Client ID	MW12-06-06	DUP	MW17-09-01		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	845	833	400		
	Hardness (as CaCO3) (mg/L)	401	402	808		
	pH (pH)	7.84	7.87	8.15		
	Total Suspended Solids (mg/L)	<3.0	<3.0	89.0		
	TDS (Calculated) (mg/L)	519	522	621		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	315	318	175		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	315	318	175		
	Ammonia, Total (as N) (mg/L)	0.0050	<0.0050	0.120		
	Bromide (Br) (mg/L)			<0.050		
	Chloride (Cl) (mg/L)	6.48	6.51	44.1		
	Nitrate and Nitrite (as N) (mg/L)	1.18	1.17	1.18		
	Nitrate (as N) (mg/L)	1.10	1.10	1.11		
	Nitrite (as N) (mg/L)	0.0793	0.0756	0.0653		
	Sulfate (SO4) (mg/L)	155	155	56.8		
	Anion Sum (meq/L)	9.80	9.86	6.01		
	Cation Sum (meq/L)	9.50	9.50	21.8		
	Cation - Anion Balance (%)	-1.5	-1.9	56.8		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0016	<0.0010	0.0056		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00425		
	Arsenic (As)-Dissolved (mg/L)	<0.00010	<0.00010	0.00276		
	Barium (Ba)-Dissolved (mg/L)	0.0146	0.0144	0.113		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	DLM <0.000040		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	DLM <0.00010		
	Boron (B)-Dissolved (mg/L)	0.075	0.077	0.129		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000055	0.0000070	DLM <0.00025		
	Calcium (Ca)-Dissolved (mg/L)	77.4	79.7	198		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00020		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00277		
	Copper (Cu)-Dissolved (mg/L)	0.00036	0.00032	0.00459		
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	1.41		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	0.00016		
	Lithium (Li)-Dissolved (mg/L)	0.0047	0.0048	0.0256		
	Magnesium (Mg)-Dissolved (mg/L)	50.5	49.3	76.2		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1983905-1 Water 29-AUG-17 10:35 MW12-06-01	L1983905-2 Water 29-AUG-17 11:05 MW12-06-02	L1983905-3 Water 29-AUG-17 11:25 MW12-06-03	L1983905-4 Water 29-AUG-17 11:40 MW12-06-04	L1983905-5 Water 29-AUG-17 13:25 MW12-06-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0799	0.0260	0.0149	0.0408	0.356
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00104	0.00715	0.00174	0.00771	0.00850
	Nickel (Ni)-Dissolved (mg/L)	0.00073	<0.00050	<0.00050	<0.00050	0.00083
	Phosphorus (P)-Dissolved (mg/L)	0.055	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.55	3.53	3.96	3.72	3.96
	Selenium (Se)-Dissolved (mg/L)	0.000560	<0.000050	<0.000050	<0.000050	<0.000050
	Silicon (Si)-Dissolved (mg/L)	7.67	10.1	9.35	8.73	8.31
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	60.0	39.4	36.6	35.0	35.7
	Strontium (Sr)-Dissolved (mg/L)	3.04	9.24	4.11	2.85	2.56
	Sulfur (S)-Dissolved (mg/L)	2.48	71.4	69.8	62.5	60.5
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00022	<0.00010	0.00013	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00236	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000720	0.00234	0.00215	0.00562	0.00589
	Vanadium (V)-Dissolved (mg/L)	0.0136	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0066	0.0029	0.0092	0.0125	0.0185
	Zirconium (Zr)-Dissolved (mg/L)	0.00109	<0.00030	<0.00030	<0.00030	<0.00030

	Sample ID	L1983905-6	L1983905-7	L1983905-8		
	Description	Water	Water	Water		
	Sampled Date	29-AUG-17	29-AUG-17	29-AUG-17		
	Sampled Time	13:40		16:28		
	Client ID	MW12-06-06	DUP	MW17-09-01		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0383	0.0384	0.490		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00514	0.00539	0.464		
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	0.0183		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	DLM <0.10		
	Potassium (K)-Dissolved (mg/L)	3.50	3.49	15.4		
	Selenium (Se)-Dissolved (mg/L)	0.000316	0.000332	0.0111		
	Silicon (Si)-Dissolved (mg/L)	7.22	6.82	27.6		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	DLM <0.000020		
	Sodium (Na)-Dissolved (mg/L)	32.0	31.5	118		
	Strontium (Sr)-Dissolved (mg/L)	1.42	1.51	3.17		
	Sulfur (S)-Dissolved (mg/L)	55.0	52.0	127		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	DLM <0.000020		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	0.00290		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	DLM <0.00075		
	Uranium (U)-Dissolved (mg/L)	0.00403	0.00407	0.000552		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	DLM <0.0010		
	Zinc (Zn)-Dissolved (mg/L)	0.0133	0.0147	0.141		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Boron (B)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Cadmium (Cd)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1983905-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-30 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1983905-COFC

COC Number: 2017-08-30 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Dissolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions						Number of Containers
					P	F/P	P	F/P	P	F/P							
	MW12-06-01	29-Aug-17	10:35	Water		E1		E1	E1		E1						4
	MW12-06-02	29-Aug-17	11:05	Water		E1		E1	E1		E1						4
	MW12-06-03	29-Aug-17	11:25	Water		E1		E1	E1		E1						4
	MW12-06-04	29-Aug-17	11:40	Water		E1		E1	E1		E1						4
	MW12-06-05	29-Aug-17	13:25	Water		E1		E1	E1		E1						4
	MW12-06-06	29-Aug-17	13:40	Water		E1		E1	E1		E1						4
	DUP	29-Aug-17		Water		E1		E1	E1		E1						4
	MW17-09-01	29-Aug-17	16:28	Water		E1		E1	E1		E1						4

RUSH

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☒ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES ºC			FINAL COOLER TEMPERATURES ºC		
7°C			10		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-08-30 7:45	Time:	Received by:	Date: Aug 30/17	Time: 14:33	Received by:	Date: 9/1/17	Time: 18:20

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 16-AUG-17
Report Date: 29-AUG-17 15:24 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1976082
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-08-16 B
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1976082-1	L1976082-2	L1976082-3		
	Description	Water	Water	Water		
	Sampled Date	15-AUG-17	15-AUG-17	15-AUG-17		
	Sampled Time	15:35	16:00			
	Client ID	MW12-07-01	MW12-07-02	DUP		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1100	1460	1450		
	Hardness (as CaCO3) (mg/L)	454	660	671		
	pH (pH)	7.83	7.88	7.87		
	Total Suspended Solids (mg/L)	<3.0	<3.0	4.0		
	TDS (Calculated) (mg/L)	599	1130	1140		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	554	106	105		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	554	106	105		
	Ammonia, Total (as N) (mg/L)	0.218	0.0387	0.0234		
	Chloride (Cl) (mg/L)	<2.5 DLDS	<2.5 DLDS	<2.5 DLDS		
	Nitrate and Nitrite (as N) (mg/L)	0.133	0.281	0.283		
	Nitrate (as N) (mg/L)	0.044	0.081	0.088		
	Nitrite (as N) (mg/L)	0.0891	0.199	0.195		
	Sulfate (SO4) (mg/L)	12.4	754	756		
	Anion Sum (meq/L)	11.3	17.8	17.9		
	Cation Sum (meq/L)	12.6	16.2	16.5		
	Cation - Anion Balance (%)	5.4	-4.7	-4.0		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0049	0.0047	0.0025		
	Antimony (Sb)-Dissolved (mg/L)	0.00013	0.00012	0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00034	0.00142	0.00144		
	Barium (Ba)-Dissolved (mg/L)	0.127	0.0137	0.0137		
	Beryllium (Be)-Dissolved (mg/L)	0.000046	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.388	0.204	0.209		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000115	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	155	213	217		
	Chromium (Cr)-Dissolved (mg/L)	0.00025	<0.00010	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	<0.00020	0.00070	0.00028		
	Iron (Fe)-Dissolved (mg/L)	0.035	0.132	0.132		
	Lead (Pb)-Dissolved (mg/L)	0.000380	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0261	0.0282	0.0285		
	Magnesium (Mg)-Dissolved (mg/L)	16.3	30.9	31.6		
	Manganese (Mn)-Dissolved (mg/L)	0.103	0.0986	0.100		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1976082-1	L1976082-2	L1976082-3		
	Description	Water	Water	Water		
	Sampled Date	15-AUG-17	15-AUG-17	15-AUG-17		
	Sampled Time	15:35	16:00			
	Client ID	MW12-07-01	MW12-07-02	DUP		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.000252	0.0178	0.0179		
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	2.62	2.74	2.73		
	Selenium (Se)-Dissolved (mg/L)	0.00145	0.000193	0.000137		
	Silicon (Si)-Dissolved (mg/L)	9.16	5.90	5.93		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	79.9	68.3	69.3		
	Strontium (Sr)-Dissolved (mg/L)	6.50	10.5	10.5		
	Sulfur (S)-Dissolved (mg/L)	31.4	245	253		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	0.00258	0.00043	0.00043		
	Titanium (Ti)-Dissolved (mg/L)	0.00053	0.00042	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.000152	0.00180	0.00175		
	Vanadium (V)-Dissolved (mg/L)	0.00162	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0041	0.0032	0.0027		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Antimony (Sb)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1976082-1, -2, -3
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1976082-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Reference Information

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

2017-08-16 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1976082-COFC

COC Number: 2017-08-16 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	**Sampler:** CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	P Total Metals(TM)	F/P Disolved Metals (DM)	P Total Mercury, Hardness	F/P Dissolved Mercury	P Ammonia (Total Nutrients)	F/P Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions	Number of Containers
1	MW12-07-01	15-Aug-17	15:35	Water		R		R	R		R	4
2	MW12-07-02	15-Aug-17	16:00	Water								4
3	DUP	15-Aug-17		Water								4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5°C.					

SHIPMENT RELEASE (client use)		
Released by:Chris Harry	Date:2017-08-16 8:30	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: Aug 16/17.	Time: 14:22

FINAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: Aug 17/17.	Time: 1318

6.7.3°C

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 16-AUG-17
Report Date: 25-AUG-17 17:56 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1975619
Project P.O. #: 224161
Job Reference:
C of C Numbers: 2017-08-15 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1975619-1	L1975619-2	L1975619-3	L1975619-4	
	Description	Water	Water	Water	Water	
	Sampled Date	13-AUG-17	13-AUG-17	13-AUG-17	13-AUG-17	
	Sampled Time	09:20	10:00			
	Client ID	MW09-03-01	MW09-03-02	DUP1	DUP2	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	310	379			
	Hardness (as CaCO3) (mg/L)	140	183	140		
	pH (pH)	8.28	8.28			
	Total Suspended Solids (mg/L)	<3.0	15.3			
	TDS (Calculated) (mg/L)	169	213			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	147	196			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	147	196			
	Ammonia, Total (as N) (mg/L)	0.0404	<0.0050		<0.0050	
	Chloride (Cl) (mg/L)	<0.50	0.70			
	Nitrate and Nitrite (as N) (mg/L)	0.0654	2.76			
	Nitrate (as N) (mg/L)	<0.0050	2.69			
	Nitrite (as N) (mg/L)	0.0654	0.0683			
	Sulfate (SO4) (mg/L)	20.0	6.5			
	Anion Sum (meq/L)	3.36	4.27			
	Cation Sum (meq/L)	3.27	3.95			
	Cation - Anion Balance (%)	-1.3	-3.9			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0031	0.0040	0.0025		
	Antimony (Sb)-Dissolved (mg/L)	0.00033	0.00010	0.00028		
	Arsenic (As)-Dissolved (mg/L)	0.00095	0.00012	0.00086		
	Barium (Ba)-Dissolved (mg/L)	0.0717	0.0674	0.0715		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.234	0.093	0.236		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000136	0.0000194	0.0000073		
	Calcium (Ca)-Dissolved (mg/L)	37.3	60.0	37.8		
	Chromium (Cr)-Dissolved (mg/L)	0.00012	<0.00010	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	DLB <0.00040	0.00340	<0.00020		
	Iron (Fe)-Dissolved (mg/L)	0.339	0.015	0.339		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0040	0.0014	0.0040		
	Magnesium (Mg)-Dissolved (mg/L)	11.4	8.05	11.1		
	Manganese (Mn)-Dissolved (mg/L)	0.0873	0.0178	0.0874		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1975619-1	L1975619-2	L1975619-3	L1975619-4	
	Description	Water	Water	Water	Water	
	Sampled Date	13-AUG-17	13-AUG-17	13-AUG-17	13-AUG-17	
	Sampled Time	09:20	10:00			
	Client ID	MW09-03-01	MW09-03-02	DUP1	DUP2	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00448	0.00511	0.00454		
	Nickel (Ni)-Dissolved (mg/L)	0.00102	<0.00050	0.00099		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	2.18	2.51	2.14		
	Selenium (Se)-Dissolved (mg/L)	0.000082	0.000211	0.000080		
	Silicon (Si)-Dissolved (mg/L)	5.25	5.04	5.06		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	8.98	5.15	8.86		
	Strontium (Sr)-Dissolved (mg/L)	0.909	0.378	0.927		
	Sulfur (S)-Dissolved (mg/L)	6.94	2.38	6.60		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	0.00016	0.00027	0.00017		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.000982	0.00358	0.00101		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0304	0.0179	0.0308		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Copper (Cu)-Dissolved	MB-LOR	L1975619-1, -3
Method Blank	Lead (Pb)-Dissolved	MB-LOR	L1975619-1, -3
Method Blank	Zinc (Zn)-Dissolved	MB-LOR	L1975619-1, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1975619-2
Matrix Spike	Boron (B)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1975619-2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1975619-2
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1975619-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1975619-2
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1975619-2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are

Reference Information

included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-15 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1975619-COFC

COC Number: 2017-08-15 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
Company address below will appear on the final report		
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM) (P)	Disolved Metals (DM) (F/P)	Total Mercury, Hardness (P)	Dissolved Mercury (F/P)	Ammonia (Total Nutrients) (P)	Dissolved Organic Carbon (DOC) (F/P)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
	MW09-03-01	13-Aug-17	9:20	Water		R		R	R		R							4
	MW09-03-02	13-Aug-17	10:00	Water		R		R	R		R							4
	DUP1	13-Aug-17		Water		R												1
	DUP2	13-Aug-17		Water					R									1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 5°C.
FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-08-15 8:00	Time:	Received by:	Date: Aug 16, 2017	Time: 09:15	Received by: GK	Date: Aug 17/17	Time: 13:15

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

6,7,3°C

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-AUG-17
Report Date: 14-AUG-17 13:18 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1968910

Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-08-01 B
Legal Site Desc:

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968910-1	L1968910-2	L1968910-3	L1968910-4	L1968910-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	28-JUL-17	28-JUL-17	29-JUL-17	29-JUL-17	29-JUL-17
	Sampled Time	14:00	14:45	10:55	11:50	
	Client ID	MW12-07-01	MW12-07-02	MW09-03-01	MW09-03-02	DUP 1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1100	1450	319	352	
	Hardness (as CaCO3) (mg/L)	480	700	151	183	145
	pH (pH)	7.85	7.85	8.17	8.03	
	Total Suspended Solids (mg/L)	6.1	4.3	<3.0	9.1	
	TDS (Calculated) (mg/L)	637	1130	178	202	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	573	111	148	179	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	573	111	148	179	
	Ammonia, Total (as N) (mg/L)	0.279	0.0221	0.0853	0.0088	
	Chloride (Cl) (mg/L)	<2.5 DLDS	<2.5 DLDS	0.42	0.57	
	Fluoride (F) (mg/L)	1.01	1.23	1.76	0.427	
	Nitrate and Nitrite (as N) (mg/L)	0.188	0.302	0.270	2.32	
	Nitrate (as N) (mg/L)	0.060	0.094	0.0211	2.18	
	Nitrite (as N) (mg/L)	0.128	0.208	0.249	0.145	
	Sulfate (SO4) (mg/L)	15.9	722	21.9	7.1	
	Anion Sum (meq/L)	11.9	17.3	3.53	3.93	
	Cation Sum (meq/L)	13.7	17.5	3.52	4.00	
	Cation - Anion Balance (%)	7.4	0.4	-0.2	0.8	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0026	0.0014	0.0026	0.0028	0.0044
	Antimony (Sb)-Dissolved (mg/L)	0.00026	0.00014	0.00041	0.00016	0.00141
	Arsenic (As)-Dissolved (mg/L)	0.00081	0.00164	0.00085	0.00021	0.00109
	Barium (Ba)-Dissolved (mg/L)	0.146	0.0167	0.0695	0.169	0.0676
	Beryllium (Be)-Dissolved (mg/L)	0.000037	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.399	0.245	0.216	0.153	3.64
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.000010 DLM	<0.0000050	0.0000732	0.0000338
	Calcium (Ca)-Dissolved (mg/L)	159	219	40.2	58.5	38.8
	Chromium (Cr)-Dissolved (mg/L)	0.00020	<0.00010	<0.00010	0.00013	0.00111
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	<0.00020	<0.00020	0.00029	0.00229	0.00120
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	0.284
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.000127	<0.000050	<0.000050	0.000070
	Lithium (Li)-Dissolved (mg/L)	0.0267	0.0287	0.0039	0.0013	0.0039
	Magnesium (Mg)-Dissolved (mg/L)	20.1	37.4	12.3	8.86	11.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968910-6				
	Description	WATER				
	Sampled Date	29-JUL-17				
	Sampled Time					
	Client ID	DUP 2				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)					
	Hardness (as CaCO3) (mg/L)					
	pH (pH)					
	Total Suspended Solids (mg/L)					
	TDS (Calculated) (mg/L)					
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)					
	Alkalinity, Carbonate (as CaCO3) (mg/L)					
	Alkalinity, Hydroxide (as CaCO3) (mg/L)					
	Alkalinity, Total (as CaCO3) (mg/L)					
	Ammonia, Total (as N) (mg/L)	0.0076				
	Chloride (Cl) (mg/L)					
	Fluoride (F) (mg/L)					
	Nitrate and Nitrite (as N) (mg/L)					
	Nitrate (as N) (mg/L)					
	Nitrite (as N) (mg/L)					
	Sulfate (SO4) (mg/L)					
	Anion Sum (meq/L)					
	Cation Sum (meq/L)					
	Cation - Anion Balance (%)					
Dissolved Metals	Dissolved Mercury Filtration Location					
	Dissolved Metals Filtration Location					
	Aluminum (Al)-Dissolved (mg/L)					
	Antimony (Sb)-Dissolved (mg/L)					
	Arsenic (As)-Dissolved (mg/L)					
	Barium (Ba)-Dissolved (mg/L)					
	Beryllium (Be)-Dissolved (mg/L)					
	Bismuth (Bi)-Dissolved (mg/L)					
	Boron (B)-Dissolved (mg/L)					
	Cadmium (Cd)-Dissolved (mg/L)					
	Calcium (Ca)-Dissolved (mg/L)					
	Chromium (Cr)-Dissolved (mg/L)					
	Cobalt (Co)-Dissolved (mg/L)					
	Copper (Cu)-Dissolved (mg/L)					
	Iron (Fe)-Dissolved (mg/L)					
	Lead (Pb)-Dissolved (mg/L)					
	Lithium (Li)-Dissolved (mg/L)					
	Magnesium (Mg)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1968910-1	L1968910-2	L1968910-3	L1968910-4	L1968910-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	28-JUL-17	28-JUL-17	29-JUL-17	29-JUL-17	29-JUL-17
	Sampled Time	14:00	14:45	10:55	11:50	
	Client ID	MW12-07-01	MW12-07-02	MW09-03-01	MW09-03-02	DUP 1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.114	0.110	0.0859	0.0111	0.0874
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.000473	0.0192	0.00491	0.0106	0.0158
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	0.00122	0.00084	0.00106
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.24	3.25	2.48	3.16	2.62
	Selenium (Se)-Dissolved (mg/L)	0.000277	0.000104	<0.000050	0.000202	0.000418
	Silicon (Si)-Dissolved (mg/L)	9.72	6.31	5.45	5.32	6.39
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	92.9	78.6	9.69	6.10	27.9
	Strontium (Sr)-Dissolved (mg/L)	6.79	11.1	1.01	0.405	0.939
	Sulfur (S)-Dissolved (mg/L)	11.1	267	7.85	2.72	6.92
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	0.00020	0.00011	0.00047
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000159	0.00180	0.000981	0.00341	0.000939
	Vanadium (V)-Dissolved (mg/L)	0.00183	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0327	0.0153	0.0228	0.0291	0.0213
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968910-6				
	Description	WATER				
	Sampled Date	29-JUL-17				
	Sampled Time					
	Client ID	DUP 2				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)					
	Mercury (Hg)-Dissolved (mg/L)					
	Molybdenum (Mo)-Dissolved (mg/L)					
	Nickel (Ni)-Dissolved (mg/L)					
	Phosphorus (P)-Dissolved (mg/L)					
	Potassium (K)-Dissolved (mg/L)					
	Selenium (Se)-Dissolved (mg/L)					
	Silicon (Si)-Dissolved (mg/L)					
	Silver (Ag)-Dissolved (mg/L)					
	Sodium (Na)-Dissolved (mg/L)					
	Strontium (Sr)-Dissolved (mg/L)					
	Sulfur (S)-Dissolved (mg/L)					
	Thallium (Tl)-Dissolved (mg/L)					
	Tin (Sn)-Dissolved (mg/L)					
	Titanium (Ti)-Dissolved (mg/L)					
	Uranium (U)-Dissolved (mg/L)					
	Vanadium (V)-Dissolved (mg/L)					
	Zinc (Zn)-Dissolved (mg/L)					
	Zirconium (Zr)-Dissolved (mg/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Fluoride (F)	MS-B	L1968910-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-01 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.

mg/kg wwt - milligrams per kilogram based on wet weight of sample.

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.

mg/L - milligrams per litre.

< - Less than.

D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).

N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1968910-COFC

COC Number: 2017- 08 - 01 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-07-01	28-Jul-17	14:00	Water		R		R	R		R							4
	MW12-07-02	28-Jul-17	14:45	Water		R		R	R		R							4
	MW09-03-01	29-Jul-17	10:55	Water		R		R	R		R							4
	MW09-03-02	29-Jul-17	11:50	Water		R		R	R		R							4
	DUP 1	29-Jul-17		Water				R										1
	DUP 2	29-Jul-17		Water					R									1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
10.0			5.4	7.5	9.5

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Emilie Bouchard	Date: August 1st, 2017	Time:	Received by: EHT	Date: 2 Aug 2017	Time: 13:30	Received by: Shayan	Date: Aug 3	Time: 1130

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-JUN-17
Report Date: 10-JUL-17 17:36 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1949598

Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-06-23 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte					
	Sample ID	L1949598-1	L1949598-2	L1949598-3	L1949598-4	L1949598-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	22-JUN-17	22-JUN-17	23-JUN-17	23-JUN-17	23-JUN-17
	Sampled Time	16:30	16:45	08:10	08:30	
	Client ID	MW09-03-01	MW09-03-02	MW12-07-01	MW12-07-02	DUP
WATER						
Physical Tests	Conductivity (uS/cm)	314	311	1090	1440	1110
	Hardness (as CaCO3) (mg/L)	152	148	499	707	497
	pH (pH)	8.18	8.23	8.13	7.95	8.13
	Total Suspended Solids (mg/L)	<3.0	7.0	<3.0	<3.0	3.4
	TDS (Calculated) (mg/L)	173	177	646	1140	646
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	144	149	571	106	574
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	144	149	571	106	574
	Ammonia, Total (as N) (mg/L)	0.0466	0.0165	0.325	0.0402	0.233
	Chloride (Cl) (mg/L)	<0.50	0.53	DLDS <2.5	DLDS <2.5	DLDS <2.5
	Nitrate and Nitrite (as N) (mg/L)	0.311	3.35	0.294	0.200	0.261
	Nitrate (as N) (mg/L)	0.0053	2.27	0.089	0.060	0.080
	Nitrite (as N) (mg/L)	0.306	1.08	0.206	0.140	0.180
	Sulfate (SO4) (mg/L)	20.5	9.11	25.3	735	25.3
	Anion Sum (meq/L)	3.34	3.42	12.0	17.4	12.0
	Cation Sum (meq/L)	3.53	3.30	13.8	17.4	13.7
	Cation - Anion Balance (%)	2.8	-1.8	7.1	-0.2	6.7
Dissolved Metals	Dissolved Mercury Filtration Location	LAB	LAB	LAB	LAB	LAB
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0027	0.0026	0.0015	0.0024	0.0018
	Antimony (Sb)-Dissolved (mg/L)	0.00019	0.00032	0.00023	0.00010	0.00020
	Arsenic (As)-Dissolved (mg/L)	0.00106	0.00031	0.00061	0.00174	0.00060
	Barium (Ba)-Dissolved (mg/L)	0.0676	0.0257	0.132	0.0142	0.130
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	0.000039	<0.000020	0.000035
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.253	0.431	0.497	0.246	0.496
	Cadmium (Cd)-Dissolved (mg/L)	0.0000205	0.0000916	<0.0000050	0.0000071	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	41.3	49.2	169	224	168
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00017	0.00031	<0.00010	0.00030
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00015	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00032	0.00225	<0.00020	0.00043	<0.00020
	Iron (Fe)-Dissolved (mg/L)	0.292	0.014	0.016	0.123	0.015
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0039	0.0013	0.0262	0.0278	0.0256
	Magnesium (Mg)-Dissolved (mg/L)	11.9	6.08	18.8	35.8	19.0
	Manganese (Mn)-Dissolved (mg/L)	0.0894	0.0513	0.119	0.112	0.119

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1949598-1	L1949598-2	L1949598-3	L1949598-4	L1949598-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	22-JUN-17	22-JUN-17	23-JUN-17	23-JUN-17	23-JUN-17
	Sampled Time	16:30	16:45	08:10	08:30	
	Client ID	MW09-03-01	MW09-03-02	MW12-07-01	MW12-07-02	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00478	0.00769	0.000889	0.0182	0.000820
	Nickel (Ni)-Dissolved (mg/L)	0.00130	<0.00050	<0.00050	<0.00050	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.23	2.29	2.95	2.98	2.91
	Selenium (Se)-Dissolved (mg/L)	0.000067	0.000216	0.000378	0.000073	0.000271
	Silicon (Si)-Dissolved (mg/L)	5.60	5.00	9.79	6.13	9.66
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.30	6.38	85.1	72.8	85.6
	Strontium (Sr)-Dissolved (mg/L)	1.00	0.309	6.99	11.1	7.03
	Sulfur (S)-Dissolved (mg/L)	6.62	2.70	13.8	243	13.6
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00250	0.00091	0.00042	<0.00010	0.00042
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000874	0.00207	0.000181	0.00156	0.000169
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00182	<0.00050	0.00180
	Zinc (Zn)-Dissolved (mg/L)	0.0092	0.0240	<0.0010	0.0029	0.0011
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-06-23 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1949598-COFC

COC Number: 2017- 06-23 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Di

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

ll E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information	
ALS Account # / Quote #:	
Job #:	
PO / AFE:	224161 (GW)
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact:	**Sampler:** CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
1	MW09-03-01	22-Jun-17	16:30	Water		R		R	R		R							4
2	MW09-03-02	22-Jun-17	16:45	Water		R		R	R		R							4
3	MW12-07-01	23-Jun-17	8:10	Water		R		R	R		R							4
4	MW12-07-02	23-Jun-17	8:30	Water		R		R	R		R							4
5	DUP	23-Jun-17		Water		R		R	R		R							4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
16.0			9	9	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-06-23 10:30	Time:	Received by: EHF	Date: 27 June 2017	Time: 15:30	Received by: ND	Date: 6/28/17	Time: 15:40

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	23-MAY-17
Report Date:	08-JUN-17 18:33 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1929689

Project P.O. #:	224161 (GW)
Job Reference:	
C of C Numbers:	2017-05-22 A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929689-1	L1929689-2	L1929689-3	L1929689-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	20-MAY-17	20-MAY-17	21-MAY-17	21-MAY-17	
	Sampled Time	14:30	17:45	16:20	16:45	
	Client ID	MW09-03-01	MW09-03-02	MW12-07-01	MW12-07-02	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	299	315	1080	1390	
	Hardness (as CaCO3) (mg/L)	141	149	512	685	
	pH (pH)	8.25	8.32	8.23	8.00	
	Total Suspended Solids (mg/L)	<3.0	5.3	<3.0	<3.0	
	TDS (Calculated) (mg/L)	170	178	629	1130	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	140	139	517	99.0	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	3.2	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	140	142	517	99.0	
	Ammonia, Total (as N) (mg/L)	0.0445	0.0355	0.243	0.0384	
	Chloride (Cl) (mg/L)	<0.50	0.54	<2.5 DLDS	<2.5 DLDS	
	Nitrate and Nitrite (as N) (mg/L)	0.286	3.93	0.306	0.293	
	Nitrate (as N) (mg/L)	0.0130	1.99	0.090	0.085	
	Nitrite (as N) (mg/L)	0.273	1.93	0.216	0.208	
	Sulfate (SO4) (mg/L)	20.4	11.7	34.6	741	
	Anion Sum (meq/L)	3.25	3.38	11.1	17.4	
	Cation Sum (meq/L)	3.31	3.51	14.1	17.0	
	Cation - Anion Balance (%)	1.0	1.9	12.1	-1.2	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0028	0.0021	0.0030	0.0175	
	Antimony (Sb)-Dissolved (mg/L)	0.00058	0.00036	<0.00010	<0.00020	
	Arsenic (As)-Dissolved (mg/L)	0.00020	0.00078	0.00050	0.00174	
	Barium (Ba)-Dissolved (mg/L)	0.0534	0.0664	0.123	0.0150	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	0.000041	<0.000040 DLA	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.00010 DLA	
	Boron (B)-Dissolved (mg/L)	0.787	0.423	0.422	0.210	
	Cadmium (Cd)-Dissolved (mg/L)	0.0000890	0.0000083	0.0000130	0.000030	
	Calcium (Ca)-Dissolved (mg/L)	46.5	40.2	174	219	
	Chromium (Cr)-Dissolved (mg/L)	0.00039	<0.00010	0.00028	<0.00020 DLA	
	Cobalt (Co)-Dissolved (mg/L)	0.00056	<0.00010	<0.00010	<0.00020 DLA	
	Copper (Cu)-Dissolved (mg/L)	0.00133	<0.00020	<0.00020	0.00123	
	Iron (Fe)-Dissolved (mg/L)	0.021	0.299	0.051	0.148	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.00010 DLA	
	Lithium (Li)-Dissolved (mg/L)	0.0011	0.0035	0.0262	0.0268	
	Magnesium (Mg)-Dissolved (mg/L)	6.16	11.8	18.8	33.6	
	Manganese (Mn)-Dissolved (mg/L)	0.149	0.0982	0.125	0.110	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929689-1	L1929689-2	L1929689-3	L1929689-4
	Description	WATER	WATER	WATER	WATER
	Sampled Date	20-MAY-17	20-MAY-17	21-MAY-17	21-MAY-17
	Sampled Time	14:30	17:45	16:20	16:45
	Client ID	MW09-03-01	MW09-03-02	MW12-07-01	MW12-07-02
Grouping	**Analyte**				
WATER					
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0124	0.00528	0.000484	0.0181
	Nickel (Ni)-Dissolved (mg/L)	0.00128	0.00107	<0.00050	DLA <0.0010
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	DLA <0.10
	Potassium (K)-Dissolved (mg/L)	2.65	2.19	2.80	3.02
	Selenium (Se)-Dissolved (mg/L)	0.000239	0.000109	0.00196	0.00013
	Silicon (Si)-Dissolved (mg/L)	5.02	5.60	9.69	6.02
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	DLA <0.000020
	Sodium (Na)-Dissolved (mg/L)	9.33	10.5	87.0	74.4
	Strontium (Sr)-Dissolved (mg/L)	0.321	0.960	7.10	10.6
	Sulfur (S)-Dissolved (mg/L)	3.93	7.02	33.3	256
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	DLA <0.000020
	Tin (Sn)-Dissolved (mg/L)	0.00118	0.00014	0.00011	DLA <0.00020
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	DLA <0.00060
	Uranium (U)-Dissolved (mg/L)	0.00218	0.000902	0.000168	0.00160
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00176	DLA <0.0010
	Zinc (Zn)-Dissolved (mg/L)	0.0593	0.0067	0.0027	0.0027
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1929689-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1929689-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1929689-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1929689-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1929689-1, -2, -3, -4
Matrix Spike	Nitrite (as N)	MS-B	L1929689-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et

Reference Information

al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-05-22 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1929689-COFC

COC Number: 2017-05-22 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ ☑ NO
	Copy of Invoice with Report	☐ ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format

Select Report Format: ☑ ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

…m all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions								Number of Containers
					P	F/P	P	F/P	P	F/P									
	MW09-03-01	20-May-17	14:30	Water		R		R	R		R								4
	MW09-03-02	20-May-17	17:45	Water		R		R	R		R								4
	MW12-07-01	21-May-17	16:20	Water		R		R	R		R								4
	MW12-07-02	21-May-17	16:45	Water		R		R	R		R								4

Short Holding Time

○ *Rush Processing*

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ ☑ NO

Are samples for human drinking water use?
☐ ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 7.4

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-05-22 9:00	Time:	Received by: VD	Date: May 23/17	Time: 9:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

CEF May 29/17 9.16°C 12:40

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 04-MAY-17
Report Date: 15-MAY-17 18:00 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1921486

Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-05-03 A
Legal Site Desc:

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1921486-1				
	Description	Water				
	Sampled Date	01-MAY-17				
	Sampled Time	00:10				
	Client ID	MW11-04 A				
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	134				
Anions and Nutrients	Ammonia, Total (as N) (mg/L)	0.0302				
Dissolved Metals	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.707				
	Antimony (Sb)-Dissolved (mg/L)	0.00184				
	Arsenic (As)-Dissolved (mg/L)	0.00352				
	Barium (Ba)-Dissolved (mg/L)	0.156				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	<0.010				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000085				
	Calcium (Ca)-Dissolved (mg/L)	53.8				
	Chromium (Cr)-Dissolved (mg/L)	0.00204				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	0.0852				
	Iron (Fe)-Dissolved (mg/L)	0.021				
	Lead (Pb)-Dissolved (mg/L)	0.000059				
	Lithium (Li)-Dissolved (mg/L)	0.0173				
	Magnesium (Mg)-Dissolved (mg/L)	<0.10				
	Manganese (Mn)-Dissolved (mg/L)	0.00119				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00271				
	Nickel (Ni)-Dissolved (mg/L)	<0.00050				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	3.58				
	Selenium (Se)-Dissolved (mg/L)	0.00261				
	Silicon (Si)-Dissolved (mg/L)	5.77				
	Silver (Ag)-Dissolved (mg/L)	0.000012				
	Sodium (Na)-Dissolved (mg/L)	3.81				
	Strontium (Sr)-Dissolved (mg/L)	0.222				
	Sulfur (S)-Dissolved (mg/L)	2.10				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	0.00021				
	Titanium (Ti)-Dissolved (mg/L)	0.00055				
	Uranium (U)-Dissolved (mg/L)	<0.000010				
	Vanadium (V)-Dissolved (mg/L)	0.0160				
	Zinc (Zn)-Dissolved (mg/L)	0.0024				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-05-03 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1921486-COFC

COC Number: 2017-05-03 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224161 (GW)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler:**

...irm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	**1 Business day [E1]**	☐
3 day [P3]	☐	**Same Day, Weekend or Statutory holiday [E0]**	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	P Total Metals(TM)	F/P Disolved Metals (DM)	P Total Mercury, Hardness	F/P Dissolved Mercury	P Ammonia (Total Nutrients)	F/P Dissolved Organic Carbon (DOC)	pH, Cond., TDS, TSS, Alkalinity, Anions							Number of Containers
	MW11-04 A	1-May-17	12:10	Water		R			R									2

Drinking Water (DW) Samples[1] (client use)	**Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)**
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	
Are samples for human drinking water use? ☐ YES ☑ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-05-03 7:00	Time:	Received by: EHF	Date: 4 May 2017	Time: 09:15	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 26-APR-17
Report Date: 16-MAY-17 13:03 (MT)
Version: DRAFT REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1917619
Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-04-25 A
Legal Site Desc:

Comments: May 16 2017: Please note, this report has been revised to include bromide data.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1917619-1	L1917619-2	L1917619-3	L1917619-4	L1917619-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-APR-17	24-APR-17	24-APR-17	24-APR-17	24-APR-17
	Sampled Time	14:45	15:45	16:00	16:15	16:45
	Client ID	MW12-06-01	MW12-06-02	MW12-06-03	MW12-06-04	MW12-06-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	717	993	1010	991	1020
	Hardness (as CaCO3) (mg/L)	284	501	499	510	504
	pH (pH)	8.15	8.08	8.15	8.11	8.11
	Total Suspended Solids (mg/L)	<3.0	34.0	<3.0	<3.0	<3.0
	Total Dissolved Solids (mg/L)	499	649	629	614	610
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	386	359	385	408	414
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	386	359	385	408	414
	Ammonia, Total (as N) (mg/L)	0.100	0.0528	0.0579	0.0097	0.0054
	Bromide (Br) (mg/L)	<0.25 DLDS	<0.25 DLDS	<0.25 DLDS	<0.25 DLDS	<0.25 DLDS
	Chloride (Cl) (mg/L)	5.2	<2.5 DLDS	<2.5 DLDS	<2.5 DLDS	<2.5 DLDS
	Nitrate and Nitrite (as N) (mg/L)	0.141	0.160	0.143	0.149	0.122
	Nitrate (as N) (mg/L)	0.031	0.035	0.028	0.030	0.025
	Nitrite (as N) (mg/L)	0.110	0.126	0.115	0.120	0.0972
	Sulfate (SO4) (mg/L)	<1.5 DLDS	213	205	181	177
	Anion Sum (meq/L)	7.87	11.6	12.0	11.9	12.0
	Cation Sum (meq/L)	8.14	11.9	11.7	11.9	11.7
	Cation - Anion Balance (%)	1.7	1.1	-1.1	-0.1	-1.0
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0169	0.0037	0.0010	0.0017	0.0026
	Antimony (Sb)-Dissolved (mg/L)	0.00017	0.00011	0.00012	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00571	0.00398	0.00059	0.00237	0.00074
	Barium (Ba)-Dissolved (mg/L)	0.243	0.0336	0.0268	0.0172	0.0404
	Beryllium (Be)-Dissolved (mg/L)	0.000099	0.000042	<0.000020	0.000024	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.143	0.118	0.092	0.084	0.076
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	83.1	143	110	104	102
	Chromium (Cr)-Dissolved (mg/L)	0.00362	0.00017	0.00030	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00107
	Copper (Cu)-Dissolved (mg/L)	0.00120	0.00039	<0.00020	<0.00020	0.00022
	Iron (Fe)-Dissolved (mg/L)	0.259	1.10	1.19	0.725	0.153
	Lead (Pb)-Dissolved (mg/L)	0.000085	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0094	0.0092	0.0081	0.0068	0.0066
	Magnesium (Mg)-Dissolved (mg/L)	18.6	34.6	54.5	60.7	60.2

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1917619-6	L1917619-7			
	Description	Water	Water			
	Sampled Date	24-APR-17	24-APR-17			
	Sampled Time	17:15				
	Client ID	MW12-06-06	DUP			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	853	989			
	Hardness (as CaCO3) (mg/L)	410	503			
	pH (pH)	8.16	8.15			
	Total Suspended Solids (mg/L)	<3.0	<3.0			
	Total Dissolved Solids (mg/L)	527	615			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	322	413			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	322	413			
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050			
	Bromide (Br) (mg/L)	<0.25 DLDS	<0.25 DLDS			
	Chloride (Cl) (mg/L)	6.1	<2.5 DLDS			
	Nitrate and Nitrite (as N) (mg/L)	1.14	0.126			
	Nitrate (as N) (mg/L)	1.08	0.027			
	Nitrite (as N) (mg/L)	0.0685	0.0992			
	Sulfate (SO4) (mg/L)	155	180			
	Anion Sum (meq/L)	9.91	12.0			
	Cation Sum (meq/L)	9.67	11.7			
	Cation - Anion Balance (%)	-1.2	-1.2			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0027	0.0020			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	<0.00010	0.00077			
	Barium (Ba)-Dissolved (mg/L)	0.0143	0.0399			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.065	0.077			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	77.9	101			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00111			
	Copper (Cu)-Dissolved (mg/L)	0.00060	<0.00020			
	Iron (Fe)-Dissolved (mg/L)	0.014	0.154			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0052	0.0068			
	Magnesium (Mg)-Dissolved (mg/L)	52.4	60.9			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1917619-1	L1917619-2	L1917619-3	L1917619-4	L1917619-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-APR-17	24-APR-17	24-APR-17	24-APR-17	24-APR-17
	Sampled Time	14:45	15:45	16:00	16:15	16:45
	Client ID	MW12-06-01	MW12-06-02	MW12-06-03	MW12-06-04	MW12-06-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0890	0.0283	0.0154	0.0444	0.343
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00104	0.00743	0.00197	0.00841	0.00913
	Nickel (Ni)-Dissolved (mg/L)	0.00051	<0.00050	<0.00050	<0.00050	0.00055
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.43	3.34	3.68	3.60	3.56
	Selenium (Se)-Dissolved (mg/L)	0.000170	<0.000050	<0.000050	<0.000050	<0.000050
	Silicon (Si)-Dissolved (mg/L)	7.29	9.77	8.84	8.31	7.96
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	54.6	39.8	36.1	36.4	35.8
	Strontium (Sr)-Dissolved (mg/L)	3.35	10.7	4.42	2.97	2.69
	Sulfur (S)-Dissolved (mg/L)	1.72	70.6	68.9	62.2	60.4
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00016	<0.00010	0.00013	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00293	DLM <0.00060	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000653	0.00255	0.00217	0.00575	0.00585
	Vanadium (V)-Dissolved (mg/L)	0.0134	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0025	0.0034	0.0020	0.0103	0.0094
	Zirconium (Zr)-Dissolved (mg/L)	0.00101	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1917619-6	L1917619-7			
	Description	Water	Water			
	Sampled Date	24-APR-17	24-APR-17			
	Sampled Time	17:15				
	Client ID	MW12-06-06	DUP			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0377	0.338			
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00575	0.00911			
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00057			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	3.25	3.57			
	Selenium (Se)-Dissolved (mg/L)	0.000294	<0.000050			
	Silicon (Si)-Dissolved (mg/L)	6.63	8.22			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	31.8	36.2			
	Strontium (Sr)-Dissolved (mg/L)	1.53	2.69			
	Sulfur (S)-Dissolved (mg/L)	52.4	62.1			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	0.00031	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00406	0.00594			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0138	0.0129			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1917619-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Reference Information

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-04-25 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1917619-COFC

COC Number: 2017-04-25 A

Page 1 of 1

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To
Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO

Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

ALS Lab Work Order # (lab use only)

Report Format
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Oil and Gas Required Fields (client use)
AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Contact:
Sampler: CH/CP

onfirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-06-01	24-Apr-17	14:45	Water		R		R	R		R							4
	MW12-06-02	24-Apr-17	15:45	Water		R		R	R		R							4
	MW12-06-03	24-Apr-17	16:00	Water		R		R	R		R							4
	MW12-06-04	24-Apr-17	16:15	Water		R		R	R		R							4
	MW12-06-05	24-Apr-17	16:45	Water		R		R	R		R							4
	MW12-06-06	24-Apr-17	17:15	Water		R		R	R		R							4
	DUP	24-Apr-17		Water		R		R	R		R							4

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-04-25 8:00	Time:	Received by: CHF	Date: 26 Apr 2017	Time: 11:40	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	24-APR-17
Report Date:	16-MAY-17 13:37 (MT)
Version:	DRAFT REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1916507

Project P.O. #:	224161 (GW)
Job Reference:	
C of C Numbers:	2017-04-24 B
Legal Site Desc:	

Comments: May 16 2017: Please note, this report has been revised to include bromide data.

Shane Stack
Account Manager

	Sample ID	L1916507-1	L1916507-2	L1916507-3	L1916507-4	L1916507-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	21-APR-17	21-APR-17	21-APR-17	22-APR-17	22-APR-17
	Sampled Time	14:14	17:07		14:12	14:17
	Client ID	MW09-03-01	MW09-03-02	DUP1	MW12-07-01	MW12-07-02
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	314	332	317	1170	1460
	Hardness (as CaCO3) (mg/L)	139	144	141	490	686
	pH (pH)	8.24	8.28	8.28	8.14	8.00
	Total Suspended Solids (mg/L)	<3.0	4.8	3.4	6.2	<3.0
	Total Dissolved Solids (mg/L)	201	219	198	906	1180
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	143	157	146	566	108
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	143	157	146	566	108
	Ammonia, Total (as N) (mg/L)	0.0401	0.0319	0.0422	0.248	0.0461
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050	<0.25 DLDS	<0.25 DLDS
	Chloride (Cl) (mg/L)	<0.50	<0.50	<0.50	<5.0 DLCI	<2.5 DLCI
	Nitrate and Nitrite (as N) (mg/L)	0.196	2.71	0.113	0.298	0.248
	Nitrate (as N) (mg/L)	0.0051	1.91	<0.0050	0.092	0.077
	Nitrite (as N) (mg/L)	0.191	0.803	0.113	0.206	0.170
	Sulfate (SO4) (mg/L)	19.4	11.1	19.5	43.5	722
	Anion Sum (meq/L)	3.28	3.56	3.33	12.2	17.2
	Cation Sum (meq/L)	3.16	3.23	3.22	13.2	16.6
	Cation - Anion Balance (%)	-1.9	-4.8	-1.7	3.9	-1.7
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0021	0.0018	0.0029	0.0055	0.0021
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00035	0.00011	<0.00010	<0.00020 DLA
	Arsenic (As)-Dissolved (mg/L)	0.00064	0.00028	0.00063	0.00040	0.00141
	Barium (Ba)-Dissolved (mg/L)	0.0620	0.0462	0.0618	0.106	0.0129
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	0.000048	<0.000040 DLA
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.00010 DLA
	Boron (B)-Dissolved (mg/L)	0.111	0.477	0.175	0.395	0.226
	Cadmium (Cd)-Dissolved (mg/L)	0.0000057	0.0000370	0.0000070	0.0000876	<0.000010 DLA
	Calcium (Ca)-Dissolved (mg/L)	38.3	47.7	39.2	167	223
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00023	<0.00010	0.00026	<0.00020 DLA
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00087	<0.00010	<0.00010	<0.00020 DLA
	Copper (Cu)-Dissolved (mg/L)	<0.00020	0.00105	0.00082	0.00037	<0.00040 DLA
	Iron (Fe)-Dissolved (mg/L)	0.303	0.084	0.331	0.040	0.142
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	0.000054	<0.00010 DLA
	Lithium (Li)-Dissolved (mg/L)	0.0038	0.0014	0.0039	0.0246	0.0272
	Magnesium (Mg)-Dissolved (mg/L)	10.4	5.92	10.4	17.7	31.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1916507-6	L1916507-7	L1916507-8	L1916507-9	L1916507-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	22-APR-17	23-APR-17	23-APR-17	23-APR-17	23-APR-17
	Sampled Time		11:00	11:30	11:45	13:40
	Client ID	DUP2	MW12-05-01	MW12-05-03	MW12-05-04	MW12-05-05
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1460	2180	1710	489	496
	Hardness (as CaCO3) (mg/L)	682	924	740	211	212
	pH (pH)	7.98	8.15	8.31	8.32	8.13
	Total Suspended Solids (mg/L)	5.0	5.8	5.6	<3.0	<3.0
	Total Dissolved Solids (mg/L)	1170	1740	1350	296	287
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	106	140	229	232	212
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	5.2	3.8	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	106	140	234	236	212
	Ammonia, Total (as N) (mg/L)	0.0382	0.0447	0.0296	0.0352	0.0122
	Bromide (Br) (mg/L)	DLDS <0.25	DLDS <0.50	DLDS <0.50	<0.050	<0.050
	Chloride (Cl) (mg/L)	DLDS <2.5	12.0	7.6	5.10	5.00
	Nitrate and Nitrite (as N) (mg/L)	0.288	<0.051	<0.051	0.0248	0.373
	Nitrate (as N) (mg/L)	0.087	DLDS <0.050	DLDS <0.050	<0.0050	0.334
	Nitrite (as N) (mg/L)	0.201	0.032	0.028	0.0248	0.0388
	Sulfate (SO4) (mg/L)	728	1120	751	28.1	44.5
	Anion Sum (meq/L)	17.3	26.4	20.5	5.44	5.33
	Cation Sum (meq/L)	16.5	24.7	18.6	5.00	4.90
	Cation - Anion Balance (%)	-2.2	-3.5	-4.8	-4.2	-4.2
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0026	0.0032	0.0034	0.0040	0.0026
	Antimony (Sb)-Dissolved (mg/L)	DLA <0.00020	DLA <0.00020	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00133	0.00060	0.00022	<0.00010	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0119	0.0401	0.0395	0.0650	0.0610
	Beryllium (Be)-Dissolved (mg/L)	DLA <0.000040	DLA <0.000040	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	DLA <0.00010	DLA <0.00010	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.227	0.092	0.075	0.047	0.046
	Cadmium (Cd)-Dissolved (mg/L)	DLA <0.000010	DLA <0.000010	<0.0000050	<0.0000050	0.0000080
	Calcium (Ca)-Dissolved (mg/L)	221	310	190	43.8	46.2
	Chromium (Cr)-Dissolved (mg/L)	DLA <0.00020	0.00029	0.00017	0.00021	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	DLA <0.00020	DLA <0.00020	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00044	DLA <0.00040	<0.00020	0.00021	0.00178
	Iron (Fe)-Dissolved (mg/L)	0.141	0.025	0.651	0.082	<0.010
	Lead (Pb)-Dissolved (mg/L)	DLA <0.00010	DLA <0.00010	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0263	0.0065	0.0031	0.0033	0.0038
	Magnesium (Mg)-Dissolved (mg/L)	31.6	36.0	64.4	24.6	23.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1916507-11	L1916507-12	L1916507-13	L1916507-14
	Description	Water	Water	Water	Water
	Sampled Date	23-APR-17	23-APR-17	23-APR-17	23-APR-17
	Sampled Time	14:00	14:20		14:50
	Client ID	MW12-05-06	MW12-05-02	DUP	MW12-05-07
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	486	2200	504	514
	Hardness (as CaCO3) (mg/L)	210	967	215	237
	pH (pH)	8.13	8.22	8.31	8.20
	Total Suspended Solids (mg/L)	<3.0	5.2	<3.0	217
	Total Dissolved Solids (mg/L)	293	1870	293	306
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	209	173	233	236
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	4.4	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	209	173	237	236
	Ammonia, Total (as N) (mg/L)	0.0181	0.0334	0.0329	0.0248
	Bromide (Br) (mg/L)	<0.050	DLDS <0.50	<0.050	<0.050
	Chloride (Cl) (mg/L)	4.96	11.7	5.05	4.65
	Nitrate and Nitrite (as N) (mg/L)	0.453	<0.051	0.0256	0.0098
	Nitrate (as N) (mg/L)	0.423	DLDS <0.050	<0.0050	<0.0050
	Nitrite (as N) (mg/L)	0.0301	0.025	0.0256	0.0098
	Sulfate (SO4) (mg/L)	45.5	1140	28.4	35.6
	Anion Sum (meq/L)	5.30	27.6	5.48	5.59
	Cation Sum (meq/L)	4.86	24.8	5.12	5.47
	Cation - Anion Balance (%)	-4.4	-5.3	-3.4	-1.0
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0027	0.0045	0.0042	0.0032
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	DLA <0.00020	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00011	DLA <0.00020	0.00010	0.00023
	Barium (Ba)-Dissolved (mg/L)	0.0535	0.114	0.0680	0.396
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	DLA <0.000040	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	DLA <0.00010	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.042	0.075	0.046	0.034
	Cadmium (Cd)-Dissolved (mg/L)	0.0000129	DLA <0.000010	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	45.5	301	44.1	53.7
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00031	0.00023	0.00015
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	DLA <0.00020	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00132	DLA <0.00040	0.00026	<0.00020
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.052	0.085	0.233
	Lead (Pb)-Dissolved (mg/L)	<0.000050	DLA <0.00010	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0038	0.0053	0.0032	0.0032
	Magnesium (Mg)-Dissolved (mg/L)	23.4	52.3	25.4	25.1

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1916507-1	L1916507-2	L1916507-3	L1916507-4	L1916507-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	21-APR-17	21-APR-17	21-APR-17	22-APR-17	22-APR-17
	Sampled Time	14:14	17:07		14:12	14:17
	Client ID	MW09-03-01	MW09-03-02	DUP1	MW12-07-01	MW12-07-02
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0763	0.281	0.0768	0.111	0.102
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00441	0.0118	0.00481	0.000351	0.0196
	Nickel (Ni)-Dissolved (mg/L)	0.00085	0.00072	0.00090	<0.00050	DLA <0.0010
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	DLA <0.10
	Potassium (K)-Dissolved (mg/L)	1.87	2.23	1.88	2.46	2.53
	Selenium (Se)-Dissolved (mg/L)	<0.000050	0.000238	<0.000050	0.00850	0.00072
	Silicon (Si)-Dissolved (mg/L)	4.94	4.85	5.08	8.79	5.58
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	DLA <0.000020
	Sodium (Na)-Dissolved (mg/L)	7.35	6.67	7.76	76.9	65.4
	Strontium (Sr)-Dissolved (mg/L)	0.920	0.320	0.941	7.13	10.9
	Sulfur (S)-Dissolved (mg/L)	5.86	3.66	6.30	63.7	239
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	DLA <0.000020
	Tin (Sn)-Dissolved (mg/L)	0.00033	0.00034	0.00024	0.00045	DLA <0.00020
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	0.00039	DLA <0.00060
	Uranium (U)-Dissolved (mg/L)	0.000901	0.00264	0.000910	0.000177	0.00177
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00164	DLA <0.0010
	Zinc (Zn)-Dissolved (mg/L)	0.0067	0.0283	0.0086	0.0051	DLA <0.0020
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1916507-6	L1916507-7	L1916507-8	L1916507-9	L1916507-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	22-APR-17	23-APR-17	23-APR-17	23-APR-17	23-APR-17
	Sampled Time		11:00	11:30	11:45	13:40
	Client ID	DUP2	MW12-05-01	MW12-05-03	MW12-05-04	MW12-05-05
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.102	0.134	1.91	0.520	0.128
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0204	0.00022	0.000832	0.00248	0.00393
	Nickel (Ni)-Dissolved (mg/L)	<0.0010 DLA	<0.0010 DLA	<0.00050	<0.00050	0.00058
	Phosphorus (P)-Dissolved (mg/L)	<0.10 DLA	<0.10 DLA	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.55	3.23	3.47	1.89	1.83
	Selenium (Se)-Dissolved (mg/L)	0.00038	0.00225	0.000562	0.00128	0.000173
	Silicon (Si)-Dissolved (mg/L)	5.59	7.06	6.76	6.05	5.65
	Silver (Ag)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	65.0	141	84.2	16.4	14.0
	Strontium (Sr)-Dissolved (mg/L)	11.2	8.75	7.18	0.819	0.727
	Sulfur (S)-Dissolved (mg/L)	235	385	247	10.9	14.3
	Thallium (Tl)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010	0.00011	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLA	<0.00060 DLA	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00183	0.000917	0.00247	0.00113	0.00267
	Vanadium (V)-Dissolved (mg/L)	<0.0010 DLA	<0.0010 DLA	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0043	<0.0020 DLA	0.0015	0.0015	0.0112
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1916507-11	L1916507-12	L1916507-13	L1916507-14	
	Description	Water	Water	Water	Water	
	Sampled Date	23-APR-17	23-APR-17	23-APR-17	23-APR-17	
	Sampled Time	14:00	14:20		14:50	
	Client ID	MW12-05-06	MW12-05-02	DUP	MW12-05-07	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0662	0.776	0.544	0.636	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00368	0.00021	0.00256	0.00224	
	Nickel (Ni)-Dissolved (mg/L)	0.00054	DLA <0.0010	<0.00050	<0.00050	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	DLA <0.10	<0.050	0.056	
	Potassium (K)-Dissolved (mg/L)	1.78	3.61	1.95	1.70	
	Selenium (Se)-Dissolved (mg/L)	0.000190	0.00275	0.00171	0.00168	
	Silicon (Si)-Dissolved (mg/L)	5.62	6.65	6.18	6.25	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	DLA <0.000020	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	14.0	122	17.3	14.9	
	Strontium (Sr)-Dissolved (mg/L)	0.704	10.4	0.863	0.845	
	Sulfur (S)-Dissolved (mg/L)	14.6	364	12.9	18.4	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	DLA <0.000020	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	DLA <0.00020	0.00014	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	DLA <0.00060	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00287	0.000262	0.00114	0.00267	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	DLA <0.0010	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	0.0157	DLA <0.0020	0.0018	0.0014	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Boron (B)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Nitrite (as N)	MS-B	L1916507-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLCI	Detection Limit Raised: Chromatographic Interference due to co-elution.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Reference Information

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-04-24 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1916507-COFC

COC Number: 2017-04-24 B

Page 1 of 1

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
Company address below will appear on the final report	
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH

Short Holding Time
Rush Processing

Analysis Request — Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM) P	Disolved Metals (DM) F/P	Total Mercury, Hardness P	Dissolved Mercury F/P	Ammonia (Total Nutrients) P	Dissolved Organic Carbon (DOC) F/P	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
	MW09-03-01	21-Apr-17	14:14	Water		R		R	R		R							4
	MW09-03-02	21-Apr-17	17:07	Water		R		R	R		R							4
	DUP1	21-Apr-17		Water		R		R	R		R							4
	MW12-07-01	22-Apr-17	14:12	Water		R		R	R		R							4
	MW12-07-02	22-Apr-17	14:17	Water		R		R	R		R							4
	DUP2	22-Apr-17		Water		R		R	R		R							4
	MW12-05-01	23-Apr-17	11:00	Water		R		R	R		R							4
	MW12-05-03	23-Apr-17	11:30	Water		R		R	R		R							4
	MW12-05-04	23-Apr-17	11:45	Water		R		R	R		R							4
	MW12-05-05	23-Apr-17	13:40	Water		R		R	R		R							4
	MW12-05-06	23-Apr-17	14:00	Water		R		R	R		R							4
	MW12-05-02	23-Apr-17	14:20	Water		R		R	R		R							4
	DUP	23-Apr-17		Water		R		R	R		R							4
	MW12-05-07	23-Apr-17	14:50	Water		R		R	R		R							4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 5.0

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-04-24 8:00	Time:	Received by: UD.	Date: April 24 /17	Time: 13:30	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytica Request Form

Canada Toll Free: 1 800 668 9878

L1916507-COFC

COC Number: 2017-04-24 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report For

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)
ALS Contact:
Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW09-03-01	21-Apr-17	14:14	Water		R		R	R		R							4
	MW09-03-02	21-Apr-17	17:07	Water		R		R	R		R							4
	DUP1	21-Apr-17		Water		R		R	R		R							4
	MW12-07-01	22-Apr-17	14:12	Water		R		R	R		R							4
	MW12-07-02	22-Apr-17	14:17	Water		R		R	R		R							4
	DUP2	22-Apr-17		Water		R		R	R		R							4
	MW12-05-01	23-Apr-17	11:00	Water		R		R	R		R							4
	MW12-05-03	23-Apr-17	11:30	Water		R		R	R		R							4
	MW12-05-04	23-Apr-17	11:45	Water		R		R	R		R							4
	MW12-05-05	23-Apr-17	13:40	Water		R		R	R		R							4
	MW12-05-06	23-Apr-17	14:00	Water		R		R	R		R							4
	MW12-05-02	23-Apr-17	14:20	Water		R		R	R		R							4
	DUP	23-Apr-17		Water		R		R	R		R							4
	MW12-05-07	23-Apr-17	14:50	Water		R		R	R		R							4

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☐ Ice Cubes ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-04-24 8:00	Time:	Received by: UD	Date: April 24 /17	Time: 13:30	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 30-MAR-17
Report Date: 10-APR-17 16:35 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1907261
Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-03-30 B
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1907261-1	L1907261-2			
	Description	WATER	WATER			
	Sampled Date	30-MAR-17	30-MAR-17			
	Sampled Time	08:40	09:10			
	Client ID	MW12-07-01	MW12-07-02			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1170	1430			
	Hardness (as CaCO3) (mg/L)	523	665			
	pH (pH)	8.04	8.05			
	Total Suspended Solids (mg/L)	6.2	5.7			
	Total Dissolved Solids (mg/L)	921	1160			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	577	106			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	577	106			
	Ammonia, Total (as N) (mg/L)	0.229	0.0594			
	Chloride (Cl) (mg/L)	DLDS <2.5	DLDS <2.5			
	Nitrate and Nitrite (as N) (mg/L)	0.293	0.313			
	Nitrate (as N) (mg/L)	0.091	0.092			
	Nitrite (as N) (mg/L)	0.202	0.221			
	Sulfate (SO4) (mg/L)	49.8	731			
	Anion Sum (meq/L)	12.6	17.4			
	Cation Sum (meq/L)	14.6	16.7			
	Cation - Anion Balance (%)	7.1	-2.0			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0058	0.0038			
	Antimony (Sb)-Dissolved (mg/L)	0.00018	0.00017			
	Arsenic (As)-Dissolved (mg/L)	0.00053	0.00170			
	Barium (Ba)-Dissolved (mg/L)	0.107	0.0138			
	Beryllium (Be)-Dissolved (mg/L)	0.000049	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.470	0.256			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000073	0.0000865			
	Calcium (Ca)-Dissolved (mg/L)	179	213			
	Chromium (Cr)-Dissolved (mg/L)	0.00086	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00139	0.00060			
	Iron (Fe)-Dissolved (mg/L)	0.038	0.151			
	Lead (Pb)-Dissolved (mg/L)	0.000090	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0261	0.0292			
	Magnesium (Mg)-Dissolved (mg/L)	18.6	32.3			
	Manganese (Mn)-Dissolved (mg/L)	0.122	0.109			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1907261-1	L1907261-2			
	Description	WATER	WATER			
	Sampled Date	30-MAR-17	30-MAR-17			
	Sampled Time	08:40	09:10			
	Client ID	MW12-07-01	MW12-07-02			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.000373	0.0188			
	Nickel (Ni)-Dissolved (mg/L)	0.00227	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	3.05	3.00			
	Selenium (Se)-Dissolved (mg/L)	0.00132	0.000100			
	Silicon (Si)-Dissolved (mg/L)	9.82	6.29			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	92.5	77.6			
	Strontium (Sr)-Dissolved (mg/L)	7.25	10.5			
	Sulfur (S)-Dissolved (mg/L)	45.2	280			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	0.00033	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.000174	0.00171			
	Vanadium (V)-Dissolved (mg/L)	0.00189	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0040	0.0027			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Arsenic (As)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Cadmium (Cd)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1907261-1, -2
Matrix Spike	Nitrate (as N)	MS-B	L1907261-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-03-30 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1907261-COFC

COC Number: 2017-03-30 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)	
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report ☑ YES ☐ NO	
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224161 (GW)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler:** CH/EB

…rm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days)	**4 day [P4]** ☐	EMERGENCY	**1 Business day [E1]** ☐
	3 day [P3] ☐		**Same Day, Weekend or Statutory holiday [E0]** ☐
	2 day [P2] ☐		
Date and Time Required for all E&P TATs:			

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Dissolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-07-01	30-Mar-17	8:40	Water		R		R	R		R							4
	MW12-07-02	30-Mar-17	9:10	Water		R		R	R		R							4

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)	**Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)**
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	
Are samples for human drinking water use? ☐ YES ☑ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☑	Ice Cubes	☐	Custody seal Intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.0			8		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-03-30 9:00	Time:	Received by: EHF	Date: 30 March 2017	Time: 15:03	Received by: JN	Date: 03/31/17	Time: 15:50

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1907261-COFC

COC Number: 2017-03-30 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224161 (GW)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler:** CH/EB

...rm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days)	**4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐	EMERGENCY	**1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐
Date and Time Required for all E&P TATs:	dd-mmm-yy hh:mm		

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Dissolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-07-01	30-Mar-17	8:40	Water		R		R	R		R							4
	MW12-07-02	30-Mar-17	9:10	Water		R		R	R		R							4

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☑	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.0			8		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-03-30 9:00	Time:	Received by: EHF	Date: 30 March 2017	Time: 15:03	Received by: JN	Date: 03/31/17	Time: 15:50

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 15-MAR-17
Report Date: 24-MAR-17 16:49 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1901640

Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-03-15B
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1901640-1	L1901640-2	L1901640-3		
	Description	Water	Water	Water		
	Sampled Date	12-MAR-17	14-MAR-17	14-MAR-17		
	Sampled Time	17:30	15:55	16:15		
	Client ID	MW11-04A	MW09-03-01	MW09-03-02		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	293	313	321		
	Hardness (as CaCO3) (mg/L)	145	144	151		
	pH (pH)	11.11	8.14	8.04		
	Total Suspended Solids (mg/L)	234	5.0	<3.0		
	Total Dissolved Solids (mg/L)	148 RRV	202	196		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	<1.0	145	150		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	101	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	30.7	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	132	145	150		
	Ammonia, Total (as N) (mg/L)	0.0191	0.0380	0.0116		
	Chloride (Cl) (mg/L)	<0.50	<0.50	<0.50		
	Nitrate (as N) (mg/L)	1.10	<0.0050	2.02		
	Nitrite (as N) (mg/L)	0.0085	0.116	0.286		
	Sulfate (SO4) (mg/L)	5.49	20.2	10.4		
	Anion Sum (meq/L)	2.82	3.33	3.37		
	Cation Sum (meq/L)	3.22	3.32	3.36		
	Cation - Anion Balance (%)	6.6	-0.2	-0.2		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.572	0.0026	0.0036		
	Antimony (Sb)-Dissolved (mg/L)	0.00157	0.00012	0.00022		
	Arsenic (As)-Dissolved (mg/L)	0.00238	0.00078	0.00014		
	Barium (Ba)-Dissolved (mg/L)	0.194	0.0710	0.0368		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	0.125	0.298		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000063	<0.0000050	0.0000414		
	Calcium (Ca)-Dissolved (mg/L)	58.1	39.0	49.6		
	Chromium (Cr)-Dissolved (mg/L)	0.00188	<0.00010	0.00019		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00040		
	Copper (Cu)-Dissolved (mg/L)	0.0362	0.00040	0.00214		
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.242	0.019		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0174	0.0033	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	<0.10	11.4	6.64		
	Manganese (Mn)-Dissolved (mg/L)	0.00027	0.0842	0.113		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1901640-1	L1901640-2	L1901640-3		
	Description	Water	Water	Water		
	Sampled Date	12-MAR-17	14-MAR-17	14-MAR-17		
	Sampled Time	17:30	15:55	16:15		
	Client ID	MW11-04A	MW09-03-01	MW09-03-02		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00226	0.00448	0.00807		
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00107	0.00064		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	3.63	2.17	2.47		
	Selenium (Se)-Dissolved (mg/L)	0.00250	<0.000050	0.000193		
	Silicon (Si)-Dissolved (mg/L)	5.14	5.30	5.27		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	3.73	8.39	6.26		
	Strontium (Sr)-Dissolved (mg/L)	0.234	0.960	0.320		
	Sulfur (S)-Dissolved (mg/L)	1.91	6.58	3.76		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	<0.000010	0.000940	0.00266		
	Vanadium (V)-Dissolved (mg/L)	0.0100	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0016	0.0057	0.0446		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Qualifiers for Individual Parameters Listed:

Qualifier	Description
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-03-15B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1901640-COFC

COC Number: 2017-03-15 B

Page of

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked.	
Company address below will appear on the final report		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224161 (GW)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** SR/SB

Confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW11-04A	12-Mar-17	17:30	Water		R		R	R		R							4
	MW09-03-01	14-Mar-17	15:55	Water		R		R	R		R							4
	MW09-03-02	14-Mar-17	16:15	Water		R		R	R		R							4

Short Holding Time

○ Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1.0.			4,4,4	3,3,6	5,7,7

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-03-15	Time: 11:00	Received by: VD.	Date: March 15/17	Time: 14:50	Received by: JC	Date: MAR 1 6 2017	Time: 14:35

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 22-FEB-17
Report Date: 03-MAR-17 16:51 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1893584
Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-02-22 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1893584-1	L1893584-2	L1893584-3	L1893584-4	L1893584-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-FEB-17	18-FEB-17	18-FEB-17	20-FEB-17	20-FEB-17
	Sampled Time	10:15	10:45	11:25	13:50	14:15
	Client ID	MW12-06-02	MW12-06-04	MW12-06-06	MW12-05-01	MW12-05-02
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	983	991	845	2080	2110
	Hardness (as CaCO3) (mg/L)	467	498	408	933	1020
	pH (pH)	8.04	8.11	8.13	8.03	8.18
	Total Suspended Solids (mg/L)	61.3	8.1	7.6	<3.0	4.4
	TDS (Calculated) (mg/L)	637	635	522	1760	1730
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	361	414	325	145	181
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	361	414	325	145	181
	Ammonia, Total (as N) (mg/L)	0.0261	0.0080	<0.0050	0.0110	0.0121
	Chloride (Cl) (mg/L)	<2.5 DLDS	<2.5 DLDS	5.4	12.6	11.1
	Nitrate and Nitrite (as N) (mg/L)	0.519	1.08	1.27	0.068	0.053
	Nitrate (as N) (mg/L)	0.106	0.202	1.05	<0.050 DLDS	<0.050 DLDS
	Nitrite (as N) (mg/L)	0.413	0.875	0.221	0.068	0.0531
	Sulfate (SO4) (mg/L)	214	182	153	1170	1110
	Anion Sum (meq/L)	11.7	12.1	9.91	27.5	27.0
	Cation Sum (meq/L)	11.0	11.6	9.53	24.8	26.0
	Cation - Anion Balance (%)	-3.0	-2.3	-2.0	-5.2	-1.9
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0015	0.0021	0.0016	0.0036	0.0043
	Antimony (Sb)-Dissolved (mg/L)	0.00025	0.00022	0.00013	0.00032	0.00025
	Arsenic (As)-Dissolved (mg/L)	0.00364	0.00258	0.00016	0.00079	0.00029
	Barium (Ba)-Dissolved (mg/L)	0.0234	0.0172	0.0138	0.0410	0.109
	Beryllium (Be)-Dissolved (mg/L)	0.000039	0.000027	<0.000020	<0.000040 DLA	<0.000040 DLA
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.00010 DLA	<0.00010 DLA
	Boron (B)-Dissolved (mg/L)	0.252	0.435	0.156	0.111	0.106
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000423	<0.000010 DLA	<0.000010 DLA
	Calcium (Ca)-Dissolved (mg/L)	131	104	80.2	311	319
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00022	0.00045	0.00030
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00020 DLA	<0.00020 DLA
	Copper (Cu)-Dissolved (mg/L)	0.0202	0.00030	0.00059	<0.00040 DLA	0.00060
	Iron (Fe)-Dissolved (mg/L)	0.743	0.442	<0.010	0.026	0.042
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.00010 DLA	<0.00010 DLA
	Lithium (Li)-Dissolved (mg/L)	0.0108	0.0067	0.0051	0.0084	0.0059
	Magnesium (Mg)-Dissolved (mg/L)	33.9	57.6	50.5	37.8	54.7
	Manganese (Mn)-Dissolved (mg/L)	0.0266	0.0432	0.0360	0.137	0.789

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte					
	Sample ID	L1893584-6	L1893584-7	L1893584-8	L1893584-9	L1893584-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	20-FEB-17	20-FEB-17	20-FEB-17	20-FEB-17	20-FEB-17
	Sampled Time	14:40	15:00	15:20	15:40	16:00
	Client ID	MW12-05-03	MW12-05-04	MW12-05-05	MW12-05-06	MW12-05-07
WATER						
Physical Tests	Conductivity (uS/cm)	1670	506	479	475	500
	Hardness (as CaCO3) (mg/L)	771	225	216	214	239
	pH (pH)	8.12	8.24	8.15	8.18	8.26
	Total Suspended Solids (mg/L)	3.0	<3.0	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	1270	279	264	265	278
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	255	242	212	212	247
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	255	242	212	212	247
	Ammonia, Total (as N) (mg/L)	0.0150	0.0194	0.0082	<0.0050	0.0154
	Chloride (Cl) (mg/L)	7.9	5.32	5.12	5.13	4.84
	Nitrate and Nitrite (as N) (mg/L)	<0.051	0.0677	0.393	0.497	0.0267
	Nitrate (as N) (mg/L)	<0.050 DLDS	<0.0050	0.332	0.463	0.0090
	Nitrite (as N) (mg/L)	0.049	0.0677	0.0606	0.0344	0.0177
	Sulfate (SO4) (mg/L)	749	34.6	43.5	44.4	29.0
	Anion Sum (meq/L)	20.9	5.70	5.31	5.35	5.67
	Cation Sum (meq/L)	19.4	5.35	5.02	4.97	5.48
	Cation - Anion Balance (%)	-3.8	-3.2	-2.8	-3.6	-1.7
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0025	0.0034	0.0025	0.0042	0.0025
	Antimony (Sb)-Dissolved (mg/L)	<0.00020 DLA	0.00019	0.00019	0.00032	0.00022
	Arsenic (As)-Dissolved (mg/L)	0.00029	0.00014	0.00015	0.00014	0.00024
	Barium (Ba)-Dissolved (mg/L)	0.0441	0.0661	0.0675	0.0598	0.469
	Beryllium (Be)-Dissolved (mg/L)	<0.000040 DLA	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.00010 DLA	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.088	0.081	0.064	0.040	0.035
	Cadmium (Cd)-Dissolved (mg/L)	0.000014	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	196	46.7	43.6	44.0	51.9
	Chromium (Cr)-Dissolved (mg/L)	<0.00020 DLA	<0.00010	<0.00010	0.00015	0.00036
	Cobalt (Co)-Dissolved (mg/L)	<0.00020 DLA	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00579	<0.00020	0.00082	0.00197	0.00025
	Iron (Fe)-Dissolved (mg/L)	0.042	0.012	<0.010	<0.010	0.089
	Lead (Pb)-Dissolved (mg/L)	<0.00010 DLA	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0034	0.0033	0.0036	0.0037	0.0032
	Magnesium (Mg)-Dissolved (mg/L)	68.3	26.2	25.9	25.4	26.6
	Manganese (Mn)-Dissolved (mg/L)	2.07	0.555	0.142	0.0639	0.617

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1893584-11				
	Description	Water				
	Sampled Date	18-FEB-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	988				
	Hardness (as CaCO3) (mg/L)	496				
	pH (pH)	8.17				
	Total Suspended Solids (mg/L)	6.6				
	TDS (Calculated) (mg/L)	635				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	418				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	418				
	Ammonia, Total (as N) (mg/L)	0.0068				
	Chloride (Cl) (mg/L)	DLDS <2.5				
	Nitrate and Nitrite (as N) (mg/L)	1.16				
	Nitrate (as N) (mg/L)	0.220				
	Nitrite (as N) (mg/L)	0.940				
	Sulfate (SO4) (mg/L)	180				
	Anion Sum (meq/L)	12.2				
	Cation Sum (meq/L)	11.5				
	Cation - Anion Balance (%)	-2.7				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0014				
	Antimony (Sb)-Dissolved (mg/L)	0.00017				
	Arsenic (As)-Dissolved (mg/L)	0.00267				
	Barium (Ba)-Dissolved (mg/L)	0.0169				
	Beryllium (Be)-Dissolved (mg/L)	0.000031				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.490				
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050				
	Calcium (Ca)-Dissolved (mg/L)	105				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	<0.00020				
	Iron (Fe)-Dissolved (mg/L)	0.389				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0070				
	Magnesium (Mg)-Dissolved (mg/L)	56.6				
	Manganese (Mn)-Dissolved (mg/L)	0.0444				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1893584-1	L1893584-2	L1893584-3	L1893584-4	L1893584-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-FEB-17	18-FEB-17	18-FEB-17	20-FEB-17	20-FEB-17
	Sampled Time	10:15	10:45	11:25	13:50	14:15
	Client ID	MW12-06-02	MW12-06-04	MW12-06-06	MW12-05-01	MW12-05-02
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00695	0.00783	0.00569	0.00031	0.00039
	Nickel (Ni)-Dissolved (mg/L)	0.00235	<0.00050	<0.00050	<0.0010 DLA	<0.0010 DLA
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.10 DLA	<0.10 DLA
	Potassium (K)-Dissolved (mg/L)	3.78	3.80	3.47	3.84	4.07
	Selenium (Se)-Dissolved (mg/L)	0.000721	0.000569	0.000487	0.00034	<0.00010 DLA
	Silicon (Si)-Dissolved (mg/L)	10.6	9.20	7.20	7.45	7.20
	Silver (Ag)-Dissolved (mg/L)	0.000011	<0.000010	<0.000010	<0.000020 DLA	<0.000020 DLA
	Sodium (Na)-Dissolved (mg/L)	35.5	35.2	29.4	140	125
	Strontium (Sr)-Dissolved (mg/L)	10.1	3.07	1.58	8.56	11.2
	Sulfur (S)-Dissolved (mg/L)	72.6	63.8	54.6	412	406
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000020 DLA	0.000020
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00020 DLA	<0.00020 DLA
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00060 DLA	<0.00060 DLA
	Uranium (U)-Dissolved (mg/L)	0.00277	0.00603	0.00494	0.00110	0.000569
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.0010 DLA	<0.0010 DLA
	Zinc (Zn)-Dissolved (mg/L)	0.0016	0.0402	0.0488	<0.0020 DLA	0.0024
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00060 DLA	<0.00060 DLA

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1893584-6	L1893584-7	L1893584-8	L1893584-9	L1893584-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	20-FEB-17	20-FEB-17	20-FEB-17	20-FEB-17	20-FEB-17
	Sampled Time	14:40	15:00	15:20	15:40	16:00
	Client ID	MW12-05-03	MW12-05-04	MW12-05-05	MW12-05-06	MW12-05-07
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00076	0.00406	0.00365	0.00347	0.00221
	Nickel (Ni)-Dissolved (mg/L)	<0.0010 DLA	<0.00050	0.00065	0.00066	0.00057
	Phosphorus (P)-Dissolved (mg/L)	<0.10 DLA	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.86	2.21	2.16	2.13	1.97
	Selenium (Se)-Dissolved (mg/L)	<0.00010 DLA	0.000172	0.000172	0.000150	0.000129
	Silicon (Si)-Dissolved (mg/L)	7.47	6.58	6.42	6.35	6.78
	Silver (Ag)-Dissolved (mg/L)	<0.000020 DLA	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	87.6	18.0	15.0	14.6	14.4
	Strontium (Sr)-Dissolved (mg/L)	7.04	0.892	0.683	0.682	0.729
	Sulfur (S)-Dissolved (mg/L)	256	12.2	15.1	15.6	10.6
	Thallium (Tl)-Dissolved (mg/L)	<0.000020 DLA	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	0.00039	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLA	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00255	0.00149	0.00295	0.00319	0.00280
	Vanadium (V)-Dissolved (mg/L)	<0.0010 DLA	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0026	<0.0010	0.0457	0.0613	0.0025
	Zirconium (Zr)-Dissolved (mg/L)	<0.00060 DLA	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1893584-11				
	Description	Water				
	Sampled Date	18-FEB-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00845				
	Nickel (Ni)-Dissolved (mg/L)	<0.00050				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	3.77				
	Selenium (Se)-Dissolved (mg/L)	0.000258				
	Silicon (Si)-Dissolved (mg/L)	9.17				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	34.7				
	Strontium (Sr)-Dissolved (mg/L)	3.03				
	Sulfur (S)-Dissolved (mg/L)	63.0				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.00626				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0667				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

ALK-TITR-VA | Water | Alkalinity Species by Titration | APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA | Water | Nitrite & Nitrate in Water (Calculation) | EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA | Water | Diss. Be (low) in Water by CRC ICPMS | APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA | Water | Chloride in Water by IC | EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA | Water | Conductivity (Automated) | APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA | Water | Conductivity Screen (Internal Use Only) | APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA | Water | Hardness | APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA | Water | Diss. Mercury in Water by CVAAS or CVAFS | APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA | Water | Ion Balance Calculation | APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA | Water | Dissolved Metals in Water by CRC ICPMS | APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA | Water | Ammonia in Water by Fluorescence | APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA | Water | Ammonia in Water by Fluorescence | J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA | Water | Nitrite in Water by IC (Low Level) | EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-02-22 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1893584-COFC

COC Number: 2017-02-22 A

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** SR/SB

Short Holding Time
Rush Processing

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
1	MW12-06-02	18-Feb-17	10:15	Water		R		R	R		R							4
2	MW12-06-04	18-Feb-17	10:45	Water		R		R	R		R							4
3	MW12-06-06	18-Feb-17	11:25	Water		R		R	R		R							4
4	MW12-05-01	20-Feb-17	13:50	Water		R		R	R		R							4
5	MW12-05-02	20-Feb-17	14:15	Water		R		R	R		R							4
6	MW12-05-03	20-Feb-17	14:40	Water		R		R	R		R							4
7	MW12-05-04	20-Feb-17	15:00	Water		R		R	R		R							4
8	MW12-05-05	20-Feb-17	15:20	Water		R		R	R		R							4
9	MW12-05-06	20-Feb-17	15:40	Water		R		R	R		R							4
10	MW12-05-07	20-Feb-17	16:00	Water		R		R	R		R							4
11	DUP	18-Feb-17		Water		R		R	R		R							4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.0°C					

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts
Date: 2016-02-22
Time: 11:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: VD
Date: Feb 22/17
Time: 14:55

FINAL SHIPMENT RECEPTION (lab use only)

Received by:
Date:
Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	20-FEB-17
Report Date:	01-MAR-17 20:15 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #:	L1892400
Project P.O. #:	224161 (GW)
Job Reference:	
C of C Numbers:	2016-02-18 A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1892400-1	L1892400-2			
	Description	Water	Water			
	Sampled Date	16-FEB-17	16-FEB-17			
	Sampled Time	14:40	15:05			
	Client ID	MW12-07-01	MW12-07-02			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1190	1430			
	Hardness (as CaCO3) (mg/L)	542	673			
	pH (pH)	7.70	7.83			
	Total Suspended Solids (mg/L)	<3.0	3.6			
	TDS (Calculated) (mg/L)	708	1080			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	566	110			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	566	110			
	Ammonia, Total (as N) (mg/L)	0.525	0.0322			
	Chloride (Cl) (mg/L)	<2.5 DLDS	<2.5 DLDS			
	Nitrate and Nitrite (as N) (mg/L)	0.825	1.16			
	Nitrate (as N) (mg/L)	0.250	0.162			
	Nitrite (as N) (mg/L)	0.575	1.00			
	Sulfate (SO4) (mg/L)	69.1	687			
	Anion Sum (meq/L)	12.8	16.6			
	Cation Sum (meq/L)	14.8	16.8			
	Cation - Anion Balance (%)	7.2	0.5			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0020	0.0027			
	Antimony (Sb)-Dissolved (mg/L)	0.00023	0.00022			
	Arsenic (As)-Dissolved (mg/L)	0.00074	0.00160			
	Barium (Ba)-Dissolved (mg/L)	0.0880	0.0139			
	Beryllium (Be)-Dissolved (mg/L)	0.000042	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.638	0.317			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000125			
	Calcium (Ca)-Dissolved (mg/L)	185	215			
	Chromium (Cr)-Dissolved (mg/L)	0.00047	0.00013			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	<0.00020	0.00094			
	Iron (Fe)-Dissolved (mg/L)	0.022	0.108			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0260	0.0289			
	Magnesium (Mg)-Dissolved (mg/L)	19.8	33.1			
	Manganese (Mn)-Dissolved (mg/L)	0.115	0.110			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1892400-1	L1892400-2			
	Description	Water	Water			
	Sampled Date	16-FEB-17	16-FEB-17			
	Sampled Time	14:40	15:05			
	Client ID	MW12-07-01	MW12-07-02			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.000550	0.0189			
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.94	3.04			
	Selenium (Se)-Dissolved (mg/L)	0.00204	0.000205			
	Silicon (Si)-Dissolved (mg/L)	9.50	6.27			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	88.5	74.5			
	Strontium (Sr)-Dissolved (mg/L)	7.63	10.9			
	Sulfur (S)-Dissolved (mg/L)	58.0	250			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.000179	0.00169			
	Vanadium (V)-Dissolved (mg/L)	0.00175	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0023	0.0031			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-02-18 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1892400-COFC

COC Number: 2016-02-18 A

Page of

Report To
Contact and company name below will appear on the final report

Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659

Company address below will appear on the final report

Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224161 (GW)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack
Sampler: SR/SB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-07-01	16-Feb-17	14:40	Water		R		R	R		R							4
	MW12-07-02	16-Feb-17	15:05	Water		R		R	R		R							4

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐
Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 3.8C
FINAL COOLER TEMPERATURES °C: 10

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-02-18	Time: 11:00	Received by: VD	Date: Feb 20/17	Time: 10:55	Received by: JC	Date: FEB 2 1 2017	Time: 15:15

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 17-FEB-17
Report Date: 01-MAR-17 17:46 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1892186

Project P.O. #:	NOT SUBMITTED
Job Reference:	224161 (GW)
C of C Numbers:	2016-02-16 A
Legal Site Desc:	

Shane Stack
Account Manager

	Sample ID	L1892186-1	L1892186-2			
	Description	Water	Water			
	Sampled Date	15-FEB-17	15-FEB-17			
	Sampled Time	14:50	15:30			
	Client ID	MW09-03-01	MW09-03-02			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	316	318			
	Hardness (as CaCO3) (mg/L)	153	163			
	pH (pH)	8.18	8.16			
	Total Suspended Solids (mg/L)	4.5	9.7			
	TDS (Calculated) (mg/L)	177	187			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	150	160			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	150	160			
	Ammonia, Total (as N) (mg/L)	0.0420	0.0122			
	Chloride (Cl) (mg/L)	<0.50	<0.50			
	Nitrate and Nitrite (as N) (mg/L)	0.290	2.40			
	Nitrate (as N) (mg/L)	0.0172	1.99			
	Nitrite (as N) (mg/L)	0.273	0.406			
	Sulfate (SO4) (mg/L)	20.9	10.2			
	Anion Sum (meq/L)	3.45	3.58			
	Cation Sum (meq/L)	3.52	3.62			
	Cation - Anion Balance (%)	1.1	0.5			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0033	0.0026			
	Antimony (Sb)-Dissolved (mg/L)	0.00035	0.00044			
	Arsenic (As)-Dissolved (mg/L)	0.00079	0.00021			
	Barium (Ba)-Dissolved (mg/L)	0.0695	0.0323			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.286	0.490			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000679			
	Calcium (Ca)-Dissolved (mg/L)	42.5	54.3			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00026			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00031			
	Copper (Cu)-Dissolved (mg/L)	0.00068	0.00279			
	Iron (Fe)-Dissolved (mg/L)	0.103	0.016			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0039	0.0013			
	Magnesium (Mg)-Dissolved (mg/L)	11.5	6.66			
	Manganese (Mn)-Dissolved (mg/L)	0.0861	0.0882			

	Sample ID	L1892186-1	L1892186-2			
	Description	Water	Water			
	Sampled Date	15-FEB-17	15-FEB-17			
	Sampled Time	14:50	15:30			
	Client ID	MW09-03-01	MW09-03-02			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00509	0.00732			
	Nickel (Ni)-Dissolved (mg/L)	0.00110	0.00066			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.20	2.38			
	Selenium (Se)-Dissolved (mg/L)	<0.000050	0.000163			
	Silicon (Si)-Dissolved (mg/L)	5.24	5.06			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	8.92	6.74			
	Strontium (Sr)-Dissolved (mg/L)	0.992	0.342			
	Sulfur (S)-Dissolved (mg/L)	7.06	3.32			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	0.00030	0.00025			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.000935	0.00255			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0172	0.0727			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

Reference Information

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-02-16 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1892186-COFC

COC Number: 2016-02-16 A

Page of

Report To
Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To

Same as Report To ☐ YES ☑ NO

Copy of Invoice with Report ☐ YES ☑ NO

Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:

Requisitioner:

Location:

ALS Contact:

Sampler: SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Disolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW09-03-01	15-Feb-17	14:50	Water		R		R	R		R							4
	MW09-03-02	15-Feb-17	15:30	Water		R		R	R		R							4

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐

Ice Packs ☑ Ice Cubes ☐

Cooling Initiated ☑

SIF Observations Yes ☐ No ☐

Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.0					

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts | Date: 2017-02-16 | Time: 10:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF | Date: 17 Feb 2017 | Time: 13:34

FINAL SHIPMENT RECEPTION (lab use only)

Received by: | Date: | Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-FEB-17
Report Date: 10-FEB-17 19:10 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1885861
Project P.O. #: 224161 (GW)
Job Reference:
C of C Numbers: 2017-01-31 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1885861-1	L1885861-2			
	Description	Water	Water			
	Sampled Date	30-JAN-17	30-JAN-17			
	Sampled Time	16:05	16:20			
	Client ID	MW12-07-01	MW12-07-02			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1200	1400			
	Hardness (as CaCO3) (mg/L)	531	658			
	pH (pH)	7.59	7.79			
	Total Suspended Solids (mg/L)	3.9	3.6			
	TDS (Calculated) (mg/L)	717	1110			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	570	110			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	570	110			
	Ammonia, Total (as N) (mg/L)	0.459	0.0407			
	Chloride (Cl) (mg/L)	<2.5 DLDS	<2.5 DLDS			
	Nitrate and Nitrite (as N) (mg/L)	0.520	0.710			
	Nitrate (as N) (mg/L)	0.158	0.212			
	Nitrite (as N) (mg/L)	0.363	0.499			
	Sulfate (SO4) (mg/L)	80.0	727			
	Anion Sum (meq/L)	13.1	17.4			
	Cation Sum (meq/L)	14.6	16.1			
	Cation - Anion Balance (%)	5.6	-3.8			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0026	0.0019			
	Antimony (Sb)-Dissolved (mg/L)	0.00038	0.00019			
	Arsenic (As)-Dissolved (mg/L)	0.00065	0.00159			
	Barium (Ba)-Dissolved (mg/L)	0.0942	0.0143			
	Beryllium (Be)-Dissolved (mg/L)	0.000045	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.557	0.349			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000154	0.0000056			
	Calcium (Ca)-Dissolved (mg/L)	179	215			
	Chromium (Cr)-Dissolved (mg/L)	0.00042	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00023	<0.00020			
	Iron (Fe)-Dissolved (mg/L)	0.023	0.145			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0268	0.0291			
	Magnesium (Mg)-Dissolved (mg/L)	20.5	29.4			
	Manganese (Mn)-Dissolved (mg/L)	0.134	0.109			

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID		L1885861-1	L1885861-2			
Description		Water	Water			
Sampled Date		30-JAN-17	30-JAN-17			
Sampled Time		16:05	16:20			
Client ID		MW12-07-01	MW12-07-02			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	DLM <0.000010	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.000596	0.0191			
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.97	2.69			
	Selenium (Se)-Dissolved (mg/L)	0.00147	0.000155			
	Silicon (Si)-Dissolved (mg/L)	10.2	6.10			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	90.0	66.2			
	Strontium (Sr)-Dissolved (mg/L)	7.66	11.0			
	Sulfur (S)-Dissolved (mg/L)	72.4	256			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.000187	0.00176			
	Vanadium (V)-Dissolved (mg/L)	0.00189	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	0.0027	0.0035			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1885861-1, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1885861-1, -2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1885861-1, -2
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1885861-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1885861-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1885861-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et

Reference Information

al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-01-31 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1885861-COFC

COC Number: 2017-01-31 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224161 (GW)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals(TM)	Dissolved Metals (DM)	Total Mercury, Hardness	Dissolved Mercury	Ammonia (Total Nutrients)	Dissolved Organic Carbon (DOC)	pH, Cond., TSS, TDS, Alkalinity, Anions							Number of Containers
					P	F/P	P	F/P	P	F/P								
	MW12-07-01	30-Jan-17	16:05	Water		R		R	R		R							4
	MW12-07-02	30-Jan-17	16:20	Water		R		R	R		R							4

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-01-31 8:45	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Appendix D – Seepage Monitoring Program Laboratory Results

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	Deborah Flemming, Ryan Herbert	**Client:**	Minto Explorations Ltd.
From:	Soren Jensen, Kaitlyn Kooy	**Project No:**	1CM002.024
Cc:	Dylan MacGregor (SRK)	**Date:**	March 28, 2018

Subject: 2017 Water Balance and Water Quality Model Summary for the Minto Mine Site

1 Introduction and Background

This memorandum provides a summary of the 2017 water balance and water quality model updates for the Minto Mine site. The update covers the period January 1, 2017 through December 31, 2017.

The water balance update includes a review and summary of precipitation, flow and water inventory data for the Mine site. The water quality update includes a comparison of water quality data collected in 2017 to water quality model predictions for Phase VII of the Mine development, which were recently updated as part of a revised Reclamation and Closure Plan. Water quality predictions for the Main Pit Tailings Management Facility (MPTMF) and the Water Storage Pond (WSP) are provided for 2017, 2018 and for the post-closure period when predicted concentrations are the same from year to year (steady state concentrations).

2 Water Balance Update

2.1 Precipitation

Table 1 shows a summary of monthly precipitation measured at the Mine site between October 2016 and December 2017 along with precipitation data from the regional station at Carmacks, YT (Climate ID: 2100301)[1], which is located 77 km Southwest of the Minto Mine. In the past, the meteorological station at Pelly Ranch (Climate ID 2100880)[1] located 25 km north of Minto was used as a regional reference station. However, the published data record from Pelly Ranch ends in March 2015 so the Carmacks Station was used instead.

Approximately 210 mm of precipitation was measured at the Mine site in the 2017 hydrological year, which was lower than total precipitation measured in 2015 (243 mm) and 2016 (242 mm). Total annual precipitation of 210 mm roughly corresponds to a 1 in 50 to a 1 in 100 dry year.

---

[1] Data obtained from Meteorological Service of Canada, Environment Canada.

Table 1: Precipitation Records for the Minto Mine Site and Carmacks

		Campbell Scientific Station (Minto Mine)		
Year	**Month**	**Tipping Bucket Gauge**	**Geonor Gauge**	**Carmacks Ranch^A (Climate ID 2100301)**
		mm/month	mm/month	mm/month
2016	Oct	6.7	9.8	8.4
2016	Nov	24.2	13.6	14.4
2016	Dec	7.4	14.1	17.5
2017	Jan	1.3	8.0	13.9
2017	Feb	0.0	6.6	4.3
2017	Mar	3.8	7.5	13.1
2017	Apr	7.0	9.4	8.7
2017	May	22.0	17.5	13.1
2017	Jun	40.0	13.2	76.6
2017	Jul	42.3	44.7	92.3
2017	Aug	20.4	20.9	24.4
2017	Sept	37.4	38.8	39.9
2017	Oct	4.7	17.9	27.3
2017	Nov	7.9	7.9	14.4
2017	Dec	4.7	4.7	6.1
SUM Hydrological Year, Nov. 2016 to Oct. 2017		210.5	212.2	345.5

Source: Minto Site Data: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\Minto Water Balance\2017 Met Station Data Summary.xlsx

Notes:
A: Data obtained from Meteorological Service of Canada, Environment Canada.

Minto's Campbell Scientific meteorological station measures total precipitation using a Geonor gauge and a tipping bucket rain gauge. From October through May, the tipping bucket is equipped with a snowfall conversion adaptor, which allows it to measure snowfall as snow water equivalent. The Geonor precipitation gauge collects precipitation in a bucket and records precipitation by measuring the weight of the bucket. In the winter months, the bucket is partially filled with an antifreeze solution that melts any snow collected. Figure 1 shows monthly precipitation recorded by the two gauges as well as total precipitation recorded at Carmacks.

Precipitation measured by the tipping bucket gauge and Geonor gauge were in good agreement on the total annual precipitation measurements (see Table 1) so the measured annual precipitation was assumed to be reliable for use in the annual summary. However, considerable discrepancy was noted in monthly precipitation measurements between January and June (Figure 1). Agreement is better in the second half of the year. Precipitation measured at Carmacks was much higher in June and July than at the Minto Mine.

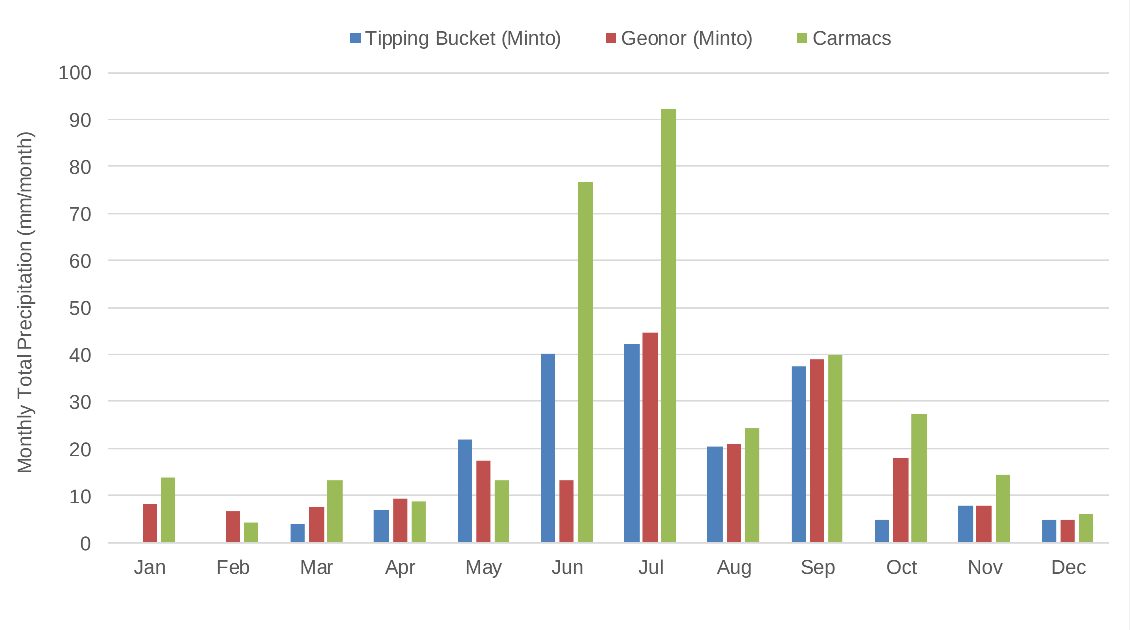


Figure 1: 2017 Monthly Total Precipitation Measurements at Minto and at Carmacks

2.2 Snow Course Data

Snow course surveys were completed at the three established snow survey stations at the Mine site in 2017. Table 2 shows a summary of the snow survey data (i.e. an average of the results from the three stations) from 2009 to 2017. The depth and water equivalent of the snow pack provides an indication of the volume of surface runoff that must be managed the following freshet. In March, April and May 2017, approximately 210,000 m^3 of surface runoff was collected from catchments at the Mine site upstream of the Water Storage Dam. This volume corresponds to roughly 20 mm of runoff, which was slightly less than the estimated 25 mm of runoff observed in 2016.

Table 2: Summary of Snow Survey Data for the Minto Mine Site

Year	February	March	April
	Water Equivalent (mm)	Water Equivalent (mm)	Water Equivalent (mm)
2009	92.7	110.0	150.7
2010	107.7	120.7	56.0
2011	106.0	141.7	111.7
2012	111.0	127.0	132.7
2013	91.3	106.0	62.7
2014	84.3	99.7	67.3
2015	90.3	76.6	67.8
2016	80.3	80.7	n/a
2017	79.0	72.7	59.3

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2017_Water_Balance_Update\MintoSnowMaster_2017.xlsx

2.3 Water Management

Water that is suitable for release into Minto Creek is conveyed to the Water Storage Pond (WSP), while water collected from active mine areas is routed to the Main Pit Tailings Management Facility (MPTMF) or the Area 2 Pit Tailings Management Facility (A2PTMF). Since November 2012, the MPTMF has also been used for subaqueous deposition of tailings. Deposition of mine water and tailings (subaqueous) to the A2PTMF commenced in April 2015.

Other water management features on the Mine site include:

- W15 sump: collects surface runoff and seepage from:
  - The Southwest Waste Dump;
  - Part of the Main Waste Dump; and
  - Adjacent undisturbed catchments.

  In 2017, water collected at W15 was routed to the Main Pit TMF from April until late May and when water quality met discharge criteria, W15 was re-routed to the WSP. Approximately 50% of the catchment that report to W15 is covered by waste rock.
- W35 sump: collects surface runoff from the minimally disturbed southern catchments. Water collected at W35 in 2017 was piped to the Main Pit TMF from April until early May, then to the WSP from May until July once water quality met release criteria. Water quality was closely monitored and W35 sump water was re-routed to the Main Pit periodically throughout the summer. Construction of the re-alignment of the South Diversion Ditch (SDD) in July necessitated the routing of W35 water to the Main Pit TMF for the rest of the year.
- W62 sump (formerly known as W36 or W37 sump): collects surface runoff and seepage from the mill valley, including contributions from the Dry Stack Tailings Storage Facility. Water collected at the W62 sump is pumped to the MPTMF.
- South Diversion Ditch: diverts water from (W35 Sump) minimally disturbed southern catchments to the WSP (can also be routed to the MPTMF).
- WSP: reservoir for water that meets discharge criteria and is destined for discharge to Minto Creek.

2.4 2017 Water Balance

Table 3 summarizes the monthly water and tailings inventory in Minto's MPTMF and A2PTMF as well as water inventory in the WSP. In 2017, the water inventory in the MPTMF was reduced by approximately 22,000 m^3, while the water inventory in A2PTMF increased by roughly 501,000 m^3. The increase in water inventory in the A2PTMF roughly corresponds to the volume of pore water in the sub-aqueously deposited tailings in 2017. Therefore, the free water volume in the pits should be unchanged from last year. The WSP water inventory increased by about 6,000 m^3 between January 1 and December 31, 2017.

Table 4 shows a summary of the 2017 water balance for the Mine site. The total surface runoff collected on site was estimated to be 565,000 m^3 based on the change in the water inventory and the known volume of water released to Minto Creek. Including an estimated inflow of 30,000 m^3 of groundwater, the total site-wide yield was estimated at about 595,000 m^3 for the year. The total catchment upstream of the Water Storage Dam measures approximately 1,040 ha. Therefore, 595,000 m^3 of runoff from 1,040 ha gives a unit yield of approximately 57 mm/year.

The water and load balance model used for forecasting surface runoff volumes uses a site-wide annual average runoff coefficient, which has been derived based on previous years' water balance results. The runoff coefficient is estimated based on the total annual precipitation as follows:

- For dry years with less than 190 mm total precipitation: runoff coefficient = 0.15.
- For average to wet years with more than 309 mm total precipitation: runoff coefficient = 0.30.
- Runoff coefficients for years with total precipitation between 190 mm and 309 mm: interpolated values between 0.15 and 0.30.

In 2017 (hydraulic year) the estimated total precipitation was 210 mm (Table 1), which corresponds to a modelled runoff coefficient of 0.18. The site-wide runoff coefficient, based on the 2017 water balance (measured flows, water inventory and total precipitation), is:

$$\textit{Annual Yield/ Total Annual Precipitation} = \textit{Runoff Coefficient} \rightarrow \quad 57\ mm/210\ mm = \boldsymbol{0.27}$$

The calculated value for the annual site-wide runoff coefficient is higher than the runoff coefficient estimated by the water balance model. However, the site-wide runoff coefficient is similar to the coefficient calculated in previous, slightly wetter years. Therefore, the method used by the water balance model to estimate runoff in dry years is likely too conservative (i.e. conservatively dry).

Table 3: 2017 Water Inventory and Release to Minto Creek

Month/	MPTMF Volume Occupied (Water + Tailings)^A	Change in MPTMF Water Inventory	Tailings Solids Deposition in MPTMF	A2PTMF Volume Occupied (Water + Tailings)^A	Change in A2PTMF Water Inventory	Tailings Solids Deposition in A2PTMF	WSP Volume^A	Change in WSP Water Inventory
Year	m^3	m^3/month	BCM/month	m^3	m^3/month	BCM/month	m^3	m^3/month
Jan-17	3,924,000	41,000	0	2,077,000	-2,000	45,000	67,000	-4,000
Feb-17	3,965,000	48,000	0	2,120,000	5,000	40,000	63,000	-5,000
Mar-17	4,013,000	32,000	0	2,164,000	20,000	48,000	58,000	-3,000
Apr-17	4,046,000	-140,000	0	2,231,000	147,000	43,000	55,000	18,000
May-17	3,906,000	68,000	0	2,421,000	43,000	47,000	73,000	5,000
Jun-17	3,974,000	71,000	0	2,511,000	-29,000	47,000	78,000	6,000
Jul-17	4,045,000	17,000	0	2,529,000	24,000	43,000	84,000	-5,000
Aug-17	4,061,000	63,000	0	2,596,000	-17,000	40,000	79,000	-7,000
Sep-17	4,124,000	-8,000	0	2,618,000	98,000	41,000	72,000	6,000
Oct-17	4,116,000	-162,000	0	2,757,000	162,000	45,000	77,000	0
Nov-17	3,954,000	-100,000	0	2,964,000	89,000	39,000	77,000	-4,000
Dec-17	3,854,000	49,000	0	3,092,000	-37,000	42,000	74,000	-2,000
Jan-18	3,903,000		0	3,098,000			72,000	
SUM		**-22,000**	**0**		**501,000**	**524,000**		**6,000**

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2017_Water_Balance_Update\2017 Water Balance Update REV00 KNK.xlsx

Notes:

A – on the first day of the month.

Table 4: Water Balance Summary of the Minto Mine Site, 2017 (Jan to Dec)

	Units	**Main Pit TMF**	**Area 2 Pit TMF**	**WSP**
Volume Change 2017 (water + tailings)	m^3	-22,000	1,021,000	6,000
Tailings Deposited, total	BCM	-	524,000	-
Water Volume Change 2017	m^3	-22,000	501,000	6,000
Estimated Groundwater Inflow	m^3	-	30,000	-
Total Water Inventory Increase in 2017	**m^3**	515,000		
Total Water Discharged to Minto Creek	m^3	80,000		
Total Site-Wide Yield in 2017	**m^3**	**595,000**		

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2017_Water_Balance_Update\2017 Water Balance Update REV00 KNK.xlsx

3 Water Quality Model Update

3.1 Solid Phase Geochemistry

The neutralization potential ratio (NPR) and copper content of waste rock and tailings were reviewed in order to identify any new trends in the solid phase geochemistry that may have developed since the last source term update. Significant changes in the solid phase geochemistry would indicate a need for further analysis of the waste rock and tailings to generate new source terms that reflect the observed changes in the geochemistry.

The NPR and copper content of waste rock and tailings are shown in Figure 2 to Figure 5. The NPR of tailings solids appear to show a decreasing trend in 2017 and copper concentrations an increasing trend. However, measured NPR was greater than 3 for all samples, which indicates that the tailings are not potentially acid generating and the lower NPRs are therefore not expected to affect source terms. Copper concentrations increased only to the levels measured in 2015. This range of copper concentrations has already been accounted for in the existing source terms. No significant changes in geochemistry were observed in the properties of the waste rock in 2017 compared to similar materials produced in prior years. Therefore, no further evaluation of 2017 solid phase geochemistry was warranted.

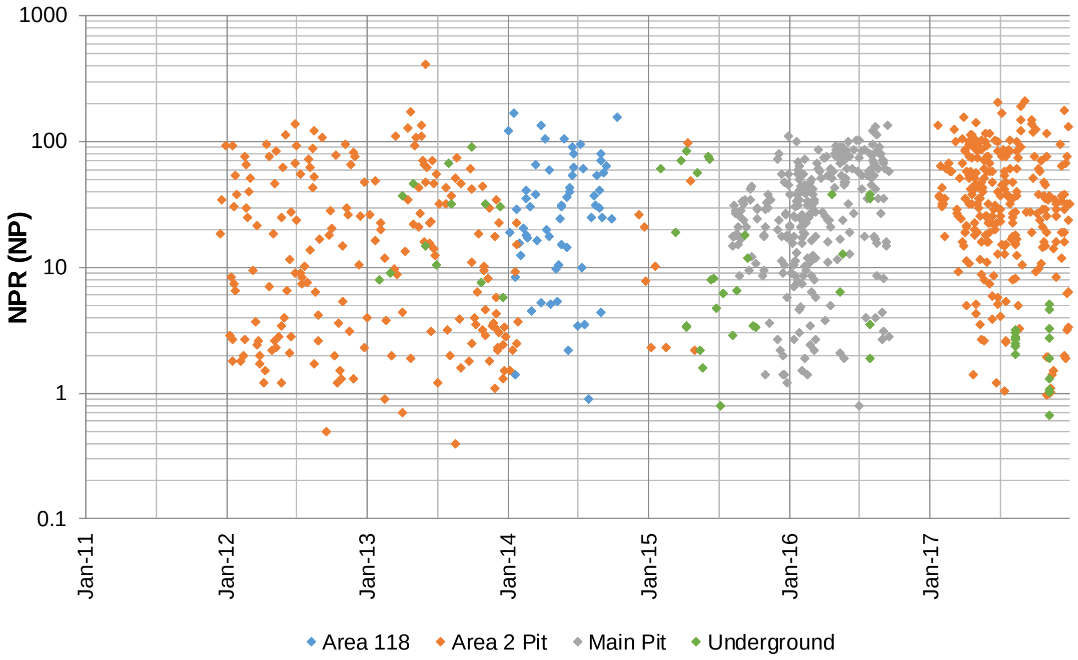


Figure 2: Waste Rock Neutralization Potential Ratio over Time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

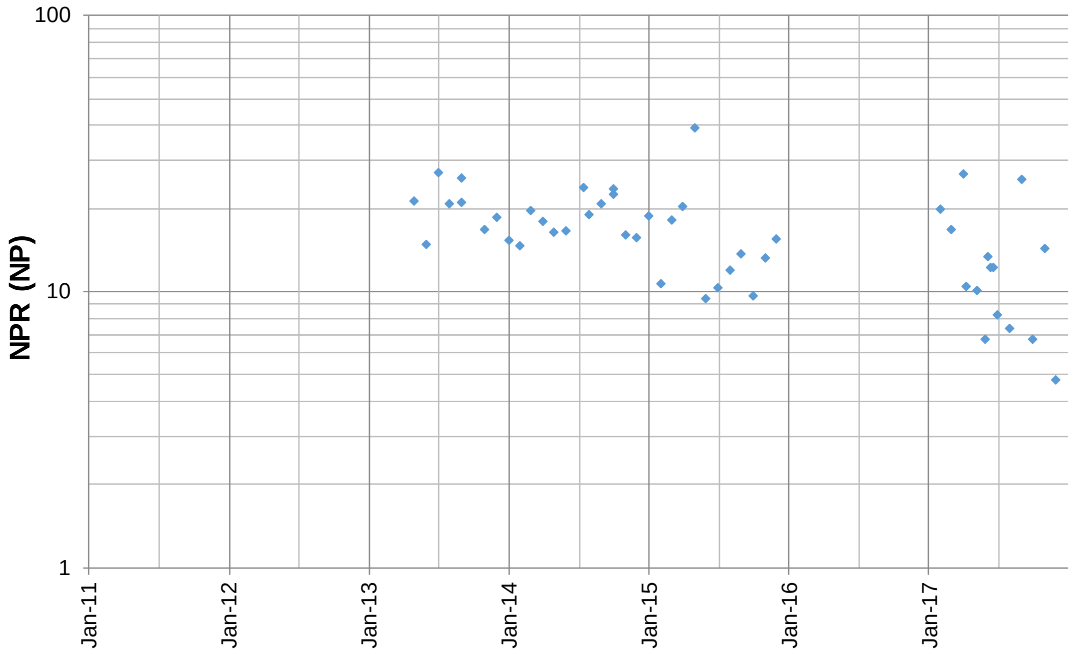


Figure 3: Tailings Neutralization Potential Ratio over Time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

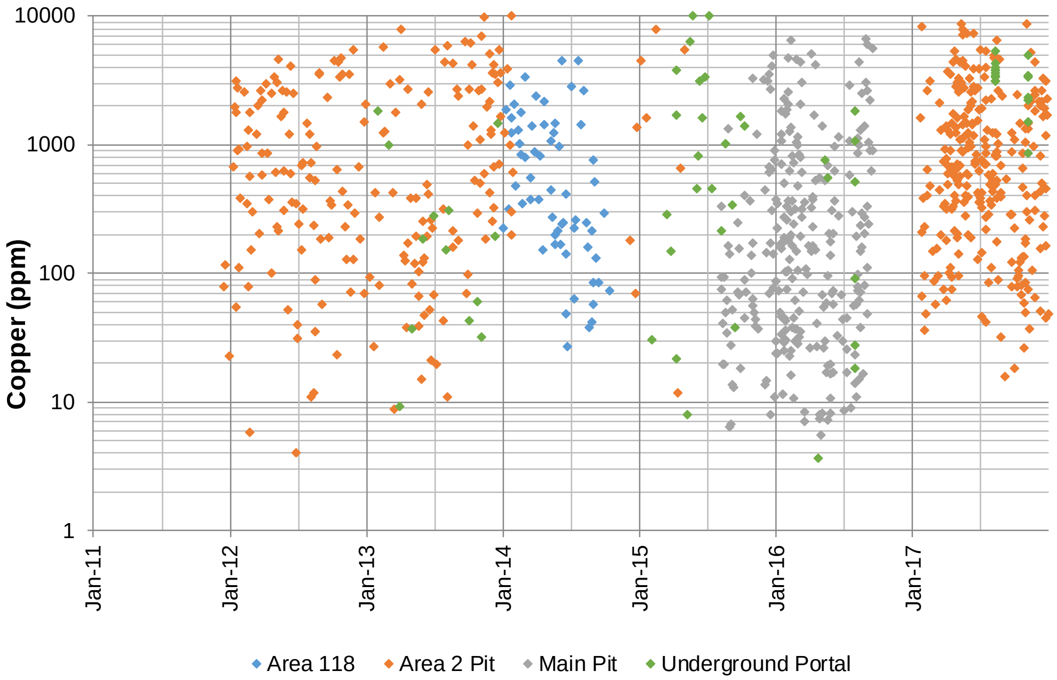


Figure 4: Waste Rock Copper Concentration over Time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

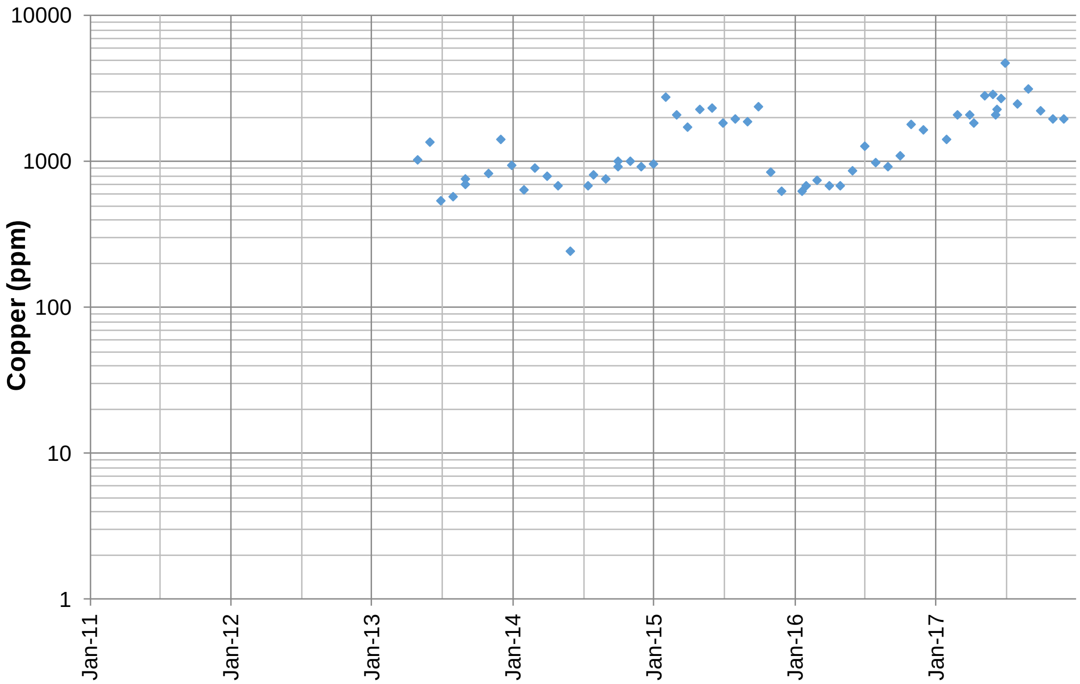


Figure 5: Tailings copper concentration over time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

3.2 Comparison of Measured Water Quality Data to Source Terms

3.2.1 Source Terms – Dry Stack Tailings Storage Facility

The Dry Stack Tailings Storage Facility (DSTSF) source terms used in the water and load balance model for the Minto were developed based on the observed water chemistry of samples collected at station W8 and W8A. This station was chosen because it had the highest concentrations of copper, cadmium, selenium, and sulfate during the period of record. The following points describe the source terms:

- Best Estimate source term: 50th percentile dissolved concentrations from W8A;
- Reasonable Worst Case source term: 95th percentile dissolved concentrations from W8A.

The Best Estimate and Reasonable Worst Case source terms were updated to include data to 2017 for comparison to the existing source terms. It was found that the updated source terms did not differ from the source terms used in the latest model revision, which included data up to and including 2016. Therefore, for consistency the original DSTSF source terms was be used in this 2017 update of the water balance and water quality model.

3.2.2 Source Terms – Waste Rock

The Main Waste Dump and the Southwest Waste Dump source terms used in the water and load balance model were defined based on observed water chemistry at station W15, which collects runoff from the Southwest Waste Dump. The latest model revision assigned Best Estimate waste rock source term as the 50th percentile dissolved concentrations at W15 until the end of 2016 and the Reasonable Worst Case waste rock source term was the 95th percentile dissolved concentrations. Water quality data collected at W15 in 2017 followed the same trends as the historical data. Therefore, the original source term was used for the updated predictions presented here.

3.2.3 Source Term – Tailings Slurry

In 2017, sulfate concentrations in the Area 2 and Main Pit water increased at a greater rate than in previous years. After investigating possible causes, it was concluded that variability in sulfate loadings from tailings slurry was the most likely cause of the concentration increases.

In order to properly represent the variability in the mill effluent water quality in the water and load balance model, the tailings slurry source term was divided into two parts: sulfide ore tailings source term and oxide ore (referred to as POX) tailings source term. Typically, just sulfide ore or a blend of sulfide ore and POX ore are processed in the mill. Elevated concentrations of sulfate in the mill effluent coincided with processing of POX. Accordingly, the tailings slurry source terms for sulfide ore and POX ore were developed based on measured sulfate concentrations in the tailings thickener when sulfide ore and POX ore were milled.

The loading rates associated with POX processing are highly variable. To maintain conservatism in the model predictions, the Expected Case and Worst Case POX ore slurry source term that represents the highest sulfate loading rates was used for all model scenarios.

3.3 Water Quality Model Results

Table 5 and 6 show revised model outputs from the updated water and load balance model for water quality in the Water Storage Pond (WSP) for 2017, 2018, and post-closure (best estimate and worst case) along with concentrations measured in 2017. Table 7 and 8 show revised model predictions of water quality in the MPTMF for 2017, 2018 and post-closure. Predictions for 2018 and post-closure were selected to provide representative short-term and long-term indications of water quality trends. Predictions are for average precipitation conditions. The Water Use Licence (QZ14-031) effluent limits are also listed in the tables. Model runs started on 1 January 2016 and ended on 1 January 2045, at which point concentrations in the model roughly have reached steady state.

The MPTMF was historically the primary water reservoir on site. In the model, the free water in the MPTMF and A2PTMF are more or less considered to belong to the same reservoir due to the high rate of flow between the two reservoirs. Reclaim water is drawn from the MPTMF and excess free water in the A2PTMF is pumped back to the MPTMF.

Therefore, a comparison of measured MPTMF water quality with concentrations predicted for pit water for the Phase V/VI environmental assessment provides a good measure of actual vs. expected geochemical performance of the site. Water collected in the WSP includes clean (non-contact) runoff and effluent from Minto’s water treatment plant.

Median measured concentrations in the WSP in 2017 were lower than or comparable to the revised model predictions using best estimate source terms (Table 5), except for dissolved copper, for which the measured median concentration was 27 µg/L compared to expected median concentrations of approximately 18 µg/L. Dissolved copper concentrations in the WSP shows a decreasing trend between 2011 and 2015 followed by an increasing trend between 2015 and 2017 (Figure 6). The increase in copper concentrations in the WSP in 2017 was due to a reduction in the volume of treated MPTMF water that was pumped to the WSP. MPTMF water is treated using reverse osmosis, which removes nearly all dissolved copper.

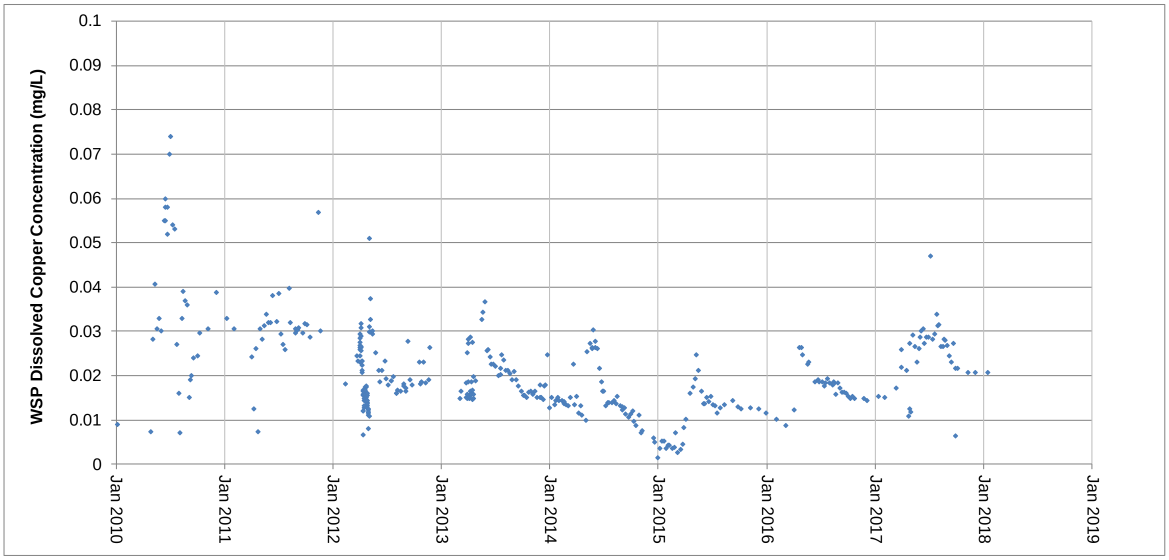


Figure 6 Dissolved Copper Concentrations in WSP (Station W16)

The overall favorable agreement in the results tables below indicates that the revised source terms are appropriate for describing the existing geochemical performance and the actual water management practices on site. Best estimate source terms are intended to provide an indication of the general trend in water quality parameter concentrations, but are not intended to capture maximum or outlier concentration values. Therefore, the median values of best estimate model predictions are compared to measured median values.

Revised model predictions using reasonable worst case source terms are generally higher than comparable median and maximum measured values for the WSP, except for copper (Table 6).

Revised model predictions for water quality in the MPTMF (and by extension the A2PTMF) using the best estimate source terms are in reasonable agreement with median measured concentrations in 2017 (Table 7) except for dissolved cadmium and nitrite. Median measured cadmium concentrations are approximately a factor of 2 greater than expected concentration but still well below the concentrations predicted based on reasonable worst case source terms (Table 8). Nitrite is relatively unstable and is produced and consumed by biological activity in the pit water. An investigation of the matter indicated that it may the activity of heterotrophic microorganisms in the MPTMF water that is responsible for producing the elevated nitrite concentrations.

Water quality model predictions using reasonable worst-case source terms are higher than measured median and maximum concentrations, with the exception of nitrite (Table 8).

Table 5: WSP Water Quality Model Predictions and Measured Concentrations in 2017, Best Estimate

		WUL Effluent Limits (QZ14-031)	WSP Measured Water Quality (Station W16)	Modelling Predictions of Quality in WSP (Station W16)		
Year			2017	2017	2018	Post-Closure
			Median	Median	Median	Median
Ammonia	mg/L	0.75	0.055	0.095	0.09	0.23
N-NO_2	mg/L	0.18	0.029	0.066	0.057	0.059
N-NO_3	mg/L	27.3	2	4.5	4.8	1.2
Ag-Dissolved	mg/L	0.0003	0.00001	0.000023	0.000023	0.000049
Al-Dissolved	mg/L	0.3	0.0062	0.062	0.058	0.28
As-Dissolved	mg/L	0.015	0.00039	0.00078	0.00078	0.0021
Cd-Dissolved	mg/L	0.0014a	0.0000099	0.000031	0.000029	0.000022
Cr-Dissolved	mg/L	0.003	0.00011	0.0012	0.0012	0.0019
Cu-Dissolved	mg/L	0.06/0.039b	0.027	0.018	0.017	0.013
Fe-Dissolved	mg/L	3.3	0.069	0.54	0.55	0.59
Pb-Dissolved	mg/L	0.012	0.00005	0.00026	0.00026	0.00042
Mo-Dissolved	mg/L	0.219	0.0027	0.0026	0.0027	0.0097
Ni-Dissolved	mg/L	0.33	0.0008	0.0019	0.0018	0.0024
Se-Dissolved	mg/L	0.006	0.00073	0.0013	0.0014	0.002
Zn-Dissolved	mg/L	0.09	0.0011	0.007	0.0068	0.0035

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 6: WSP Water Quality Model Predictions and Measured Concentrations in 2017, Reasonable Worst Case

		WUL Effluent Limits (QZ14-031)	WSP Measured Water Quality (Station W16)		Modelling Predictions of Quality in WSP (Station W16)					
Year			2017		2017		2018		Post-Closure	
			Median	Max	Median	Max	Median	Max	Median	Max
Ammonia	mg/L	0.75	0.055	0.16	0.26	0.32	0.25	0.29	0.83	1.6
N-NO2	mg/L	0.18	0.029	0.12	0.2	0.22	0.18	0.22	0.12	0.23
N-NO3	mg/L	27.3	2	4.9	12	19	13	16	3.3	6.4
Ag-Dissolved	mg/L	0.0003	0.00001	0.00001	0.000023	0.000027	0.000023	0.000025	0.000088	0.00021
Al-Dissolved	mg/L	0.3	0.0062	0.034	0.12	0.15	0.11	0.14	0.55	1.2
As-Dissolved	mg/L	0.015	0.00039	0.00048	0.0011	0.0013	0.0011	0.0012	0.0047	0.011
Cd-Dissolved	mg/L	0.0014a	9.9E-06	0.000049	0.000091	0.00011	0.000088	0.0001	0.000096	0.00024
Cr-Dissolved	mg/L	0.003	0.00011	0.00022	0.0013	0.0015	0.0013	0.0014	0.0036	0.0086
Cu-Dissolved	mg/L	0.06/0.039b	0.027	0.047	0.031	0.038	0.03	0.035	0.02	0.057
Fe-Dissolved	mg/L	3.3	0.069	0.14	1.1	1.4	1.1	1.2	1.4	3.9
Pb-Dissolved	mg/L	0.012	0.00005	0.000096	0.00027	0.00031	0.00028	0.00029	0.0018	0.004
Mo-Dissolved	mg/L	0.219	0.0027	0.0048	0.0052	0.0069	0.0054	0.0061	0.03	0.071
Ni-Dissolved	mg/L	0.33	0.0008	0.0013	0.0029	0.0033	0.0029	0.0031	0.0054	0.015
Se-Dissolved	mg/L	0.006	0.00073	0.0015	0.0029	0.0043	0.0031	0.0038	0.0044	0.0084
Zn-Dissolved	mg/L	0.09	0.0011	0.011	0.0098	0.01	0.0092	0.01	0.0083	0.023

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto’s water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 7: MPTMF Water Quality Model Predictions and Measured Concentrations in 2017, Best Estimate

		WUL Effluent Limits (QZ14-031)	MPTMF Measured Water Quality (Station W12)	Modelling Predictions of Quality in MPTMF (Station W12)		
Year			**2017**	**2017**	**2018**	**Post-Closure**
			Median	**Median**	**Median**	**Median**
Ammonia	mg/L	0.75	4	5.2	4.4	0.079
N-NO2	mg/L	0.18	3.7	2	1.5	0.017
N-NO3	mg/L	27.3	14	38	33	0.38
Ag-Dissolved	Mg/L	0.0003	0.00002	0.000063	0.000063	0.000057
Al-Dissolved	mg/L	0.3	0.0055	0.37	0.37	0.26
As-Dissolved	mg/L	0.015	0.00044	0.0026	0.0026	0.0021
Cd-Dissolved	mg/L	0.0014a	0.00016	0.000084	0.000087	0.00006
Cr-Dissolved	mg/L	0.003	0.0002	0.0021	0.0022	0.0023
Cu-Dissolved	mg/L	0.06/0.039b	0.039	0.032	0.037	0.035
Fe-Dissolved	mg/L	3.3	0.02	0.39	0.48	0.71
Pb-Dissolved	mg/L	0.012	0.0001	0.00052	0.00053	0.00051
Mo-Dissolved	mg/L	0.219	0.079	0.1	0.077	0.011
Ni-Dissolved	mg/L	0.33	0.0035	0.0035	0.0034	0.0028
Se-Dissolved	mg/L	0.006	0.013	0.019	0.016	0.0034
Zn-Dissolved	mg/L	0.09	0.0069	0.011	0.011	0.012

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 8: MPTMF Water Quality Model Predictions and Measured Concentrations in 2017, Reasonable Worst Case

		WUL Effluent Limits (QZ14-031)	MPTMF Measured Water Quality (Station W12)		Modelling Predictions of Quality in MPTMF (Station W12)					
Year			**2017**		**2017**		**2018**		**Post-Closure**	
			Median	**Max**	**Median**	**Max**	**Median**	**Max**	**Median**	**Max**
Ammonia	mg/L	0.75	4	6.9	17	18	15	19	0.28	0.45
N-NO2	mg/L	0.18	3.7	6.7	3.8	4.3	3.1	4	0.037	0.057
N-NO3	mg/L	27.3	14	27	84	90	77	96	1.1	1.7
Ag-Dissolved	Mg/L	0.0003	0.00002	0.00005	0.00012	0.00013	0.00012	0.00013	0.000089	0.00012
Al-Dissolved	mg/L	0.3	0.0055	0.012	0.77	0.82	0.76	0.84	0.53	0.83
As-Dissolved	mg/L	0.015	0.00044	0.00054	0.0063	0.0066	0.0063	0.0066	0.0049	0.0063
Cd-Dissolved	mg/L	0.0014a	0.00016	0.00021	0.00034	0.00035	0.00035	0.00036	0.00031	0.00037
Cr-Dissolved	mg/L	0.003	0.0002	0.0002	0.0049	0.0051	0.0049	0.0051	0.0038	0.0048
Cu-Dissolved	mg/L	0.06/0.039b	0.039	0.074	0.081	0.083	0.09	0.093	0.077	0.098
Fe-Dissolved	mg/L	3.3	0.02	0.047	0.85	0.97	1.1	1.2	1.9	2.3
Pb-Dissolved	mg/L	0.012	0.0001	0.00021	0.0026	0.0027	0.0026	0.0028	0.0017	0.0025
Mo-Dissolved	mg/L	0.219	0.079	0.085	0.16	0.18	0.13	0.17	0.031	0.037
Ni-Dissolved	mg/L	0.33	0.0035	0.0046	0.0077	0.008	0.0077	0.008	0.0067	0.0074
Se-Dissolved	mg/L	0.006	0.013	0.015	0.028	0.031	0.025	0.031	0.008	0.01
Zn-Dissolved	mg/L	0.09	0.0069	0.009	0.033	0.034	0.033	0.035	0.03	0.036

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto’s water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

4 Closing

The summary of the updated water balance and water quality model for the Minto Mine was prepared in support of annual reporting. SRK would be pleased to address any questions or comments.

Appendix E – 2017 Water Balance and Water Quality Model Summary for the Minto Mine

srk consulting

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532

vancouver@srk.com
www.srk.com

Memo

To:	Deborah Flemming, Ryan Herbert	**Client:**	Minto Explorations Ltd.
From:	Soren Jensen, Kaitlyn Kooy	**Project No:**	1CM002.024
Cc:	Dylan MacGregor (SRK)	**Date:**	March 28, 2018
Subject:	2017 Water Balance and Water Quality Model Summary for the Minto Mine Site		

1 Introduction and Background

This memorandum provides a summary of the 2017 water balance and water quality model updates for the Minto Mine site. The update covers the period January 1, 2017 through December 31, 2017.

The water balance update includes a review and summary of precipitation, flow and water inventory data for the Mine site. The water quality update includes a comparison of water quality data collected in 2017 to water quality model predictions for Phase VII of the Mine development, which were recently updated as part of a revised Reclamation and Closure Plan. Water quality predictions for the Main Pit Tailings Management Facility (MPTMF) and the Water Storage Pond (WSP) are provided for 2017, 2018 and for the post-closure period when predicted concentrations are the same from year to year (steady state concentrations).

2 Water Balance Update

2.1 Precipitation

Table 1 shows a summary of monthly precipitation measured at the Mine site between October 2016 and December 2017 along with precipitation data from the regional station at Carmacks, YT (Climate ID: 2100301)[1], which is located 77 km Southwest of the Minto Mine. In the past, the meteorological station at Pelly Ranch (Climate ID 2100880)[1] located 25 km north of Minto was used as a regional reference station. However, the published data record from Pelly Ranch ends in March 2015 so the Carmacks Station was used instead.

Approximately 210 mm of precipitation was measured at the Mine site in the 2017 hydrological year, which was lower than total precipitation measured in 2015 (243 mm) and 2016 (242 mm). Total annual precipitation of 210 mm roughly corresponds to a 1 in 50 to a 1 in 100 dry year.

---

[1] Data obtained from Meteorological Service of Canada, Environment Canada.

Table 1: Precipitation Records for the Minto Mine Site and Carmacks

		Campbell Scientific Station (Minto Mine)		
Year	**Month**	**Tipping Bucket Gauge**	**Geonor Gauge**	**Carmacks Ranch[A] (Climate ID 2100301)**
		mm/month	mm/month	mm/month
2016	Oct	6.7	9.8	8.4
2016	Nov	24.2	13.6	14.4
2016	Dec	7.4	14.1	17.5
2017	Jan	1.3	8.0	13.9
2017	Feb	0.0	6.6	4.3
2017	Mar	3.8	7.5	13.1
2017	Apr	7.0	9.4	8.7
2017	May	22.0	17.5	13.1
2017	Jun	40.0	13.2	76.6
2017	Jul	42.3	44.7	92.3
2017	Aug	20.4	20.9	24.4
2017	Sept	37.4	38.8	39.9
2017	Oct	4.7	17.9	27.3
2017	Nov	7.9	7.9	14.4
2017	Dec	4.7	4.7	6.1
SUM Hydrological Year, Nov. 2016 to Oct. 2017		210.5	212.2	345.5

Source: Minto Site Data: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\Minto Water Balance\2017 Met Station Data Summary.xlsx

Notes:

A: Data obtained from Meteorological Service of Canada, Environment Canada.

Minto's Campbell Scientific meteorological station measures total precipitation using a Geonor gauge and a tipping bucket rain gauge. From October through May, the tipping bucket is equipped with a snowfall conversion adaptor, which allows it to measure snowfall as snow water equivalent. The Geonor precipitation gauge collects precipitation in a bucket and records precipitation by measuring the weight of the bucket. In the winter months, the bucket is partially filled with an antifreeze solution that melts any snow collected. Figure 1 shows monthly precipitation recorded by the two gauges as well as total precipitation recorded at Carmacks.

Precipitation measured by the tipping bucket gauge and Geonor gauge were in good agreement on the total annual precipitation measurements (see Table 1) so the measured annual precipitation was assumed to be reliable for use in the annual summary. However, considerable discrepancy was noted in monthly precipitation measurements between January and June (Figure 1). Agreement is better in the second half of the year. Precipitation measured at Carmacks was much higher in June and July than at the Minto Mine.

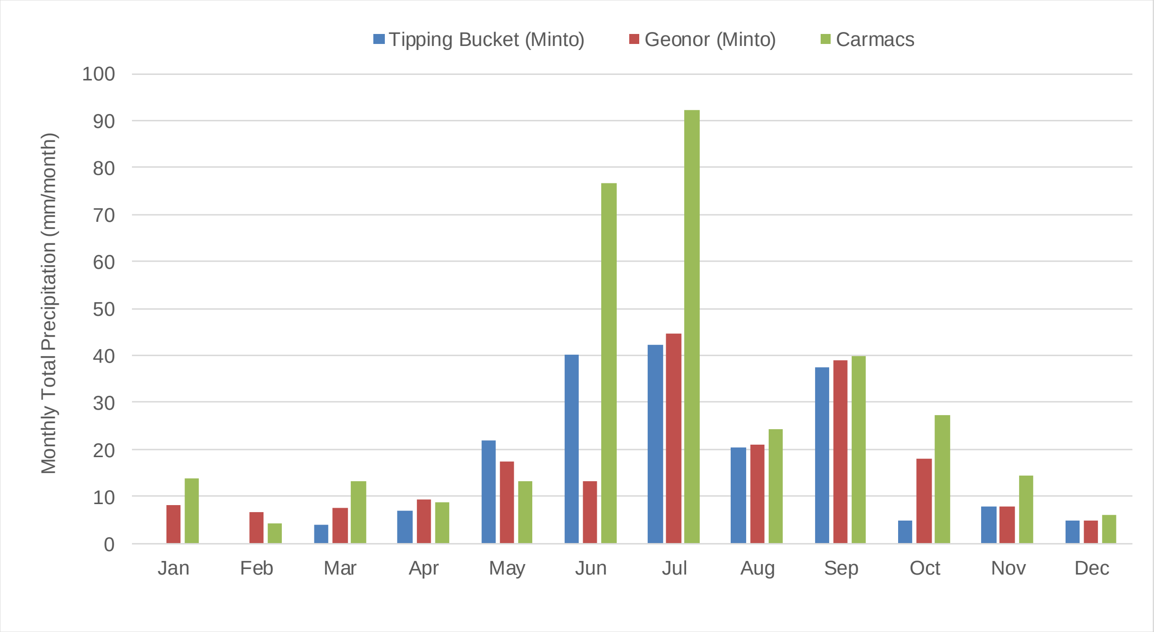


Figure 1: 2017 Monthly Total Precipitation Measurements at Minto and at Carmacks

2.2 Snow Course Data

Snow course surveys were completed at the three established snow survey stations at the Mine site in 2017. Table 2 shows a summary of the snow survey data (i.e. an average of the results from the three stations) from 2009 to 2017. The depth and water equivalent of the snow pack provides an indication of the volume of surface runoff that must be managed the following freshet. In March, April and May 2017, approximately 210,000 m^3 of surface runoff was collected from catchments at the Mine site upstream of the Water Storage Dam. This volume corresponds to roughly 20 mm of runoff, which was slightly less than the estimated 25 mm of runoff observed in 2016.

Table 2: Summary of Snow Survey Data for the Minto Mine Site

Year	February	March	April
	Water Equivalent (mm)	Water Equivalent (mm)	Water Equivalent (mm)
2009	92.7	110.0	150.7
2010	107.7	120.7	56.0
2011	106.0	141.7	111.7
2012	111.0	127.0	132.7
2013	91.3	106.0	62.7
2014	84.3	99.7	67.3
2015	90.3	76.6	67.8
2016	80.3	80.7	n/a
2017	79.0	72.7	59.3

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2017_Water_Balance_Update\MintoSnowMaster_2017.xlsx

2.3 Water Management

Water that is suitable for release into Minto Creek is conveyed to the Water Storage Pond (WSP), while water collected from active mine areas is routed to the Main Pit Tailings Management Facility (MPTMF) or the Area 2 Pit Tailings Management Facility (A2PTMF). Since November 2012, the MPTMF has also been used for subaqueous deposition of tailings. Deposition of mine water and tailings (subaqueous) to the A2PTMF commenced in April 2015.

Other water management features on the Mine site include:

- W15 sump: collects surface runoff and seepage from:
  - The Southwest Waste Dump;
  - Part of the Main Waste Dump; and
  - Adjacent undisturbed catchments.

  In 2017, water collected at W15 was routed to the Main Pit TMF from April until late May and when water quality met discharge criteria, W15 was re-routed to the WSP. Approximately 50% of the catchment that report to W15 is covered by waste rock.

- W35 sump: collects surface runoff from the minimally disturbed southern catchments. Water collected at W35 in 2017 was piped to the Main Pit TMF from April until early May, then to the WSP from May until July once water quality met release criteria. Water quality was closely monitored and W35 sump water was re-routed to the Main Pit periodically throughout the summer. Construction of the re-alignment of the South Diversion Ditch (SDD) in July necessitated the routing of W35 water to the Main Pit TMF for the rest of the year.
- W62 sump (formerly known as W36 or W37 sump): collects surface runoff and seepage from the mill valley, including contributions from the Dry Stack Tailings Storage Facility. Water collected at the W62 sump is pumped to the MPTMF.
- South Diversion Ditch: diverts water from (W35 Sump) minimally disturbed southern catchments to the WSP (can also be routed to the MPTMF).
- WSP: reservoir for water that meets discharge criteria and is destined for discharge to Minto Creek.

2.4 2017 Water Balance

Table 3 summarizes the monthly water and tailings inventory in Minto's MPTMF and A2PTMF as well as water inventory in the WSP. In 2017, the water inventory in the MPTMF was reduced by approximately 22,000 m^3, while the water inventory in A2PTMF increased by roughly 501,000 m^3. The increase in water inventory in the A2PTMF roughly corresponds to the volume of pore water in the sub-aqueously deposited tailings in 2017. Therefore, the free water volume in the pits should be unchanged from last year. The WSP water inventory increased by about 6,000 m^3 between January 1 and December 31, 2017.

Table 4 shows a summary of the 2017 water balance for the Mine site. The total surface runoff collected on site was estimated to be 565,000 m^3 based on the change in the water inventory and the known volume of water released to Minto Creek. Including an estimated inflow of 30,000 m^3 of groundwater, the total site-wide yield was estimated at about 595,000 m^3 for the year. The total catchment upstream of the Water Storage Dam measures approximately 1,040 ha. Therefore, 595,000 m^3 of runoff from 1,040 ha gives a unit yield of approximately 57 mm/year.

The water and load balance model used for forecasting surface runoff volumes uses a site-wide annual average runoff coefficient, which has been derived based on previous years' water balance results. The runoff coefficient is estimated based on the total annual precipitation as follows:

- For dry years with less than 190 mm total precipitation: runoff coefficient = 0.15.
- For average to wet years with more than 309 mm total precipitation: runoff coefficient = 0.30.
- Runoff coefficients for years with total precipitation between 190 mm and 309 mm: interpolated values between 0.15 and 0.30.

In 2017 (hydraulic year) the estimated total precipitation was 210 mm (Table 1), which corresponds to a modelled runoff coefficient of 0.18. The site-wide runoff coefficient, based on the 2017 water balance (measured flows, water inventory and total precipitation), is:

$$\textit{Annual Yield/ Total Annual Precipitation} = \textit{Runoff Coefficient} \rightarrow \quad 57\ mm/210\ mm = \boldsymbol{0.27}$$

The calculated value for the annual site-wide runoff coefficient is higher than the runoff coefficient estimated by the water balance model. However, the site-wide runoff coefficient is similar to the coefficient calculated in previous, slightly wetter years. Therefore, the method used by the water balance model to estimate runoff in dry years is likely too conservative (i.e. conservatively dry).

Table 3: 2017 Water Inventory and Release to Minto Creek

Month/	MPTMF Volume Occupied (Water + Tailings)^A	Change in MPTMF Water Inventory	Tailings Solids Deposition in MPTMF	A2PTMF Volume Occupied (Water + Tailings)^A	Change in A2PTMF Water Inventory	Tailings Solids Deposition in A2PTMF	WSP Volume^A	Change in WSP Water Inventory
Year	m^3	m^3/month	BCM/month	m^3	m^3/month	BCM/month	m^3	m^3/month
Jan-17	3,924,000	41,000	0	2,077,000	-2,000	45,000	67,000	-4,000
Feb-17	3,965,000	48,000	0	2,120,000	5,000	40,000	63,000	-5,000
Mar-17	4,013,000	32,000	0	2,164,000	20,000	48,000	58,000	-3,000
Apr-17	4,046,000	-140,000	0	2,231,000	147,000	43,000	55,000	18,000
May-17	3,906,000	68,000	0	2,421,000	43,000	47,000	73,000	5,000
Jun-17	3,974,000	71,000	0	2,511,000	-29,000	47,000	78,000	6,000
Jul-17	4,045,000	17,000	0	2,529,000	24,000	43,000	84,000	-5,000
Aug-17	4,061,000	63,000	0	2,596,000	-17,000	40,000	79,000	-7,000
Sep-17	4,124,000	-8,000	0	2,618,000	98,000	41,000	72,000	6,000
Oct-17	4,116,000	-162,000	0	2,757,000	162,000	45,000	77,000	0
Nov-17	3,954,000	-100,000	0	2,964,000	89,000	39,000	77,000	-4,000
Dec-17	3,854,000	49,000	0	3,092,000	-37,000	42,000	74,000	-2,000
Jan-18	3,903,000		0	3,098,000			72,000	
SUM		**-22,000**	**0**		**501,000**	**524,000**		**6,000**

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2017_Water_Balance_Update\2017 Water Balance Update REV00 KNK.xlsx

Notes:

A – on the first day of the month.

Table 4: Water Balance Summary of the Minto Mine Site, 2017 (Jan to Dec)

	Units	**Main Pit TMF**	**Area 2 Pit TMF**	**WSP**
Volume Change 2017 (water + tailings)	m^3	-22,000	1,021,000	6,000
Tailings Deposited, total	BCM	-	524,000	-
Water Volume Change 2017	m^3	-22,000	501,000	6,000
Estimated Groundwater Inflow	m^3	-	30,000	-
Total Water Inventory Increase in 2017	**m^3**	515,000		
Total Water Discharged to Minto Creek	m^3	80,000		
Total Site-Wide Yield in 2017	**m^3**	**595,000**		

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2017_Water_Balance_Update\2017 Water Balance Update REV00 KNK.xlsx

3 Water Quality Model Update

3.1 Solid Phase Geochemistry

The neutralization potential ratio (NPR) and copper content of waste rock and tailings were reviewed in order to identify any new trends in the solid phase geochemistry that may have developed since the last source term update. Significant changes in the solid phase geochemistry would indicate a need for further analysis of the waste rock and tailings to generate new source terms that reflect the observed changes in the geochemistry.

The NPR and copper content of waste rock and tailings are shown in Figure 2 to Figure 5. The NPR of tailings solids appear to show a decreasing trend in 2017 and copper concentrations an increasing trend. However, measured NPR was greater than 3 for all samples, which indicates that the tailings are not potentially acid generating and the lower NPRs are therefore not expected to affect source terms. Copper concentrations increased only to the levels measured in 2015. This range of copper concentrations has already been accounted for in the existing source terms. No significant changes in geochemistry were observed in the properties of the waste rock in 2017 compared to similar materials produced in prior years. Therefore, no further evaluation of 2017 solid phase geochemistry was warranted.

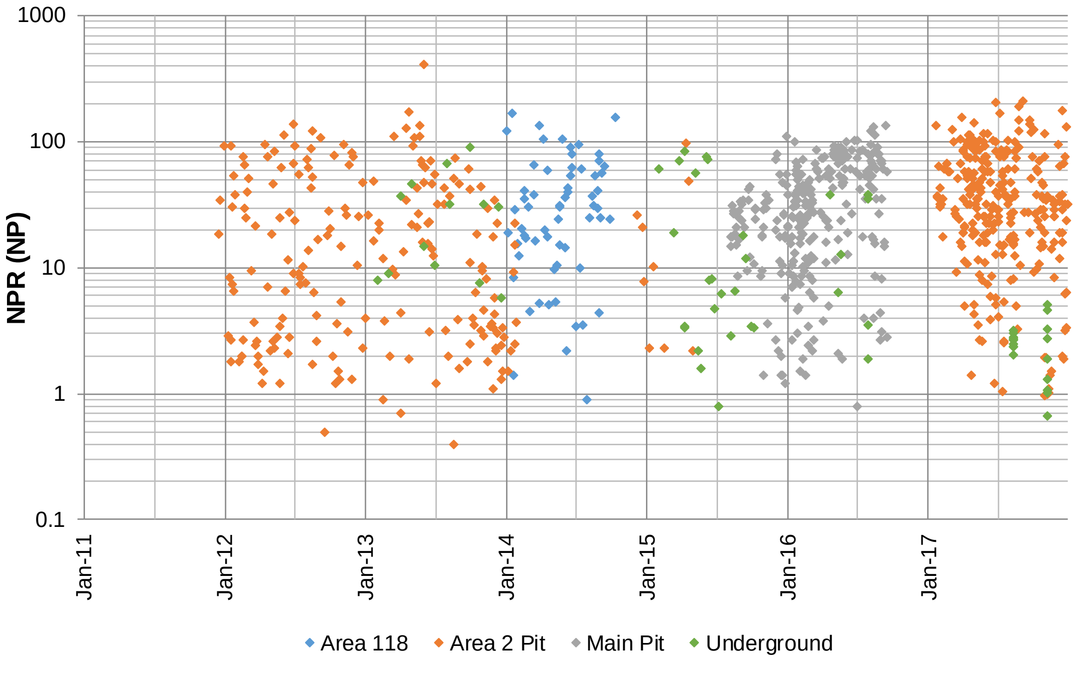


Figure 2: Waste Rock Neutralization Potential Ratio over Time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

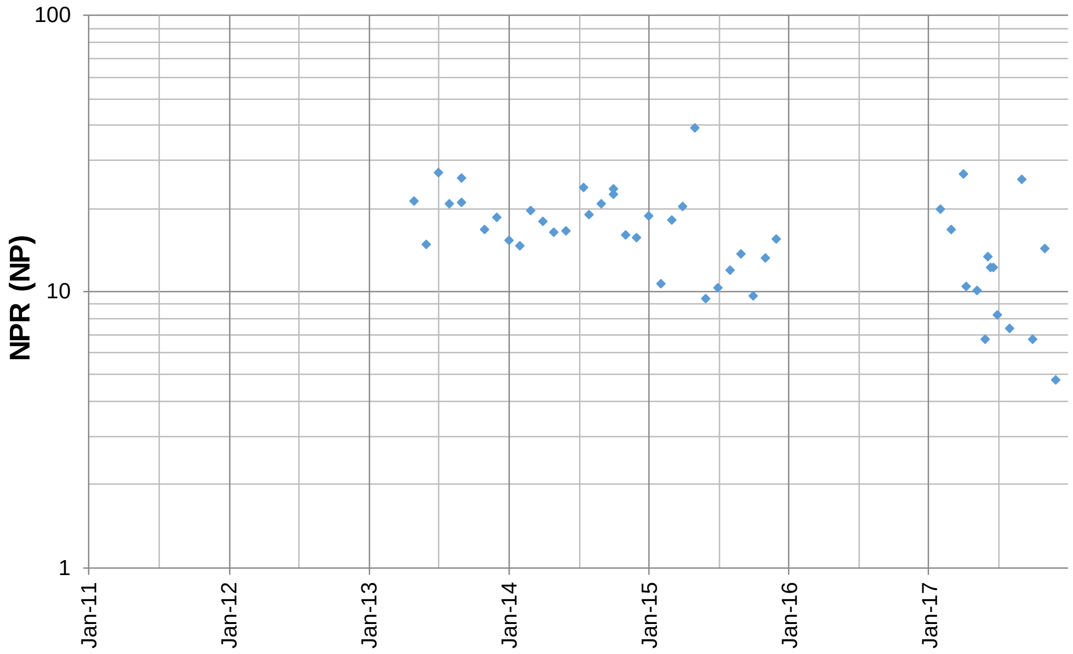


Figure 3: Tailings Neutralization Potential Ratio over Time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

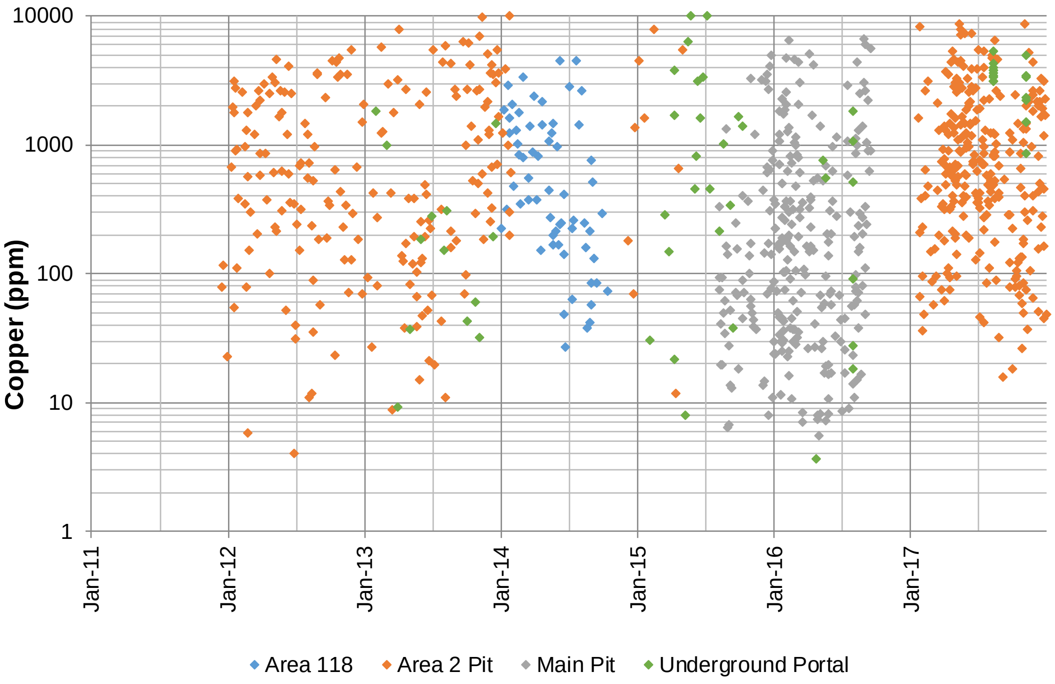


Figure 4: Waste Rock Copper Concentration over Time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

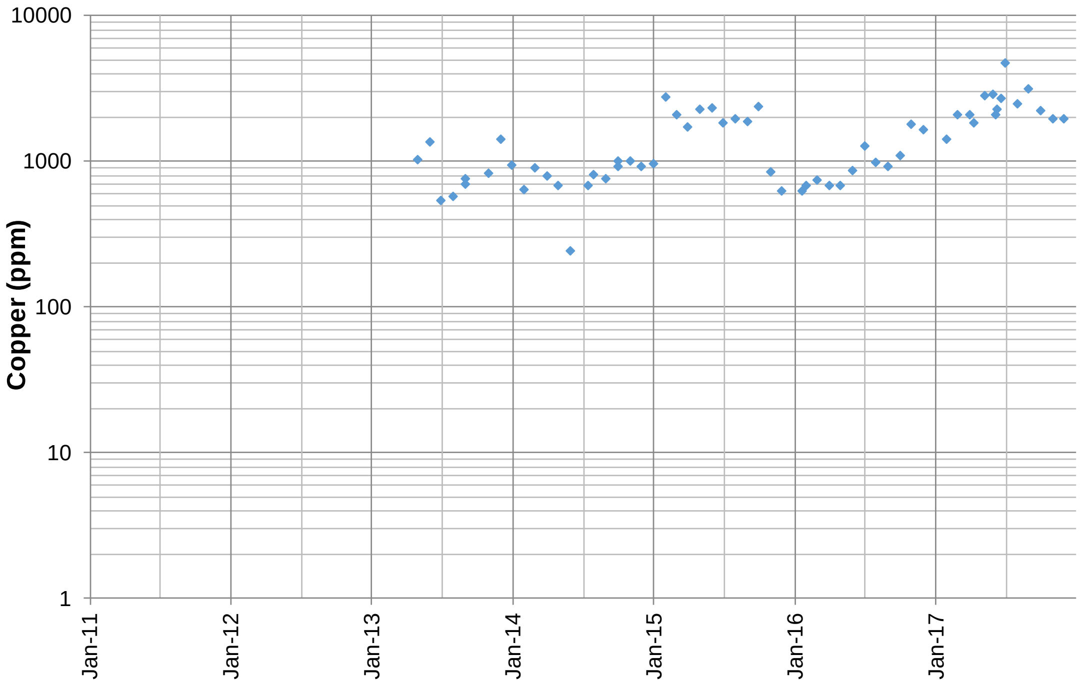


Figure 5: Tailings copper concentration over time

X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\!080_Deliverables\2017_Water_Bal_Update_Ann_Rep\ABACharts_Cu_NPR_2017_1CM002.024_REV00_KNK.xlsx

3.2 Comparison of Measured Water Quality Data to Source Terms

3.2.1 Source Terms – Dry Stack Tailings Storage Facility

The Dry Stack Tailings Storage Facility (DSTSF) source terms used in the water and load balance model for the Minto were developed based on the observed water chemistry of samples collected at station W8 and W8A. This station was chosen because it had the highest concentrations of copper, cadmium, selenium, and sulfate during the period of record. The following points describe the source terms:

- Best Estimate source term: 50th percentile dissolved concentrations from W8A;
- Reasonable Worst Case source term: 95th percentile dissolved concentrations from W8A.

The Best Estimate and Reasonable Worst Case source terms were updated to include data to 2017 for comparison to the existing source terms. It was found that the updated source terms did not differ from the source terms used in the latest model revision, which included data up to and including 2016. Therefore, for consistency the original DSTSF source terms was be used in this 2017 update of the water balance and water quality model.

3.2.2 Source Terms – Waste Rock

The Main Waste Dump and the Southwest Waste Dump source terms used in the water and load balance model were defined based on observed water chemistry at station W15, which collects runoff from the Southwest Waste Dump. The latest model revision assigned Best Estimate waste rock source term as the 50th percentile dissolved concentrations at W15 until the end of 2016 and the Reasonable Worst Case waste rock source term was the 95th percentile dissolved concentrations. Water quality data collected at W15 in 2017 followed the same trends as the historical data. Therefore, the original source term was used for the updated predictions presented here.

3.2.3 Source Term – Tailings Slurry

In 2017, sulfate concentrations in the Area 2 and Main Pit water increased at a greater rate than in previous years. After investigating possible causes, it was concluded that variability in sulfate loadings from tailings slurry was the most likely cause of the concentration increases.

In order to properly represent the variability in the mill effluent water quality in the water and load balance model, the tailings slurry source term was divided into two parts: sulfide ore tailings source term and oxide ore (referred to as POX) tailings source term. Typically, just sulfide ore or a blend of sulfide ore and POX ore are processed in the mill. Elevated concentrations of sulfate in the mill effluent coincided with processing of POX. Accordingly, the tailings slurry source terms for sulfide ore and POX ore were developed based on measured sulfate concentrations in the tailings thickener when sulfide ore and POX ore were milled.

The loading rates associated with POX processing are highly variable. To maintain conservatism in the model predictions, the Expected Case and Worst Case POX ore slurry source term that represents the highest sulfate loading rates was used for all model scenarios.

3.3 Water Quality Model Results

Table 5 and 6 show revised model outputs from the updated water and load balance model for water quality in the Water Storage Pond (WSP) for 2017, 2018, and post-closure (best estimate and worst case) along with concentrations measured in 2017. Table 7 and 8 show revised model predictions of water quality in the MPTMF for 2017, 2018 and post-closure. Predictions for 2018 and post-closure were selected to provide representative short-term and long-term indications of water quality trends. Predictions are for average precipitation conditions. The Water Use Licence (QZ14-031) effluent limits are also listed in the tables. Model runs started on 1 January 2016 and ended on 1 January 2045, at which point concentrations in the model roughly have reached steady state.

The MPTMF was historically the primary water reservoir on site. In the model, the free water in the MPTMF and A2PTMF are more or less considered to belong to the same reservoir due to the high rate of flow between the two reservoirs. Reclaim water is drawn from the MPTMF and excess free water in the A2PTMF is pumped back to the MPTMF.

Therefore, a comparison of measured MPTMF water quality with concentrations predicted for pit water for the Phase V/VI environmental assessment provides a good measure of actual vs. expected geochemical performance of the site. Water collected in the WSP includes clean (non-contact) runoff and effluent from Minto’s water treatment plant.

Median measured concentrations in the WSP in 2017 were lower than or comparable to the revised model predictions using best estimate source terms (Table 5), except for dissolved copper, for which the measured median concentration was 27 µg/L compared to expected median concentrations of approximately 18 µg/L. Dissolved copper concentrations in the WSP shows a decreasing trend between 2011 and 2015 followed by an increasing trend between 2015 and 2017 (Figure 6). The increase in copper concentrations in the WSP in 2017 was due to a reduction in the volume of treated MPTMF water that was pumped to the WSP. MPTMF water is treated using reverse osmosis, which removes nearly all dissolved copper.

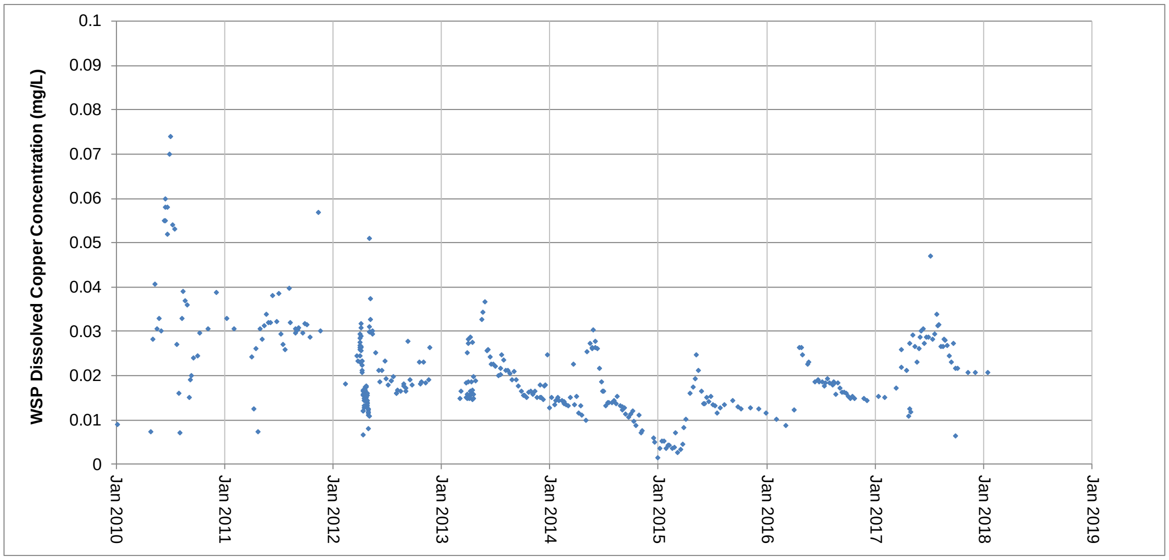


Figure 6 Dissolved Copper Concentrations in WSP (Station W16)

The overall favorable agreement in the results tables below indicates that the revised source terms are appropriate for describing the existing geochemical performance and the actual water management practices on site. Best estimate source terms are intended to provide an indication of the general trend in water quality parameter concentrations, but are not intended to capture maximum or outlier concentration values. Therefore, the median values of best estimate model predictions are compared to measured median values.

Revised model predictions using reasonable worst case source terms are generally higher than comparable median and maximum measured values for the WSP, except for copper (Table 6).

Revised model predictions for water quality in the MPTMF (and by extension the A2PTMF) using the best estimate source terms are in reasonable agreement with median measured concentrations in 2017 (Table 7) except for dissolved cadmium and nitrite. Median measured cadmium concentrations are approximately a factor of 2 greater than expected concentration but still well below the concentrations predicted based on reasonable worst case source terms (Table 8). Nitrite is relatively unstable and is produced and consumed by biological activity in the pit water. An investigation of the matter indicated that it may the activity of heterotrophic microorganisms in the MPTMF water that is responsible for producing the elevated nitrite concentrations.

Water quality model predictions using reasonable worst-case source terms are higher than measured median and maximum concentrations, with the exception of nitrite (Table 8).

Table 5: WSP Water Quality Model Predictions and Measured Concentrations in 2017, Best Estimate

		WUL Effluent Limits (QZ14-031)	WSP Measured Water Quality (Station W16)	Modelling Predictions of Quality in WSP (Station W16)		
Year			2017	2017	2018	Post-Closure
			Median	Median	Median	Median
Ammonia	mg/L	0.75	0.055	0.095	0.09	0.23
N-NO$_2$	mg/L	0.18	0.029	0.066	0.057	0.059
N-NO$_3$	mg/L	27.3	2	4.5	4.8	1.2
Ag-Dissolved	mg/L	0.0003	0.00001	0.000023	0.000023	0.000049
Al-Dissolved	mg/L	0.3	0.0062	0.062	0.058	0.28
As-Dissolved	mg/L	0.015	0.00039	0.00078	0.00078	0.0021
Cd-Dissolved	mg/L	0.0014a	0.0000099	0.000031	0.000029	0.000022
Cr-Dissolved	mg/L	0.003	0.00011	0.0012	0.0012	0.0019
Cu-Dissolved	mg/L	0.06/0.039b	0.027	0.018	0.017	0.013
Fe-Dissolved	mg/L	3.3	0.069	0.54	0.55	0.59
Pb-Dissolved	mg/L	0.012	0.00005	0.00026	0.00026	0.00042
Mo-Dissolved	mg/L	0.219	0.0027	0.0026	0.0027	0.0097
Ni-Dissolved	mg/L	0.33	0.0008	0.0019	0.0018	0.0024
Se-Dissolved	mg/L	0.006	0.00073	0.0013	0.0014	0.002
Zn-Dissolved	mg/L	0.09	0.0011	0.007	0.0068	0.0035

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 6: WSP Water Quality Model Predictions and Measured Concentrations in 2017, Reasonable Worst Case

		WUL Effluent Limits (QZ14-031)	WSP Measured Water Quality (Station W16)		Modelling Predictions of Quality in WSP (Station W16)					
Year			2017		2017		2018		Post-Closure	
			Median	Max	Median	Max	Median	Max	Median	Max
Ammonia	mg/L	0.75	0.055	0.16	0.26	0.32	0.25	0.29	0.83	1.6
N-NO2	mg/L	0.18	0.029	0.12	0.2	0.22	0.18	0.22	0.12	0.23
N-NO3	mg/L	27.3	2	4.9	12	19	13	16	3.3	6.4
Ag-Dissolved	mg/L	0.0003	0.00001	0.00001	0.000023	0.000027	0.000023	0.000025	0.000088	0.00021
Al-Dissolved	mg/L	0.3	0.0062	0.034	0.12	0.15	0.11	0.14	0.55	1.2
As-Dissolved	mg/L	0.015	0.00039	0.00048	0.0011	0.0013	0.0011	0.0012	0.0047	0.011
Cd-Dissolved	mg/L	0.0014a	9.9E-06	0.000049	0.000091	0.00011	0.000088	0.0001	0.000096	0.00024
Cr-Dissolved	mg/L	0.003	0.00011	0.00022	0.0013	0.0015	0.0013	0.0014	0.0036	0.0086
Cu-Dissolved	mg/L	0.06/0.039b	0.027	0.047	0.031	0.038	0.03	0.035	0.02	0.057
Fe-Dissolved	mg/L	3.3	0.069	0.14	1.1	1.4	1.1	1.2	1.4	3.9
Pb-Dissolved	mg/L	0.012	0.00005	0.000096	0.00027	0.00031	0.00028	0.00029	0.0018	0.004
Mo-Dissolved	mg/L	0.219	0.0027	0.0048	0.0052	0.0069	0.0054	0.0061	0.03	0.071
Ni-Dissolved	mg/L	0.33	0.0008	0.0013	0.0029	0.0033	0.0029	0.0031	0.0054	0.015
Se-Dissolved	mg/L	0.006	0.00073	0.0015	0.0029	0.0043	0.0031	0.0038	0.0044	0.0084
Zn-Dissolved	mg/L	0.09	0.0011	0.011	0.0098	0.01	0.0092	0.01	0.0083	0.023

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto's water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 7: MPTMF Water Quality Model Predictions and Measured Concentrations in 2017, Best Estimate

		WUL Effluent Limits (QZ14-031)	MPTMF Measured Water Quality (Station W12)	Modelling Predictions of Quality in MPTMF (Station W12)		
Year			2017	2017	2018	Post-Closure
			Median	Median	Median	Median
Ammonia	mg/L	0.75	4	5.2	4.4	0.079
N-NO2	mg/L	0.18	3.7	2	1.5	0.017
N-NO3	mg/L	27.3	14	38	33	0.38
Ag-Dissolved	Mg/L	0.0003	0.00002	0.000063	0.000063	0.000057
Al-Dissolved	mg/L	0.3	0.0055	0.37	0.37	0.26
As-Dissolved	mg/L	0.015	0.00044	0.0026	0.0026	0.0021
Cd-Dissolved	mg/L	0.0014a	0.00016	0.000084	0.000087	0.00006
Cr-Dissolved	mg/L	0.003	0.0002	0.0021	0.0022	0.0023
Cu-Dissolved	mg/L	0.06/0.039b	0.039	0.032	0.037	0.035
Fe-Dissolved	mg/L	3.3	0.02	0.39	0.48	0.71
Pb-Dissolved	mg/L	0.012	0.0001	0.00052	0.00053	0.00051
Mo-Dissolved	mg/L	0.219	0.079	0.1	0.077	0.011
Ni-Dissolved	mg/L	0.33	0.0035	0.0035	0.0034	0.0028
Se-Dissolved	mg/L	0.006	0.013	0.019	0.016	0.0034
Zn-Dissolved	mg/L	0.09	0.0069	0.011	0.011	0.012

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto’s water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

Table 8: MPTMF Water Quality Model Predictions and Measured Concentrations in 2017, Reasonable Worst Case

		WUL Effluent Limits (QZ14-031)	MPTMF Measured Water Quality (Station W12)		Modelling Predictions of Quality in MPTMF (Station W12)					
Year			**2017**		**2017**		**2018**		**Post-Closure**	
			Median	**Max**	**Median**	**Max**	**Median**	**Max**	**Median**	**Max**
Ammonia	mg/L	0.75	4	6.9	17	18	15	19	0.28	0.45
N-NO2	mg/L	0.18	3.7	6.7	3.8	4.3	3.1	4	0.037	0.057
N-NO3	mg/L	27.3	14	27	84	90	77	96	1.1	1.7
Ag-Dissolved	Mg/L	0.0003	0.00002	0.00005	0.00012	0.00013	0.00012	0.00013	0.000089	0.00012
Al-Dissolved	mg/L	0.3	0.0055	0.012	0.77	0.82	0.76	0.84	0.53	0.83
As-Dissolved	mg/L	0.015	0.00044	0.00054	0.0063	0.0066	0.0063	0.0066	0.0049	0.0063
Cd-Dissolved	mg/L	0.0014a	0.00016	0.00021	0.00034	0.00035	0.00035	0.00036	0.00031	0.00037
Cr-Dissolved	mg/L	0.003	0.0002	0.0002	0.0049	0.0051	0.0049	0.0051	0.0038	0.0048
Cu-Dissolved	mg/L	0.06/0.039b	0.039	0.074	0.081	0.083	0.09	0.093	0.077	0.098
Fe-Dissolved	mg/L	3.3	0.02	0.047	0.85	0.97	1.1	1.2	1.9	2.3
Pb-Dissolved	mg/L	0.012	0.0001	0.00021	0.0026	0.0027	0.0026	0.0028	0.0017	0.0025
Mo-Dissolved	mg/L	0.219	0.079	0.085	0.16	0.18	0.13	0.17	0.031	0.037
Ni-Dissolved	mg/L	0.33	0.0035	0.0046	0.0077	0.008	0.0077	0.008	0.0067	0.0074
Se-Dissolved	mg/L	0.006	0.013	0.015	0.028	0.031	0.025	0.031	0.008	0.01
Zn-Dissolved	mg/L	0.09	0.0069	0.009	0.033	0.034	0.033	0.035	0.03	0.036

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2015_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2015_An_Report_SRJ_Rev00.xlsx

Notes:

Analytical data from Minto’s water quality monitoring program.

a) at 50 mg/L hardness.

b) Cu effluent standard is 0.06 when [DOC] @ W2 > 10 mg/L and 0.039 when [DOC] @ W2 ≤ 10 mg/L.

4 Closing

The summary of the updated water balance and water quality model for the Minto Mine was prepared in support of annual reporting. SRK would be pleased to address any questions or comments.

Appendix F – Minto and McGinty Creek 2017 Surface Hydrology Update

Hydrology

1. Introduction

In 2017, and as part of the EMSRP, Minto monitored hydrological conditions at water quality stations including the following: stations within the operational mine area; stations downstream from the mine operational area that are influenced by mine effluent discharge; and reference stations downstream from the mine operational area that are not exposed to effluent. Hydrological monitoring is performed using a variety of methods including: manual discrete discharge measurements with combinations of flow meters, continuous stage measurements through the deployment of Solinst Level Loggers and Barometric Loggers and monitoring of an engineered flume.

Minto maintained and monitored 7 hydrometric stations located on Minto Creek and McGinty Creek as listed below and shown in Figure 1.

- Minto Creek
    1. W3: Flume downstream of the Water Storage Pond (WSP);
    2. MC1: Located in Minto Canyon – mid-catchment;
    3. W1: Located approximately 1 km upstream of Yukon River – lower catchment; and
    4. W7: Tributary on the south side of Minto Creek.
- McGinty Creek
    5. MN-0.5: West Tributary of McGinty Creek
    6. MN-2.5: East Tributary of McGinty Creek
    7. MN-4.5: McGinty Creek near the Mouth

The following sections will present the methods used to measure flow at the hydrometric program, the summary of each station’s hydrometric program and recommendations for future monitoring.

2. Methods

Minto personnel conduct regular discrete discharge measurements and maintenance at the stations listed below. Additionally, these stations are equipped with Solinst Level Logger and Barometric Logger for continuous measurements. Table 2-1 provides an overview of instrumentation available and discrete measurement frequency at these stations.

Table 2-1: Summary of Hydrometric Program

Station	Watershed	Years Monitored	Frequency of Discrete Measurement	Instrumentation Available
W3	Minto Creek	2012-2017	Weekly	Flume, Data Logger
MC1	Minto Creek	2012-2017	Weekly	Staff Gauge, Data Logger
W1	Minto Creek	2012-2017	Weekly	Staff Gauge, Data Logger
W7	Minto Creek	2013-2017	Monthly	Staff Gauge, Data Logger
MN-0.5	McGinty Creek	2014-2017	Monthly	Staff Gauge, Data Logger
MN-2.5	McGinty Creek	2014-2017	Monthly	Staff Gauge, Data Logger
MN-4.5	McGinty Creek	2011-2017	Monthly	Staff Gauge, Data Logger

Stream-gauge data is collected and managed throughout the open water season by the Minto personnel. Velocities are measured using a Hach FH950 handheld electromagnetic flowmeter. Velocity and water depth measurements are converted to flows using the area-velocity relationship methods. All hydrometric data, calculated flows and the time-series of recorded water levels and temperature data from the loggers were processed by Minto personnel under SRK guidance.

Level logger data were compared to the staff gauge readings, logger records for water level may have shifted over the course of the season due to repositioning, and data were corrected to match staff gauge measurements.

Stage-discharge relationships (rating curves) were created with discrete flow measurements and staff gauge readings. For stations with level loggers, discharges were determined over the course of the 2017 hydrometric season to calculate mean monthly flows and total monthly runoff.

3. Minto Creek

3.1 Station W3 – Flume below the Water Storage Pond Dam

W3 is located about 500 meters downstream of the water storage pond dam and consist of a built flume. Solinst loggers record water levels and atmospheric pressure every 30 minutes, in addition water level at the flume are recorded daily for most of the year. In mid-November, the barologger’s battery ran out, by the time it was discovered 3 weeks of barometric pressure were lost. To compensate for this data, the barometric pressure at the Minto Weather Station were used, slightly skewing the results. A summary of the level and flow data recorded at W3 are presented in Figure 2 to 5. This data provided the necessary information to correct the recorded stage data and in turn generate a stage discharge relationship which is used to calculate the creek discharge, the stage-discharge relationship is presented in Figure 3.

Figure 2 presents the Solinst recorded water levels and water temperature for Minto Creek at W3 from January to December 2017.

W3 is directly influenced by discharge from the Water Storage Pond to Minto Creek. Figure 4 shows the 2017 hydrograph and discrete flow measurements conducted. A comparison of monthly flows at W3 and the discharge from the WSP is presented in Figure 5. As expected the flows recorded at W3 are slightly larger than the rate of discharge because of baseflow and runoff at W3. In mid-March, the station overflowed and froze, causing a lack of data for the following weeks leading into April. There is an incomplete dataset for records of flow at W3 from mid-March to the beginning of April. Overflow at the flume during the colder months, creates a pressure on the Levelogger that is not representative of the actual discharge occurring, months of November to March are difficult to obtain accurate water level readings.

Water was discharged from the WSP intermittently from April 30th to August 6th, 2017, the water level changed and flow fluctuations during the discharge period

Table 3-1 provides a summary of the average water temperature, flow and total flow volume in 2017. The higher temperatures recorded from November to March indicate the important influence of the heater at the flume on minimal flow or stagnant overflow discharge. Table 3-2 summarizes the historical mean monthly flows to previous years of the hydrometric program.

Table 3-1: W3 2017 Hydrometric Data and Temperature Summary

Month	Period of Record (Day)	Mean Water Temperature (°C)	Mean Flow (m^3/s)	Total Flow (m^3)
Jan	31	3.68	0.0295	78810.5
Feb	28	3.25	0.0204	49470.7
Mar	31	3.86	0.0099	26557.6
Apr	30	2.12	0.0098	25514.7
May	31	2.44	0.0157	42273.6
Jun	30	7.57	0.0184	47711.3
Jul	31	7.70	0.0055	14633.8
Aug	31	7.05	0.0082	21871.8
Sep	30	3.48	0.0074	19241.1
Oct	31	1.12	0.0118	31711.7
Nov	30	3.11	0.0104	27061.8
Dec	31	4.51	0.0148	39510.0

Table 3-2: W3 Historical Mean Monthly Flow (m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012[1]	-	-	-	-	-	0.005	0.005	0.006	0.005	-	-	-
2013[1]	-	-	-	-	-	0.003	0.004	0.004	0.004	-	-	-
2014[1]	-	-	-	-	-	<0.001	<0.001	0.002	0.003	0.003	0.006	0.004
2015[1]	0.003	0.006	0.006	0.057	0.086	0.003	0.003	0.003	0.004	0.004	0.006	0.026
2016[1]	-	-	-	0.022	0.052	0.003	0.003	0.004	0.004	0.004	0.003	0.004
2017	0.030	0.020	0.010	0.010	0.016	0.018	0.006	0.008	0.007	0.012	0.010	0.015

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.

Note: Shaded cells indicate incomplete months of data

3.2 MC1 - Minto Creek Mid-Catchment

The hydrometric station MC1 on Minto Creek is located downstream of the W3 Flume and immediately upstream of the canyon along Minto Creek. The pressure transducer installed at this station recorded temperature and water levels at 15 minute intervals from May 2nd to October 19th (150 days). Figure 6 shows water level and temperature data for Minto Creek at MC1 from May 20th to October 16th, 2017. On May 19th, the level logger was discovered out of the water and replaced.

Over the course of the hydrometric program in 2017, numerous discrete discharge measurements were recorded in conjunction with water level readings recorded by both the pressure transducer and the staff gauge. This data provides the information necessary to generate a stage-discharge relationship which enables the computation of creek discharge for the recorded stage data. The stage-discharge relationship is presented in Figure 7.

The 2017 hydrograph and discrete measurements for MC1 are shown in Figure 8. In 2017, the maximum measured flow of 0.23 m³/s occurred on June 13th, 2017.

Table 3-3 provides a summary of the average water temperature, flow and total flow volume in 2017. The negative temperatures recorded in October indicate the start of the freeze-up period. Table 3-4 summarizes the historical mean monthly flows to previous years of the hydrometric program. During the August 11-14th period, the logger could have been partially out of the water as seen in negative pressure differences, hence the negative values recorded were purposefully removed for the data presentation in these tables.

Table 3-3: MC1 2017 Hydrometric Data and Temperature Summary

Month	Period of Record (Day)	Mean Water Temperature (°C)	Mean Flow (m^3/s)	Total Flow (m3)
Jan	No Data			
Feb	No Data			
Mar	No Data			
Apr	No Data			
May	12	-1.146	0.102	106037
Jun	30	1.915	0.0743	192640
Jul	31	4.516	0.0176	47193
Aug	29	4.141	0.0103	25808
Sep	30	1.163	0.0283	73495
Oct	16	-0.95	0.0293	39702
Nov	No Data			

Note: Shaded cells indicate incomplete months of data

Table 3-4: MC1 Historical Mean Monthly Flow (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012[1]	-	-	-	-	0.179	0.065	0.052	0.041	0.108	-	-	-
2013[1]	-	-	-	-	0.358	0.085	0.103	0.44	0.089	0.064	-	-
2014[1]	-	-	-	-	0.187	0.028	0.031	0.036	0.028	0.033	-	-
2015[1]	-	-	-	-	0.862	0.014	0.028	0.042	0.035	0.031	-	-
2016[1]	-	-	-	-	-	0.029	0.036	0.048	0.076	-	-	-
2017	-	-	-	-	0.102	0.074	0.018	0.010	0.028	0.029	-	-

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.

Note: Shaded cells indicate incomplete months of data

3.3 W1 – Lower Minto Creek above Road Crossing

W1 station is located on the lower reach of Minto Creek before flowing into the Yukon River. In 2017, water level and temperature data were continuously measured and recorded every 15 minutes by the pressure transducer/data logger. Figure 9 shows Minto Creek at W1 water level and temperature data for the 167-day record from May 2 to October 16, 2017.

The stage-discharge relationship for W1 is presented in Figure 10. The 2017 hydrograph and discrete measurements for W1 are shown in Figure 11. In 2017, the maximum measured flow of 0.379 m^3/s occurred on May 5th, 2017. Figure 12 shows W1 and MC1 flows. W1 is located downstream of MC1 and it is expected that flows would be larger because it has a much larger catchment area than MC1. W1 flows are lower than MC1 because it has been observed through the monitoring program that upstream of W1 is a losing reach. Water downstream of MC1 passes through a preferential pathway and by-passes W1.

Table 3-5 provides a summary of the average water temperature, flow and total flow volume in 2017. The negative temperatures recorded in October indicates the start of the freeze-up period. Table 3-6 summarizes the historical mean monthly flows to previous years of the hydrometric program. The history shows that freeze-up begins in October and that freshet typically occurs in April/May.

Table 3-5: W1 2017 Hydrometric Data and Temperature Summary

Month	Period of Record (Day)	Mean Water Temperature (°C)	Mean Flow (m^3/s)	Total Flow (m^3)
Jan	No Data			
Feb	No Data			
Mar	No Data			
Apr	No Data			
May	29	0.152	0.085	217443
Jun	30	3.839	0.074	192228
Jul	31	7.128	0.014	35938
Aug	31	6.069	0.011	30709
Sep	30	3.092	0.017	43169
Oct	16	-0.099	0.031	41302
Nov	No Data			
Dec	No Data			

Note: Shaded cells indicate incomplete months of data

Table 3-6: W1 Historical Mean Monthly Flow

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012[1]	-	-	-	-	0.296	0.073	0.052	0.051	0.078	0.056	-	-
2013[1]	-	-	-	-	0.485	0.064	0.065	0.044	0.85	0.059	-	-
2014[1]	-	-	-	-	0.138	0.022	0.02	0.014	0.31	0.025	-	-
2015[1]	-	-	-	-	0.117	0.01	0.01	0.03	0.24	0.02	-	-
2016[1]	-	-	-	0.252	0.047	0.02	0.017	0.024	0.043	0.026	-	-
2017	-	-	-	-	0.085	0.074	0.014	0.011	0.017	0.031	-	-

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.
Note: Shaded cells indicate incomplete months of data

In 2017, Minto personnel noticed the undercuts growing at the stream gauging transect, it is recommended to re-evaluate the location for discrete measurements in 2018.

3.4 W7 – Tributary of Minto Creek

A staff gauge was installed at this station in the summer of 2013. Before the installation of the staff gauge, this station was regularly monitored for surface water quality. The staff gauge was damaged during the winter 2014 and repaired for the hydrometric program running in 2015. In 2016, no stage measurements were continuously recorded but several discrete discharge measurements were conducted during the open water season. In early June 2017, a staff gauge and loggers were installed at this site, a continuous water level and temperature were recorded as presented in Figure 13. Table 3-7 provides a summary of the average water temperature, flow and total flow volume in 2017.

Table 3-8 presents the summary of historically measured flows at W7, based on discrete measurements. A rating curve was initiated in the 2017 hydrometric season, with limited data points the curve showed inconsistencies between discrete and pressure logger measurements, and was therefore not included in this year's report; with more data being collected the curve will become more accurate over the years. The loggers were installed June 23rd and recorded water level and temperature every 30 minutes until October 3rd.

As this was a re-established station, it is recommended for 2018 to conduct stream gauging measurements more frequently to build a larger dataset and a more accurate rating curve.

Table 3-7: W7 2017 Hydrometric Data and Temperature Summary

Month	Period of Record (Day)	Mean Water Temperature (°C)	Mean Flow (m^3/s)	Total Flow (m^3)
Jan	No Data			
Feb	No Data			
Mar	No Data			
Apr	No Data			
May	No Data			
Jun	7	4.07	0.002	1290
Jul	31	3.84	0.003	8625
Aug	31	3.55	0.002	6693
Sep	30	2.19	0.004	10648
Oct	3	0.017	0.004	953.9
Nov	No Data			
Dec	No Data			

Note: Shaded cells indicate incomplete months of data

Table 3-8: W7 Historical Mean Monthly Flow (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2013[1]	-	-	-	-	-	-	0.013	0.031	0.019	0.006	-	-
2014[1]	-	-	-	-	0.112	-	-	-	-	-	-	-
2015[1]	-	-	-	-	-	0.006	0.004	0.011	0.011	0.029	-	-
2016[1]	-	-	-	-	-	0.006	0.010	0.010	0.013	0.010	-	-
2017	-	-	-	-	-	0.002	0.003	0.003	0.004	0.004	-	-

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.

Note: Shaded cells indicate incomplete months of data

4. McGinty Creek Hydrology

In 2017, hydrological monitoring on McGinty Creek was not conducted as per the schedule outlined in the EMSRP, it was noted late in the season that MN-1.5 was not monitored for continuous flow. Station MN-0.5 was monitored in place of MN-1.5 throughout the season. During the 2017 monitoring period, Minto Mine maintained and collected data from the following three hydrometric stations along McGinty Creek.

At the hydrometric stations, Solinst Level Loggers and Barometric Loggers were used in conjunction with staff gauge readings and manual flow measurements to produce volumetric flow rates conducted monthly during flow season.

4.1 Station MN-0.5 – West Tributary of McGinty Creek

MN-0.5 station is located on the upper west stem of McGinty Creek. In 2017, water level and temperature data were continuously measured and recorded every 30 minutes by a pressure transducer/data logger. Figure 14 shows McGinty Creek at MN-0.5 water level and temperature data for the 117-day record from June 24 to October 21, 2016.

A stage-discharge relationship was established for MN-0.5 but it has limited flow data and corresponding staff gauge reading, hence is was not very accurate, the stage curve is presented in Figure 15. Additional flow measurements through the years will be required to establish a stage-discharge curve for the station with greater accuracy.

Table 4-1 provides a summary historical measured flows at MN-0.5. These flows are based on discrete measurements only.

Table 4-1: MN-0.5 Historical Mean Monthly Flow (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014[1]	-	-	-	-	0.045	-	-	-	-	-	-	-
2015[1]	-	-	-	-	0.035	0.013	0.054	0.098	0.029	0.025	-	-
2016[1]	-	-	-	-	0.28	0.016	0.01	0.016	0.035	0.018	-	-
2017	-	-	-	-	-	0.017	0.023	0.02	0.017	0.019	-	-

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.

Note: Shaded cells indicate incomplete months of data

4.2 Station MN-1.5 – Upper East Tributary of McGinty Creek

As previously mentioned, MN-1.5 was not monitored continuously but Minto personnel conducted discrete flow measurement on a monthly frequency. Results are presented in Table 4-2; July measurement could not be conducted due to low flows. As required by the EMSRP, MN-1.5 will be monitored continuously for the 2018 hydrometric season.

Table 4-2: MN-1.5 2017 Recorded Discrete Flow Measurement (m^3/s)

	May	Jun	Jul	Aug	Sep
Flow	0.007	0.001	-	0.0004	0.001

4.2 Station MN-2.5 – East Tributary of McGinty Creek

MN-2.5 station is located on the lower stem of McGinty Creek. In 2017, water level and temperature data were continuously measured and recorded every 30 minutes by a pressure transducer/data logger. Figure 16 shows McGinty Creek at MN-2.5 water level and temperature data for the 149-day record from May 26 to October 21, 2017.

A stage-discharge relationship could not be established for MN-2.5 because of limited data flow and corresponding staff gauge reading.

Table 4-3 provides a summary of historical measured flows at MN-2.5. These flows are based on discrete measurements only.

Table 4-3: MN-2.5 Historical Mean Monthly Flow (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014[1]	-	-	-	-	0.032	-	-	-	-	-	-	-
2015[1]	-	-	-	-	0.015	0.003	0.011	0.038	0.01	0.01	-	-
2016[1]	-	-	-	0.034	0.008	-	-	0.009	0.014	0.003	-	-
2017	-	-	-	-	-	0.011	0.01	0.007	0.004	0.013	-	-

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.

Note: Shaded cells indicate incomplete months of data

4.3 Station MN-4.5 -McGinty Creek near the Mouth

MN-4.5 station is located on the lower reach of McGinty Creek before flowing into the Yukon River. In 2017, water level and temperature data were continuously measured and recorded every 30 minutes by the pressure transducer/data logger. Figure 17 shows McGinty Creek at MN-4.5 water level and temperature data for the 140-day record from May 26 to October 12, 2017.

The stage-discharge relationship for MN-4.5 is presented in Figure 18. The 2017 hydrograph and discrete measurements for MN-4.5 are shown in Figure 19. In 2017, the maximum measured flow of 0.08 m^3/s occurred on July 29, 2017.

Table 4-4 provides a summary of the average water temperature, flow and total flow volume in 2017. Table 4-5 summarizes the historical mean monthly flows to previous years of the hydrometric program.

Table 4-4: MN-4.5 2017 Hydrometric Data and Temperature Summary

Month	Period of Record (Day)	Mean Water Temperature (°C)	Mean Flow (m^3/s)	Total Flow (m^3)
Jan	No Data			
Feb	No Data			
Mar	No Data			
Apr	No Data			
May	6	1.14	0.079	42847
Jun	30	2.81	0.12	310927
Jul	31	5.61	0.027	71968
Aug	31	5.75	0.003	10007
Sep	30	3.12	0.012	30138
Oct	12	0.31	0.079	114468
Nov	No Data			
Dec	No Data			

Note: Shaded cells indicate incomplete months of data

Table 4-5: MN-4.5 Historical Mean Monthly Flow (m^3/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011[1]	-	-	-	-	0.444	0.093	0.125	0.134	0.068	0.045	-	-
2012[1]	-	-	-	0.212	0.023	0.18	0.082	0.053	0.109	-	-	-
2013[1]	-	-	-	-	-	0.054	0.103	0.093	0.116	-	-	-
2014[1]	-	-	-	-	0.23	0.041	0.037	0.026	0.046	-	-	-
2015[1]	-	-	-	-	-	0.013	0.046	0.049	0.029	0.029	-	-
2016[1]	-	-	-	-	0.017	0.015	0.026	0.028	0.028	0.01	-	-
2017	-	-	-	-	0.079	0.12	0.027	0.003	0.012	0.079	-	-

Note: 1 - Data based on previous Annual Surface water Hydrology Analysis.

Note: Shaded cells indicate incomplete months of data

In 2017, Minto personnel noticed undercuts eroding on both sides on the stream gauging transect, it is recommended to re-evaluate the location of the transect for the 2018 hydrology season.

5. Hydrology QA/QC

Detailed procedures for hydrology monitoring at the Minto Mine are detailed in the *Minto Mine Surface Water Hydrology* SOP. In 2017, Minto implemented permanent discrete measurement locations at each station to ensure consistent results, on a few occasions due to changing stream bed conditions, locations were modified.

Figures

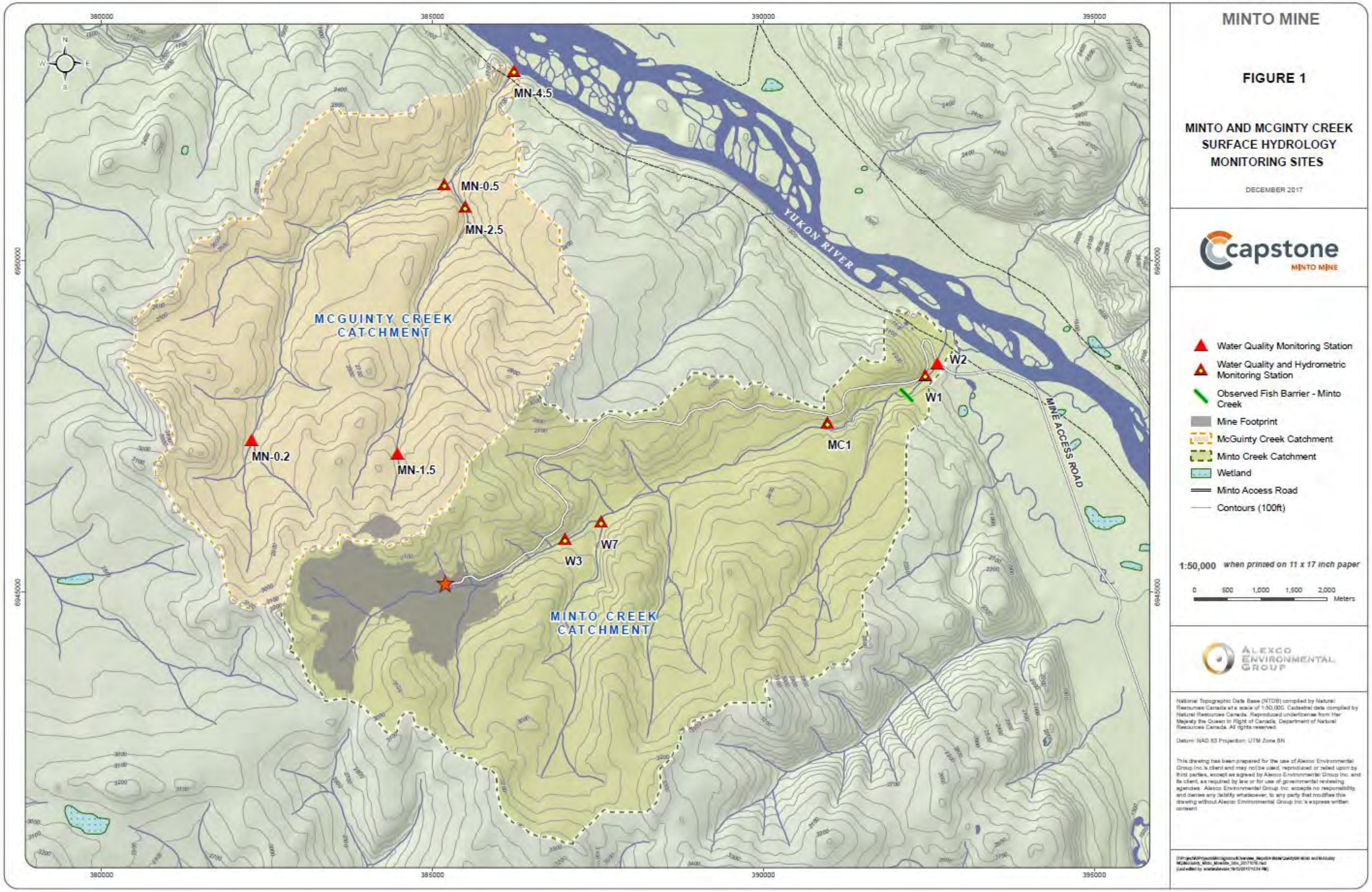


Figure 1. Minto and McGinty Creek Hydrology Surface Map

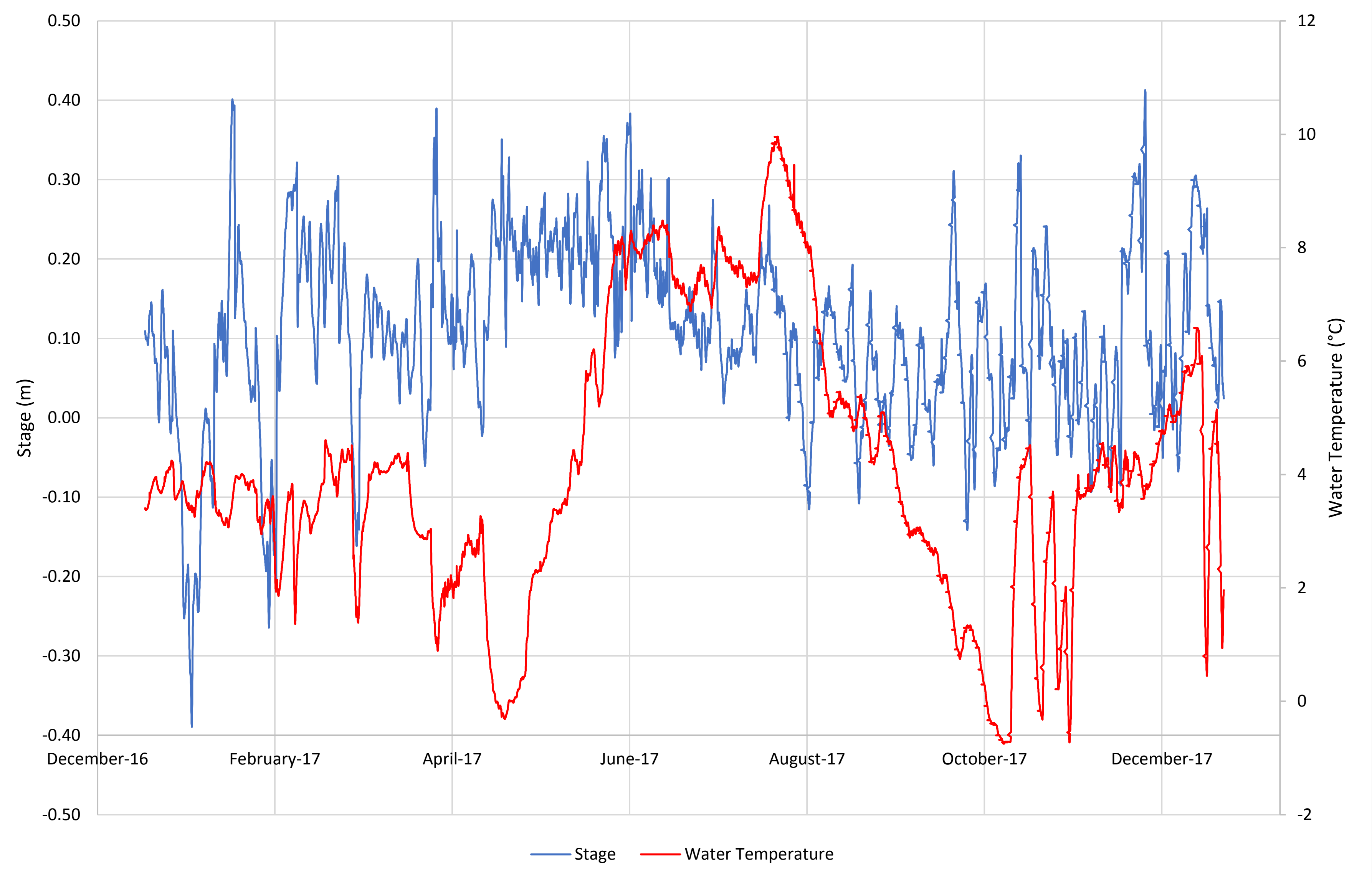


Figure 2. W3 Hydrograph Stage and Water Temperature

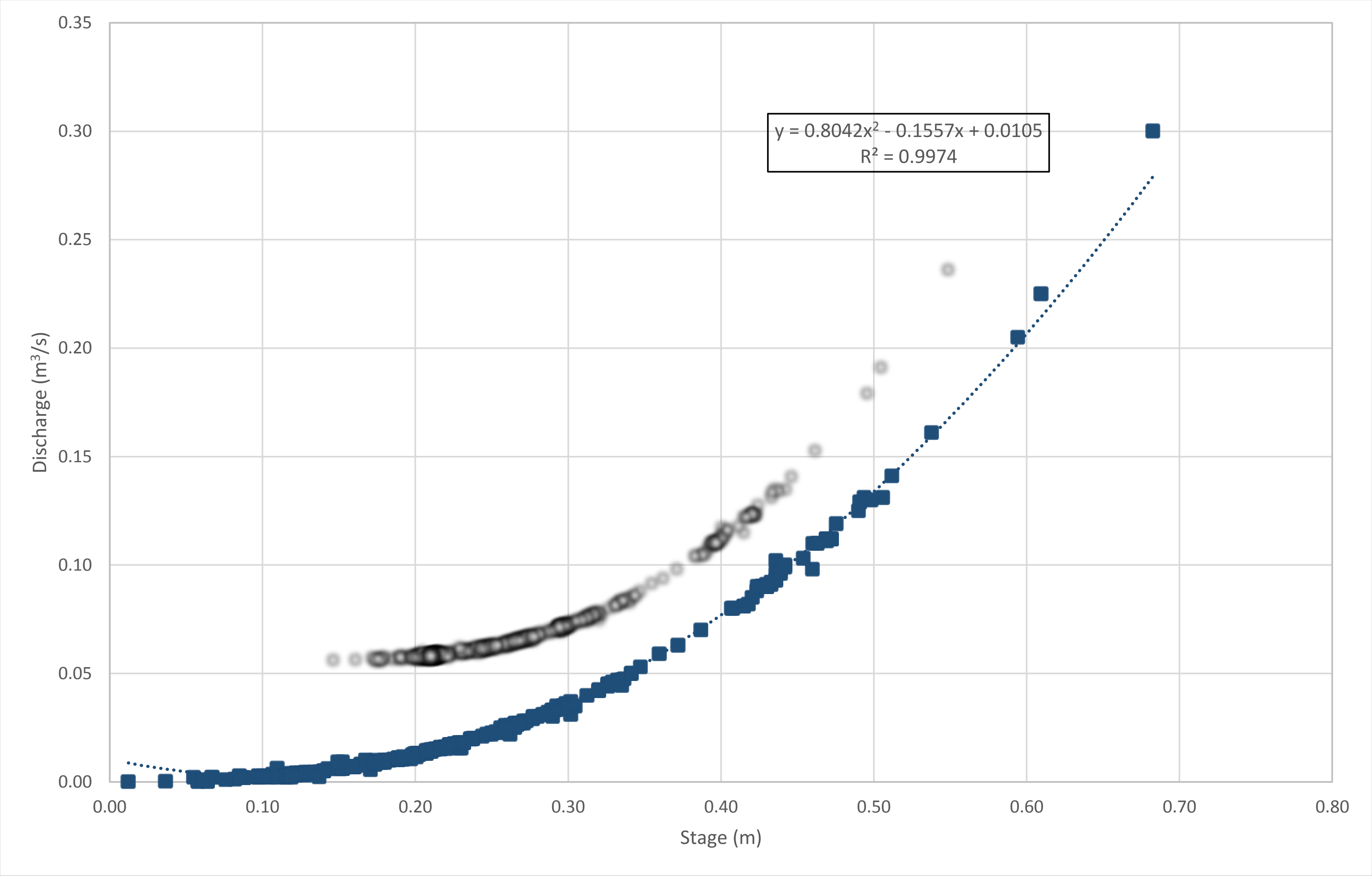


Figure 3: W3 Rating Curve

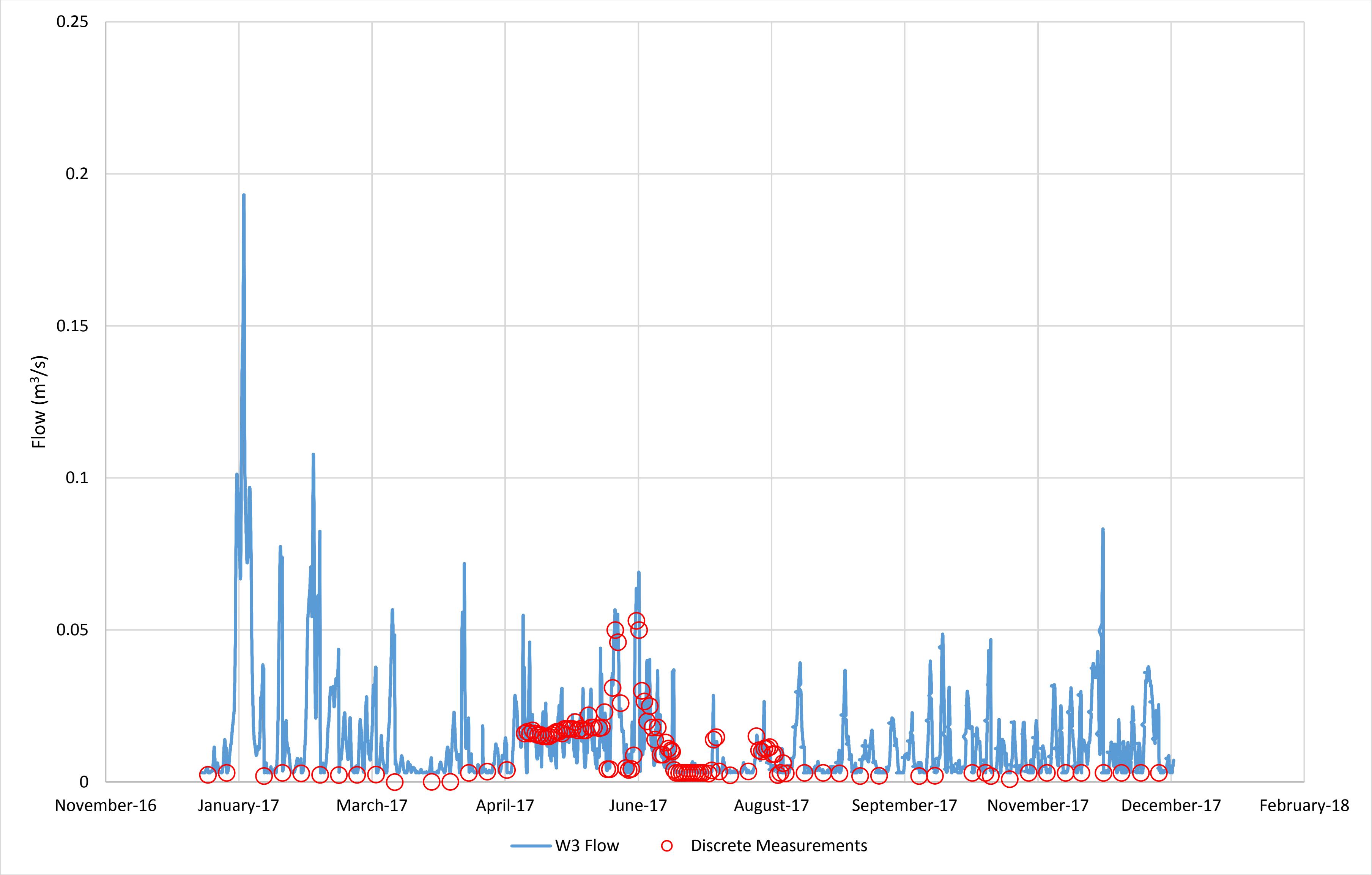


Figure 4. W3 Flow Hydrograph (with discrete measurements)

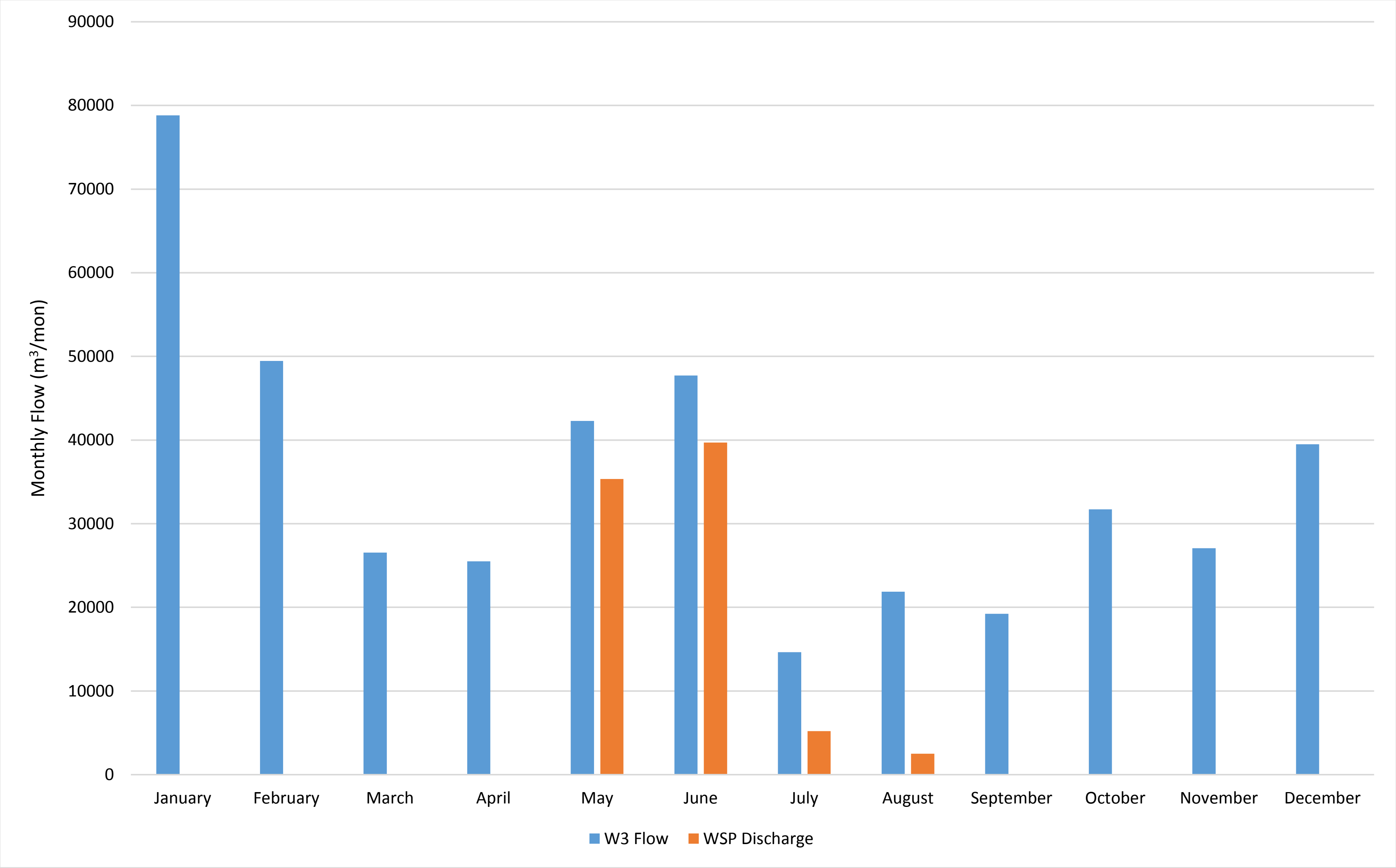


Figure 5. Monthly WSP Discharge and Flows at W3

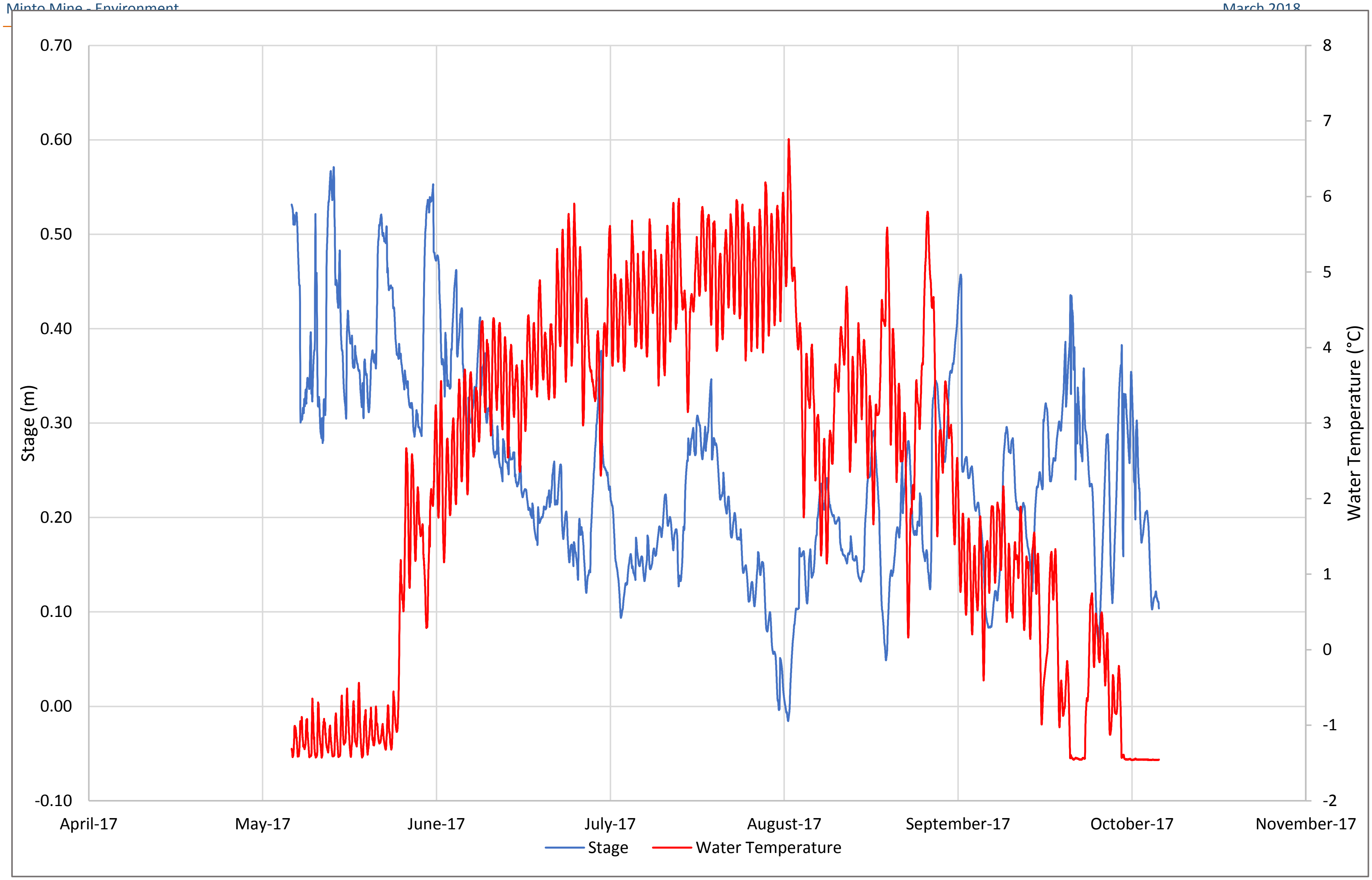


Figure 6: MC1 Stage and Temperature Hydrograph

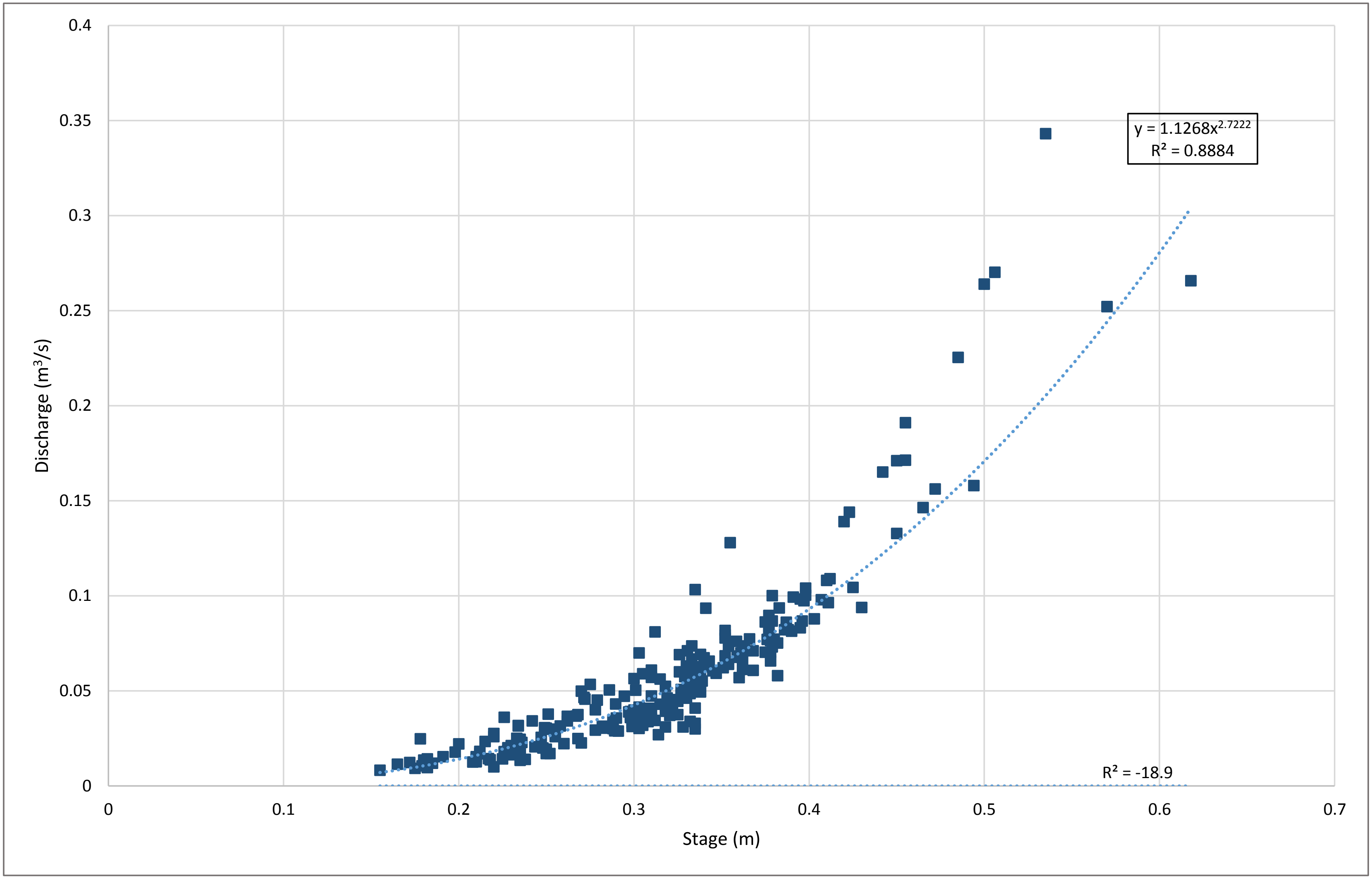


Figure 7: MC1 Rating Curve

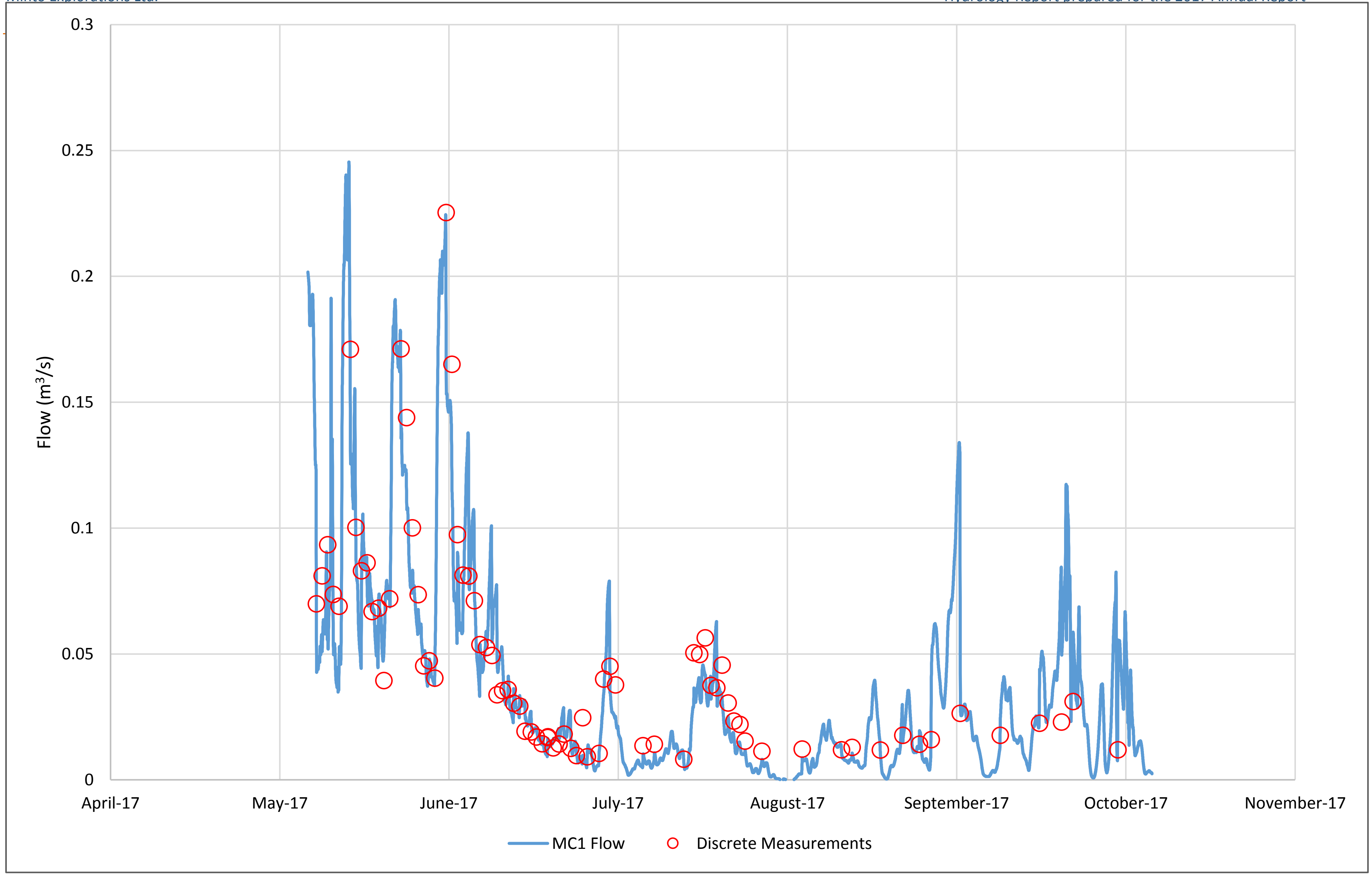


Figure 8: MC1 Flow Hydrograph

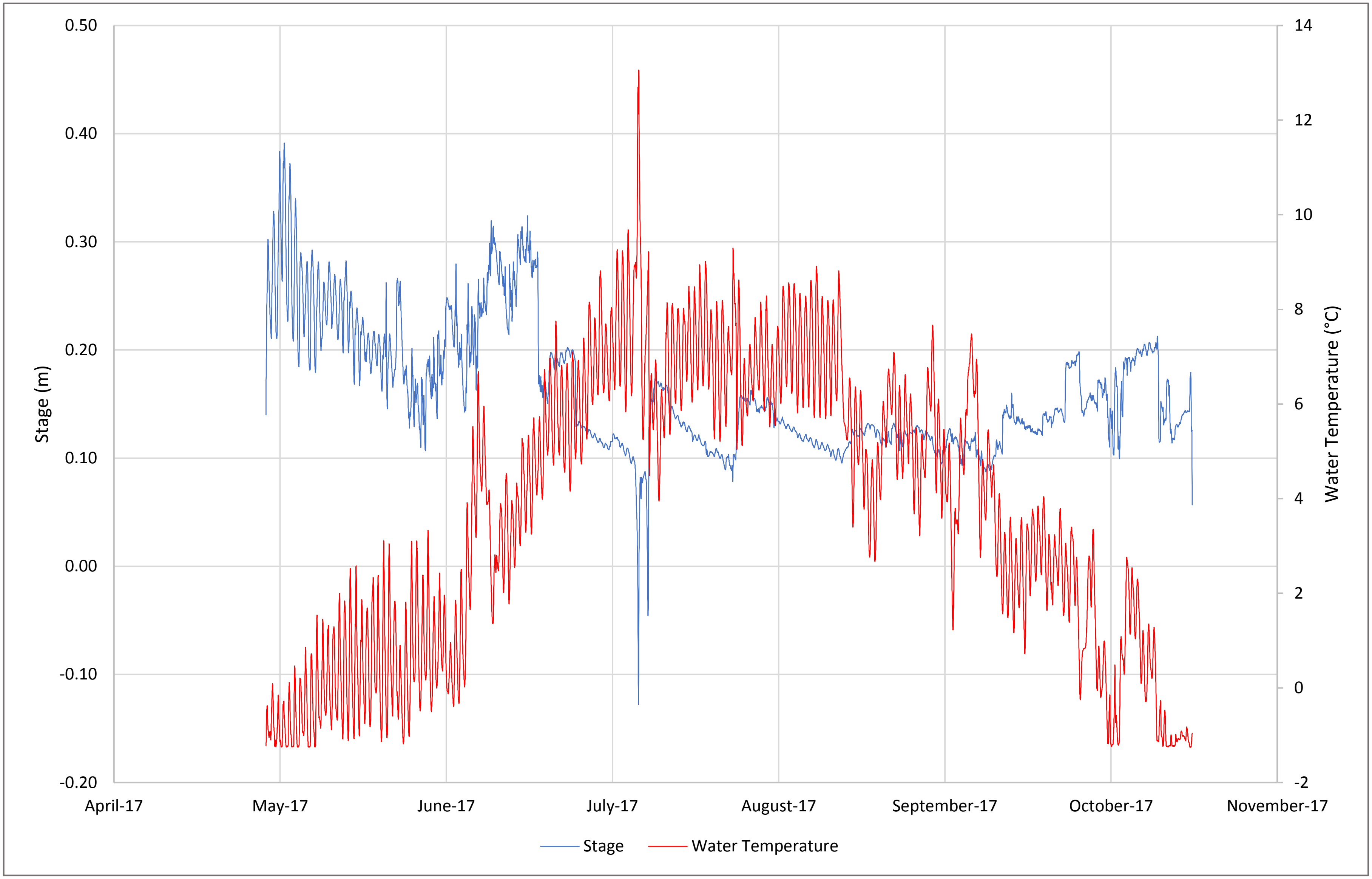


Figure 9: W1 Stage and Temperature Hydrograph

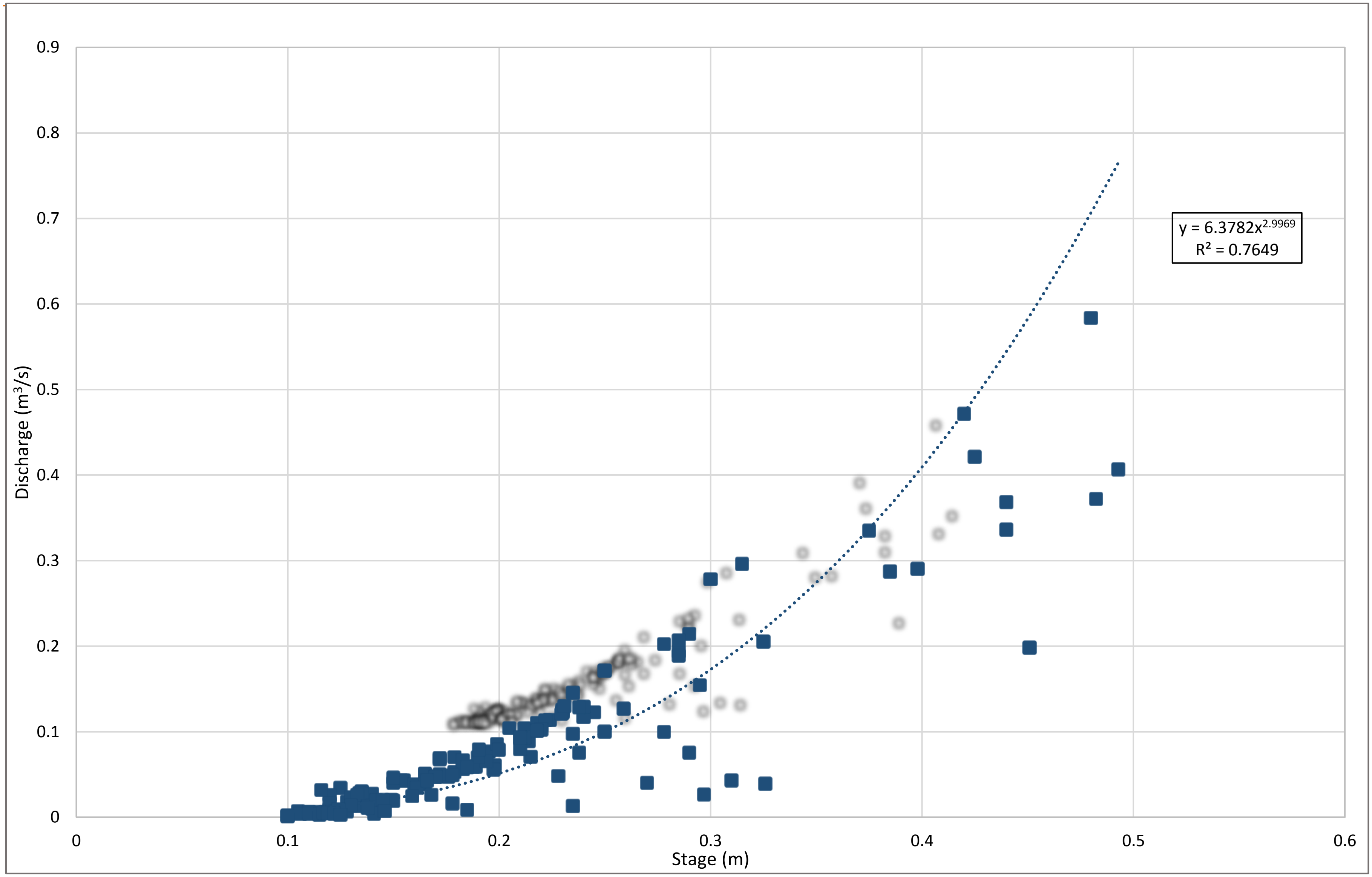


Figure 10: W1 Rating Curve

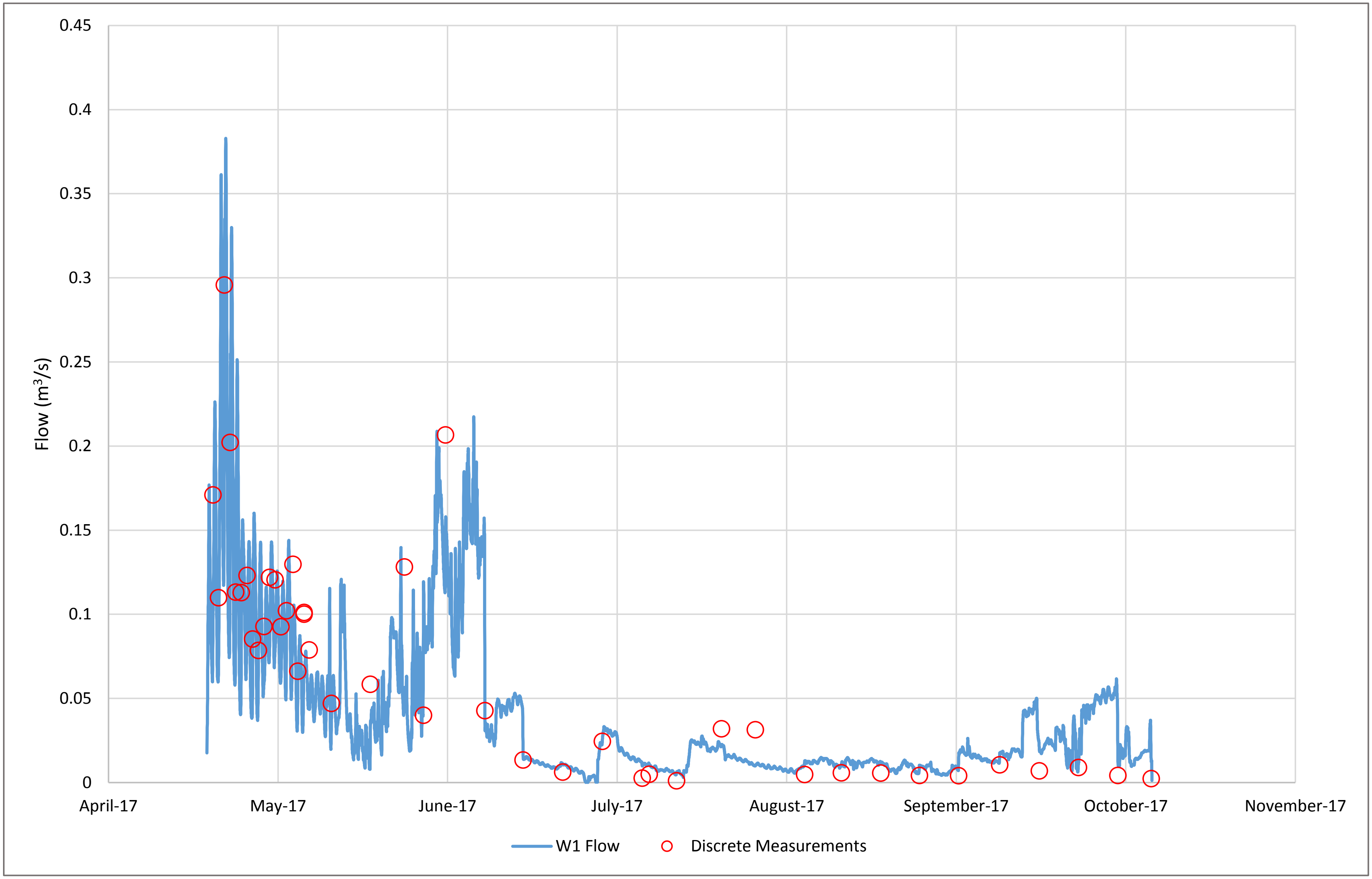


Figure 11: W1 Flow Hydrograph

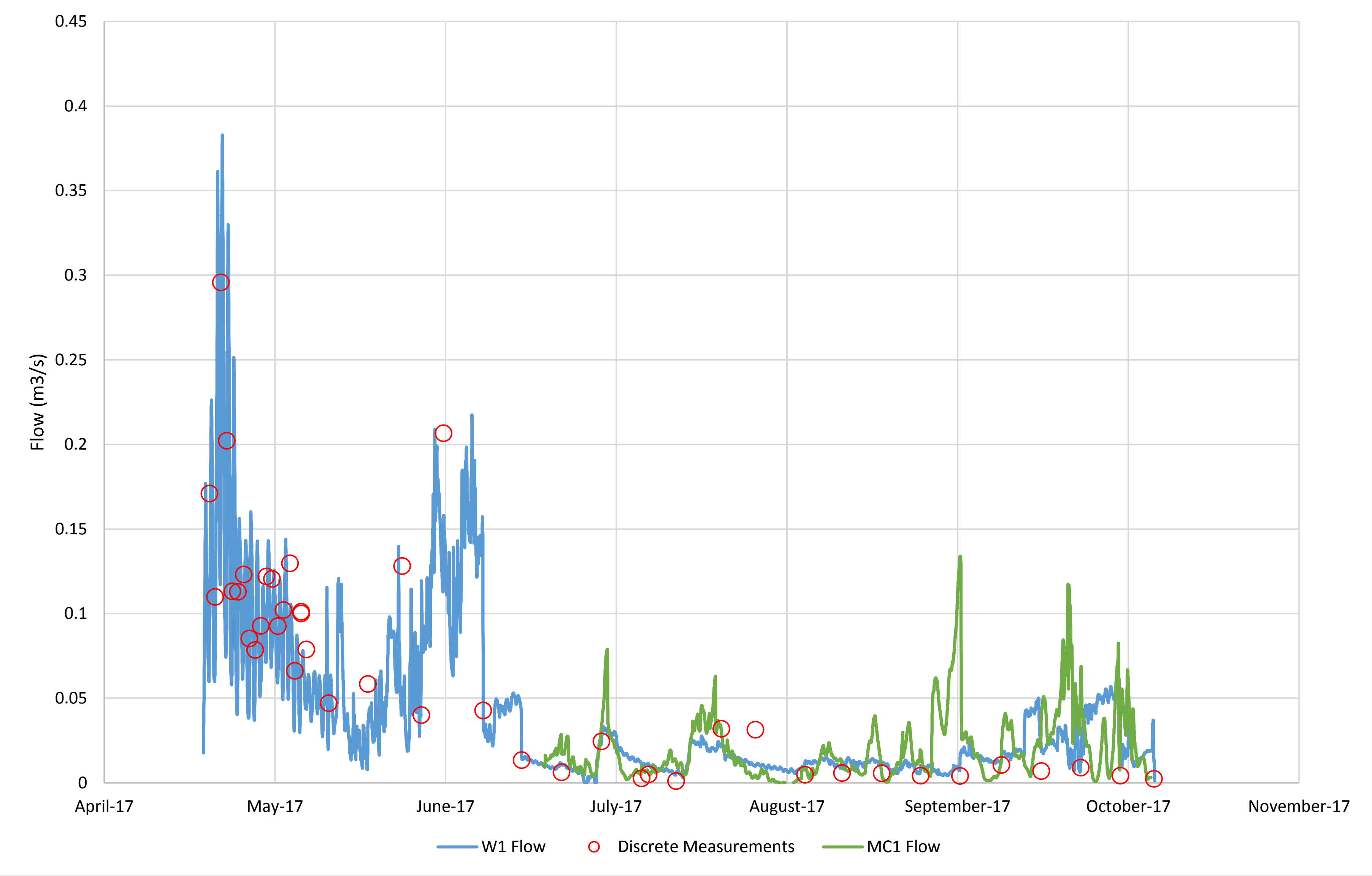


Figure 12: W1 Flow Hydrograph Comparison with MC1 Flow

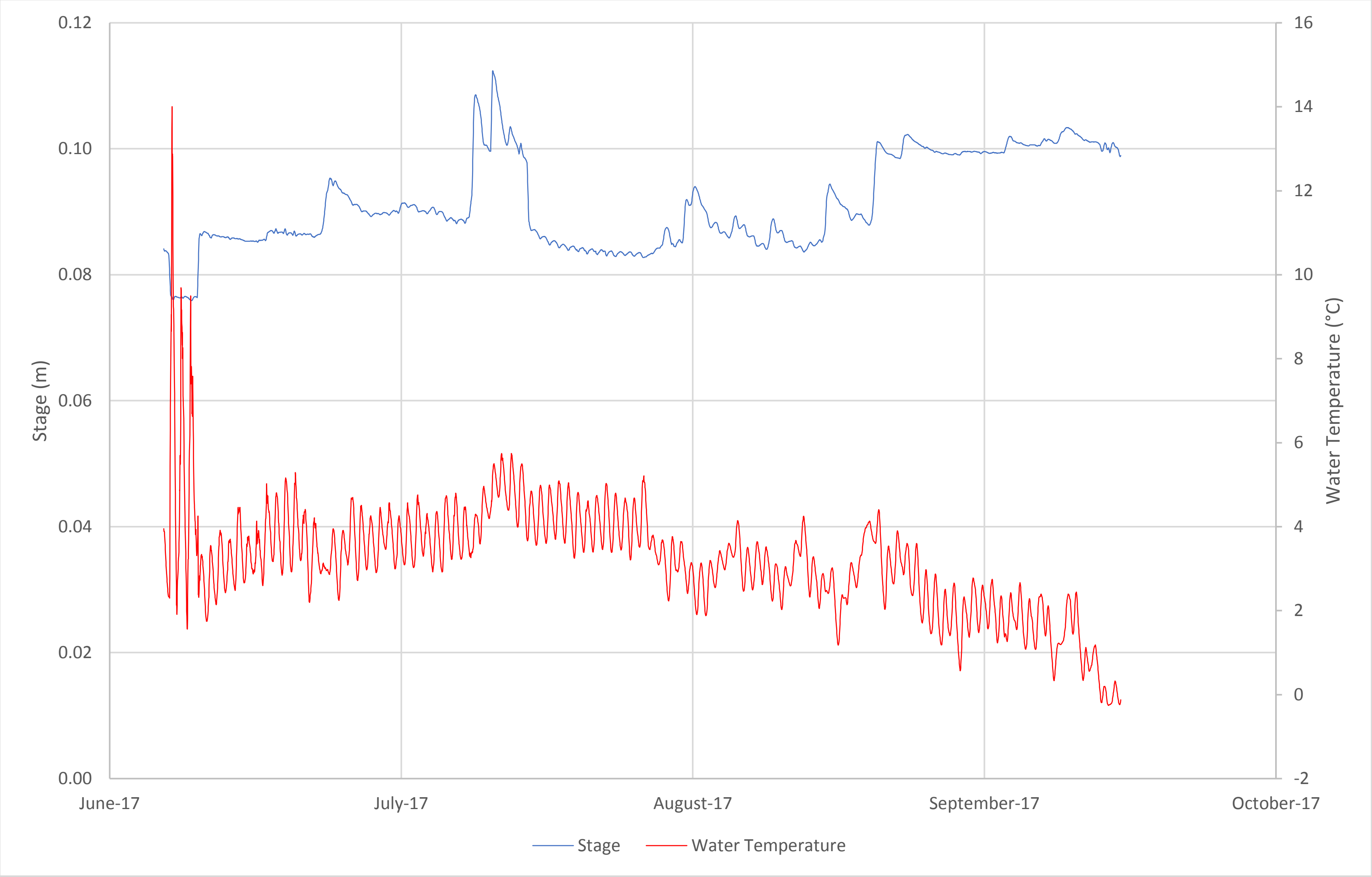


Figure 13: W7 Stage and Temperature Hydrograph

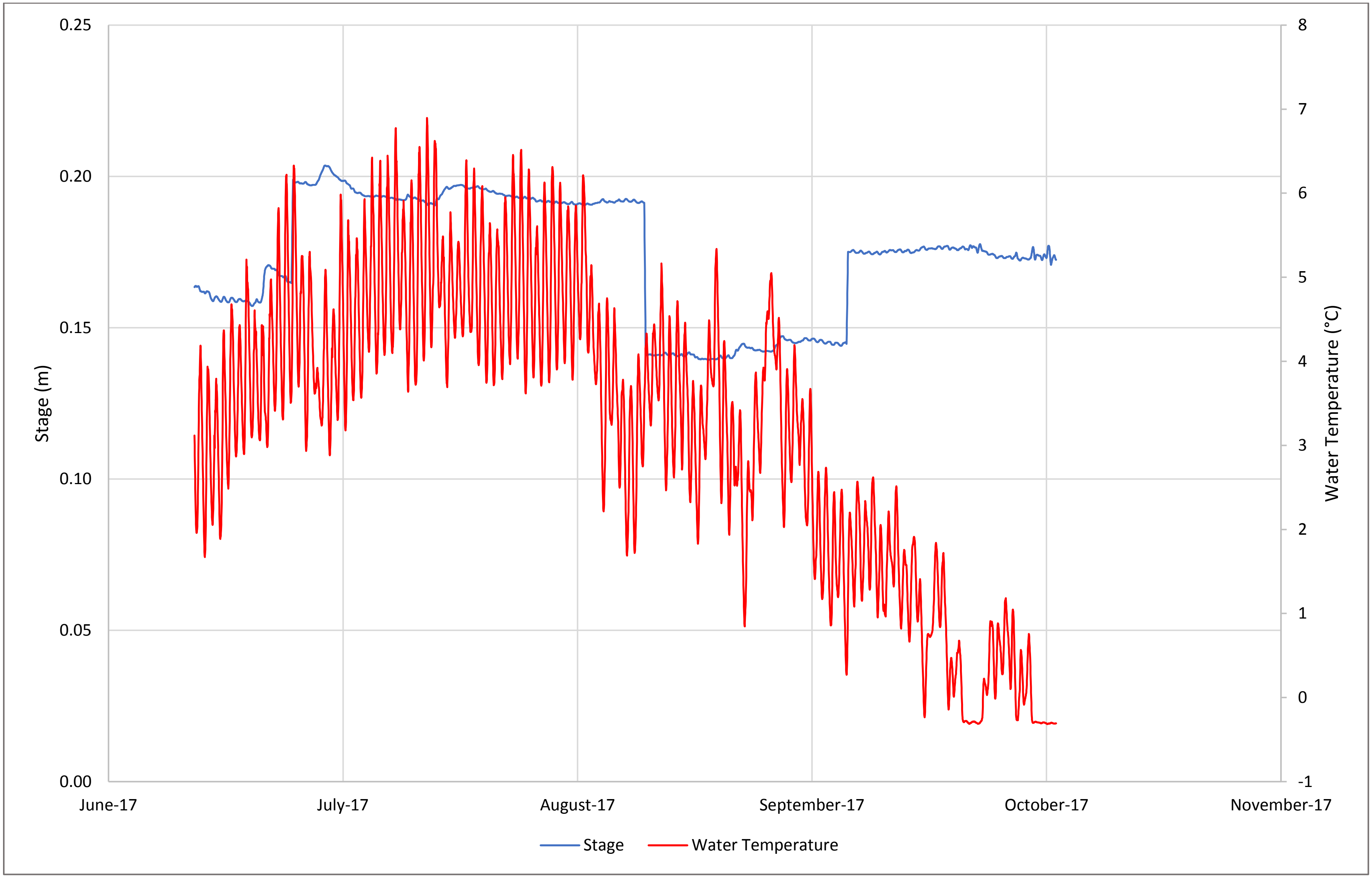


Figure 14: MN-0.5 Stage and Temperature Hydrograph

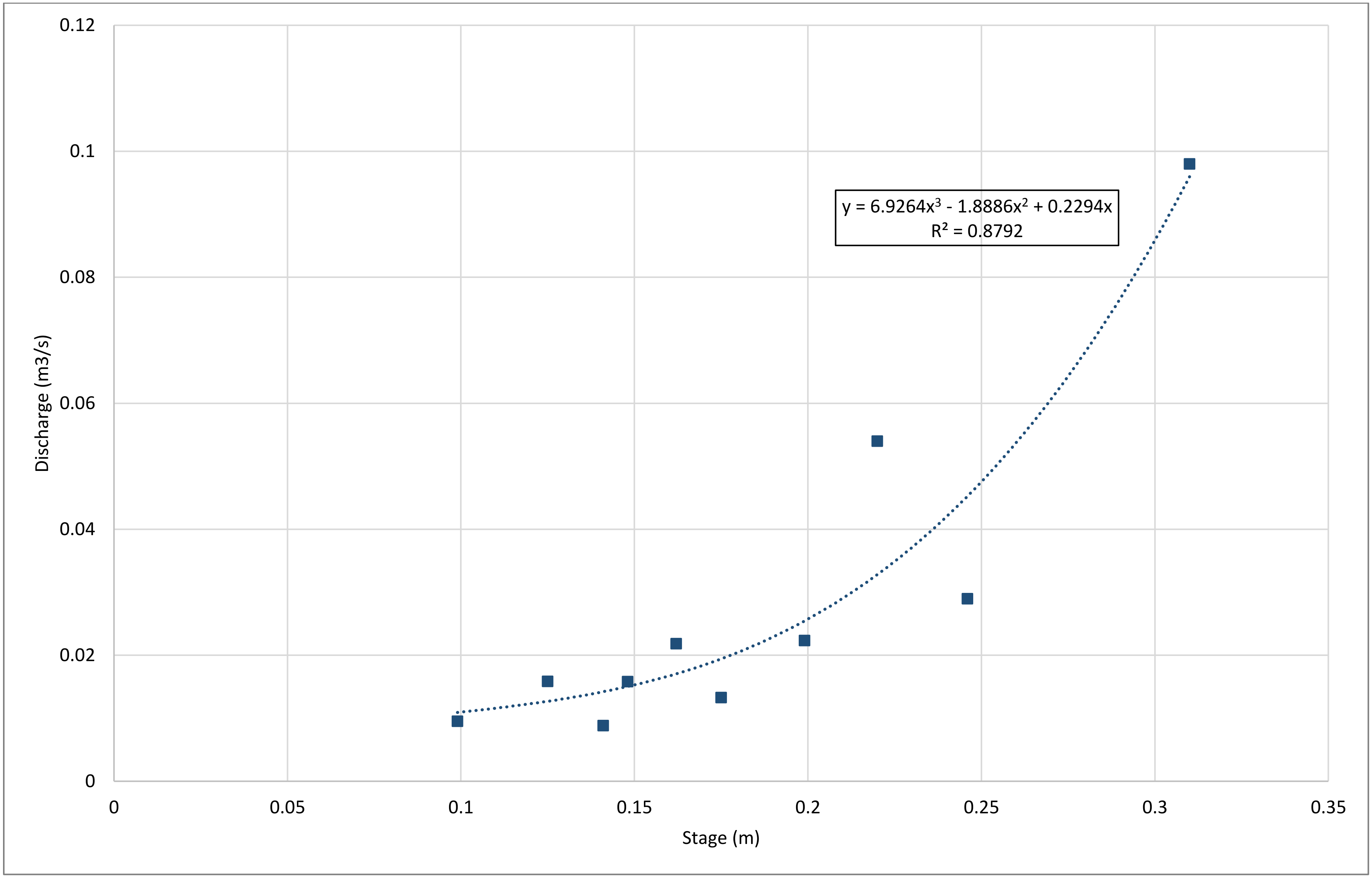


Figure 15: MN-0.5 Rating Curve

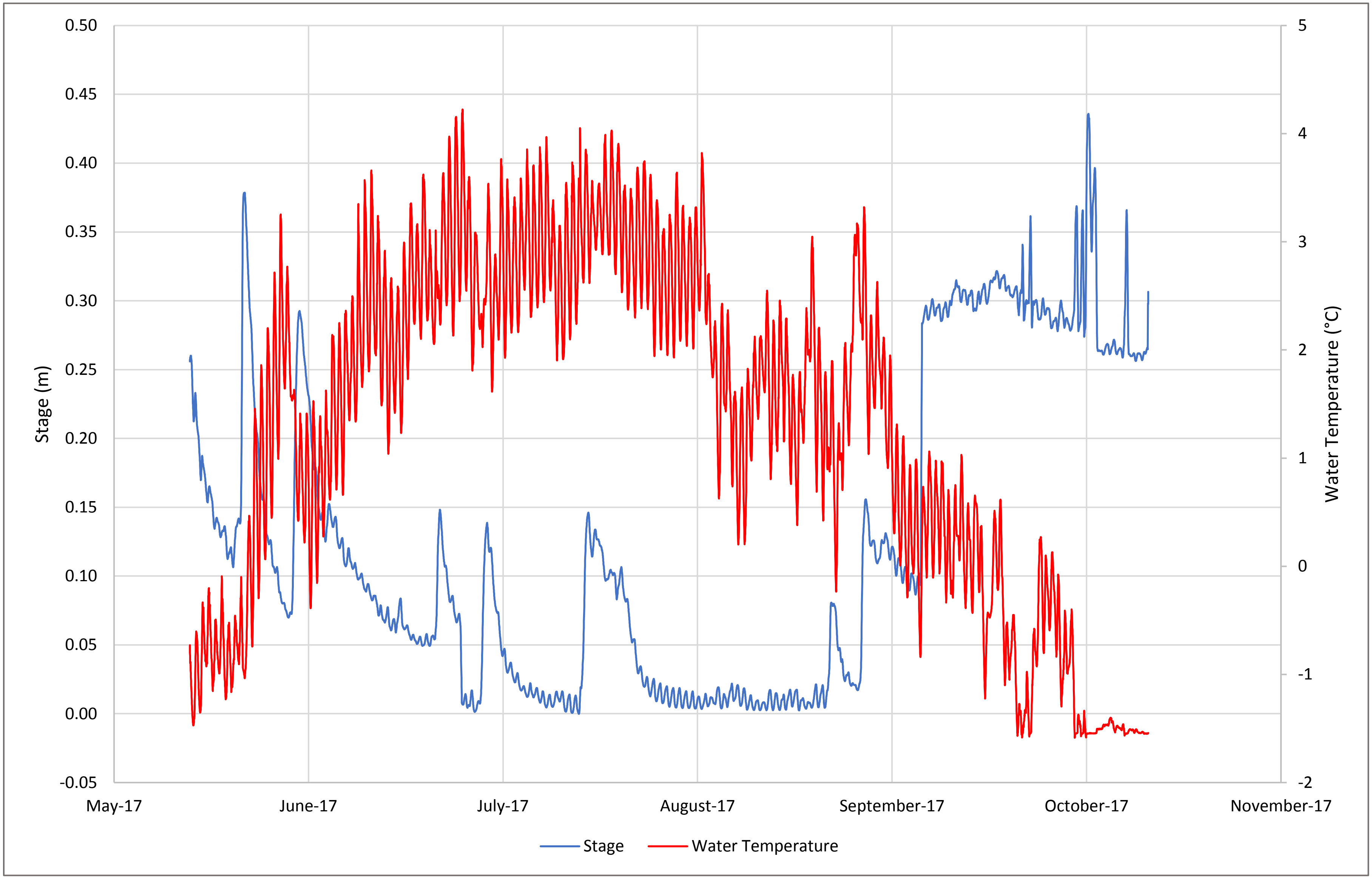


Figure 16: MN-2.5 Stage and Temperature Hydrograph

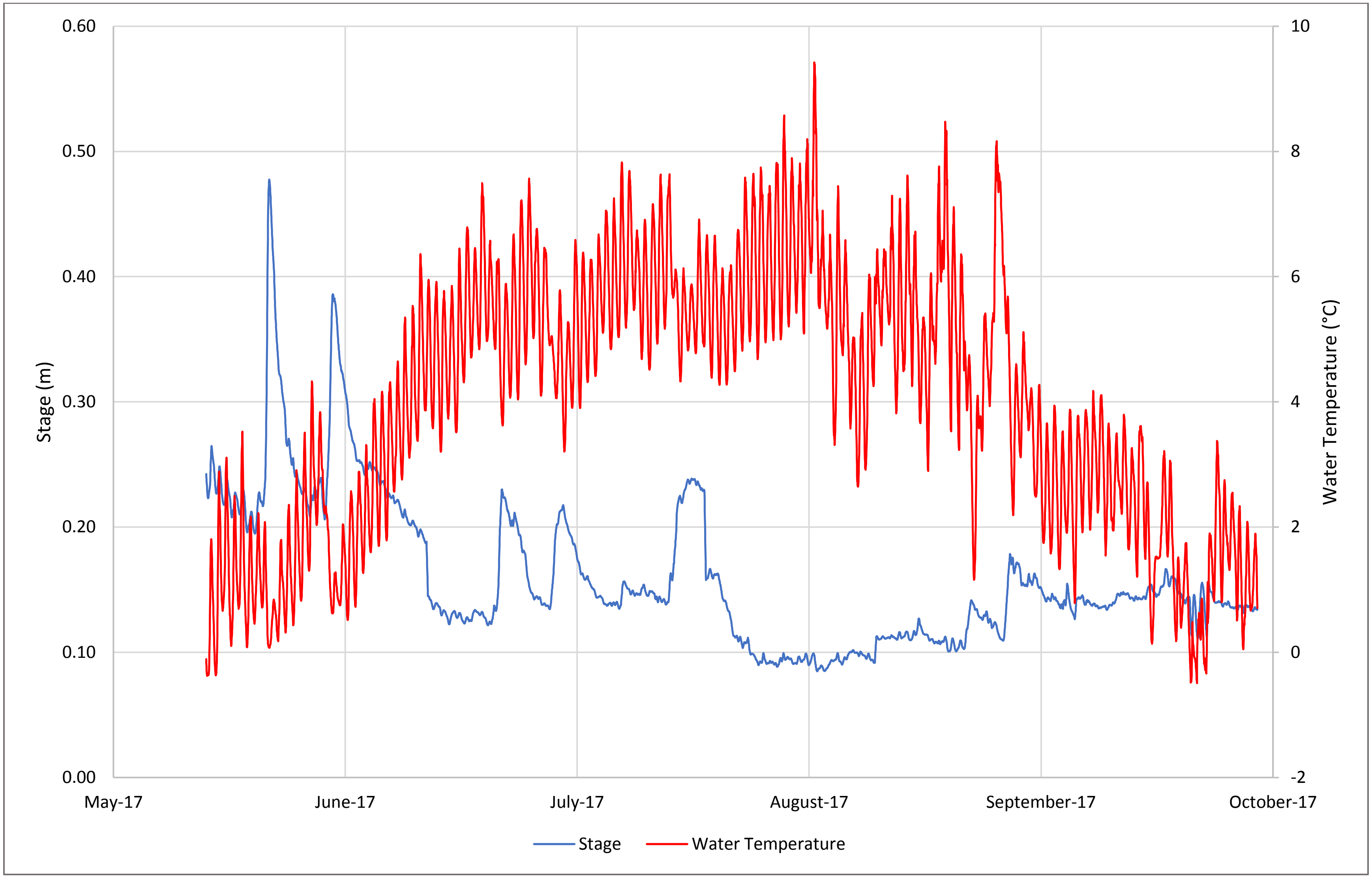


Figure 17: MN-4.5 Stage and Temperature Hydrograph

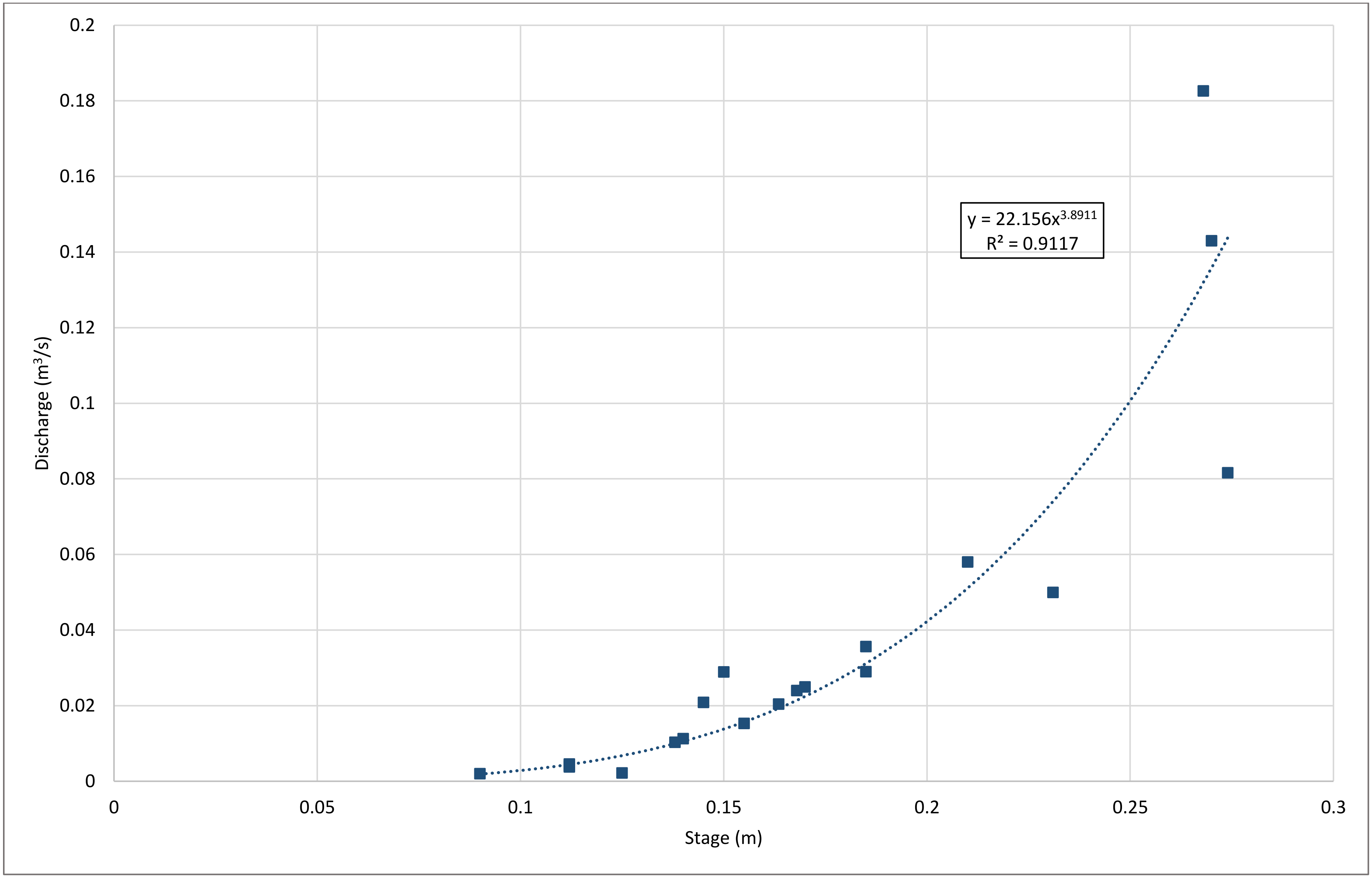


Figure 18: MN-4.5 Rating Curve

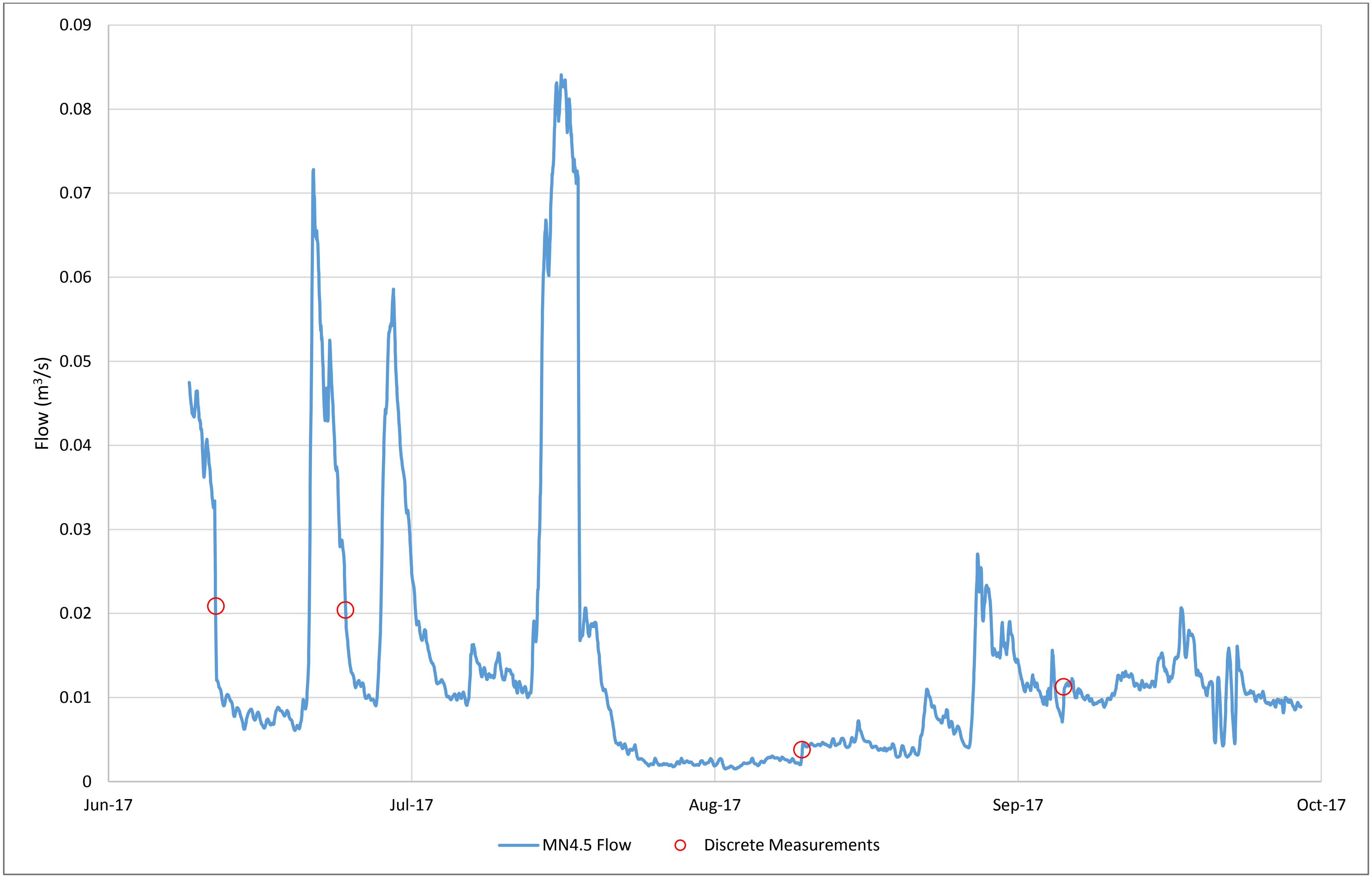


Figure 19: MN-4.5 Flow Hydrograph

Appendix G – 2017 Physical Monitoring Plan

Revision 2017-1
Physical Monitoring Plan
Minto Mine, YT

Prepared by:
Minto Explorations Ltd.
Minto Mine
December 2017

Minto Mine Physical Monitoring Plan

First Issue: June 2014

REVISION INFORMATION

Rev. Number	Issue Date	Description & Revisions Made
-	June, 2014	First issue
2015-1	November, 2015	Annual update of existing instrumentation and monitoring frequencies. Instruments Added: A215, A216, A217, A218, A2RAMP01, A2RAMP02, A2RAMP03, A2RAMP04, DSSH-26, DSSH-27, M82, M83, M84, M85, M86, M87, SWD06 Instruments Removed: DSI-14, DSI-21, DSSH-21, DSSH-22, DSSH-23, DSSH-25, WSP2
2016-1	December, 2016	Annual update of existing instrumentation and monitoring frequencies. Instruments Added: DSP-07, DSP-08, DSP-10, DSI-22, DSI-23, DSSH-28, DSSH-29, DSSH-30, DSSH-31, MV1, MV2, SWD-07, SWD-08, SWD-09 Instruments Replaced: DSSH-06, DSSH-10, DSSH-15, DSSH-18, DSSH-19, DSSH-20 Instruments Removed: A2RAMP01, A2RAMP02, A2RAMP03, A2RAMP04, SWD-02, SWD-02A, SWD-04A, SWD-05A, DSP-09
2017-1	November, 2017	Annual update of existing instrumentation and monitoring frequencies. Instruments Added: DSI-24, DSSH-32, M88, M89, M91, M92, M93, M94, SWD10, SWD11 Instruments Replaced: DSSH-17, DSSH-27, M82, M76, M86 Instruments Removed: DSI-23, DSSH-20, DSSH-29, M73, M75, M87

Updated by:

Dale Heffernan, EIT

Geotechnical Engineer-in-Training

Reviewed by:

PROFESSIONAL
YUKON
KEVIN CYMBALISTY
TERRITORY
ENGINEER

Kevin Cymbalisty, P.Eng.

Mine Manager

Table of Contents

List of Tables

List of Appendices

Appendix A: Instrumentation Map
Appendix B: Data Collection and Input Manuals

1 Introduction

The following document describes the instrumentation and monitoring program currently in place at Minto to monitor the stability of mining structures including waste rock, tailings, and water storage facilities. The program consists of two main components: instrumentation to measure ground conditions and deformation, and regular geotechnical inspections. The following sections summarize inspection and data collection frequencies, instrument installation details and locations, and data collection procedures.

Mining and monitoring activities at Minto included in this plan are licensed under the following:

- Type A Water Licence QZ14-031, August, 2015
- Type B Water Licence MS15-094, July 2016
- Quartz Mining Licence QML-0001, December, 2014

Existing mine structures at Minto are shown in Figure 1-1, and described in the following section.

Figure 1-1: Minto site plan (August 2017)

2 Mine Structures

Mine structures currently being monitored at Minto as well as future structures included in the Phase V/VI plan are listed in Table 1.

Table 1: Description of Mine Structures at Minto

Structure	Description	Instrumentation
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	The Area 2 Pit was completed in 2015 to the extents licensed under Phase IV (Stages 1 and 2); the pit was extended to the south as part of Phase V/VI (Stage 3 and Stage 3 Expansion), scheduled to be complete in 2018. Tailings deposition into Area 2 Stage 2 pit (A2S2) began in March, 2015 and the pit is now maintained as a tailings management facility. Dumping of NP:AP<3 waste rock (SAT), intended to be below the final water table at closure, has commenced into the pit.	• Survey hubs • GroundProbe radar (during active mining)
Area 2 Underground	The Area 2 underground began development in 2016 and is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining is currently taking place using a longhole stoping method and is expected to be completed in 2018.	None
Area 118 Pit	Mining of the Area 118 Pit was carried out in 2014. As part of Area 2 Stage 3 pit mining, overburden is being dispatched to the Area 118 pit, referred to as the Area 118 Backfill Dump.	• Survey hubs
Area 118 Backfill Dump	The Area 118 Backfill Dump is included in the Phase V/VI licence and commenced in 2017. Construction will continue for the duration of the Area 2 Stage 3 Pit. The dump will fill in the Area 118 Pit.	None
Area 118 Underground	The Area 118 underground began development in 2013 and was completed in 2016. It is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production mining took place using a longhole stoping method.	None
Big Creek Bridge	Bridge on the Minto access road crossing Big Creek, located at Km 19. Licenced under Type B water licence MS15-094.	None
Barge Landings	Barge landings on the Minto access road at the Yukon river. Licensed under Type B water license MS15-094.	None
Camp	The camp consists of several connected bunkhouse buildings (Sherwood, Minto, Selkirk), a kitchen building, and several separate buildings including the gym and Site Services offices.	None
Copper Keel and Wildfire Underground	The Copper Keel and Wildfire underground are in the phase V/VI mining plan and have not commenced yet.	N/A
Dry Stack Tailings Storage Facility (DSTSF)	Construction of the DSTSF with filtered tailings placement was carried out from 2007 to November 2011. As part of progressive reclamation activities in 2012-2013, the DSTSF was covered with a layer of overburden approximately one to four meters thick. The DSTSF began showing deformation in 2009, interpreted as primarily horizontal sliding towards the north/northeast on an ice-rich layer in the underlying overburden, several meters above bedrock. The movement has continued since then but at a decreasing rate in response to construction of both the Mill Valley Fill waste rock buttress and the Mill Valley Fill Extension 2 waste rock buttress.	• Survey hubs • Thermistors • Inclinometers • Piezometers

Structure	Description	Instrumentation
Ice Rich Overburden Dump (IROD)	Originally constructed as a free-standing rockfill structure to contain ice-rich overburden. The IROD is no longer active and is now entirely surrounded by the Southwest Waste Dump rockfill. The area has been reclaimed with the Southwest Waste Dump in 2017.	None
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	Mining in the Main Pit was completed in 2011. Instability in the south wall of the pit occurred in 2009 during mining of Stage 3 of the pit, and subsequently a larger failure occurred in 2011 after completion of Stage 5. Continued sloughing and creep movement of the south wall led to the design and construction of a waste rock buttress, known as the South Wall Buttress, completed in 2013. Slurry tailings deposition into the pit began in 2012 and the pit is now maintained as a tailings management facility. Dumping of NP:AP<3 waste rock (SAT) below the final water table at closure, is not currently active but remains an alternate dispatch location to the Area 2 Pit Tailings Management Facility.	• Survey hubs • Inclinometer
Main Pit Dump	The Main Pit Dump is included in the Phase V/VI licence. Construction commenced in 2017. The dump is located on the southwest side of the Main Pit.	• Survey hubs
Main Waste Dump (MWD)	The Main Waste Dump stores waste rock released during the mining of the first three stages of the Main Pit. The dump is no longer active.	• Inclinometer
Main Waste Dump Expansion (MWDE)	This dump is an extension of the MWD that stores waste rock released from the Minto North Pit. The dump is no longer active. Reclamation re-sloping began in 2016.	None
Main Waste Dump Wrap (MWDW)	This dump is a reclamation feature to shallow the slopes of the Main Waste Dump for reclamation purposes.	None
Mill Site	The mill site consists of the mill building, crusher and crusher stockpile pad.	None
Mill Valley Fill Extension (MFVE)	A waste rock buttress to the north of the DSTSF, constructed from January 2012 to March 2013 to prevent or decrease movement of the DSTSF.	• Survey hubs
Mill Valley Fill Extension 2 (MVFE2)	An extension of the MVFE waste rock buttress to the northeast, constructed from November 2015 to August 2016 to further decrease movement of the DSTSF.	• Piezometers • Survey hubs • Inclinometers
Mill Valley Fill Extension 2 Collection Sump	A replacement sump for the Minto Creek Detention Structure (MCDS), constructed in 2016. It detains surface water considered impacted from upstream sub-catchment areas and directs it to the MPTMF or water treatment plant.	None
Minto Access Road	Road from the Yukon River barge crossing to the mine site. Licenced under Type B water licence MS15-094.	None
Minto East Underground	Ramping to the Minto East underground began development in 2017 and is accessed by a portal and decline south of the Area 2 and Area 118 Pits. Production will use a longhole stoping method and is expected to start in 2018.	None

Structure	Description	Instrumentation
Minto North Pit	Mining of the North Pit was completed in September 2016. The pit is currently inactive and the access is barricaded.	None
Ore Stockpiles	There are two primary ore stockpiles on site – North and South stockpile. These are located south of the crusher and east of the Area 2 pit.	None
Reclamation Overburden Dump (ROD)	Received the bulk of the overburden released as part of Phase IV and earlier mining of the Main Pit. The material in the ROD is available for use in reclamation of the mine at closure.	None
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	The Ridgetop Pits are included in the Phase V/VI licence and has not commenced yet. Mining is planned to start in 2018.	GroundProbe radar (during mining)
Ridgetop Waste Dump	The Ridgetop Waste Dump is included in the Phase V/VI licence and has not commenced yet. Dumping is planned to start in 2018.	N/A
South Diversion Ditch	This structure was decommissioned in 2017 to allow for Area 2 Stage 3 Expansion mining activities.	None
South Wall Buttress (SWB)	Waste rock buttress constructed against the Main Pit south wall from 2009-2011 as a result of instability in the south wall of the pit.	• Survey hubs
Southwest Waste Dump (SWD)	The Southwest Waste Dump (SWD) stores waste rock released during phase IV mining. Dumping at the SWD is now complete and reclamation re-sloping began in 2015. Re-sloping is expected to be completed in 2018.	• Survey hubs • Inclinometers • Thermistors • Piezometers
Tailings Diversion Ditch (TDD)	A diversion ditch located south of the DSTSF to divert unimpacted water around the tailings facility. The intake structure was extended in 2017 to allow for the decommissioning of the South Diversion Ditch with A2S3 Expansion mining.	None
Water Storage Pond Dam (WSP)	The Water Storage Pond and Dam are located east of the mine along Minto Creek. The dam was constructed in 2006 as a clay-core water retention dam for collecting precipitation and surface water runoff at the site. Maximum depth of water at the face of the dam is approximately 15 m.	• Survey hubs • Thermistors • Piezometers

3 Design and Monitoring References

Table 2 lists the design reports for each structure and the monitoring/inspection guidance reports used to develop the inspection (Section 5) and instrumentation (Section 6) programs for each structure.

Table 2: Design Documents and Monitoring/Inspection Guidance Documents

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	*Prefeasibility Geotechnical Evaluation, Phase IV, Minto Mine.* SRK, December 2009. *Review of Minto Area 2 West Wall Stability*. SRK, September 11, 2012. *Review of Minto Area 2 West Wall Stability-April 2013*. SRK, April 18, 2013. *Review of Minto Area 2 West Wall Stability-September 2013*. SRK, September 30, 2013. *Main Dam – Area 2 Pit Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, February, 2015.	*Operation, Maintenance, and Surveillance Manual - Area 2 Pit Tailings Management Facility* Revision 2015-2. Minto, December 2015. *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.
Area 2 Stage 3 Pit and Area 2 Stage 3 Expansion	*Pit Slope Stability Evaluation, Minto Mine, Area 2 Pit – Stage 3.* SRK Consulting Project: 219500.190, August 2015. *Geotechnical Review of Saddle Between Area 2 Stage 2 and Area 2 Stage 4 Open Pits.* JDS Energy & Mining Inc., August 24, 2017.	*Minto Mine Ground Control Plan – Open Pit Operations.* Minto, 2016.
Area 2 Underground	*Area 2 Mining Stability Assessment Summary.* Golder Associates, June, 2016. *Area 2 Mining Stability Assessment Summary.* Golder Associates, December, 2016.	*Minto Mine Ground Control Plan – Underground Operations.* Minto, 2016. *Inspection of Physical Stability of Underground Workings at Minto Mine, Yukon*. Golder Associates, August 2017. *Minto Mine Geotechnical Mapping Program Memo Review.* Golder Associates, September 2017. *Independent Review of Blasting Impacting Between Minto Surface and Underground Operations*. Golder Associates, September 2017.
Area 118 Pit	*Prefeasibility Geotechnical Evaluation, Phase IV, Minto Mine.* SRK, December 2009. *Review of Final Area 118 Pit Design*. SRK Consulting, Project: 219500.070. January, 2015.	-
Area 118 Backfill Dump	*Phase V/IV Ridgetop South and Area 118 Backfill Dumps Physical Stability Assessment.* SRK, October 2013.	-

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Area 118 Underground	*Minto 118-Zone – FLAC3D Analysis of the Longhole Base Case Option.* Itasca, August 2014. *Geotechnical Characterization of Existing and Proposed Longhole Open Stope Mining Areas.* Golder Associates File: 1528754-002-R-Rev0-3000. July 30, 2015. *Longhole Open Stope Stability Addendum – Revised Mining Heights.* Golder Associates, File 1528754-006-TM-Rev0-3000, November 2015. *Area 118 Plunge Mining Stability Assessment Summary.* Golder Associates, File: 1528754-008-PP-Rev0-5000, December 2015	*Minto Mine Ground Control Plan – Underground Operations.* Minto, 2016. *Ground Control Management Plan Review*. Golder Associates, File 1528754-007-TM-Rev0-1000. September 2015.
Big Creek Bridge	-	-
Camp	-	-
Dry Stack Tailings Storage Facility (DSTSF)	*Geotechnical Design Report, Dry Stack Tailings Storage Facility, Minto Mine, Yukon*. EBA File: 1200173. January 2007.	*Operation, Maintenance, and Surveillance Manual, Dry Stack Tailings Storage Facility, Minto Mine, YT.* Revision 2014-1 Minto, November 2014. *Minto Mine Operations Adaptive Management Plan.* Revision 2016-01. Minto, May, 2016.
Ice Rich Overburden Dump (IROD)	*Geotechnical Design Ice-Rich Overburden Dump, Minto Mine, Minto, YT.* EBA file: 1200173. January 2006. *Ice-Rich Overburden Dump Containment Berm Inspection Report, Minto Mine Site, Minto Yukon.* EBA File: 1200173.001. June 19, 2007.	*Geotechnical Design Ice-Rich Overburden Dump, Minto Mine, Minto, YT.* EBA file: 1200173. January 2006. EBA, 2007. *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. .
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	*Pit Slope Evaluation for Area 1 Open Pit.* SRK Consulting, Project: 2CM022.03, July 2007. *SAT Dump on Tailings.* SRK Consulting Project: 1CM002.043, March 2016.	*Operation, Maintenance, and Surveillance Manual - Main Pit Tailings Management Facility*. Revision 2015-2 Minto, December, 2015. *Minto Mine Operations Adaptive Management Plan* Revision 2017-01. Minto, January, 2017.
Main Pit Dump	*Phase V/VI Main Pit Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.003.0701, November, 2013. *Update to the Main Pit Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.003.0701. February, 2015. *Main Pit Dump (Revision 5.6) Stability Analysis*. SRK Consulting, Project 1CM002-053, July, 2017.	-

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Main Waste Dump (MWD)	*Geotechnical Evaluation Proposed Main Waste Dump Minto Mine, Minto, YT.* EBA. April, 1998.	*Geotechnical Evaluation Proposed Main Waste Dump Minto Mine, Minto, YT.* EBA. April, 1998. *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.
Main Waste Dump Expansion (MWDE)	*Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan.* Minto. June, 2014. *Phase V/VI Main Waste Dump Expansion – Physical Stability Assessment.* SRK Consulting Project: 1CM002.012.012, November, 2013	*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.
Main Waste Dump Wrap (MWDW)	*Main Waste Dump Stability Analysis.* SRK Consulting Project: 1CM002-049, April, 2017.	-
Mill Site	-	-
Mill Valley Fill Extension (MFVE)	*Waste Rock and Overburden Management Plan, Phase IV Development, Minto Mine YT.* EBA File: W14101068.015. September 9, 2011. *Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility.* EBA File: W14101168.013. September 14, 2011.	*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.
Mill Valley Fill Extension 2 (MVFE2)	*Mill Valley Fill Extension Stage 2 Preliminary Design Report.* SRK Consulting Project: 1CM002.015. March, 2014 *Minto Mine Phase V/VI Expansion Waste Rock and Overburden Management Plan.* Minto. June, 2014. *Mill Valley Fill Extension Stage 2 Final Design Report.* SRK Consulting Project: 1CM002.040. September, 2015. *Mill Valley Fill Extension Stage 2 Record of Construction.* Minto. November, 2016.	*Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016. *Mill Valley Fill Extension Stage 2 – Expected Performance and Evaluation Criteria.* SRK Consulting Project: 1CM002.050, November, 2016. *Mill Valley Fill Extension Stage 2 Inclinometer Installations Field Report*. SRK Consulting Project: 1CM002.052. June 2017.
Mill Valley Fill Extension 2 Collection Sump	*Design for the MVFE Stage 2 Collection Sump.* SRK Consulting Project: 1CM002.020. June, 2015. *Mill Valley Fill Extension Stage 2 Colleciton Sump Record of Construction*. Minto. April, 2016.	-
Minto Access Road	-	-
Minto East, Copper Keel, Wildfire Underground	*Minto Phase VI Underground Geotech Evaluation*, SRK Consulting Project: 2UC031.005, February, 2012. *Geotechnical Characterization of Existing and Proposed Longhole Open Stope Mining Areas,* Golder Associates, Reference No. 1528754-002-R-Rev0-3000, July, 2015. *Minto Mine Underground Reserve Update Geotechnical Input*, Golder Associates, Reference No. 1528754-003-R-Rev0-3000, July, 2015.	-

Structure	Design Reports	Monitoring/Inspection Guidance Reports
	Minto East – Revised Longhole Open Stope Stability. Golder Associates, File: 1528754-009-TM-Rev0-6000, January, 2016. *Wildfire Proposed Underground Mine Area – Geotechnical Characterization and Long Hole Open Stope Stability Assessment.* Golder Associates, September, 2016. *Minto East Raise Geotechnical Investigation and Hydrogeological Testing Program Study*. Golder Associates, October, 2017.	
Minto North Pit	*Minto Phase VI Preliminary Feasibility Study Technical Report.* SRK, January 2012. *Review of Minto North Wall Stability.* SRK, May, 2016. *Site Visit and Review of North Pit – South Wall.* BGC Engineering, July, 2016. *Minto North South Wall Wedge Analysis.* SRK, August, 2016.	*Minto Open Pit Ground Control Plan_Rev0.* Minto, 2016.
Ore Stockpiles	-	-
Reclamation Overburden Dump (ROD)	*Geotechnical Design Proposed Reclamation Overburden Dump, Minto Mine, Yukon.* EBA File: W14101068.004. February 2008. *Reclamation Overburden Dump Expansion Geotechnical Design Report.* EBA File: W14101068.0040. June 29, 2010.	*Reclamation Overburden Dump Expansion Geotechnical Design Report.* EBA File: W14101068.0040. June 29, 2010. *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	*Pre-Feasibility Geotechnical Evaluation Phase IV Minto Mine,* SRK Consulting Project: 2CM022.006, December, 2009. *Ridgetop North Pit TMF Stability Assessment,* SRK Consulting Project: 1CM002.003.710, February, 2015.	-
Ridgetop Waste Dump	*Phase V/VI Ridgetop Waste Dump Physical Stability Assessment.* SRK Consulting Project: 1CM002.012.0.12, November, 2013.	-
South Diversion Ditch (SDD)	*Phase 1 – Preliminary Engineering, Stormwater Diversion Ditches Minto Mine, YT,* EBA File: W14101068.013	-
South Wall Buttress	*Area 1 South Wall Buttress Design Report, Minto Mine, Yukon.* EBA File: W141010668.012, July 2011.	-

Structure	Design Reports	Monitoring/Inspection Guidance Reports
Southwest Waste Dump (SWD)	*Geotechnical Design Proposed Southwest Waste Dump, Minto Mine, Yukon.* EBA File: W14101068.005. September 2008.	*Geotechnical Design Proposed Southwest Waste Dump, Minto Mine, Yukon.* EBA File: W14101068.005. September 2008. *Minto Mine Operations Adaptive Management Plan* Revision 2016-01. Minto, May, 2016.
Tailings Diverion Ditch (TDD)	*Preliminary Design of the Tailings Diversion Ditch Upgrade,* SRK Consulting Project: 1CM002.012.006, November, 2013. *Area 2 Stage 3 Pit Expansion – Intake Strucutre and Overflow Spillway – Final Design*, SRK Consulting Project: 1CM002.056, May 2017.	-
Water Storage Pond Dam (WSP)	*Geotechnical Design Tailings/Water Dam, Minto Project, Yukon.* EBA File: 0201-95-11509. Dec. 1995. *As-built Construction Report, Water Retention Dam, Minto Mine, Minto, YT.* EBA File: 1200173.001. April 2008.	*Operation, Maintenance and Surveillance Manual, Water Retention Dam, Minto Mine, Minto, YT.* EBA File: W14103414-01. August 2014.

4 Roles and Responsbilities

Table 3 lists the roles and responsibilites for physical monitoring on the site.

Table 3: Roles and Responsibilities

Role	Responsibilities
Mine Technician Assistants	• Collect instrumentation data at specified frequencies • Input data into monitoring spreadsheets/databases • Internal reporting of monitoring data • Maintain equipment
Geotechnical Engineers/EITs	• QA/QC of data collection • Ensure compliance with license requirements • Monthly and annual Water Licence reporting • Visual inspections at specified frequencies • Communicate with consultants as required • Review and update Physical Monitoring Plan
Environmental Officers	• Compile monthly and annual Water Licence reports • Visual inspections of water diversion/collection structures
Chief Engineer	• Review monthly and annual Water Licence reports • Ensure compliance with licence requirements

5 Inspections

Table 4 lists the regular, required inspections.

Table 4: Inspections

Structure	Frequency	Description
Area 2 Pit and Area 2 Pit Tailings Management Facility (A2PTMF)	Quarterly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as per OMS Manual.
Area 2 Stage 3 Pit and Area 2 Stage 3 Pit Expansion	Weekly (during active mining)	Weekly visual inspection by Geotechnical Engineer/EIT during active pit mining. Documented in weekly wall inspection report and two-week operating plan documents.
Area 2 Underground	Quarterly	Visual inspection by Geotechnical Engineer/EIT as per Underground Ground Control Plan.
Area 118 Pit	N/A	No longer accessible.
Area 118 Backfill Dump	Minimum every 4 hours during active dumping	Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44.
Area 118 Underground	N/A	No longer accessible.
Big Creek Bridge	Annually	Visual inspection by a Professional Engineer as per MS15-094.
Camp	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Copper Keel, Wildfire Underground	N/A	N/A – structure does not exist yet.
Dry Stack Tailings Storage Facility (DSTSF)	Monthly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as per OMS Manual.
Ice Rich Overburden Dump (IROD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	Quarterly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as per OMS Manual.

Structure	Frequency	Description
Main Pit Dump	Minimum every 4 hours during active dumping	Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44.
Main Waste Dump (MWD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Main Waste Dump Expansion (MWDE)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Main Waste Dump Wrap (MWDW)	Minimum every 4 hours during active dumping	Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44.
Mill Site	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Mill Valley Fill Extension (MFVE)	Monthly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as part of DSTSF monthly inspection.
Mill Valley Fill Extension 2 (MVFE2)	Monthly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as part of DSTSF monthly inspection.
Mill Valley Fill Extension 2 Collection Sump	Monthly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as part of DSTSF monthly inspection.
Minto Access Road	Annually	Visual inspection by a Professional Engineer as per MS15-094.
Minto East Underground	Quarterly	Structure does not exist yet. Once development commences, a visual inspection by Geotechnical Engineer/EIT as per Underground Ground Control Plan.
Minto North Pit	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Ore Stockpiles	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Reclamation Overburden Dump (ROD)	Semi-Annually – May/June post thaw, and	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.

Structure	Frequency	Description
	September pre freeze-up	
Ridgetop Pit (Ridgetop North Pit, Ridgetop South Pit)	Weekly (during active mining)	Weekly visual inspection by Geotechnical Engineer/EIT during active pit mining. Documented in weekly wall inspection report and two-week operating plan documents.
Ridgetop Waste Dump	Minimum every 4 hours during active dumping	Visual inspection by the supervisor or other competent person (typically the Pelly Shifter or Minto Operations Supervisor) as per O.I.C. 2006/178 Clause 15.44.
South Wall Buttress (SWB)	Quarterly	Visual inspection by Geotechnical Engineer/EIT and review of monitoring data as part of the MPTMF quarterly inspection.
Southwest Waste Dump (SWD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Tailings Diversion Ditch (TDD)	Semi-Annually – May/June post thaw, and September pre freeze-up	Included in site-wide geotechnical inspection - Inspection and data review by Professional Engineer as per QZ14-031 (Clause 100) and QML-0001 (Clause 13.2). Q2 inspection must be completed by an independent engineer by June 30 each year.
Water Storage Pond Dam (WSP)	Monthly	Visual inspection by Geotechnical Engineer/EIT as per OMS Manual.

6 Instrumentation

A map of site wide active instrumentation is shown in Appendix A. Installation information and data collection schedules are contained in the following sections. Instruments with a strikethrough shown were destroyed in 2017 or are no longer operational.

Inclinometers

Inclinometers are used to measure lateral, differential ground movement in a borehole. Inclinometer stations consist of grouted, slotted PVC pipe into which the inclinometer probe is lowered and deflection is measured at 0.5m intervals. The current probe used on site is an RST digital MEMS inclinometer system.

Table 5: Inclinometers

Area	ID	Northing (m)	Easting (m)	Elevation (m)	A0 Azimuth	Hole Depth (m)	Date Installed	Reading Frequency
Area 2 Pit	A2I-1	6944164.73	385298.95	822.46	302	55.5	2013-04-26	Quarterly
Dry Stack Tailings Storage Facility and Mill Valley Fill Extension 2	DSI-22	6945229	386043.4	723.471	034	14	2016-12-12	Bi-weekly
~~Dry Stack Tailings Storage Facility and Mill Valley Fill Extension 2~~	~~DSI-23~~	~~6945119~~	~~385886.8~~	~~765.679~~	~~070~~	~~49~~	~~2016-12-17~~	~~NA~~
Dry Stack Tailings Storage Facility and Mill Valley Fill Extension 2	DSI-24	6944971	385951.4	774.416	005	108	2017-02-01	Bi-weekly
Main Pit (Area 1 Pit) and Main Pit Tailings Management Facility (MPTMF)	MDI -2	6945013.08	384217.20	858.67	93	50.5	2010-02-10	Quarterly
Southwest Waste Dump	SDI-3	6944591.11	383966.00	847.42	90	46.5	2010-02-11	Quarterly

Survey Hubs

Survey hubs are used to monitor surface movement of structures and are comprised of steel posts cemented into waste rock or bedrock and equipped with a threaded base to which a high precision RTK-corrected GPS instrument is attached. The GPS currently used on site is a Trimble R8.

Table 6: Survey Hubs

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Date Installed	Frequency
Area 2 Pit	A210	6944268.42	384934.69	861.28	2011-07-01	Monthly
Area 2 Pit	A215	6944649.45	385155.49	808.72	2015-09-17	Monthly
Area 2 Pit	A216	6944749.21	385046.39	805.78	2015-09-17	Monthly
Area 2 Pit	A217	6944756.78	384852.52	806.68	2015-09-17	Monthly
Area 2 Pit	A218	6944707.23	384783.21	806.83	2015-09-17	Monthly
Area 2 Pit	A219	6944081.774	385158.519	846.042	2017-09-15	Monthly
Dry Stack Tailings Storage Facility	ASH05	6944280.52	385830.65	850.16	2011-03-07	Monthly
Dry Stack Tailings Storage Facility	ASH06	6944331.73	385623.79	824.17	2011-03-07	Monthly
Dry Stack Tailings Storage Facility	DSSH-24	6944757.90	385712.10	792.07	2014-02-28	Weekly
Dry Stack Tailings Storage Facility	DSSH-26	6944601.28	385490.96	796.35	2015-07-28	Weekly
Dry Stack Tailings Storage Facility	DSSH-27	6944757.178	385883.856	792.366	2017-06-25	Weekly
Dry Stack Tailings Storage Facility	DSSH-06	6944971.372	385553.396	783.866	2016-08-21	Weekly
Dry Stack Tailings Storage Facility	DSSH-10	6944992.584	385806.037	769.004	2016-08-21	Weekly
Dry Stack Tailings Storage Facility	DSSH-12	6944947.303	385707.165	778.364	2016-08-16	Weekly
Dry Stack Tailings Storage Facility	DSSH-14	6944920.27	385606.55	782.88	2012-04-21	Weekly
Dry Stack Tailings Storage Facility	DSSH-15	6944944.092	385490.104	784.82	2016-08-16	Weekly
Dry Stack Tailings Storage Facility	DSSH-18	6945070.727	385513.039	782.379	2016-08-16	Weekly
Dry Stack Tailings Storage Facility	DSSH-19	6945109.679	385575.406	781.303	2016-08-16	Weekly
~~Dry Stack Tailings Storage Facility~~	~~DSSH-20~~	~~6945072.083~~	~~385754.334~~	~~775.779~~	~~2016-08-21~~	~~Weekly~~
Dry Stack Tailings Storage Facility	DSSH-28	6945045.016	385930.244	768.015	2017-06-25	Weekly
~~Dry Stack Tailings Storage Facility~~	~~DSSH-29~~	~~6945162.176~~	~~385833.535~~	~~766.045~~	~~2016-08-21~~	~~Weekly~~
Dry Stack Tailings Storage Facility	DSSH-30	6944883.247	385890.044	789.008	2016-08-21	Weekly
Dry Stack Tailings Storage Facility	DSSH-31	6945030.732	386040.736	776.254	2016-11-01	Weekly
Dry Stack Tailings Storage Facility	DSSH-32	6944984.803	385895.604	772.638	2017-09-10	Weekly
Dry Stack Tailings Storage Facility	MV1	6945249.731	386021.140	727.554	2016-04-04	Weekly
Dry Stack Tailings Storage Facility	MV2	6945216.537	385979.321	740.349	2016-04-04	Weekly

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Date Installed	Frequency
South Wall Buttress	M76	6944609.57	384538.801	836.161	2011-05-23	Monthly
South Wall Buttress	M79	6944846.97	384208.90	847.66	2011-09-04	Monthly
South Wall Buttress	M80	6944931.70	384256.33	842.06	2011-09-04	Monthly
Main Pit	M81	6944971.63	384890.13	806.83	2012-05-08	Monthly
South Wall Buttress	M82	6944891	384526.4	807.338	2017-04-05	Bi-weekly
South Wall Buttress	M83	6944947.98	384475.79	809.06	2015-01-08	Bi-weekly
South Wall Buttress	M84	6945021.46	384445.11	807.37	2015-01-08	Bi-weekly
South Wall Buttress	M85	6944846.60	384315.66	826.08	2015-07-27	Monthly
South Wall Buttress	M86	6944636	384408.4	838.959	2017-09-12	Monthly
South Wall Buttress	M88	6944873.313	384376.559	837.776	2017-09-04	Monthly
South Wall Buttress	M89	6944688.487	384284.45	843.026	2017-09-04	Monthly
South Wall Buttress	M91	6944830.118	384397.843	849.617	2017-09-04	Monthly
South Wall Buttress	M92	6944785.25	384707.139	800.568	2017-09-14	Monthly
South Wall Buttress	M93	6944779.161	384620.593	801.16	2017-09-14	Monthly
South Wall Buttress	M94	6944827.05	384583.178	800.551	2017-09-14	Monthly
Southwest Waste Dump	SWD01	6944760.85	384077.86	859.07	2011-03-07	Monthly
Southwest Waste Dump	SWD05A	6943939.94	383837.70	869.16	2011-03-07	Monthly
Southwest Waste Dump	SWD06	6944762.06	384189.37	836.42	2015-07-27	Monthly
Southwest Waste Dump	SWD07	6944743.49	384111.649	840.00	2016-11-21	Monthly
Southwest Waste Dump	SWD08	6944560.14	383883.182	867.25	2016-11-21	Monthly
Southwest Waste Dump	SWD09	6944163.106	383790.749	861.532	2016-11-21	Monthly
Southwest Waste Dump	SWD10	6943943.374	383838.099	868.236	2017-07-10	Monthly
Southwest Waste Dump	SWD11	6944511.715	383916.357	849.792	2017-07-10	Monthly
Water Storage Pond Dam	WSP1	6945613.04	386480.98	723.31	2011-06-09	Monthly
Water Storage Pond Dam	WSP3	6945551.85	386548.62	719.73	2011-06-09	Monthly
Water Storage Pond Dam	WSP4	6945531.56	386555.22	719.93	2011-06-09	Monthly
Water Storage Pond Dam	WSP5	6945504.74	386560.23	721.02	2011-06-09	Monthly

Thermistors

Thermistor strings are used to measure ground temperature profiles in boreholes, and in particular permafrost conditions at Minto. Thermistor strings consist of multiple temperature sensor nodes distributed along a single multi-conductor cable, installed within or attached to the outside of grouted PVC pipe. EBA and RST thermistor strings have been installed on site. EBA thermistors are read using a basic ohmmeter and RST thermistors are read using a RST TH2016B readout unit.

Table 7: Thermistors

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Thermistor String No.	Nodes	Hole Depth (m)	Date Installed	Reading Frequency
Area 2 Pit	A2T-1	6944162.01	385305.61	822.39	3491	16	63.4	2013-04-21	Quarterly
Dry Stack Tailings Storage Facility	DST-10	6944584.06	385489.49	797.13	3492	16	63.4	2013-04-17	Quarterly
Dry Stack Tailings Storage Facility	DST-11	6944899.64	385538.89	787.66	3494	16	86.9	2013-04-05	Quarterly
Dry Stack Tailings Storage Facility	DST-13	6945014.60	386271.29	777.01	3495	16	101.5	2013-04-02	Quarterly
Dry Stack Tailings Storage Facility	DST-14	6944769.09	385713.42	791.47	3497	16	66.5	2013-04-12	Quarterly
Dry Stack Tailings Storage Facility	DST-15	6945033.78	385958.17	764.51	3493	16	64.0	2013-03-25	Quarterly
Water Storage Pond	WDT-1	6945523.08	386550.83	720.03	2072	16	42.49	2007-11-16	Monthly
Water Storage Pond	WDT-2	6945532.89	386574.77	713.66	2073	6	44.50	2007-11-07	Monthly
Water Storage Pond	WDT-3	6945544.10	386544.43	719.78	2074	16	49.42	2007-11-11	Monthly
Water Storage Pond	WDT-4	6945534.98	386547.90	719.85	2075	16	49.42	2007-11-10	Monthly
Water Storage Pond	WDT-5	6945504.57	386557.50	721.03	2076	16	35.13	2007-11-13	Monthly
Water Storage Pond	WDT-6	6945505.55	386556.32	721.03	2077	16	33.72	2007-11-13	Monthly
Water Storage Pond	WDT-7	6945504.65	386556.39	721.08	2078	16	33.92	2007-11-13	Monthly

Water Storage Pond	WDT-8	6945532.89	386574.77	713.66	2079	16	34.14	2007-11-07	Monthly
Southwest Waste Dump	SDT-1	6944766.71	384779.13	836.36	2220	16	59.1	2010-02-04	Quarterly
Southwest Waste Dump	SDT-2	6944595.06	383971.30	847.11	2221	16	14.6	2010-01-31	Quarterly
Southwest Waste Dump	SDT-3	6944333.87	383824.67	860.17	2222	16	15.8	2010-01-28	Quarterly
Southwest Waste Dump	SDT-4	6944163.62	383783.54	860.99	2223	16	13.1	2010-01-30	Quarterly

Vibrating Wire Piezometers

Vibrating wire piezometer strings are used to measure piezometric pressure profiles in boreholes. They consist of multiple vibrating wire sensors installed on PVC pipe in grouted boreholes. RST vibrating wire piezometers are installed on site and data is collected with an RST VW2106 readout unit.

Table 8: Vibrating Wire Piezometers

Area	ID	Northing (m)	Easting (m)	Elevation (m)	Sensor	No.	Sensor Elevation (m)	Date Installed	Reading Frequency
Dry Stack Tailings Storage Facility	DSP-5	6944769	385713	791.47	DSP-5A	VW24851	765.47	2013-04-16	Monthly
					DSP-5B	VW24853	761.47		
Dry Stack Tailings Storage Facility	DSP-6	6944900	385539	787.66	DSP-6A	VW24850	769.56	2013-04-05	Monthly
					DSP-6B	VW24852	765.56		
Dry Stack Tailings Storage Facility	DSP-7	6944990	385390	780.404	DSP-7-1	VW34657	771.404	2015-12-09	Bi-weekly
					DSP-7-2	VW34658	763.404	2015-12-09	Bi-weekly
					DSP-7-3	VW34659	756.404	2015-12-09	Bi-weekly
					DSP-7-4	VW34660	753.404	2015-12-09	Bi-weekly
					DSP-7-5	VW34661	751.404	2015-12-09	Bi-weekly
					DSP-7-6	VW34662	747.404	2015-12-09	Bi-weekly
Dry Stack Tailings Storage Facility	DSP-8	6945058	385872	755.548	DSP-8-1	VW34663	750.548	2015-12-10	Bi-weekly
					DSP-8-2	VW34664	745.548	2015-12-10	Bi-weekly
					DSP-8-3	VW34665	740.548	2015-12-10	Bi-weekly
					DSP-8-4	VW34666	735.458	2015-12-10	Bi-weekly
					DSP-8-5	VW34667	730.458	2015-12-10	Bi-weekly
					DSP-8-6	VW34668	720.458	2015-12-10	Bi-weekly

Dry Stack Tailings Storage Facility	DSP-10	6945223	385944	724.509	DSP-10	VW34617	717.209	2015-11-27	Weekly
Southwest Waste Dump	SDP-2	6944595.06	383971.30	843.41	SDP-2A	VW12912	843.414	2010-01-31	Monthly
					SDP-2B	VW12911	842.714		
Southwest Waste Dump	SDP-3	6944333.87	383824.67	854.27	SDP-3A	VW12906	854.266	2010-01-28	Monthly
					SDP-3B	VW12907	853.566		
Southwest Waste Dump	SDP-4	6944163.62	383783.54	858.49	SDP-4A	VW12908	858.494	2010-01-30	Monthly
					SDP-4B	VW12909	857.794		
Water Storage Pond	WDP-2	6945632	386545	701.67	WDP-2	VW7212	701.67	2007-11-04	Monthly
Water Storage Pond	WDP-3A	6945618	386498	712.62	WDP-3A	VW7557	712.62	2007-11-28	Monthly
Water Storage Pond	WDP-3	6945609	386500	712.60	WDP-3	VW7202	712.60	2007-11-12	Monthly
Water Storage Pond	WDP-4	6945609	386500	702.60	WD -4	VW7210	702.60	2007-11-14	Monthly
Water Storage Pond	WDP-5	6945605	386526	712.35	WDP-5	VW7204	712.35	2007-11-20	Monthly
Water Storage Pond	WDP-6	6945605	386526	701.50	WDP-6	VW7214	701.50	2007-11-20	Monthly
Water Storage Pond	WDP-7	6945605	386526	689.20	WDP-7	VW7208	689.20	2007-11-20	Monthly
Water Storage Pond	WDP-8	6945554	386542	693.10	WDP-8	VW7200	693.10	2007-11-18	Monthly
Water Storage Pond	WDP-9	6945554	386542	687.93	WDP-9	VW7206	687.93	2007-11-18	Monthly
Water Storage Pond	WDP-10	6945554	386542	676.17	WDP-10	VW7211	676.17	2007-11-18	Monthly
Water Storage Pond	WDP-11	6945523	386551	712.96	WDP-11	VW7201	712.96	2007-11-16	Monthly
Water Storage Pond	WDP-12	6945523	386551	694.64	WDP-12	VW7209	694.64	2007-11-16	Monthly
Water Storage Pond	WDP-13	6945533	386578	684.55	WDP-13	VW7205	684.55	2007-11-07	Monthly

7 Instrumentation Procedures and Documentation

Data collection manuals for all monitoring devices are included in Appendix B.

After collection, data is input into a series of spreadsheets and databases used for storing, tracking and interpreting instrumentation data. Instructions for data input are contained in the instrumentation manuals in Appendix B.

8 Quality Assurance/Quality Control

Planned job obsrevations (PJO's) are routinely performed and documented on Mine Technician Assistants to verify data collection is consistent with the designed procedures.

Data collection equipment is returned to the manufacturers as per their recommended calibration schedules, typically annually.

All data is reviewed and summarized by the Geotechnical Engineer/EIT monthly as part of the Water Licence reporting.

9 Reporting

Regular processing and review of monitoring data is completed and presented in the following documents.

Table 9: Reporting

Report	Frequency	Submission
Pit Wall Inspection Reports	Weekly	Submitted internally each week
Minto Mine Type A Water Licence QZ14-031 Monthly Report (Clause 4.4)	Monthly	Submitted to Yukon Water Board maximum 30 days following each month
DSTSF Inspection Reports	Monthly	Filed internally within one week of the inspection
Water Storage Pond Dam Inspection Reports	Monthly	Filed internally within one week of the inspection
Area 2 and Main Pit Tailings Storage Facility Inspection Reports	Quarterly	Filed internally within one month of the inspection
Semi-Annual Site-wide Geotechnical Inspection Report	After spring melt (May/June) and before freeze-up (September)	Submitted to Yukon Water Board within 60 days of inspection.
Minto Mine Type A Water Licence QZ14-031 Annual Report (Clause 4.5)	Annually	Submitted to Yukon Water Board by March 31 each year
Minto Mine Type B Water Licence MS15-094 Annual Inspection Report (Clause 34)	Annually	Submitted to Yukon Water Board with the Annual Report

Appendix A: Instrumentation Map

Appendix B: Data Collection and Input Manuals

Inclinometer Measurements

Please refer to RST MEMS Digital Inclinometer System Instruction Manual for complete instruction.

System Overview:

Figure 1 – System Overview

1. Soft Shell Case
2. Digital Inclinometer Probe (w/ protective end cap)
3. Reel Battery Charger
4. 70mm/2.75" OD Cable Grip
5. 85mm/3.34" OD Cable Grip
6. Ultra-Rugged Field PC
7. 12V DC car adapter for Reel Battery Charger or Ultra-Rugged Field PC
8. Spare Reel Battery
9. Silicone Lubricant (for use on connectors)
10. USB Cable for Ultra-Rugged Field PC
11. AC Adapter (110-240V) for Reel Battery Charger
12. AC Adapter (110-240V) for Ultra-Rugged Field PC
13. Cable Reel with Wireless Communication System and protective end cap
14. Reel Carrying Case

1. Make sure the battery for the reel and the Field PC are charged.
2. Lift up protective box with two hands and put it on side as a work bench.

3. Remove cap from inclinometer casing and look for A_0 marking (black mark).

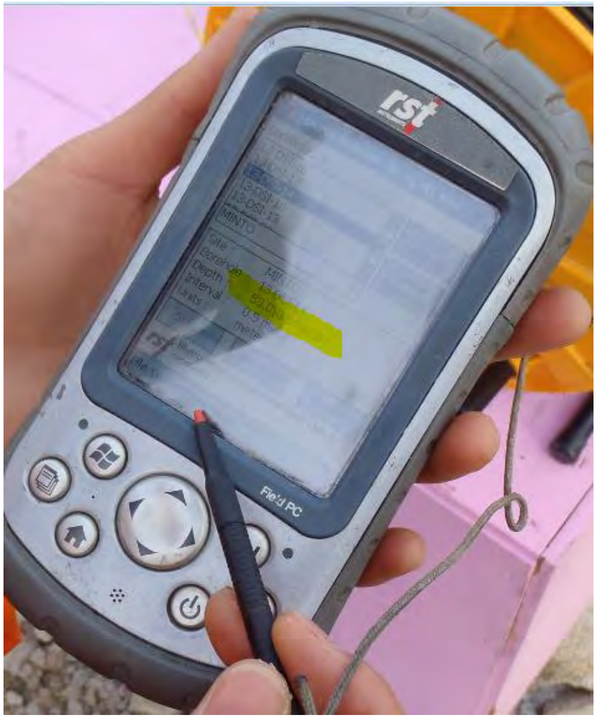
4. Remove excess water inside the probe and the cable connector.
   Probe is very sensitive and susceptible to vibration. **DO NOT BANG THE PROBE**. Use a paper towel to wipe it.

5. Apply silicon lubricant to probe and cable connector when needed.

6. Connect the inclinometer cable to the probe by aligning the keyways and threading the connector onto the probe. Turn the threaded ring, but not the cable.

7. Turn on the power of the reel. A green light indicates that the power is on. This energizes the accelerometers and makes them less susceptible to shock.

8. Check the depth of the hole. Turn on Field PC and select the hole you are going to measure.



9. Always start with **UPPER** Wheel in the A_0 direction.

10. Lower the probe gently and carefully. When it gets close to the bottom lower it very gently to avoid bouncing the probe off the bottom of the hole. The cable has aluminum sleeve marks which are spaced at 0.5m and it has a red measure mark with label every 5m.

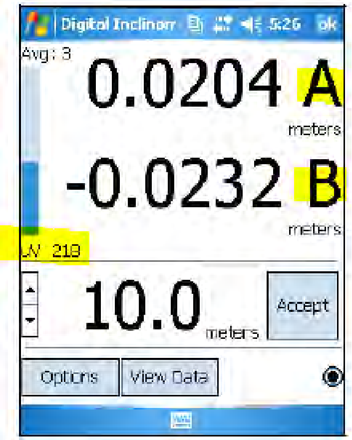
11. Lower the probe gently to ensure the bottom of the hole is encountered. (Slightly passed the designated depth). Double check your correct depth by pulling out reel to the next 5m mark and counting back each 0.5m for each increment.

12. Place the cable grip on top of the casing and hang the cable by the aluminum crimps.

13. Connect the Field PC to the reel. Use the pen attached to the field PC and press "*Connections*".

14. Once connected, hit "*Readings*".

15. At each depth allow the A and B readings as well as the noise level become stabilized before you accept the readings. Ideally noise level should be at or below 30 μV.



Avg: 3

0.0204 A meters

-0.0232 B meters

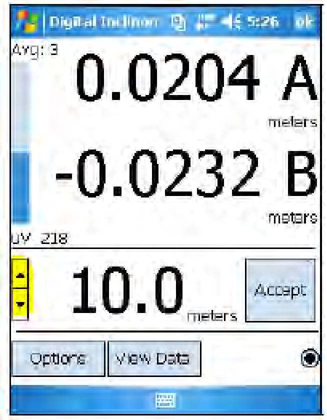
uV 218

10.0 meters

16. Wear gloves as the Envirobind inside the inclinometer casing can be sticky and irritable. Pull up gently to the next marker and let the aluminum crimp to sit on the metal grip. Wait for the readings and noise level to stabilize and then hit *"Accept"*.

17. If you accidentally pull the probe too far (more than an inch), lower the probe back down to the previous bead then pull up to the bead you want to measure. This will ensure that the readings remain consistent.

18. At each 5m mark, check that you are at the right location. If you miss or overpass a reading, go back to the previous 5m depth. For examples, if something goes wrong at 41.5m, go back to 45m and drop the cable to 45.5m. Then gently pull up to 45m and hit *"Accept"* again. There are arrow keys on the Field PC which allow you to adjust your depth.



Avg: 3

0.0204 A meters

-0.0232 B meters

uV 218

10.0 meters

19. Once the last reading (0.5m) is taken, gently take out the probe and turn it 180° so that the **Lower** wheel is now in the A_0 direction.

20. Go back gently to the bottom of hole and take the second set of readings.

21. During the measurement of the second set of readings, checksum data will appear in a smaller font below the current readings. Checksum should be reasonably small and consistent. Ideally it should be somewhere between -0.0035m to +0.0045m.

22. If the checksum is large (> 0.01m) and inconsistent, check the following:
    - Is the probe at the right depth?
    - Is the probe in the correct direction?
    - Lower the probe to the previous depth and retake the reading again.

    It is possible that checksum is high due to differential pressure in the ground. In that case continue measurement and keep monitoring checksum.

23. Once readings are completed, take out the probe and wipe away the Envirobind gently. Put the caps back onto the probe and connector.

Data Input

Note: Windows Mobile Device Center must be installed on the computer in order to collect the readout unit to the computer.

1. Connect the USB cable from the readout unit to the computer and turn the power on.
2. Open DMM for Windows

3. *File – Open – Project Database*
   The database for all inclinometer data is stored here:
   X:\Mine Technical\03 - Monitoring\! Inclinometers\Master Database

4. *File – Import – Import RPP file*
   Navigate to the mobile device and select the .rpp file for the appropriate monitoring station and date. The data will then import and save in the database automatically.

Thermistor Readings

Two different types of thermistors are currently installed on site – RST and EBA thermistors.

To read RST thermistors:

1. Connect adapter cord to the TH2016B Readout Box.
2. Record the resistivity (Ohms) for each thermistor node on paper or store the data in the readout box with the following steps:
    a. Scroll with the Up/Down arrows to the ***Memory*** screen and press enter (arrow key)

    b. Scroll with the Up/Down arrows to the ***Store Data*** screen and press enter

    c. Scroll with the Up/Down arrows to the station being monitored and press enter to store the reading

    d. The data is now stored and the readbox can be turned off by pressing the escape button (ESC) three times to get back to the main menu and scrolling to Power Off.

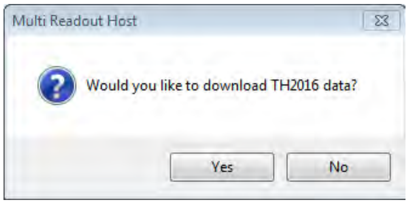
To read EBA thermistors:

1. Connect the EBA 16 Point Ground Temperature Dial into the thermistor cable.
2. Connect the multi-meter to the EBA 16 Point Ground Temperature Dial.
3. Record on paper the resistance in Ohm’s (Ω) for each point.

Data Downloading

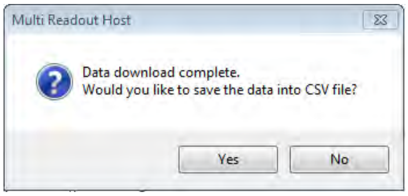
1. Connect USB cord from computer to the readout box.
2. Open the software Multi Readout Host.

3. Turn on the power on the readout box.
4. The software will recognize the readout unit and prompt to download data. Choose "Yes" to download the data from the readout unit.



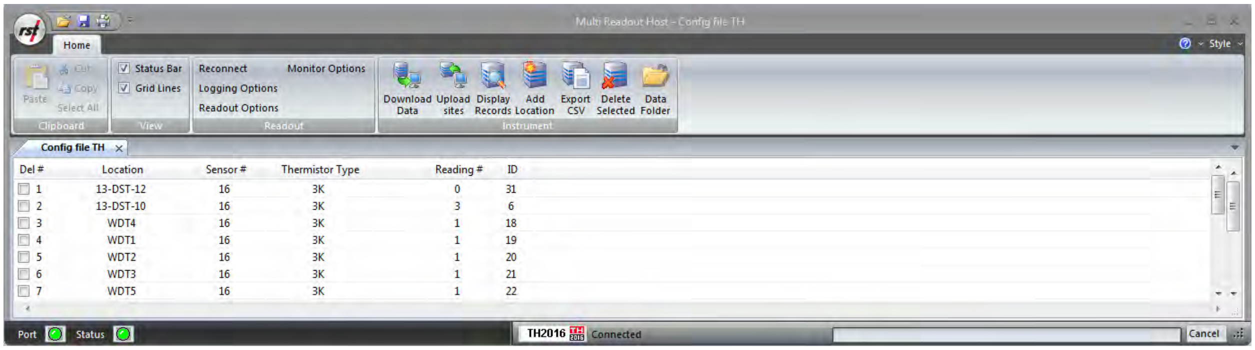
Would you like to download TH2016 data?

5. Once data is downloaded you will have the option to save all data as .csv file. Choose "Yes" and the data will be stored in My Documents in a folder named "TH2016data".



Data download complete.
Would you like to save the data into CSV file?

6. The software can be used to setup new locations or view data but no further steps are required.



Del #	Location	Sensor #	Thermistor Type	Reading #	ID
☐ 1	13-DST-12	16	3K	0	31
☐ 2	13-DST-10	16	3K	3	6
☐ 3	WDT4	16	3K	1	18
☐ 4	WDT1	16	3K	1	19
☐ 5	WDT2	16	3K	1	20
☐ 6	WDT3	16	3K	1	21
☐ 7	WDT5	16	3K	1	22

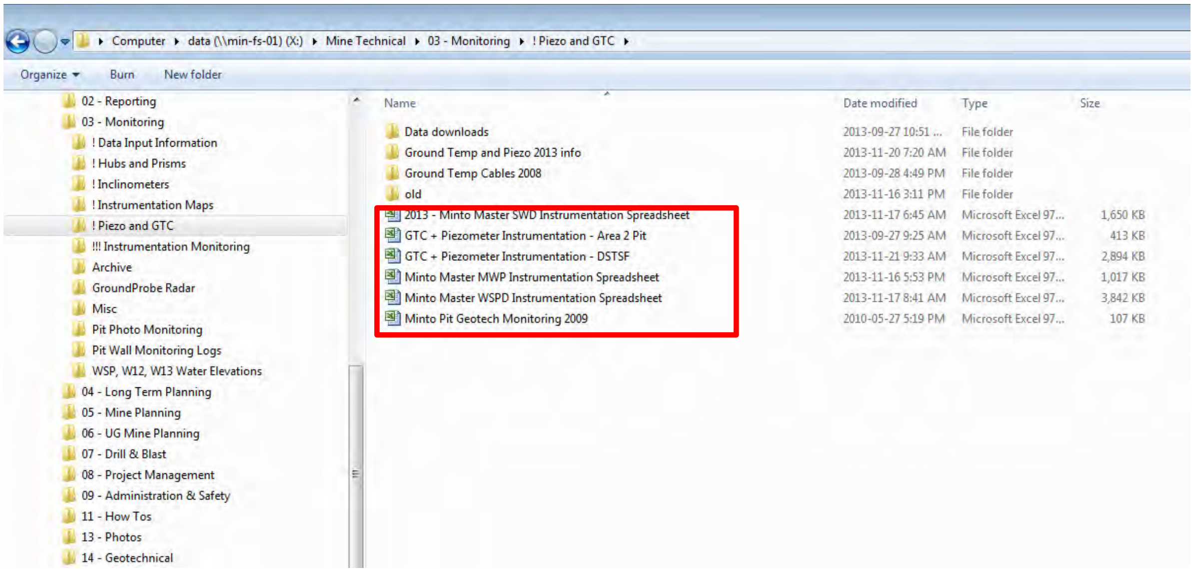
Connected

Data Input

Spreadsheets for piezometer data input and tracking are stored here:

X:\Mine Technical\03 - Monitoring\! Piezo and GTC

1. Open the spreadsheet for the area monitored

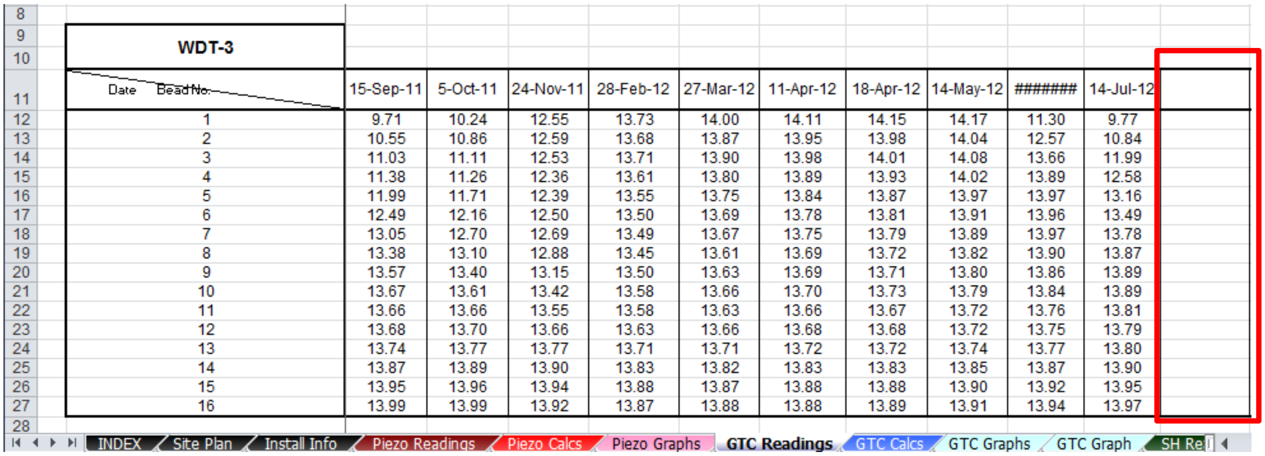


- 02 - Reporting
- 03 - Monitoring
  - ! Data Input Information
  - ! Hubs and Prisms
  - ! Inclinometers
  - ! Instrumentation Maps
  - ! Piezo and GTC
  - !!! Instrumentation Monitoring
  - Archive
  - GroundProbe Radar
  - Misc
  - Pit Photo Monitoring
  - Pit Wall Monitoring Logs
  - WSP, W12, W13 Water Elevations
- 04 - Long Term Planning
- 05 - Mine Planning
- 06 - UG Mine Planning
- 07 - Drill & Blast
- 08 - Project Management
- 09 - Administration & Safety
- 11 - How Tos
- 13 - Photos
- 14 - Geotechnical

Name	Date modified	Type	Size
Data downloads	2013-09-27 10:51 ...	File folder	
Ground Temp and Piezo 2013 info	2013-11-20 7:20 AM	File folder	
Ground Temp Cables 2008	2013-09-28 4:49 PM	File folder	
old	2013-11-16 3:11 PM	File folder	
2013 - Minto Master SWD Instrumentation Spreadsheet	2013-11-17 6:45 AM	Microsoft Excel 97...	1,650 KB
GTC + Piezometer Instrumentation - Area 2 Pit	2013-09-27 9:25 AM	Microsoft Excel 97...	413 KB
GTC + Piezometer Instrumentation - DSTSF	2013-11-21 9:33 AM	Microsoft Excel 97...	2,894 KB
Minto Master MWP Instrumentation Spreadsheet	2013-11-16 5:53 PM	Microsoft Excel 97...	1,017 KB
Minto Master WSPD Instrumentation Spreadsheet	2013-11-17 8:41 AM	Microsoft Excel 97...	3,842 KB
Minto Pit Geotech Monitoring 2009	2010-05-27 5:19 PM	Microsoft Excel 97...	107 KB

2. Open the tab “GTC Readings”

3. In a new column enter the date and copy the resistivity data (Ohms) from the paper records, or from the .csv file saved in either “TH2016data” or “VW2016data” saved in My Documents.



WDT-3

Date / Bead No.	15-Sep-11	5-Oct-11	24-Nov-11	28-Feb-12	27-Mar-12	11-Apr-12	18-Apr-12	14-May-12	#######	14-Jul-12	
1	9.71	10.24	12.55	13.73	14.00	14.11	14.15	14.17	11.30	9.77	
2	10.55	10.86	12.59	13.68	13.87	13.95	13.98	14.04	12.57	10.84	
3	11.03	11.11	12.53	13.71	13.90	13.98	14.01	14.08	13.66	11.99	
4	11.38	11.26	12.36	13.61	13.80	13.89	13.93	14.02	13.89	12.58	
5	11.99	11.71	12.39	13.55	13.75	13.84	13.87	13.97	13.97	13.16	
6	12.49	12.16	12.50	13.50	13.69	13.78	13.81	13.91	13.96	13.49	
7	13.05	12.70	12.69	13.49	13.67	13.75	13.79	13.89	13.97	13.78	
8	13.38	13.10	12.88	13.45	13.61	13.69	13.72	13.82	13.90	13.87	
9	13.57	13.40	13.15	13.50	13.63	13.69	13.71	13.80	13.86	13.89	
10	13.67	13.61	13.42	13.58	13.66	13.70	13.73	13.79	13.84	13.89	
11	13.66	13.66	13.55	13.58	13.63	13.66	13.67	13.72	13.76	13.81	
12	13.68	13.70	13.66	13.63	13.66	13.68	13.68	13.72	13.75	13.79	
13	13.74	13.77	13.77	13.71	13.71	13.72	13.72	13.74	13.77	13.80	
14	13.87	13.89	13.90	13.83	13.82	13.83	13.83	13.85	13.87	13.90	
15	13.95	13.96	13.94	13.88	13.87	13.88	13.88	13.90	13.92	13.95	
16	13.99	13.99	13.92	13.87	13.88	13.88	13.89	13.91	13.94	13.97	

Vibrating Wire Piezometer Readings

1. Connect adapter cord to the VW2106 Readout Box.
2. Connect the coloured wires to the correct wire clips on the extension cable. Make sure the wires do not touch each other.
3. Record the **DATE** and **TIME** as barometric pressure will be needed to calibrate the water level.
4. Record the measurement (between 7000B to 9000B) and the temperature (°C) for each piezometer. The piezometer ID should be labeled on the wire (eg. P5a and P5b).

5. Alternatively the data can be stored in the readout box:

   a. Scroll with the Up/Down arrows to the ***Memory*** screen and press enter (arrow key)

   b. Scroll with the Up/Down arrows to the ***Store Data*** screen and press enter

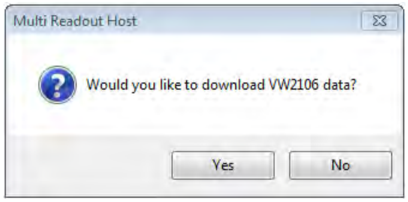
c. Scroll with the Up/Down arrows to the station being monitored and press enter to store the reading

d. The data is now stored and the readout box can be turned off by pressing the escape button (ESC) three times to get back to the main menu and scrolling to Power Off.

Data Downloading

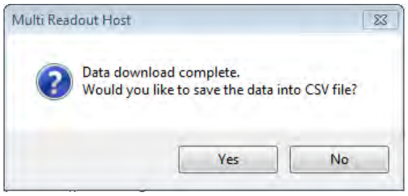
7. Connect USB cord from computer to the readout box.
8. Open the software Multi Readout Host.

9. Turn on the power on the readout box.
10. The software will recognize the readout unit and prompt to download data. Choose "Yes" to download the data from the readout unit.



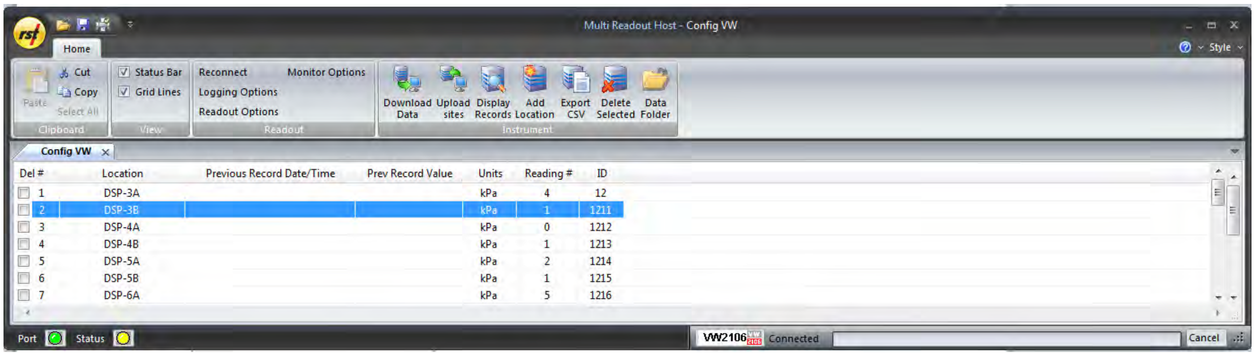
Would you like to download VW2106 data?

11. Once data is downloaded you will have the option to save all data as .csv file. Choose "Yes" and the data will be stored in My Documents in a folder named "VW2016data".



Data download complete.
Would you like to save the data into CSV file?

12. The software can be used to setup new locations or view data but no further steps are required.



☑ Status Bar
☑ Grid Lines

Del #		Location	Previous Record Date/Time	Prev Record Value	Units	Reading #	ID
☐	1	DSP-3A			kPa	4	12
☐	2	DSP-3B			kPa	1	1211
☐	3	DSP-4A			kPa	0	1212
☐	4	DSP-4B			kPa	1	1213
☐	5	DSP-5A			kPa	2	1214
☐	6	DSP-5B			kPa	1	1215
☐	7	DSP-6A			kPa	5	1216

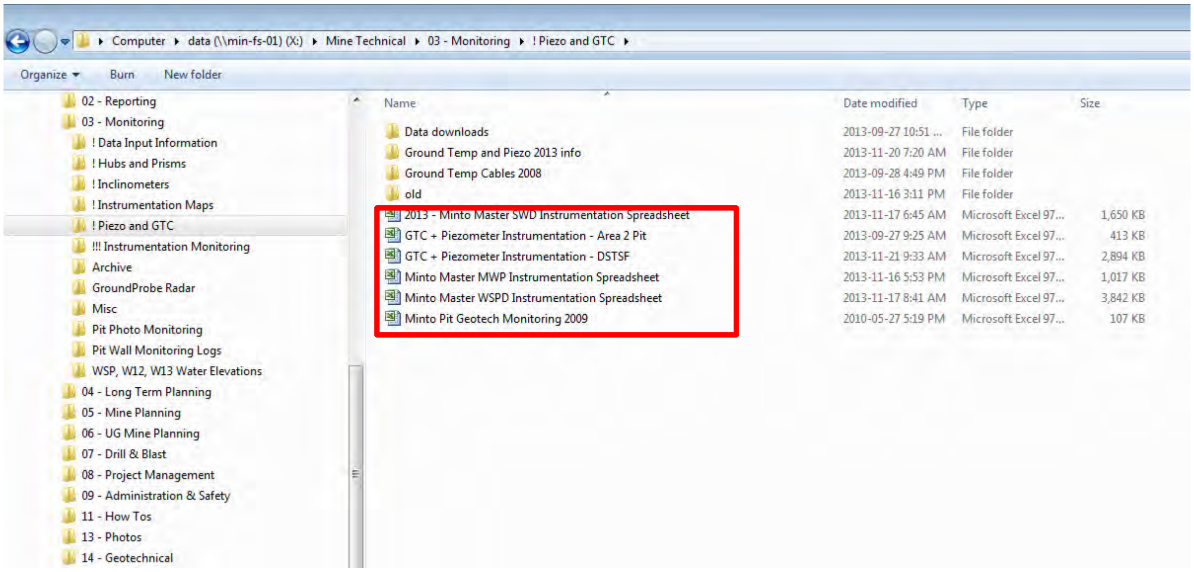
Connected

Data Input

Spreadsheets for piezometer data input and tracking are stored here:

<u>X:\Mine Technical\03 - Monitoring\! Piezo and GTC</u>

4. Open the spreadsheet for the area monitored

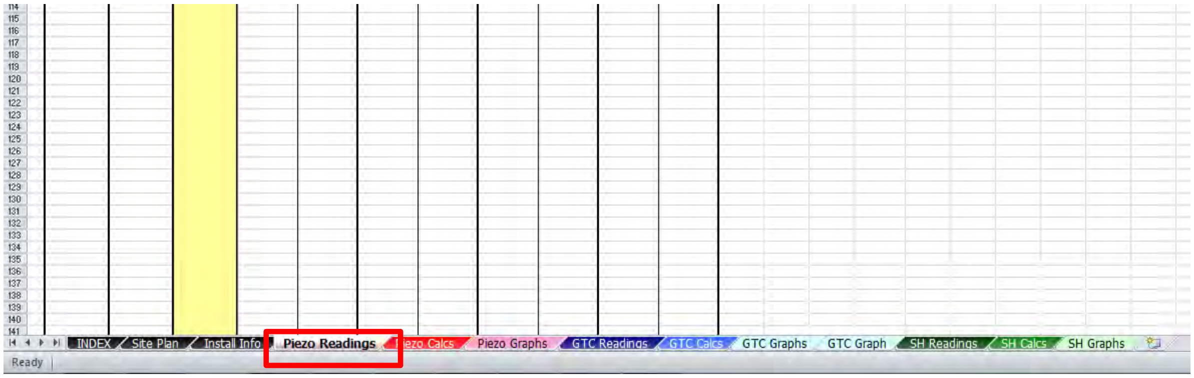


Computer ▸ data (\\min-fs-01) (X:) ▸ Mine Technical ▸ 03 - Monitoring ▸ ! Piezo and GTC ▸

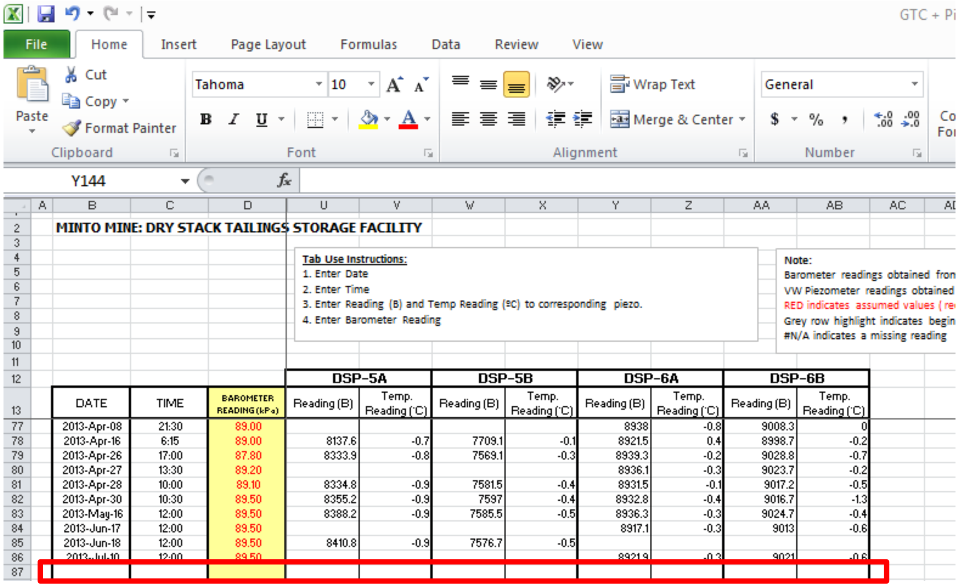
- 02 - Reporting
- 03 - Monitoring
  - ! Data Input Information
  - ! Hubs and Prisms
  - ! Inclinometers
  - ! Instrumentation Maps
  - ! Piezo and GTC
  - !!! Instrumentation Monitoring
  - Archive
  - GroundProbe Radar
  - Misc
  - Pit Photo Monitoring
  - Pit Wall Monitoring Logs
  - WSP, W12, W13 Water Elevations
- 04 - Long Term Planning
- 05 - Mine Planning
- 06 - UG Mine Planning
- 07 - Drill & Blast
- 08 - Project Management
- 09 - Administration & Safety
- 11 - How Tos
- 13 - Photos
- 14 - Geotechnical

Name	Date modified	Type	Size
Data downloads	2013-09-27 10:51 ...	File folder	
Ground Temp and Piezo 2013 info	2013-11-20 7:20 AM	File folder	
Ground Temp Cables 2008	2013-09-28 4:49 PM	File folder	
old	2013-11-16 3:11 PM	File folder	
2013 - Minto Master SWD Instrumentation Spreadsheet	2013-11-17 6:45 AM	Microsoft Excel 97...	1,650 KB
GTC + Piezometer Instrumentation - Area 2 Pit	2013-09-27 9:25 AM	Microsoft Excel 97...	413 KB
GTC + Piezometer Instrumentation - DSTSF	2013-11-21 9:33 AM	Microsoft Excel 97...	2,894 KB
Minto Master MWP Instrumentation Spreadsheet	2013-11-16 5:53 PM	Microsoft Excel 97...	1,017 KB
Minto Master WSPD Instrumentation Spreadsheet	2013-11-17 8:41 AM	Microsoft Excel 97...	3,842 KB
Minto Pit Geotech Monitoring 2009	2010-05-27 5:19 PM	Microsoft Excel 97...	107 KB

5. Open the tab "Piezo Readings"



6. In a new row, input the date, time, barometric pressure, B-unit and temperature readings for each instrument.



MINTO MINE: DRY STACK TAILINGS STORAGE FACILITY

Tab Use Instructions:
1. Enter Date
2. Enter Time
3. Enter Reading (B) and Temp Reading (ºC) to corresponding piezo.
4. Enter Barometer Reading

Note:
Barometer readings obtained fron
VW Piezometer readings obtained
RED indicates assumed values (re
Grey row highlight indicates begin
#N/A indicates a missing reading

DATE	TIME	BAROMETER READING (kPa)	DSP-5A Reading (B)	DSP-5A Temp. Reading (˚C)	DSP-5B Reading (B)	DSP-5B Temp. Reading (˚C)	DSP-6A Reading (B)	DSP-6A Temp. Reading (˚C)	DSP-6B Reading (B)	DSP-6B Temp. Reading (˚C)
2013-Apr-08	21:30	89.00					8938	-0.8	9008.3	0
2013-Apr-16	6:15	89.00	8137.6	-0.7	7709.1	-0.1	8921.5	0.4	8998.7	-0.2
2013-Apr-26	17:00	87.80	8333.9	-0.8	7569.1	-0.3	8939.3	-0.2	9028.8	-0.7
2013-Apr-27	13:30	89.20					8936.1	-0.3	9023.7	-0.2
2013-Apr-28	10:00	89.10	8334.8	-0.9	7581.5	-0.4	8931.5	-0.1	9017.2	-0.5
2013-Apr-30	10:30	89.50	8355.2	-0.9	7597	-0.4	8932.8	-0.4	9016.7	-1.3
2013-May-16	12:00	89.50	8388.2	-0.9	7585.5	-0.5	8936.3	-0.3	9024.7	-0.4
2013-Jun-17	12:00	89.50					8917.1	-0.3	9013	-0.6
2013-Jun-18	12:00	89.50	8410.8	-0.9	7576.7	-0.5				
2013-Jul-10	12:00	89.50					8921.9	-0.3	9021	-0.6

Barometric pressure can be obtained from the site's weather monitoring stations. Data is stored here:

X:\Environmental\Environmental Monitoring Program\1_MASTER LOGS\Meteorology Station Data\Met Station 1 and 2 Data Summary.xlsx

Appendix H – 2017 AMP Groundwater SRK Memo

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street
Vancouver, BC V6E 3X2

T: +1.604.681.4196
F: +1.604.687.5532
vancouver@srk.com
www.srk.com

Memo

To:	Ryan Herbert, Minto Explorations Ltd.	**Client:**	Minto Explorations Ltd.
From:	Dan Mackie, PGeo Ryan Burgess, MSc	**Project No:**	1CM002.057
Cc:		**Date:**	January 31, 2018
Subject:	Minto Mine – Summary of 2017 Groundwater OAMP SPT Exceedances		

1 Purpose

Groundwater monitoring at the Minto Mine, Yukon, is conducted and reviewed through the Minto Mine Groundwater Monitoring Plan (Minto, 2016) and the Operational Adaptive Management Plan (OAMP; Minto, 2017). The purpose of this memo is to summarize groundwater quality (and locations) at Minto that have exceeded a specific performance threshold (SPT) of the OAMP in 2017.

2 Background

The groundwater monitoring network at Minto includes 10 active multi-level monitoring wells that have been installed between 2009 and 2017. The monitoring wells are located across the site, both outside of the current mining footprint and topographically (and hydraulically) down gradient of mining activities. Monitoring locations are shown on Figure 1. All of these monitoring wells were installed after the start of mining (except MW09-03, which was installed after the main Minto operations began, but before mining at the adjacent Minto North Pit started). Details of groundwater monitoring locations can be found in SRK (2018).

Groundwater monitoring is conducted as required by the Groundwater Monitoring Plan. Review of groundwater monitoring results is carried out as part of the OAMP. In the OAMP, performance thresholds have been defined to establish changes in concentration and concentration values for specific constituents of concern (CoCs) at which actions may need to be taken by Minto to avoid potential impacts to the environment. Specifically, the OAMP states:

> *Specific Performance Thresholds (SPTs) are defined for each of the Effluent Quality Standards (EQS) parameters identified in Clause 9 (a), Table 1 of Water Use Licence QZ14-031, with the exception of pH, oil and grease, iron and nitrite.*

There are three SPT levels for groundwater quality defined in the OAMP for the Minto Creek Catchment, and two for the McGinty Creek Catchment. Of the 10 multi-port monitoring wells active in the monitoring network, only three are compared to the SPT in the AMP. They are MW12-05 and MW12-06 (Minto Creek Catchment), and MW09-03 (McGinty Creek Catchment). All three of these monitoring wells are located hydraulically or topographically down gradient of certain mine components:

- MW09-03 – topographically down gradient of the Minto North Pit in the McGinty Creek catchment;
- MW12-06 – hydraulically and/or topographically down gradient of the Main and Area 2 open pits, DSTSF and MVFE, in the Minto Creek catchment;
- MW12-05 – hydraulically and topographically down gradient of all mine activities in the Minto Creek catchment.

Attachment 1 provides table of SPT threshold concentrations. SPTs for each catchment are summarized below:

Minto Creek Catchment

1. SPT-1 corresponds to a trend-based assessment designed to flag potential rapidly-increasing groundwater concentrations that have not yet exceeded concentration-based thresholds.
2. SPT-2 generally corresponds to the EQS concentrations defined in the OAMP (with four exceptions: Cr-D, Cu-D, Ni-D and sulphate).
3. SPT-3 generally corresponds to the estimated concentrations in groundwater that would be necessary to cause exceedance of the Water Quality Objectives in lower Minto Creek under long term steady state conditions.

McGinty Creek Catchment

1. SPT-1 is triggered when there are three consecutive exceedances of the 75th percentile background level in a single monitoring port.
2. SPT-2 is triggered when there are three consecutive exceedances of the 95th percentile background level in a single monitoring port.

Groundwater monitoring results are reviewed monthly and, if a SPT is reached or exceeded, data are reviewed, interpretations are made, the risk narrative is assessed (in terms of the receiving environment), and management actions are defined. If an OAMP SPT has not been reached for any parameter at any location, no further action is taken on the assumption that there has been no change of significance from defined baseline conditions. Monthly OAMP reports are provided to the Yukon Government as per the OAMP.

3 Groundwater AMP SPT Events

Table 1 and Table 2 summarize groundwater locations and parameters for which OAMP SPTs have been reached for the 2017 monitoring year. CoCs at any groundwater monitoring location that are not identified in this table are assumed to not have changed by a significant amount relative to established baseline conditions. Baseline groundwater conditions are defined in the OAMP based on data from MW09-03 prior to 2015 (start of Minto North mining).

Groundwater monitoring data for all CoCs are included in Attachment 2.

Table 1 Minto Creek Catchment threshold exceedances

Monitoring Well Zone	Parameter	SPT	Context
MW12-05-01	SO_4	2	4 out of 4 samples exceeded threshold concentration
MW12-05-02		2	4 out of 4 samples exceeded threshold concentration
MW12-05-03		1	Increase in concentration has stabilized
MW12-06-01	Se	1	Isolated variation in data resulted in exceedance; see Attachment 2
	As	1	Isolated variation in data resulted in exceedance; see Attachment 2
	Cr	3	3 out of 3 samples exceeded threshold concentration

Table 2 McGinty Creek Catchment threshold exceedances

Monitoring Well Zone	Parameter	SPT	Context
MW09-03-01	As	1	9 out of 9 samples exceeded threshold concentration
		2	4 out of 9 samples exceeded threshold concentration
	Zn	1	5 out of 9 samples exceeded threshold concentration
		2	3 out of 9 samples exceeded threshold concentration
	Mo	1	2 out of 9 samples exceeded threshold concentration
	Se	1	3 out of 9 samples exceeded threshold concentration
MW09-03-02	SO_4	1	6 out of 9 samples exceeded threshold concentration but concentration is < 5 mg/L
	NO_3	2	9 out of 9 samples exceeded threshold concentration
	Cd	1	5 out of 9 samples exceeded threshold concentration
	Zn	1	8 out of 9 samples exceeded threshold concentration
	Zn	2	7 out of 9 samples exceeded threshold concentration

4 Discussion

Monitoring results for CoCs are routinely reviewed to provide context on potential impacts of mining activities to groundwater. Groundwater SPT exceedances (events) have occurred for a limited number of parameters and do not necessarily correlate with distance from mining activities (i.e., events have not necessarily all occurred at monitoring wells in relatively close proximity to mining activities). Some of these events may reflect elevated background concentrations that were not identified prior to start of mining because monitoring wells were not in place at that time.

Ongoing events are addressed specifically as follows:

- Sulphate SPT events in MW12-05 have been restricted to the deeper zones (MW12-05-01, MW12-05-02, and MW12-05-03) which monitor depths greater than 85 meters below ground surface (m bgs). Recently, the MW12-05-03 sulphate trend appears to have stabilised at a concentration below that of Minto Creek catchment SPT-2. The sulphate trend at MW12-05-01 continues to increase, but at a slower rate than previously. This may suggest that Zone 1 may be approaching equilibrium with groundwater. Zones shallower than Zone 3 all record stable and far lower sulphate concentrations (<100 mg/L). Surface water stations in the Minto Creek catchment downstream of the mine footprint (e.g. MC1) display stable trends in sulphate at similar concentrations to those observed in the shallow zones at MW12-05 (SRK, 2018).
- Nitrate at MW09-03-02 has increased recently, and has exceeded the McGinty Creek SPT-2. The nitrate concentration of the deeper zone, MW09-03-01, remains stable and below both SPTs. Presently, the Minto North Pit acts as a hydraulic sink, capturing (locally) groundwater topographically downgradient (including MW09-03). Therefore, migration of pit water is not the cause of the nitrate increase observed at MW09-03-02. The likely explanation for the observed water quality at MW09-03 is flushing of blasting residuals from the rock used to construct the mine haul road on the topographically downgradient side of the Minto North Pit, and immediately adjacent to the monitoring well. This effect is expected to be relatively short-lived, as blasting residuals will flush out over time. Data from the nearest McGinty Creek surface water monitoring station (MN-1.5) indicate nitrate concentrations remain within the range observed during baseline monitoring (SRK, 2018).
- As with nitrate, since the Minto North Pit is acting as a hydraulic sink, the other SPT events at MW09-03 (As, Cd, Se, Mo, sulphate, and Zn) are also likely to be caused by flushing of the rock used to construct the mine haul road. The concentration of these parameters at MN-1.5 are within pre-mining conditions, indicating no identifiable impact from SPT events.
- Events occurring at MW12-06-01 (As, Se and Cr) are likely caused by parameter concentrations that are reflective of background concentrations. MW12-06-01 was not sampled prior to October 2016, and only sampled four times in total since. In addition, the data are rather scattered (As and Se) or display a possible decreasing trend (Cr). Further regular sampling, as per the OAMP, will provide further information to assess changes over time.

5 Conclusions

Groundwater exceedances of the OAMP SPTs in 2017 have been limited. SPT exceedance is not widespread; most wells (~70%) did not exceed OAMP SPTs in 2017.

Where regular exceedances have been identified (As and Zn at MW09-03-01; Cd, Zn, nitrate, and sulphate at MW09-03-02; sulphate at MW12-05-01; Cr at MW12-06-01), the likely cause is either a lack of characterization or the range of pre-mining groundwater concentrations (MW12-05-01 and MW12-06-01), or local, temporary mine-related sources of CoCs (i.e., apparent influence of the haul road rock on groundwater in the MW09-03 zones).

Overall, the groundwater CoC exceedances of the OAMP SPTs have not required mitigation. Groundwater monitoring should continue as per the Minto Mine Groundwater Monitoring Plan, and results should continue to be evaluated against the Operational Adaptive Management Plan SPTs and compared with other studies assessing natural background conditions.

Regards,
SRK Consulting (Canada) Inc.

Ryan Burgess, MSc.
Consultant

Dan Mackie, PGeo
Principal Consultant

Disclaimer—SRK Consulting (Canada) Inc. has prepared this document for Minto Explorations Ltd.. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this report by a third party.

The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. Whilst SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

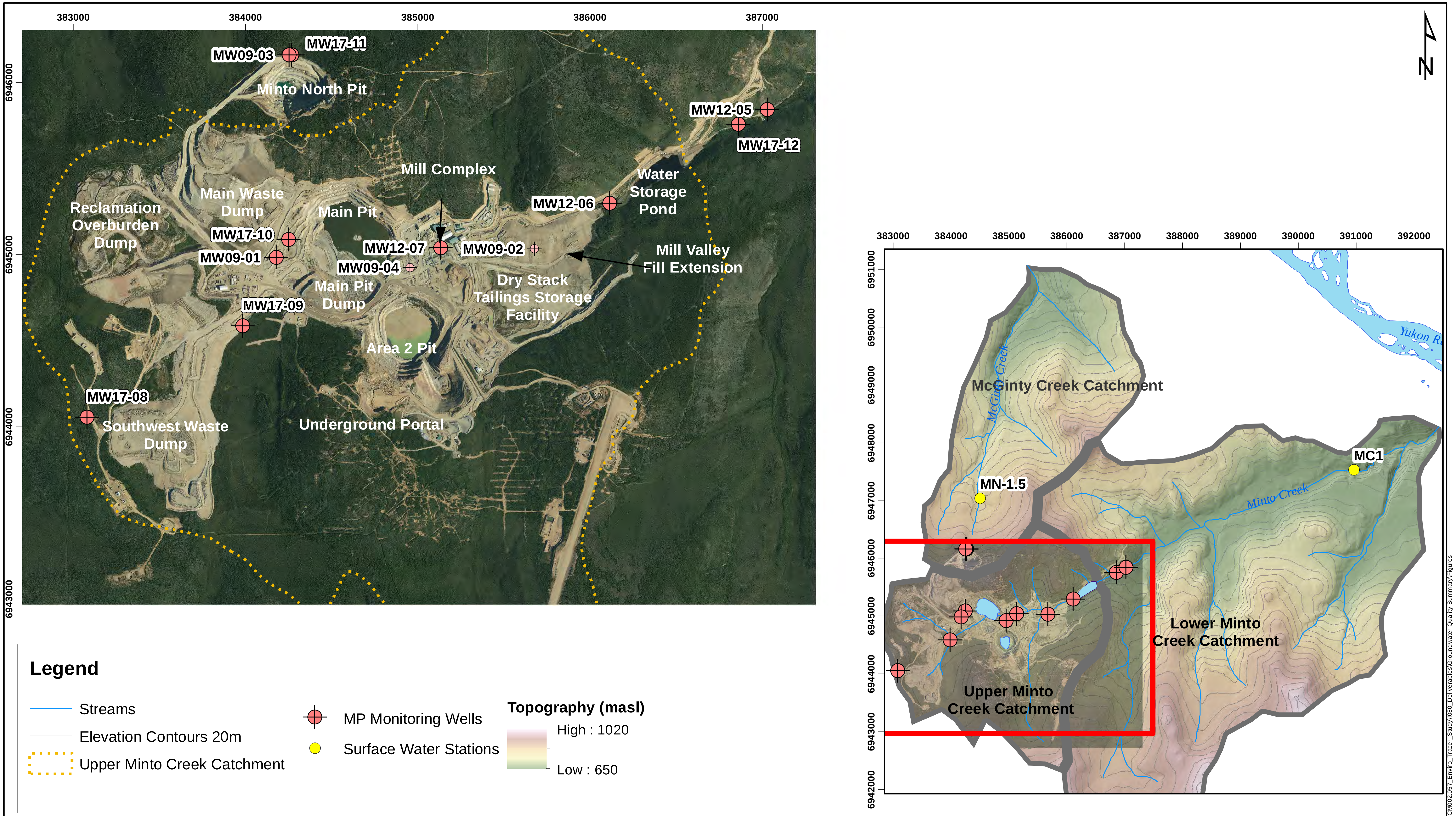
6 References

Minto Explorations Ltd., 2016. Minto Mine Groundwater Monitoring Plan, Version 2016-01. Report prepared by Minto Explorations Limited, with contributions form SRK Consulting. July 2016.

Minto Explorations Ltd., 2017. Minto Mine Operations Adaptive Management Plan 2017-02. April 2017.

SRK Consulting (Canada) Inc., 2018. Minto Groundwater Characterization and Hydrogeologic Conceptual Model Update Report. Report submitted to Minto Explorations Ltd. SRK project number 1CM002.057. January 2018. 35 pages.

Figures



Notes:
1. Data presented in NAD 1983 UTM Zone 8N.
2. Topography provided by Minto Mine, 2017.
3. Base orthophoto provided by Minto Mine, 2017.

1,600 800 0 1,600 Meters
1:13,000

srk consulting

capstone
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Summary of 2017 Groundwater OAMP SPT Exceedances

Groundwater Monitoring Stations

Job No: 1CM002.057
Filename: Monitoring_Sites_rev01_rob.mxd

MINTO MINE

Date: January 2018
Approved: ROB
Figure: 1

\\van-svr0\Projects\01_SITES\Minto\1CM002.057_Enviro_Tracer_Study\!080_Deliverables\Groundwater Quality Summary\Figures

Attachment 1: SPT Threshold Concentrations

Appendix A

Minto Creek SPTs

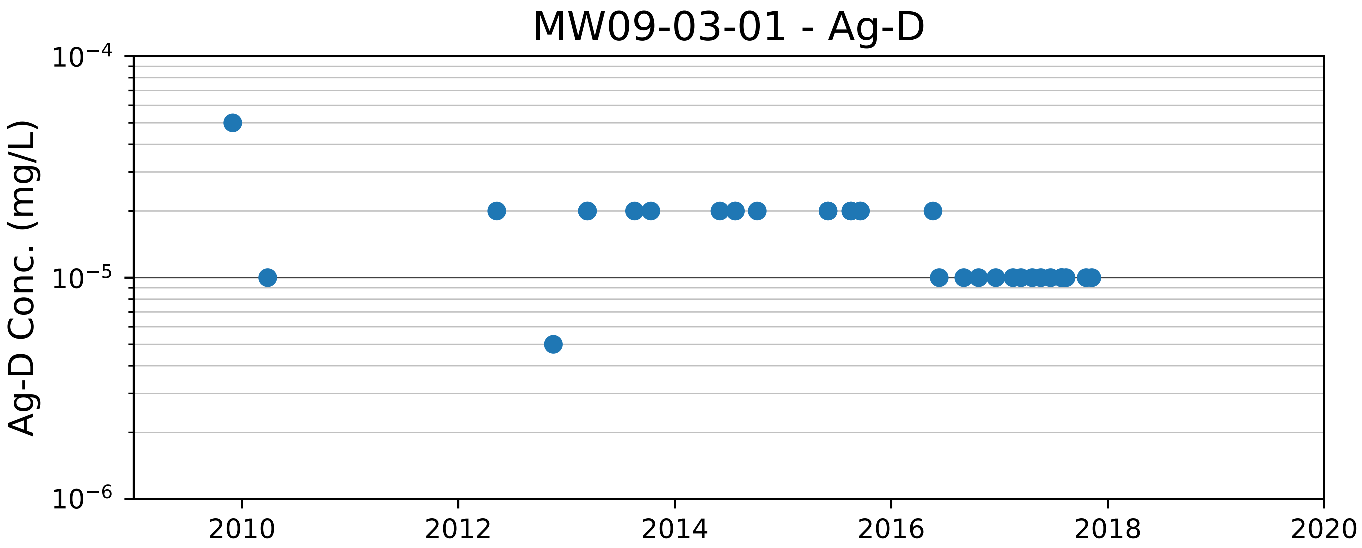
	Ag-D	Al-D	As-D	Cd-D	Cr-D	Cu-D	Pb-D	Mo-D	Ni-D	Se-D	Zn-D	N-NO3	Ammonia	Sulphate
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
SPT-2	0.00030	0.30	0.015	0.003	0.0015	0.030	0.012	0.22	0.165	0.0060	0.090	27	0.75	1000
SPT-3	0.00046	0.48	0.025	0.006	0.0030	0.060	0.020	0.34	0.34	0.0093	0.13	45	1.0	4951

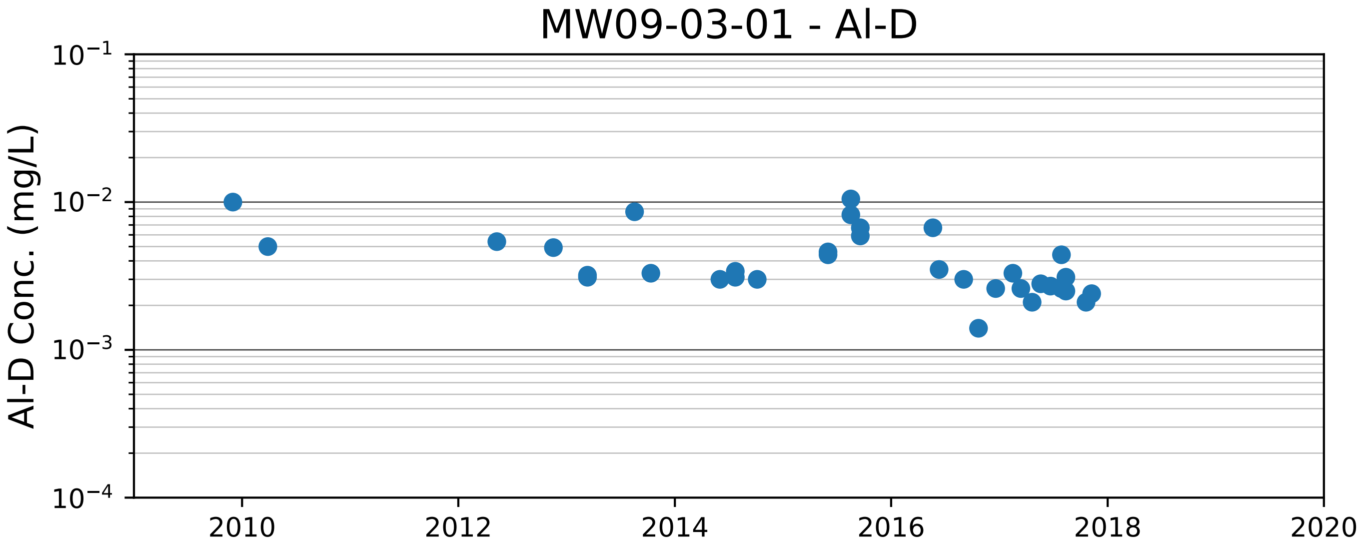
McGinty Creek SPTs

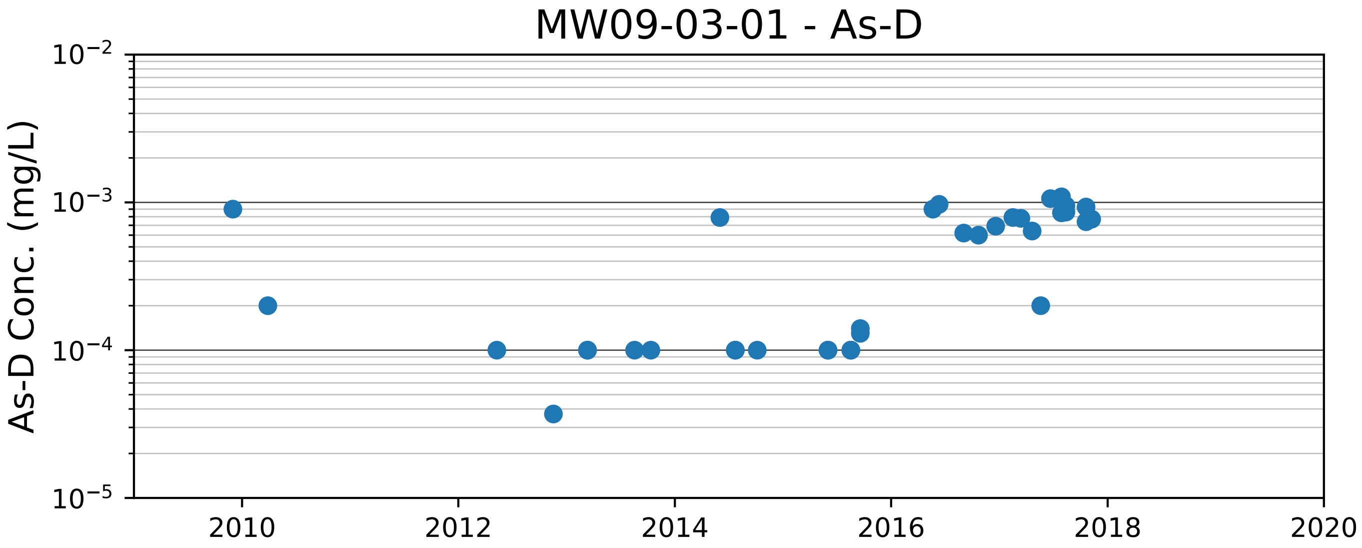
		Ag-D	Al-D	As-D	Cd-D	Cr-D	Cu-D	Pb-D	Mo-D	Ni-D	Se-D	Zn-D	N-NO3	Ammonia	Sulphate
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
MW09-03-01	SPT-1	0.000010	0.0065	0.00011	0.000075	0.000500	0.00155	0.0001	0.005	0.0021	0.0001	0.013	0.13	0.067	24
	SPT-2	0.000016	0.0101	0.00081	0.000272	0.000575	0.00625	0.0003	0.026	0.0060	0.0015	0.022	0.28	0.133	38
MW09-03-02	SPT-1	0.000018	0.0073	0.00074	0.000031	0.000500	0.00263	0.0001	0.018	0.0009	0.0005	0.010	0.03	0.230	7
	SPT-2	0.000034	0.0095	0.00092	0.000272	0.000796	0.01080	0.0002	0.062	0.0026	0.0040	0.015	0.07	0.282	67
MW09-03-03	SPT-1	0.000010	0.0047	0.00005	0.000023	0.000500	0.00247	0.0001	0.006	0.0005	0.0004	0.008	0.50	0.020	12
	SPT-2	0.000010	0.0075	0.00014	0.000069	0.000500	0.00500	0.0003	0.018	0.0011	0.0004	0.011	0.54	0.058	13

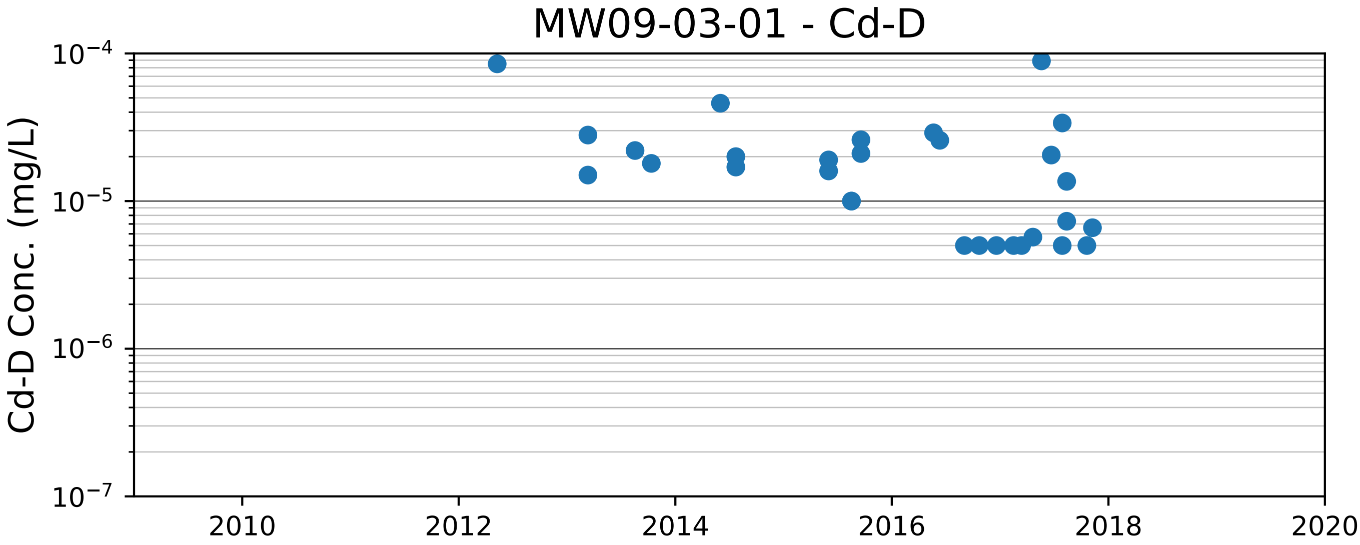
Source: Minto 2017-02 OAMP, pages 21 and 25 (Minto, 2017)

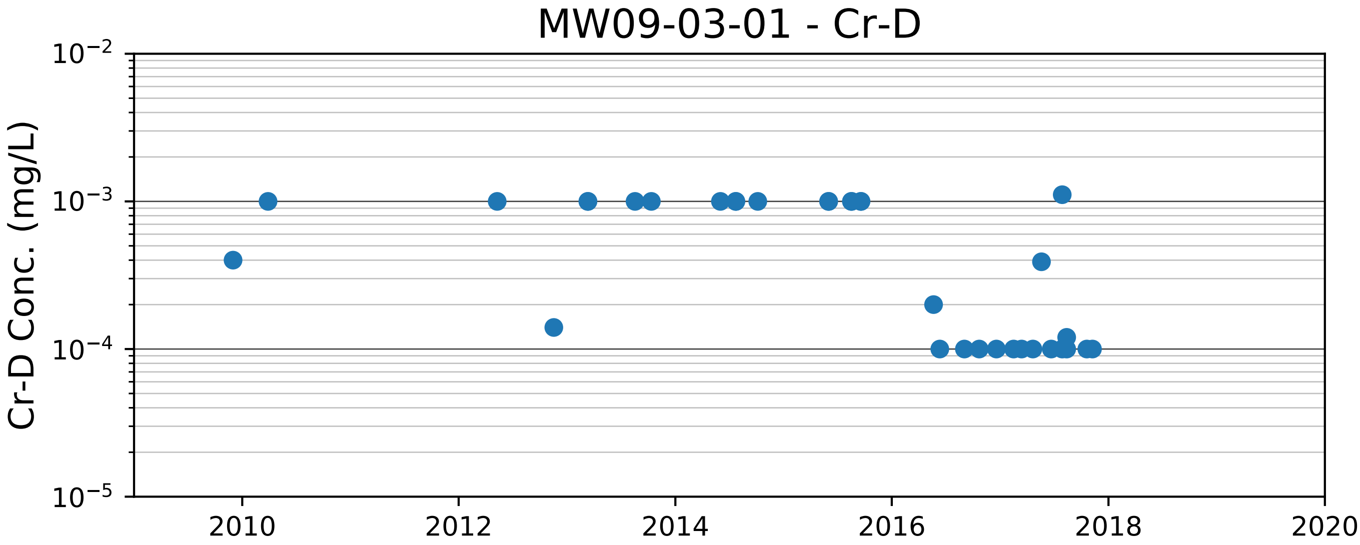
Attachment 2: Groundwater Monitoring Data for All CoCs

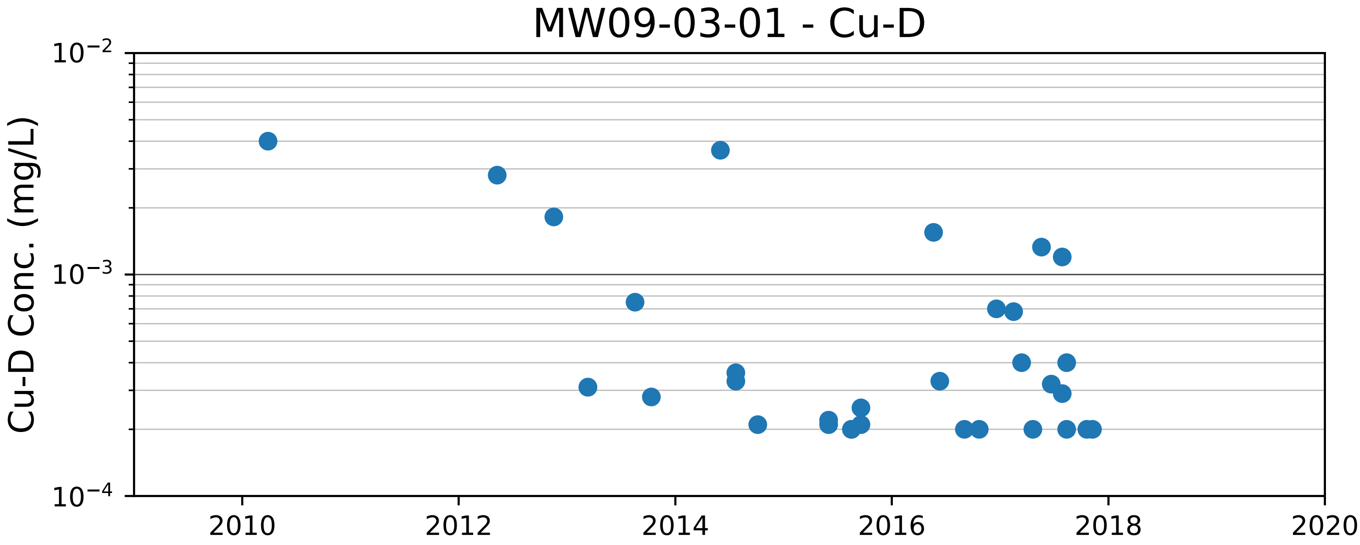

MW09-03-01 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

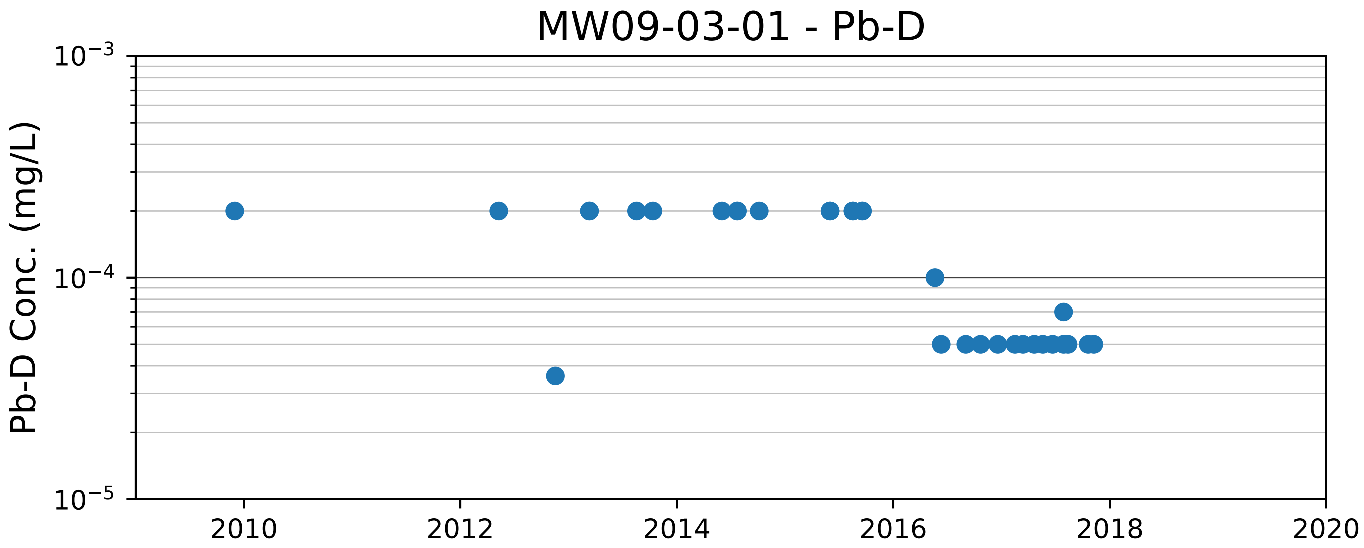

MW09-03-01 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

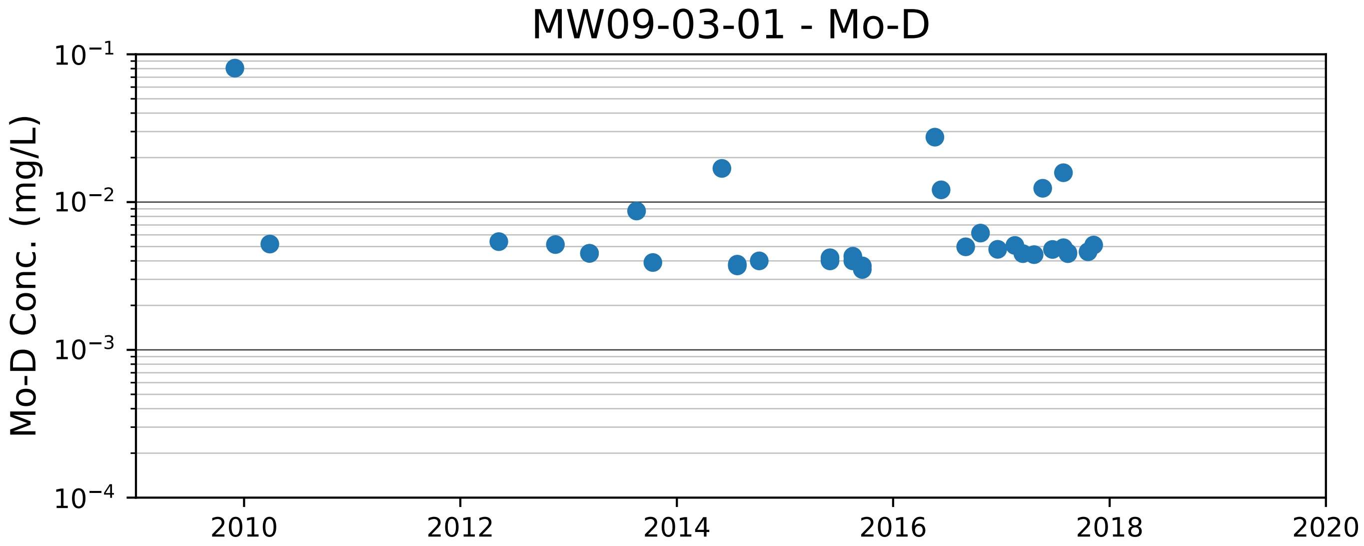

MW09-03-01 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

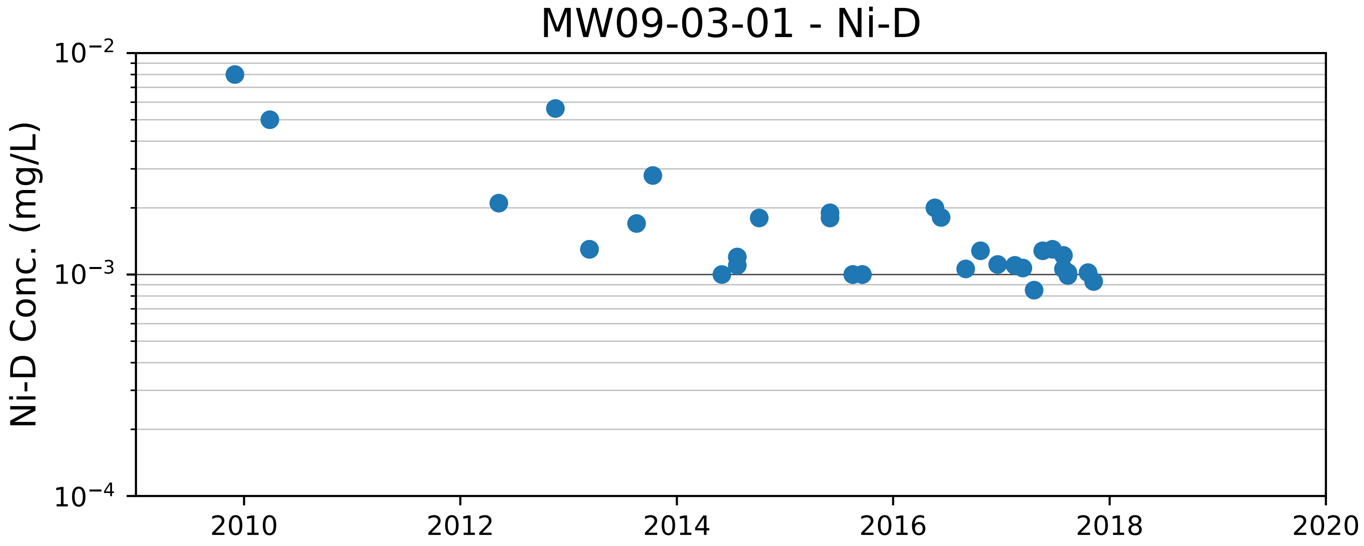

MW09-03-01 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

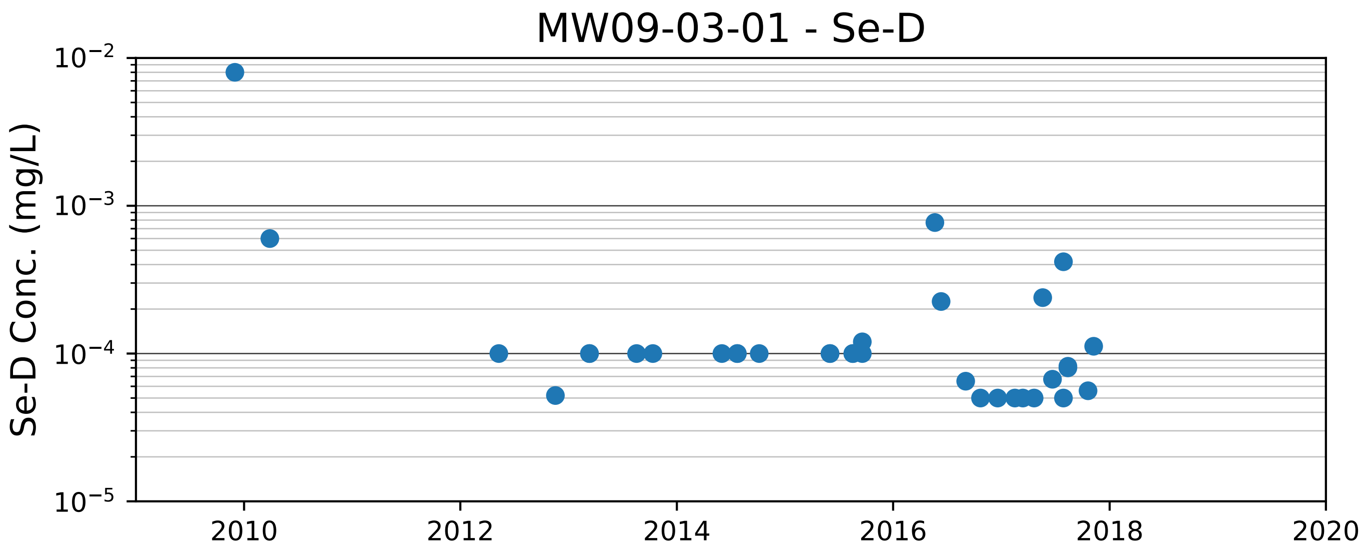

MW09-03-01 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

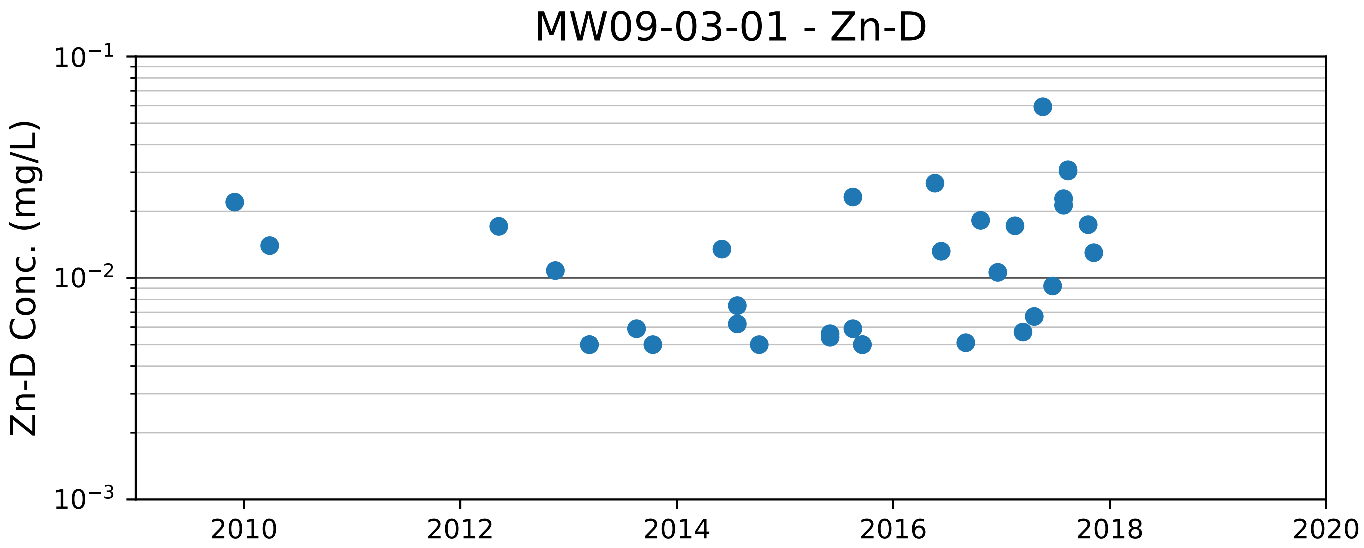

MW09-03-01 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

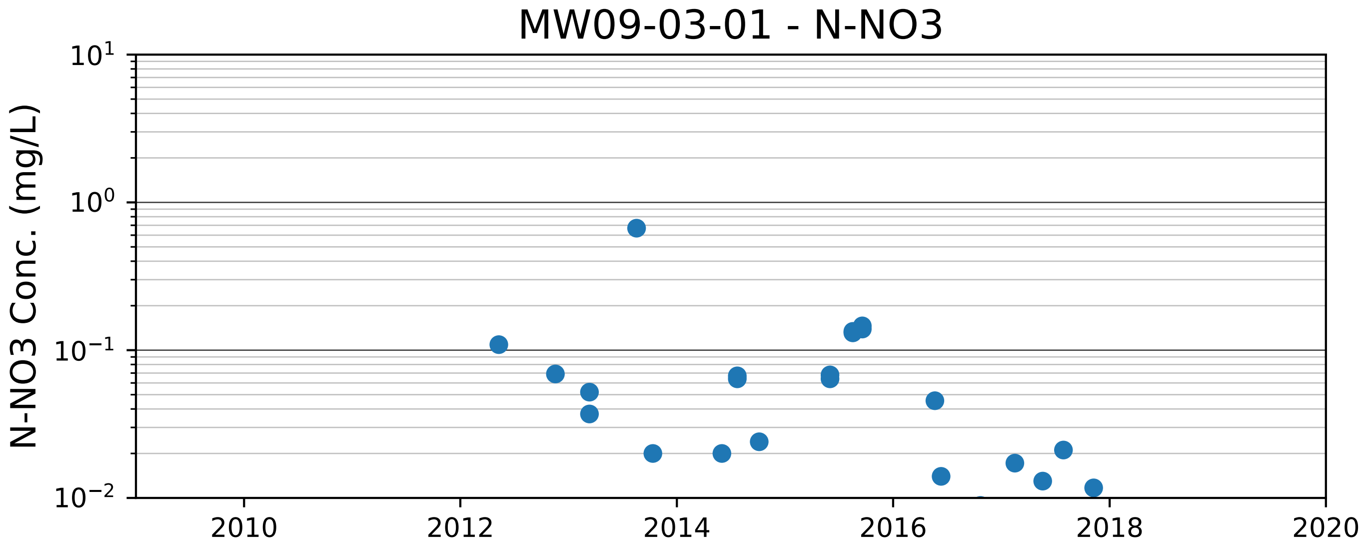

MW09-03-01 - Pb-D

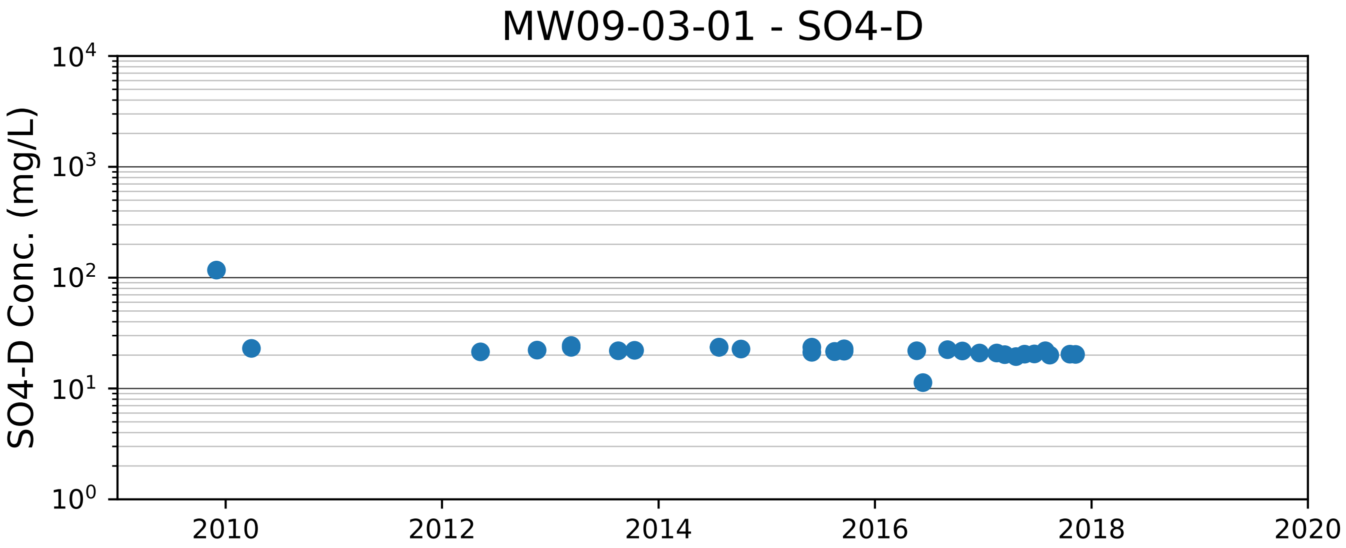

MW09-03-01 - Mo-D

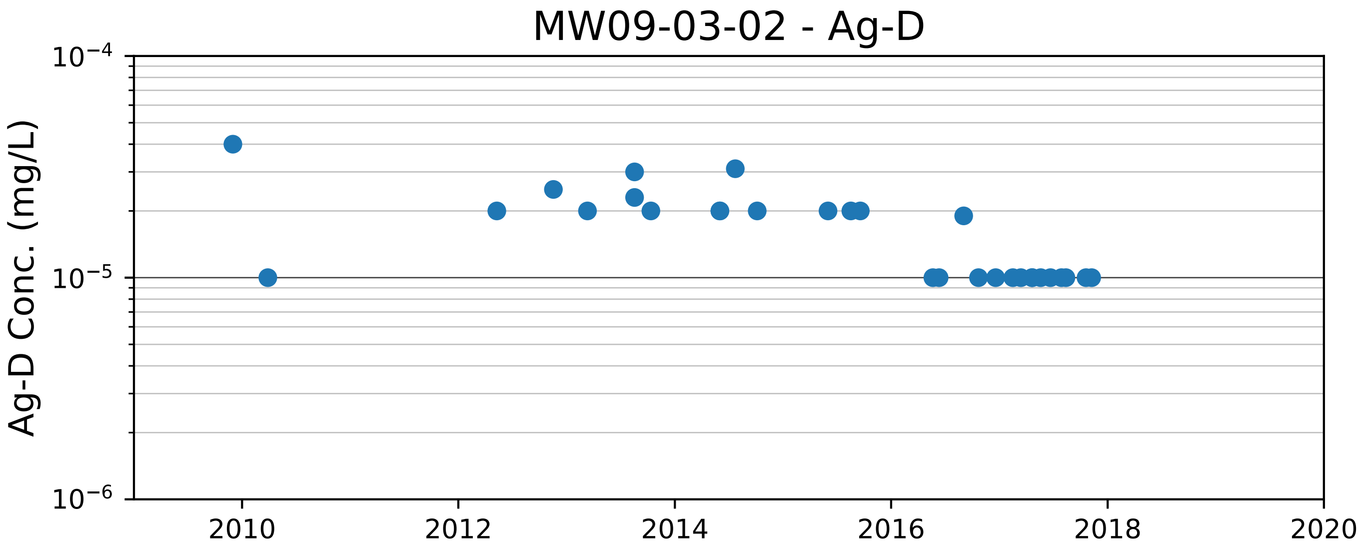

MW09-03-01 - Ni-D

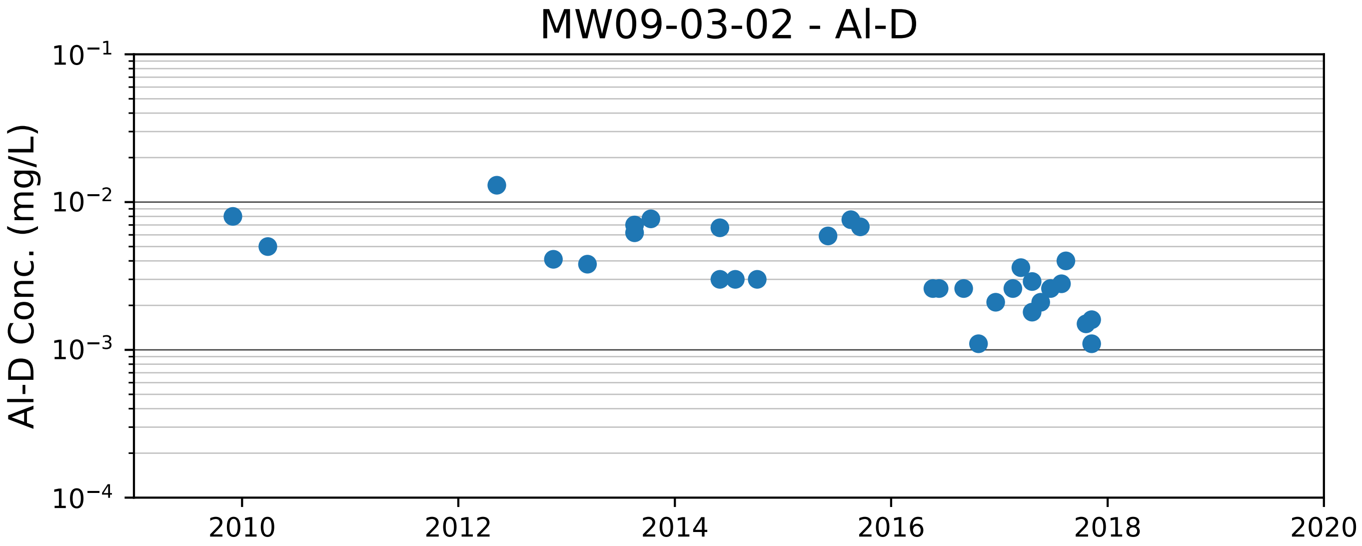

MW09-03-01 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

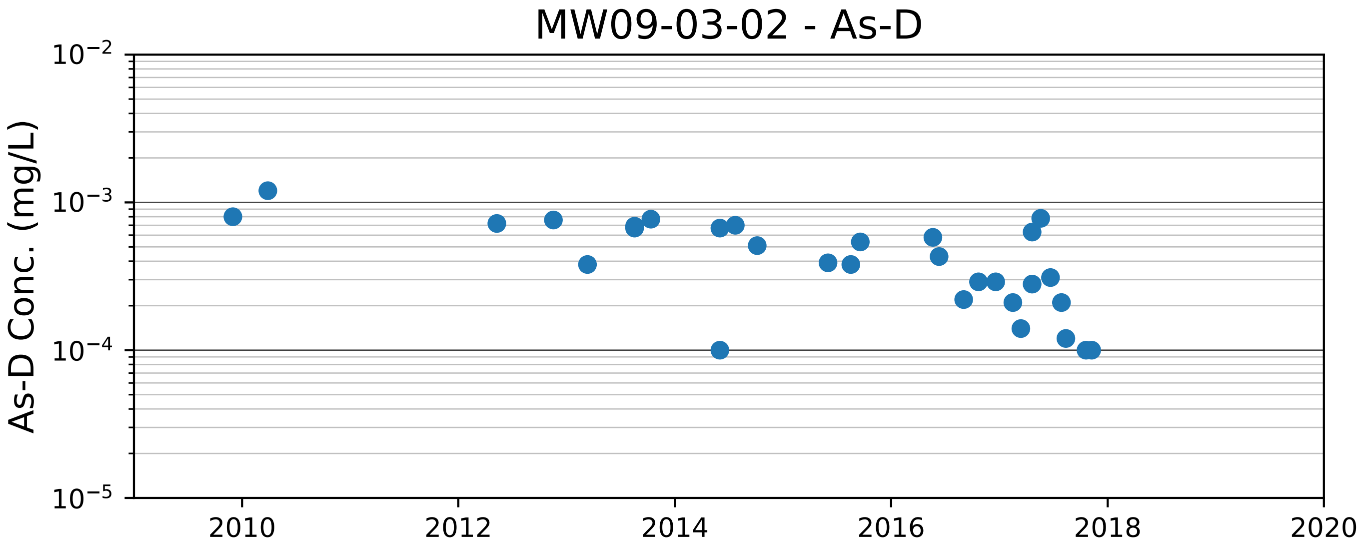

MW09-03-01 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

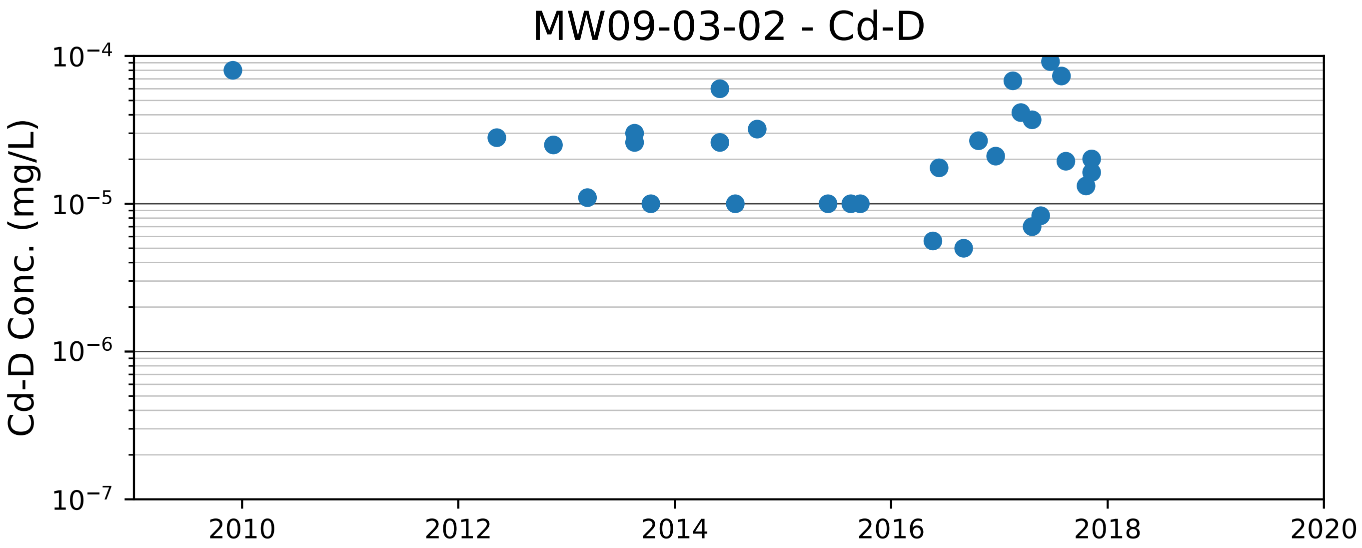

MW09-03-01 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

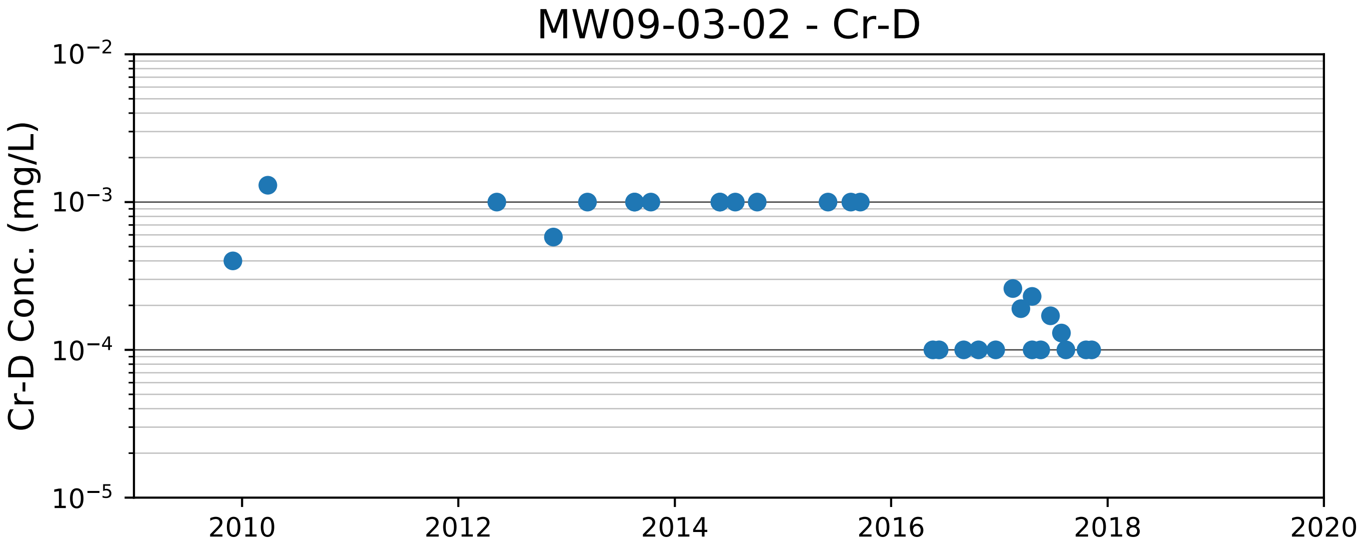

MW09-03-01 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

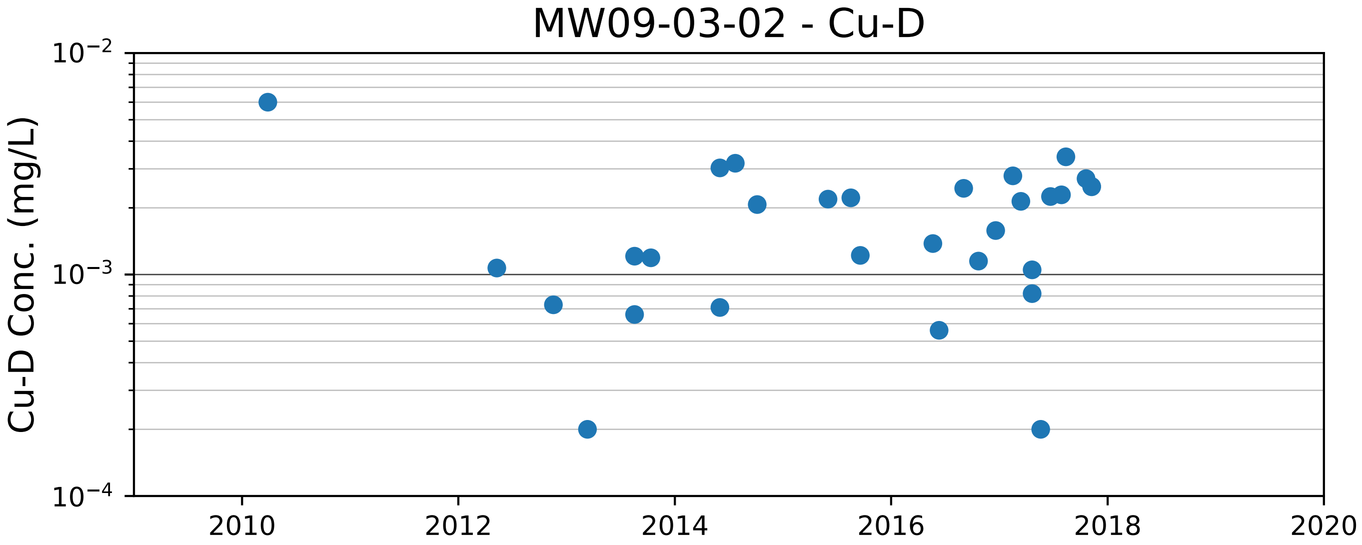

MW09-03-02 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

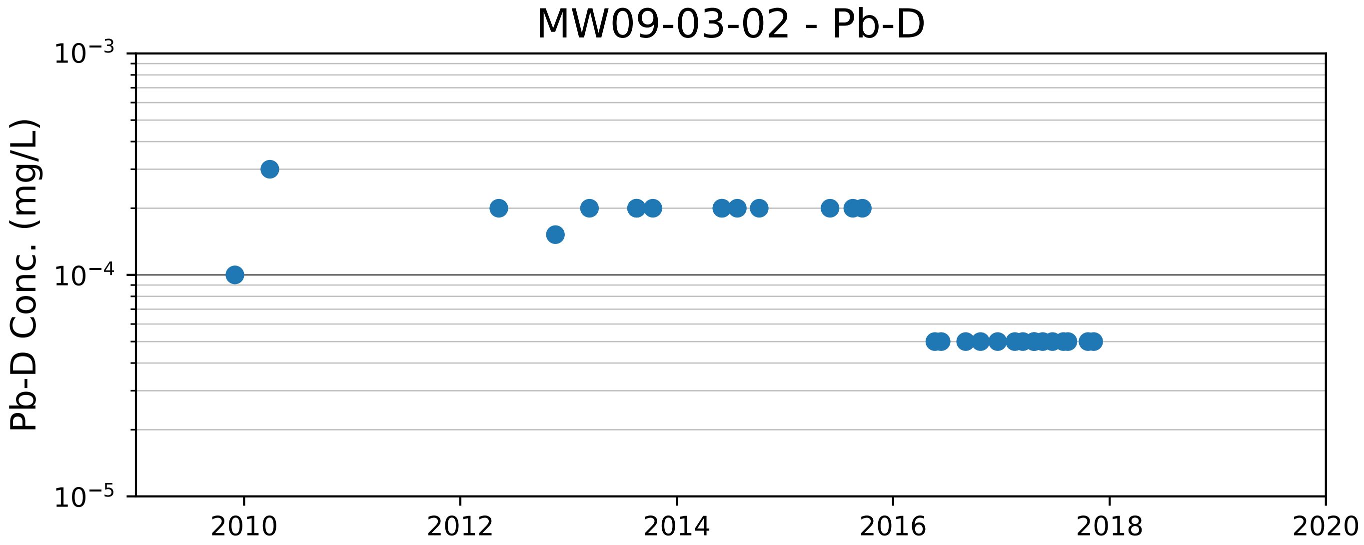

MW09-03-02 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

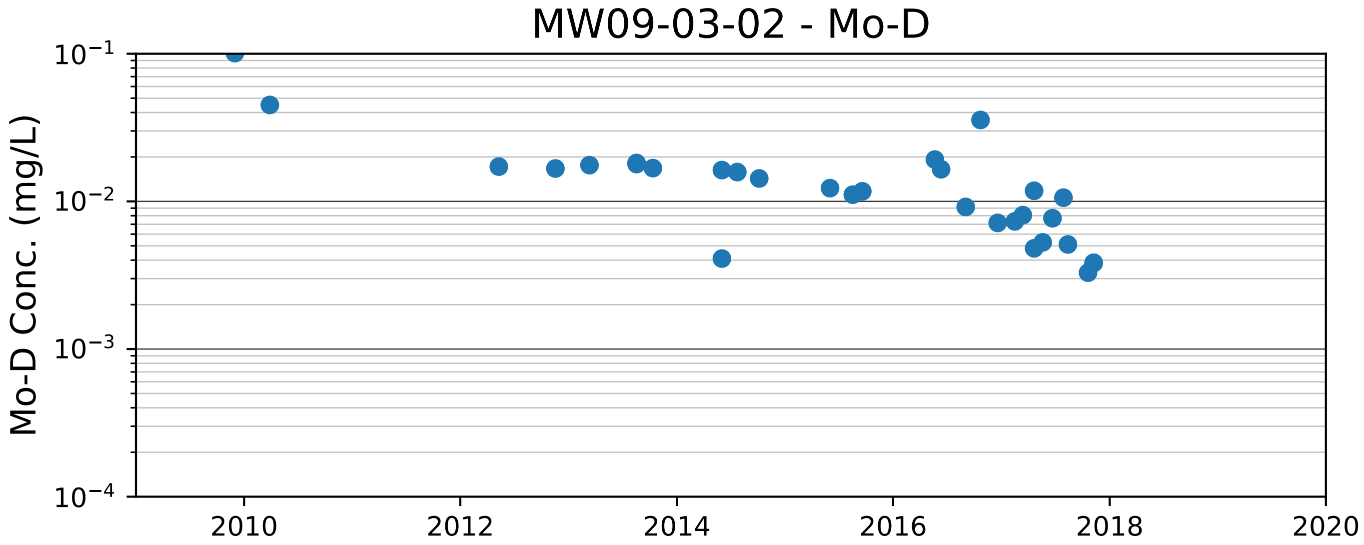

MW09-03-02 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

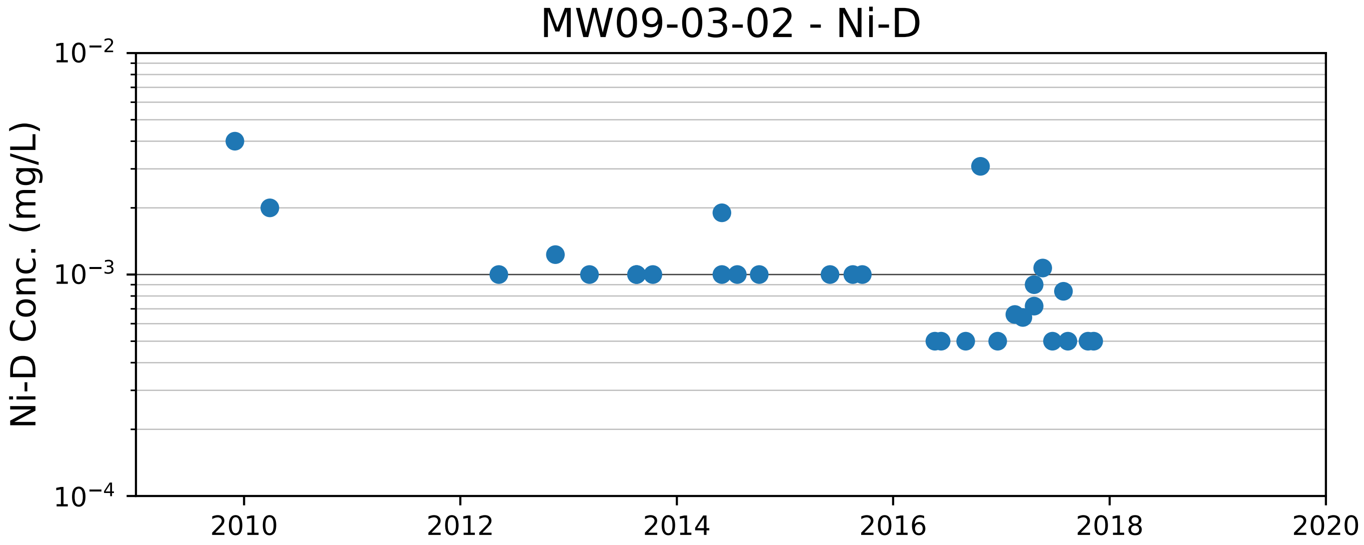

MW09-03-02 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

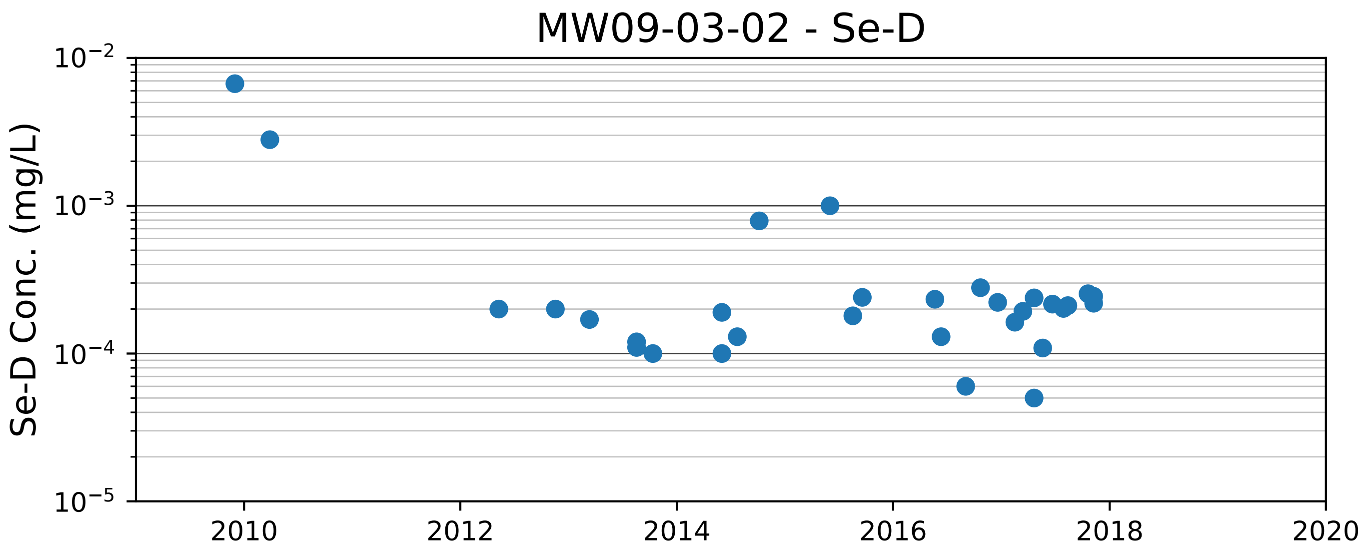

MW09-03-02 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

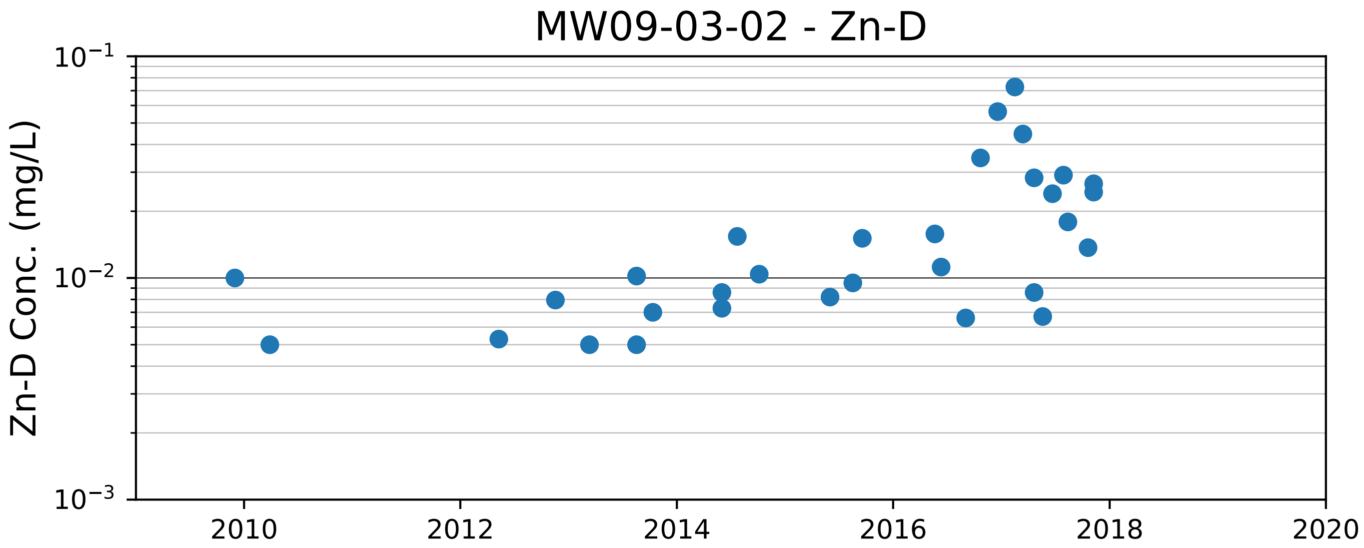

MW09-03-02 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

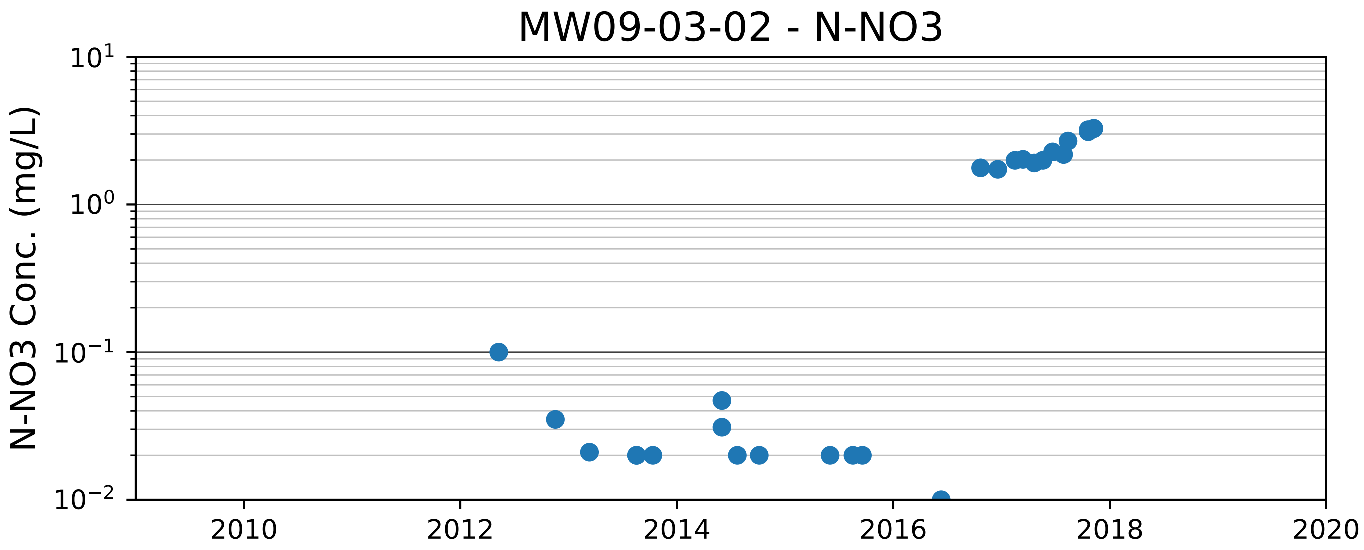

MW09-03-02 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020


MW09-03-02 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

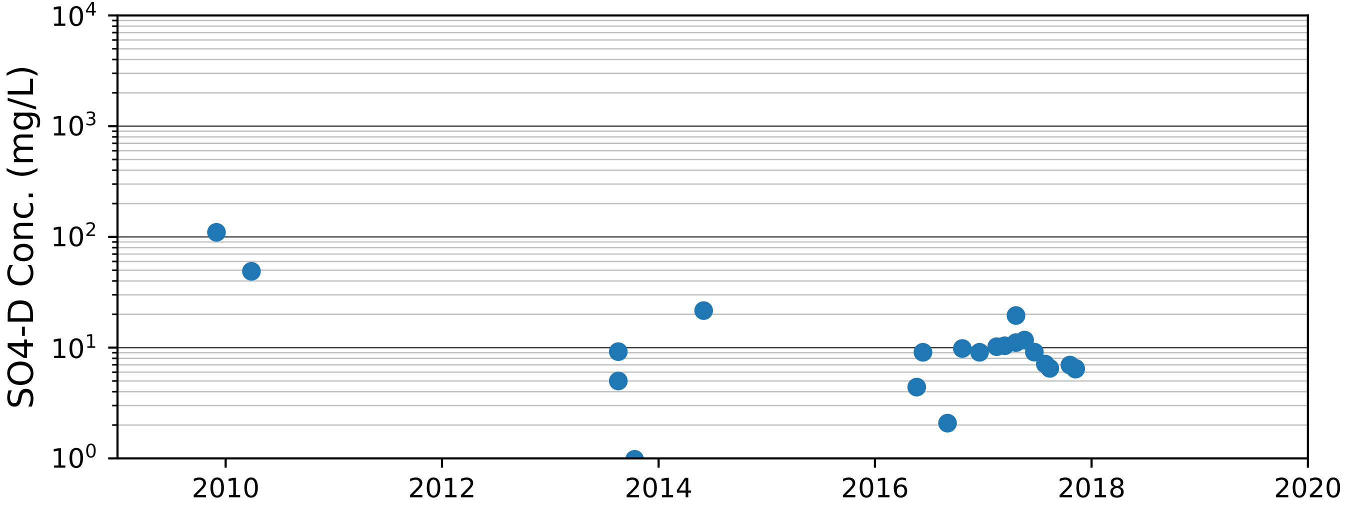

MW09-03-02 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

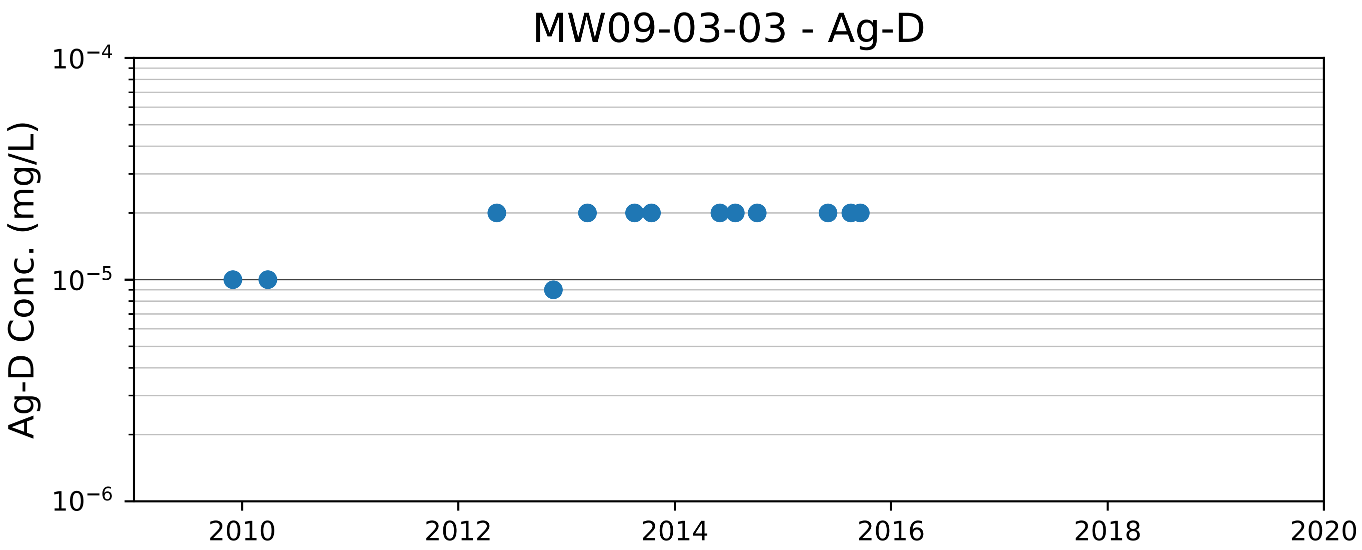

MW09-03-02 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

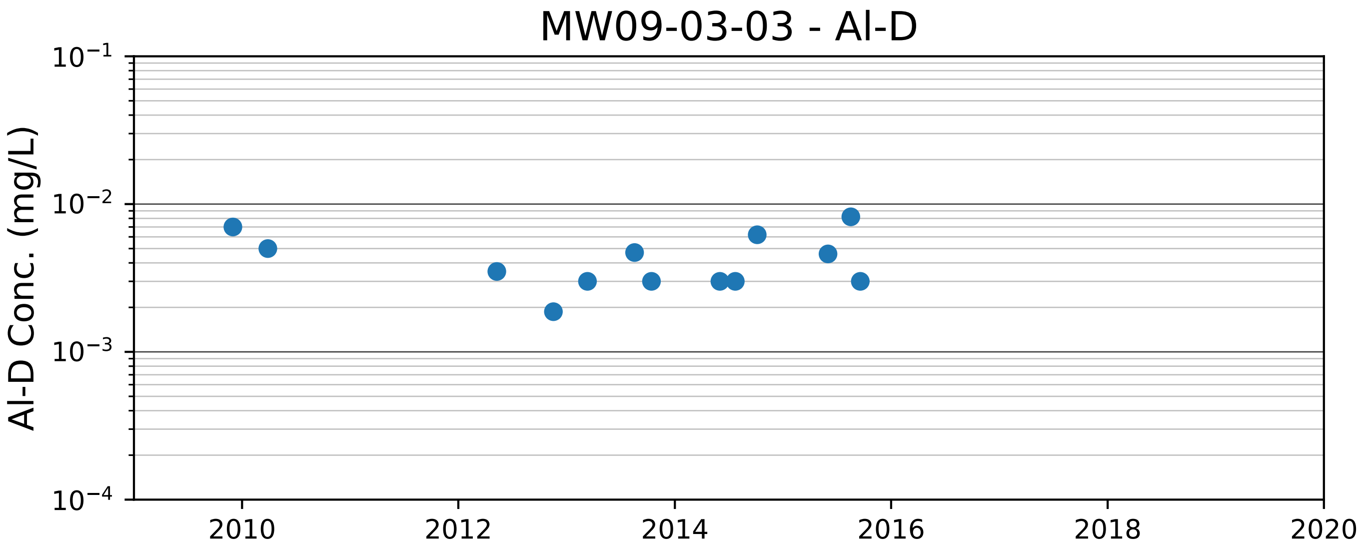

MW09-03-02 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

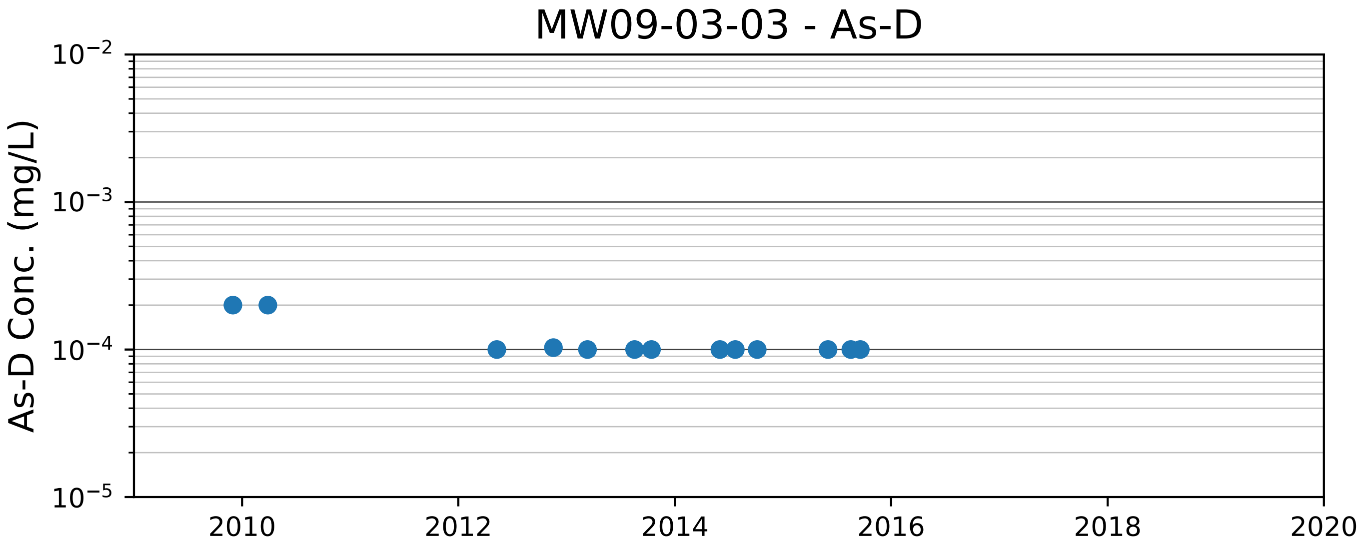

MW09-03-02 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

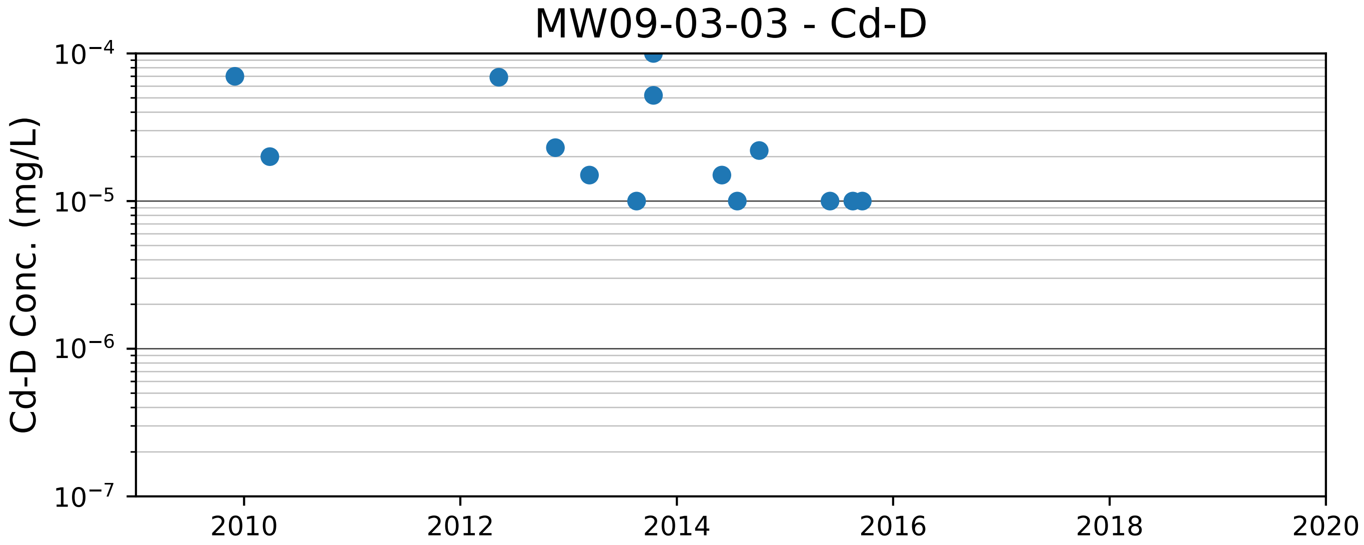
MW09-03-02 - SO4-D

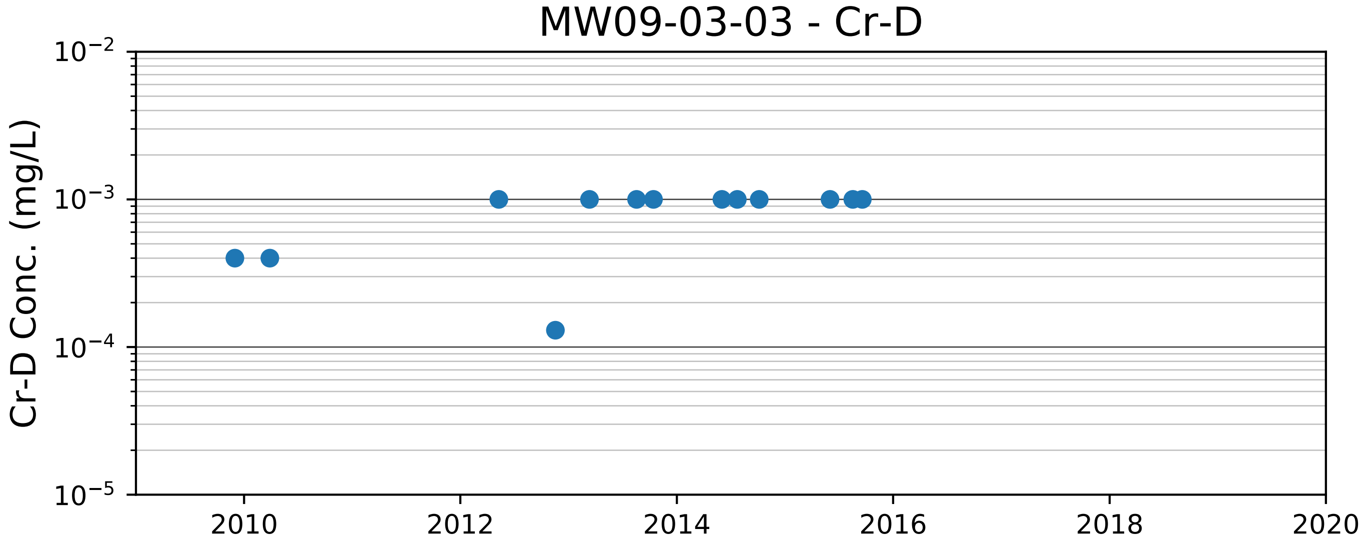


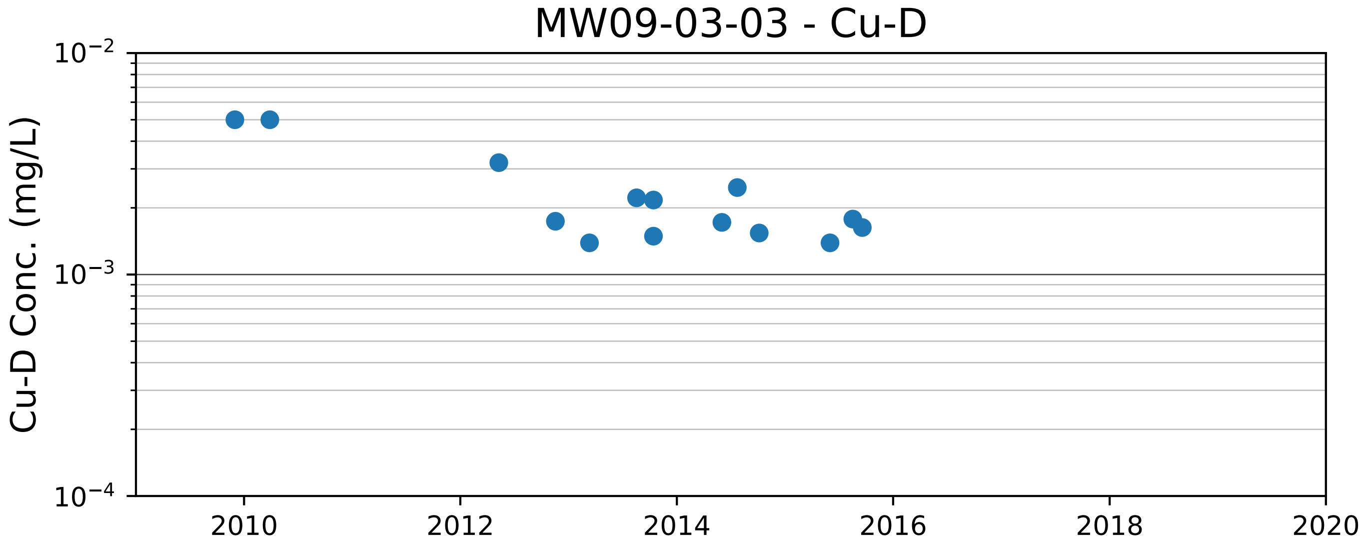

MW09-03-03 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020


MW09-03-03 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

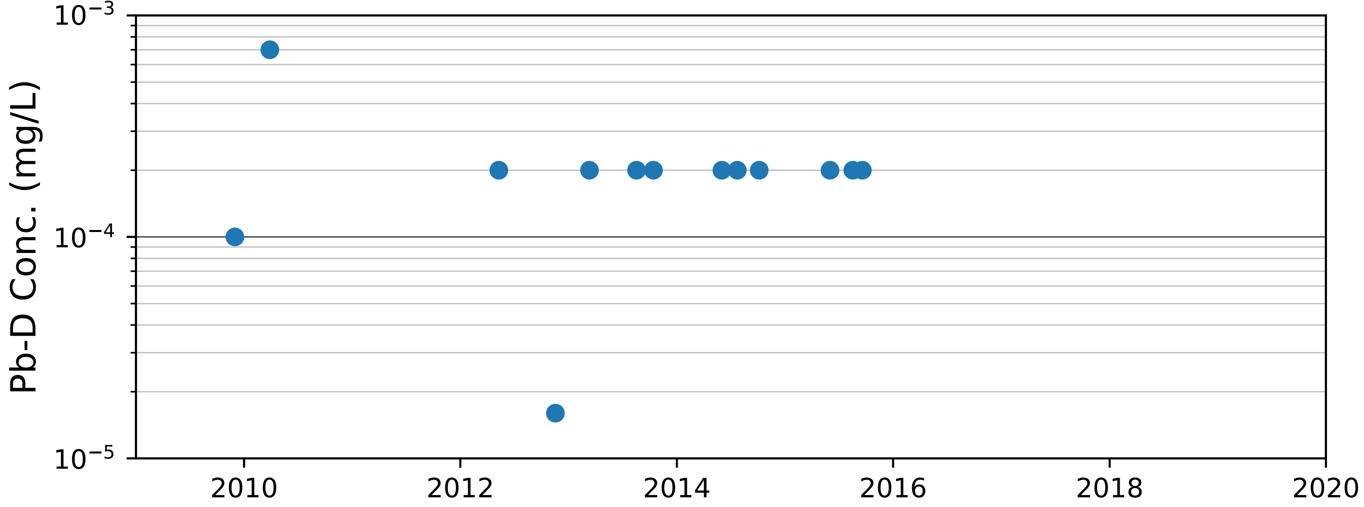

MW09-03-03 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020


MW09-03-03 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

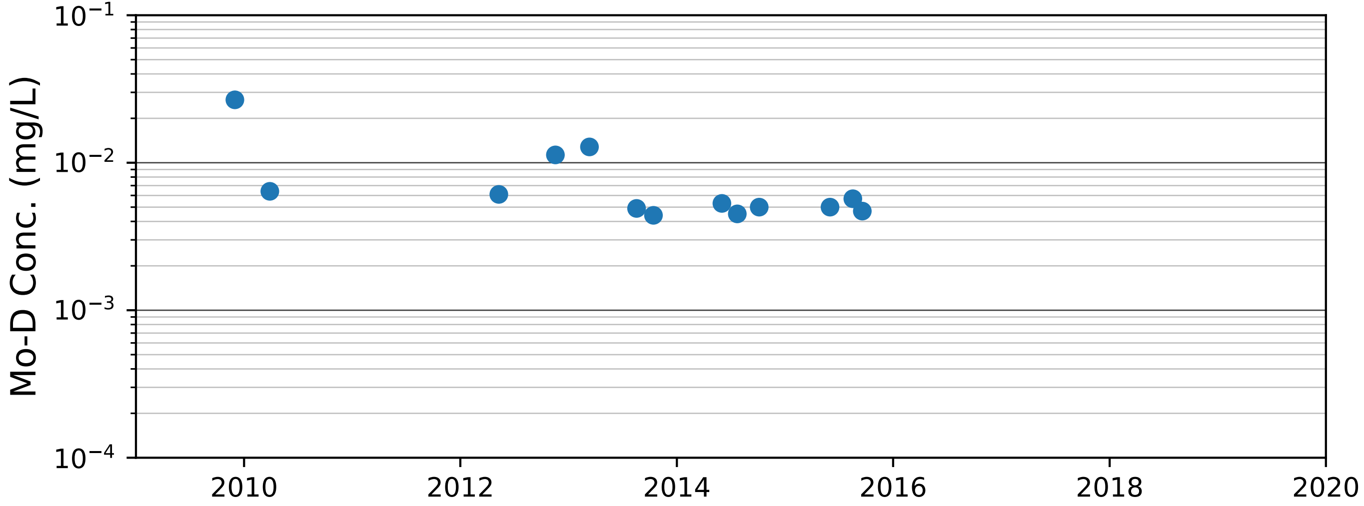

MW09-03-03 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020


MW09-03-03 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

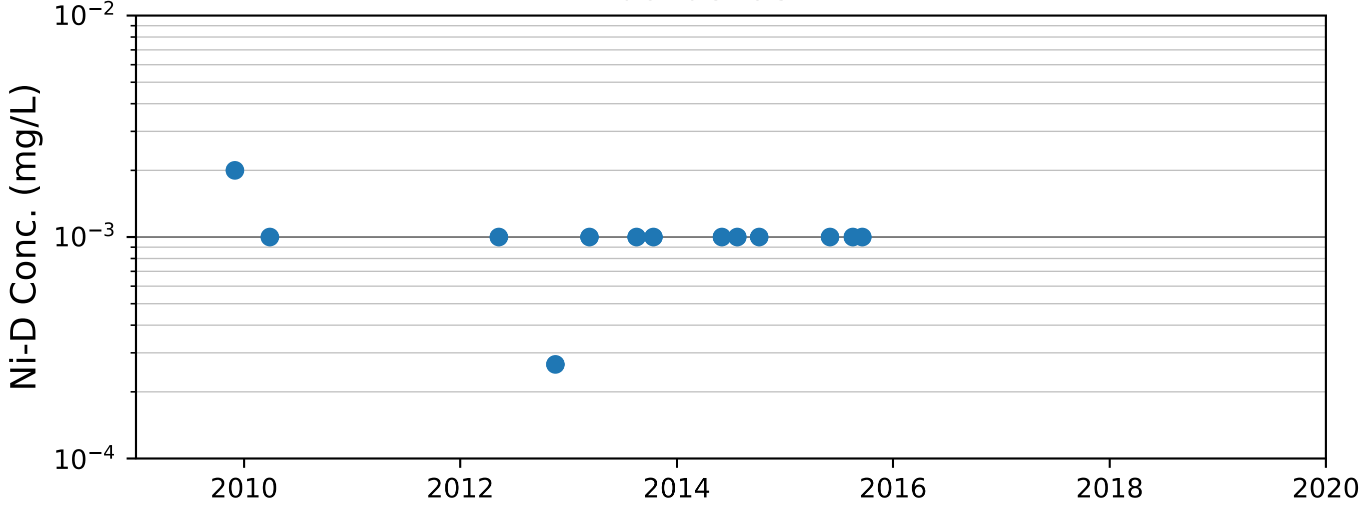
MW09-03-03 - Pb-D

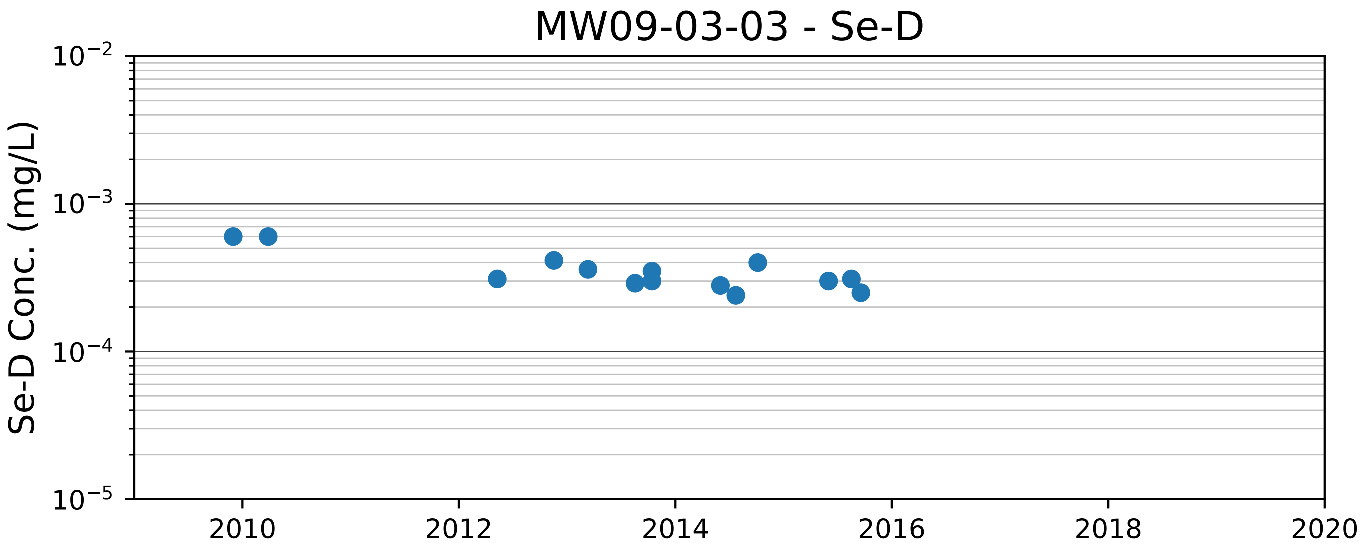


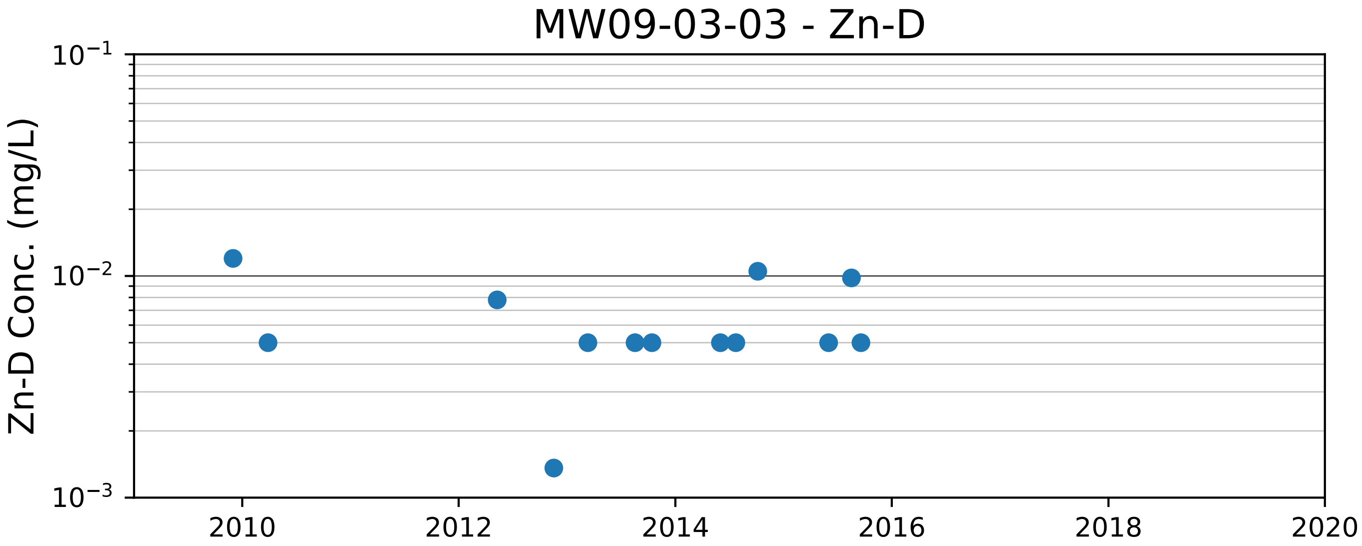
MW09-03-03 - Mo-D

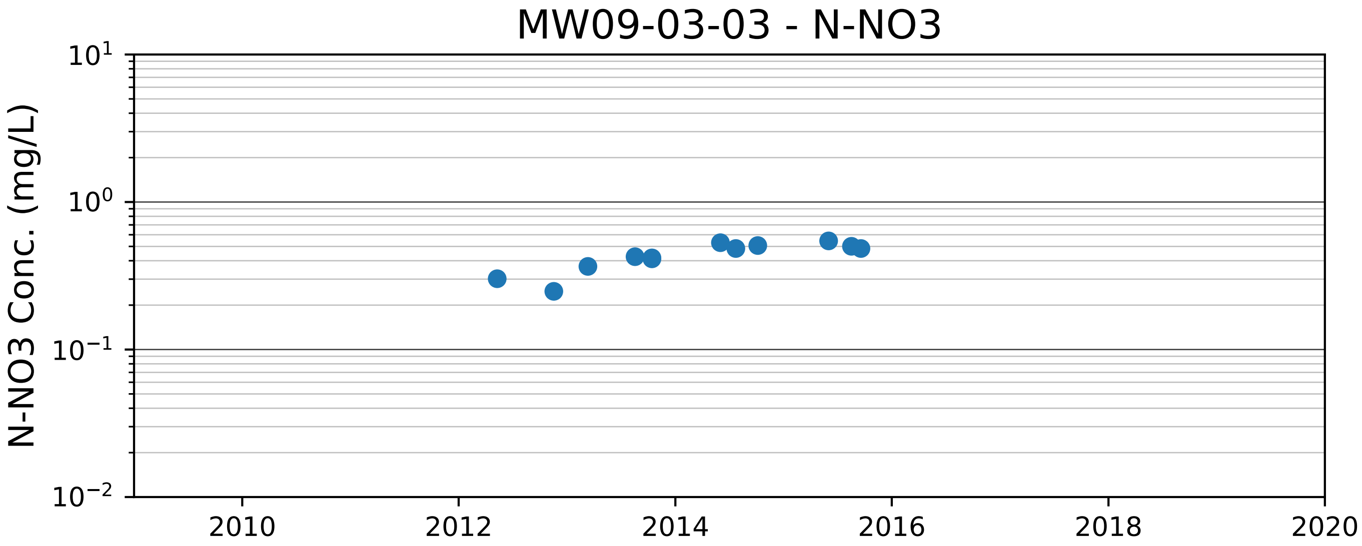


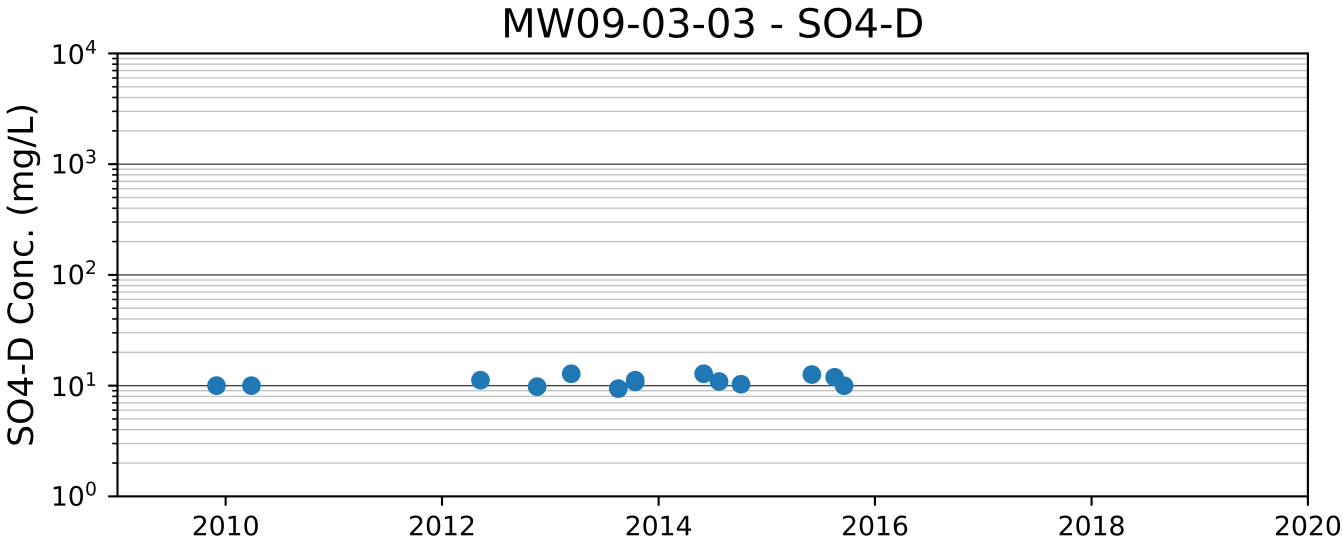
MW09-03-03 - Ni-D

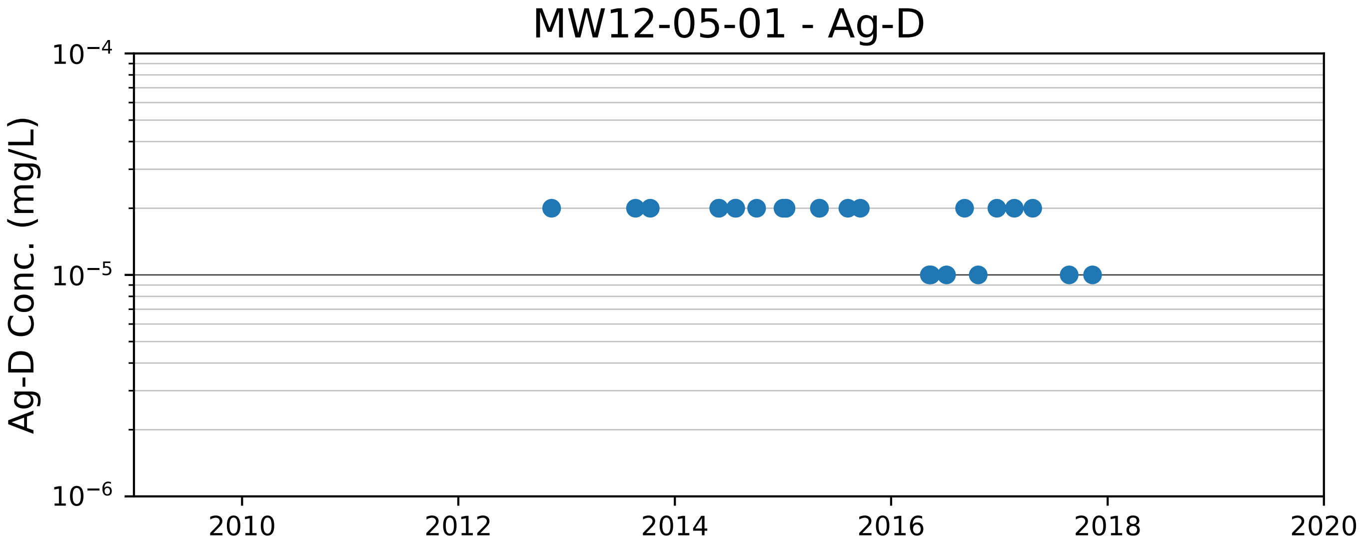


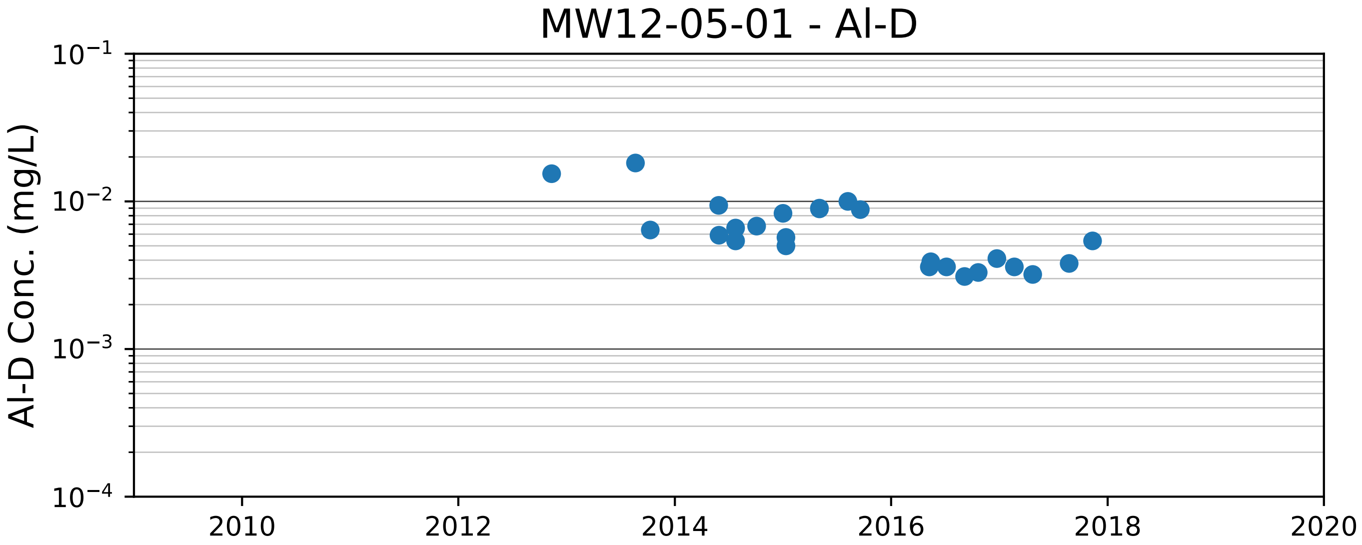

MW09-03-03 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

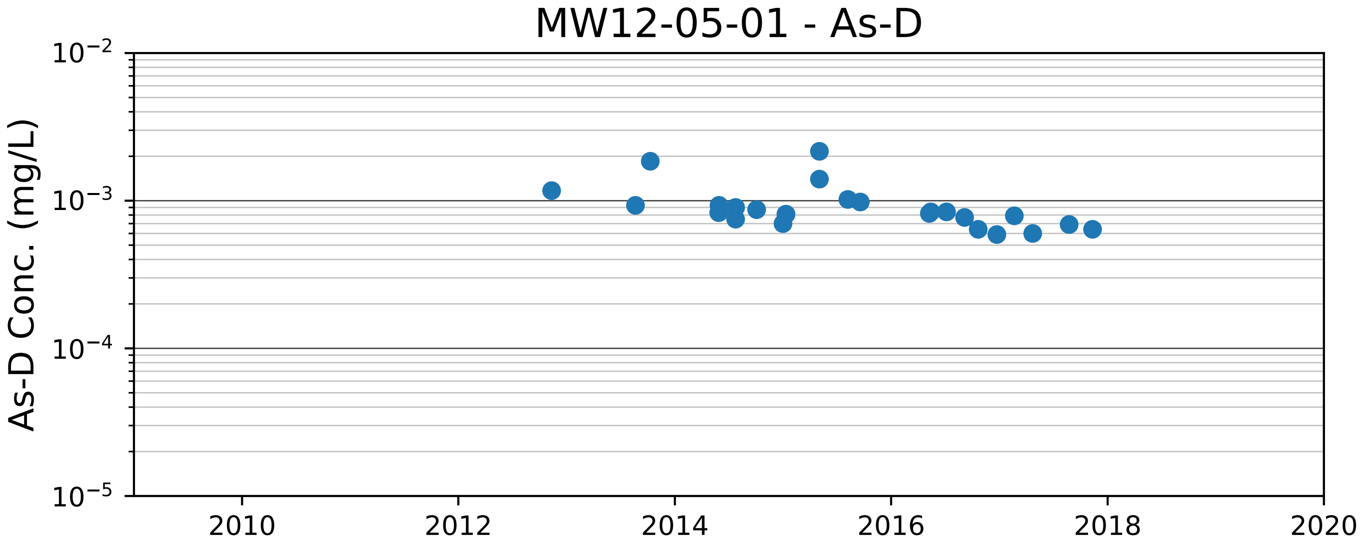

MW09-03-03 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

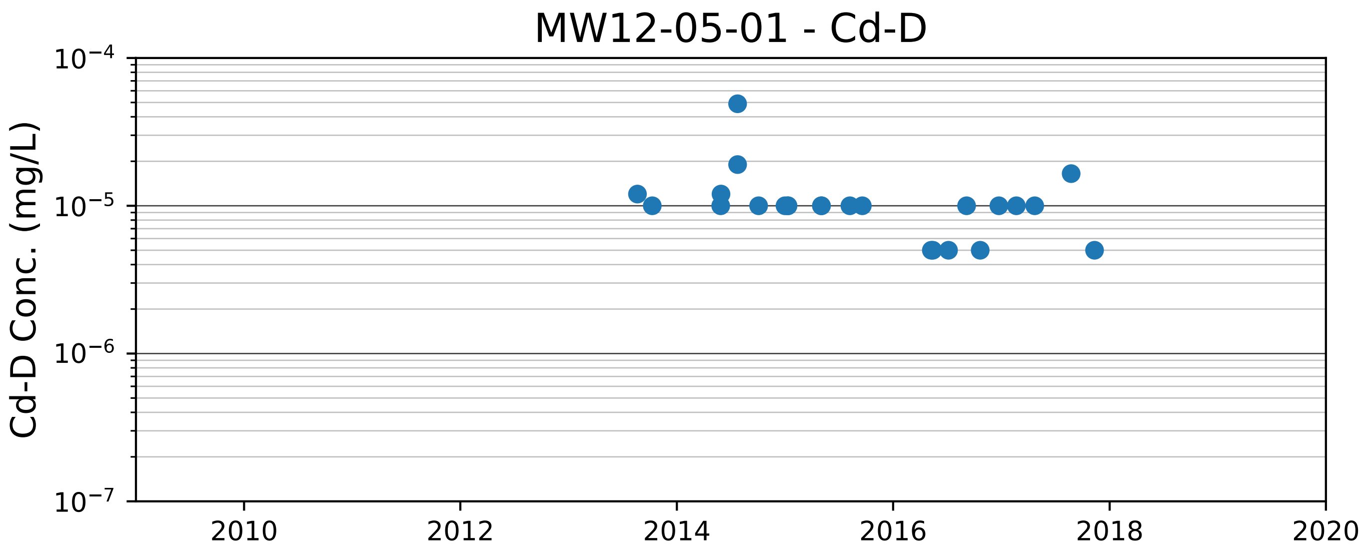

MW09-03-03 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

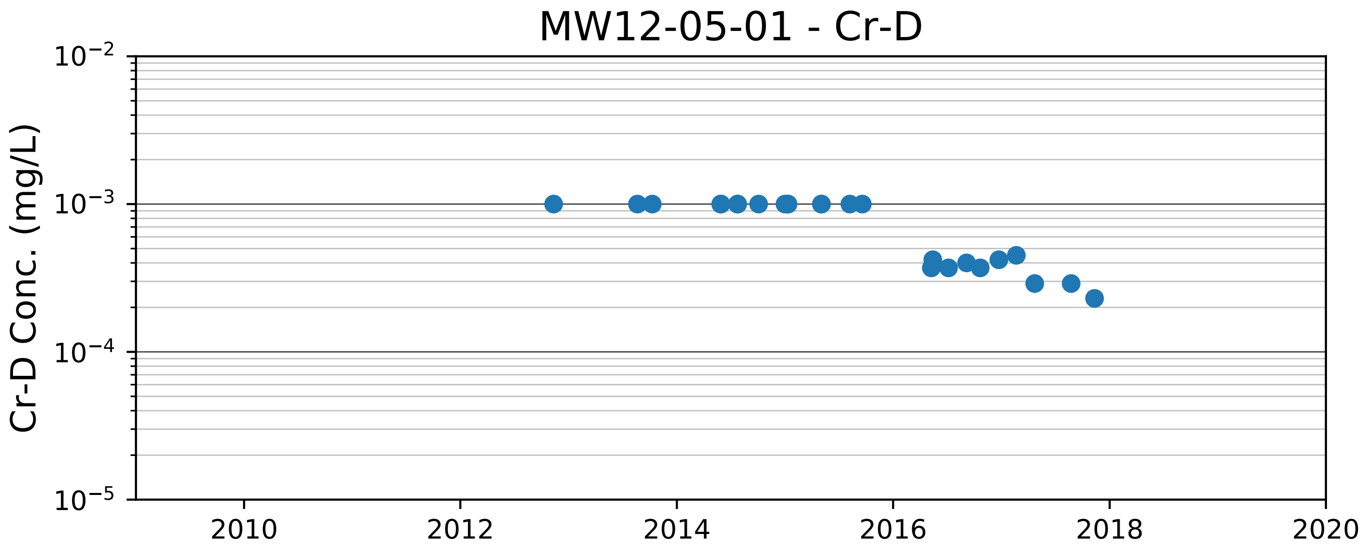

MW09-03-03 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

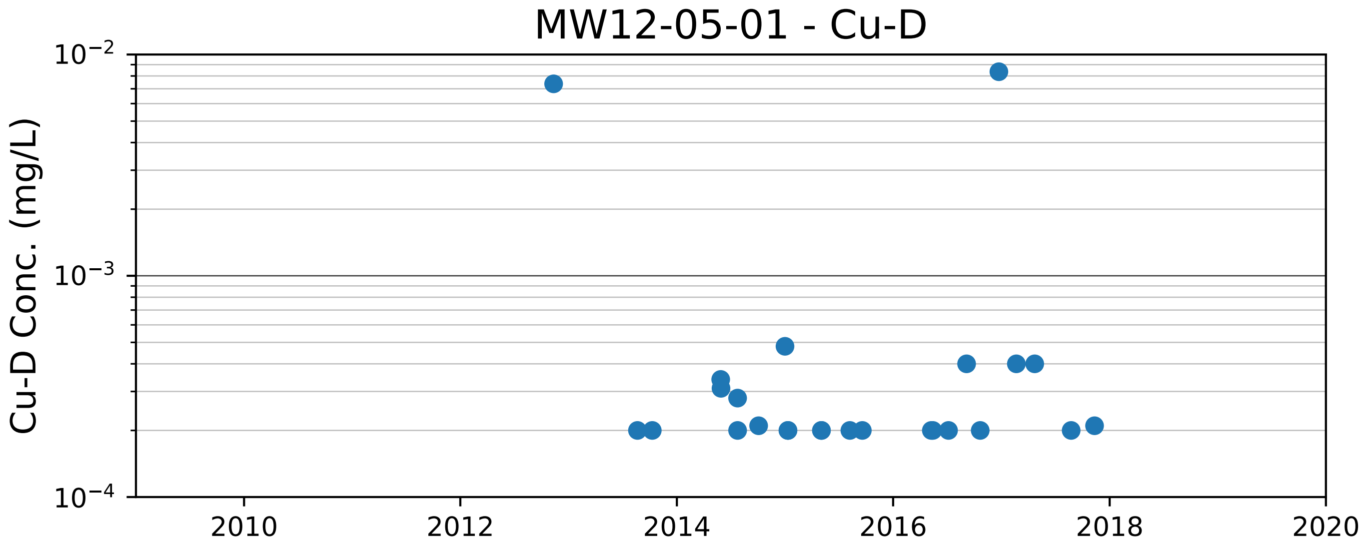

MW12-05-01 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

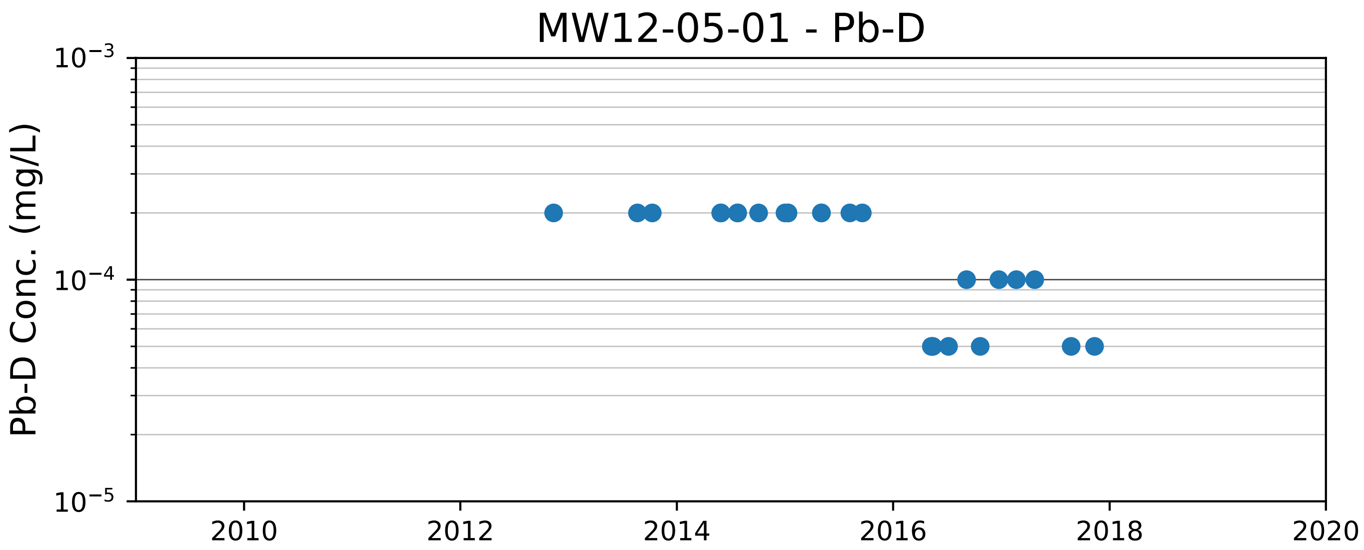

MW12-05-01 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

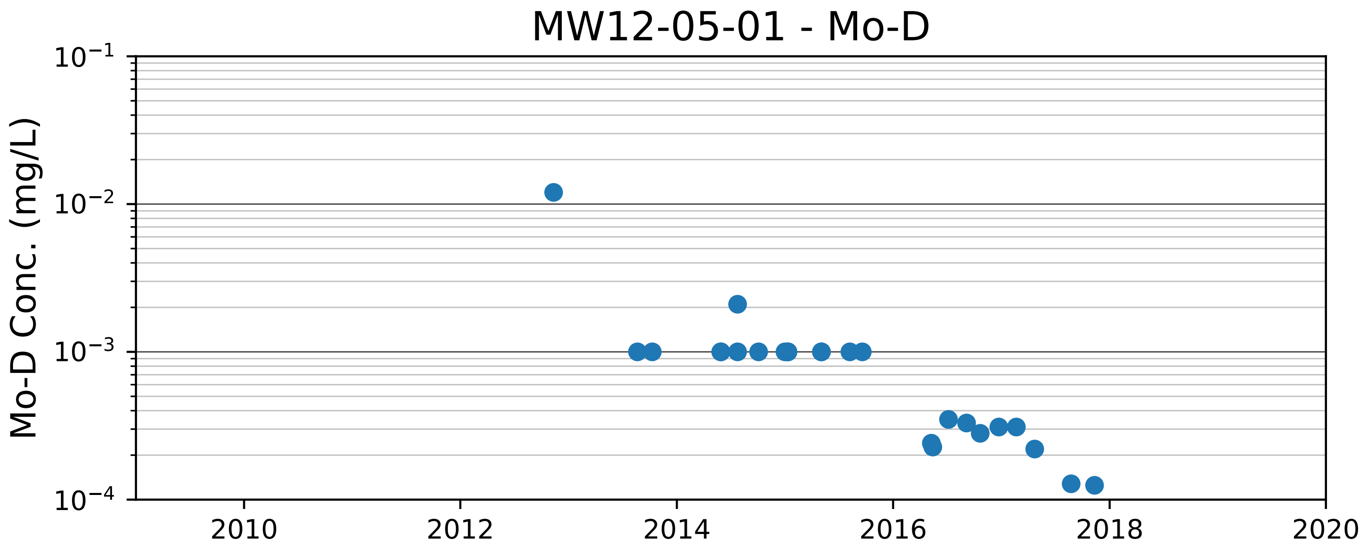

MW12-05-01 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

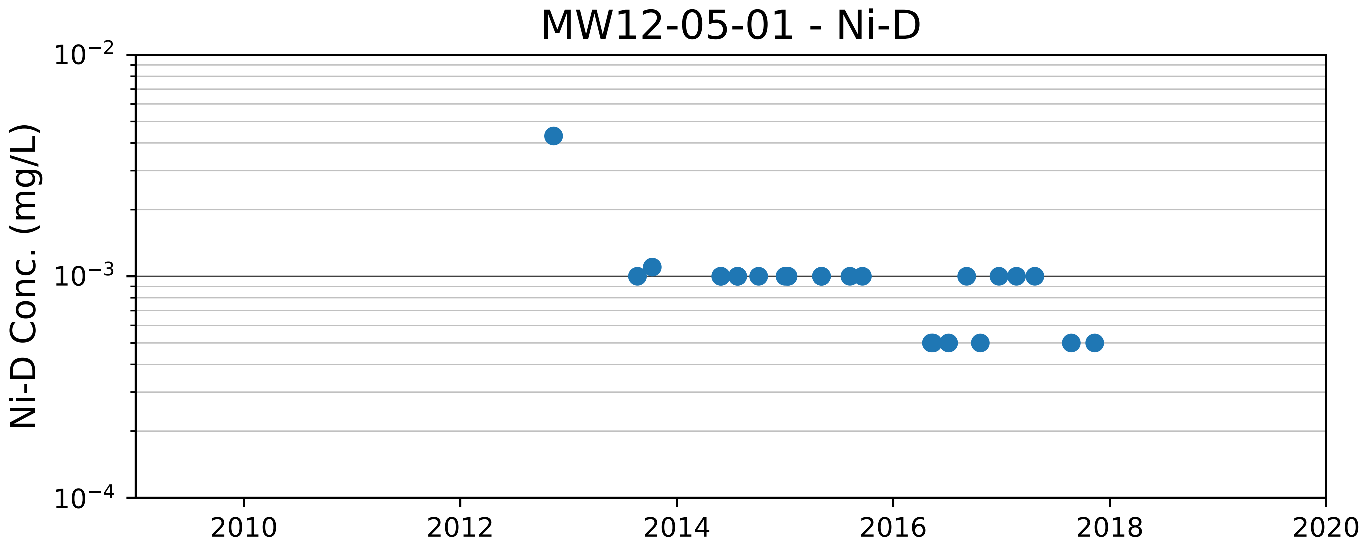

MW12-05-01 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

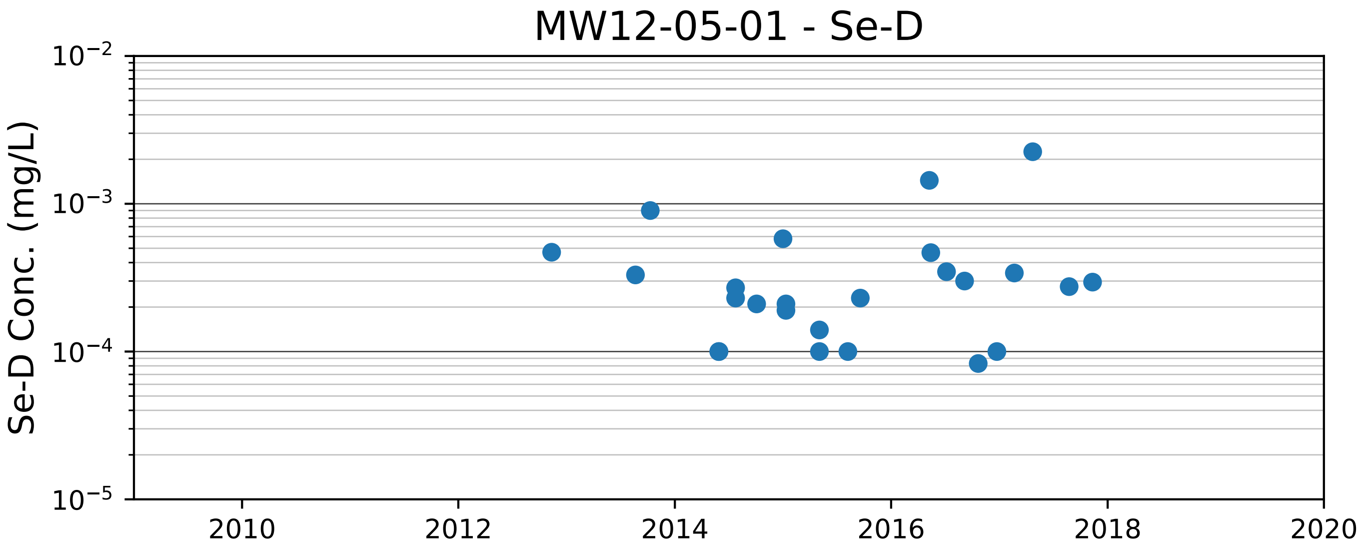

MW12-05-01 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

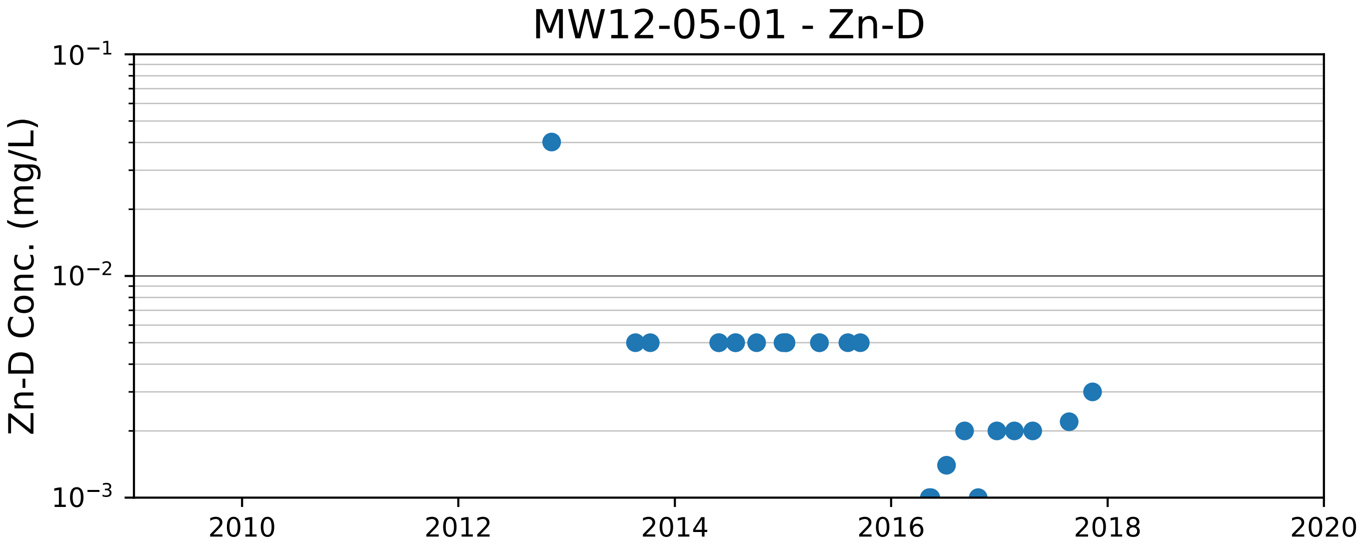

MW12-05-01 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

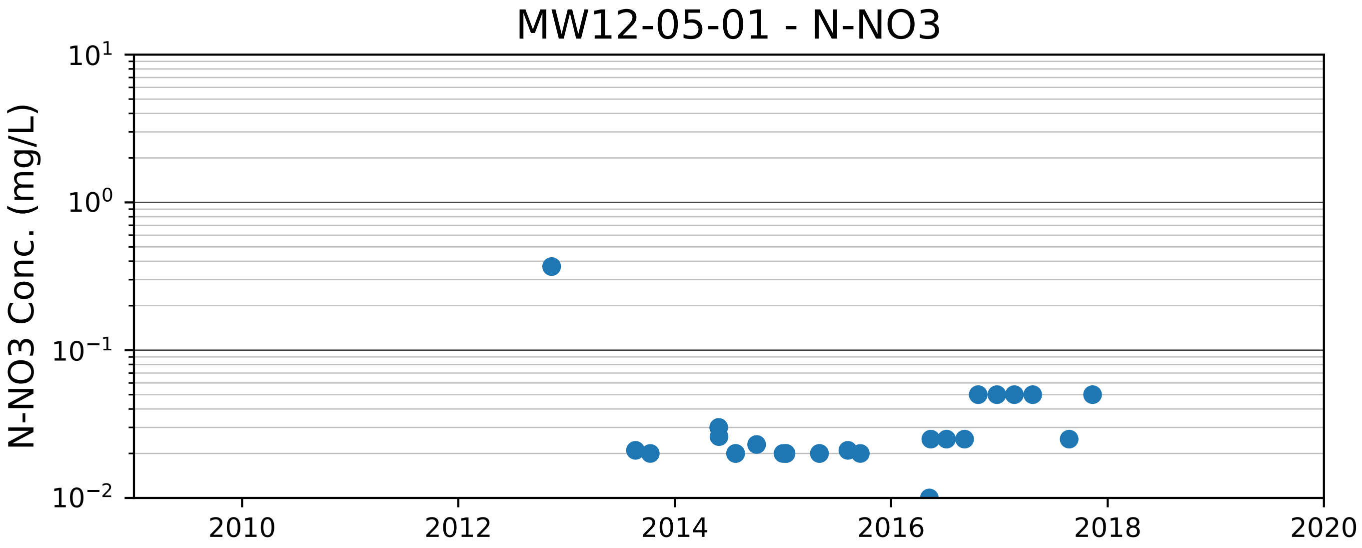

MW12-05-01 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

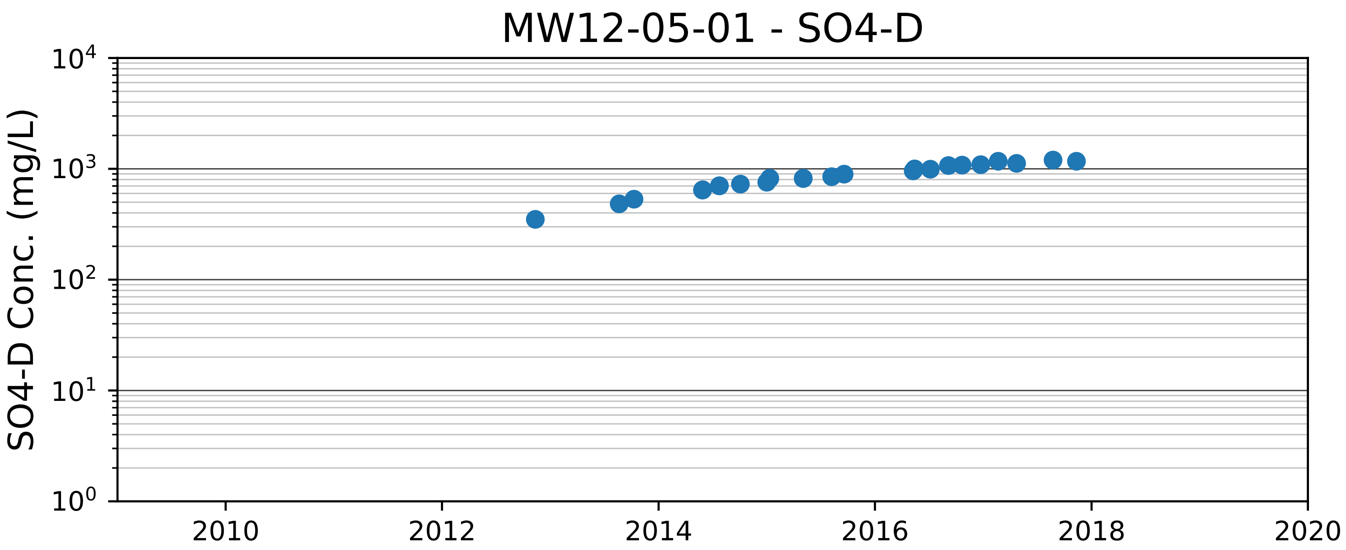

MW12-05-01 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

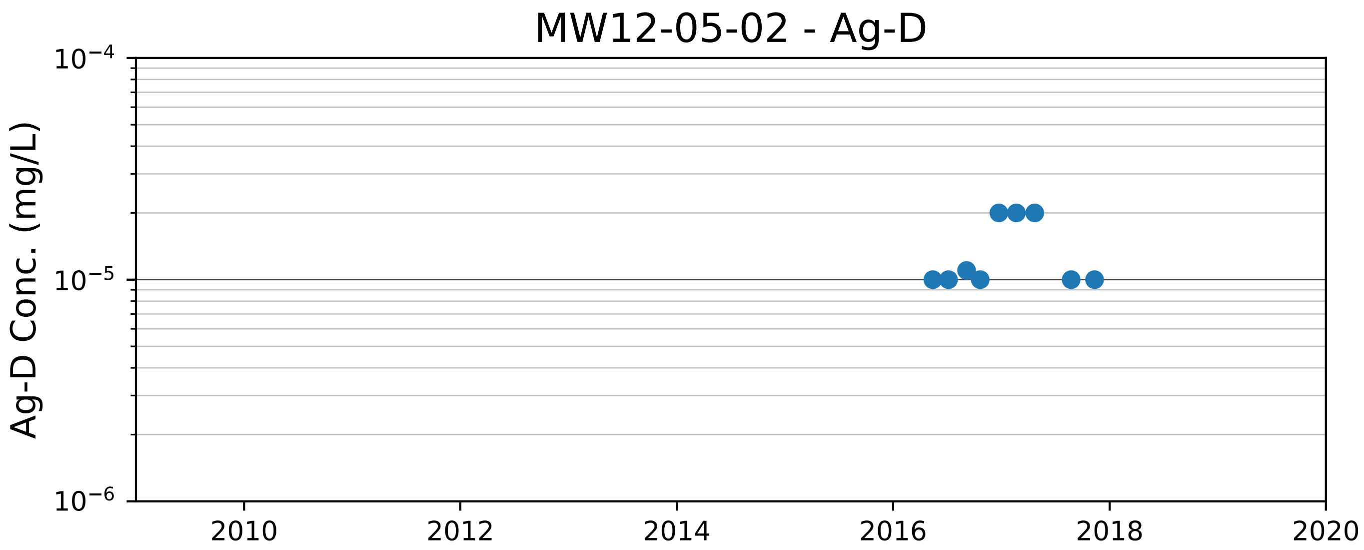

MW12-05-01 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

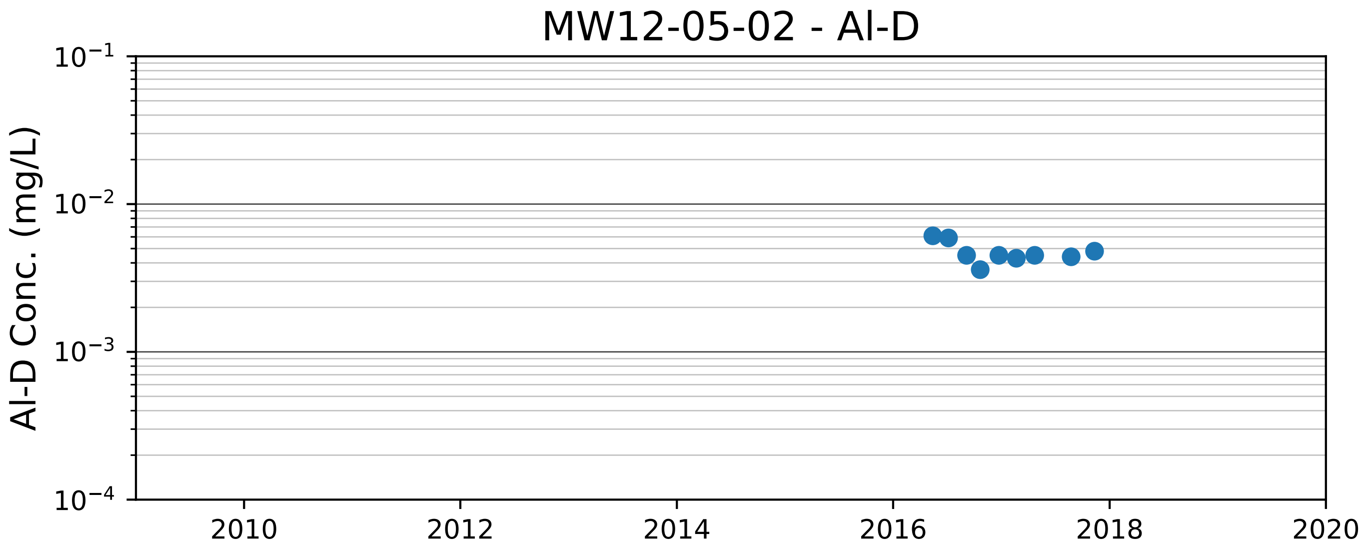

MW12-05-01 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

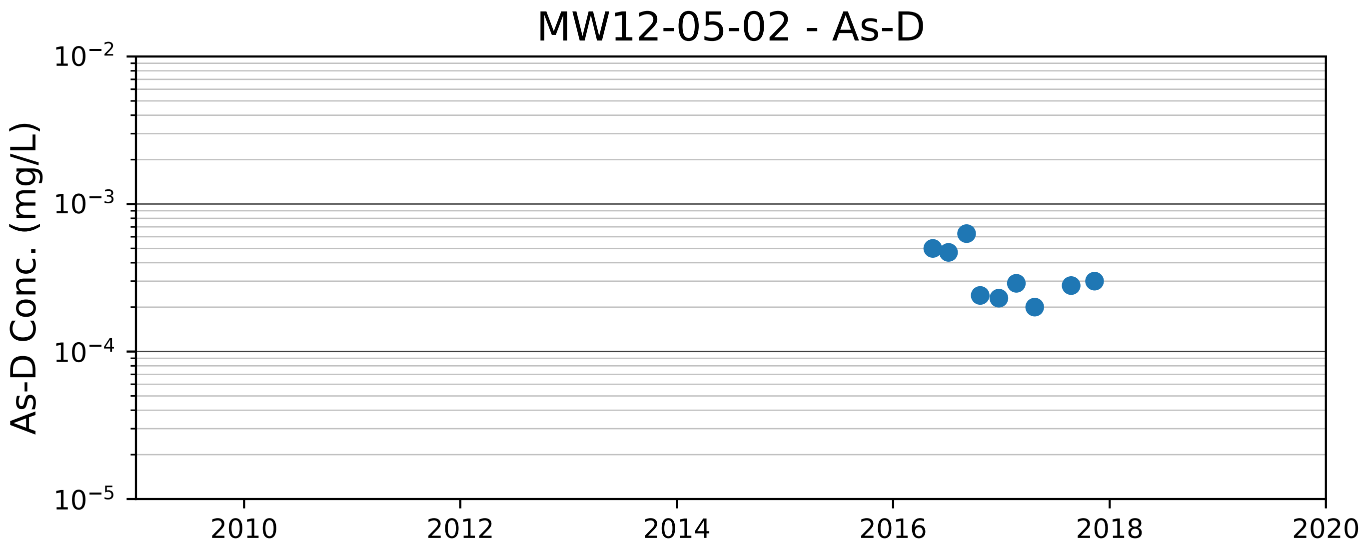

MW12-05-01 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

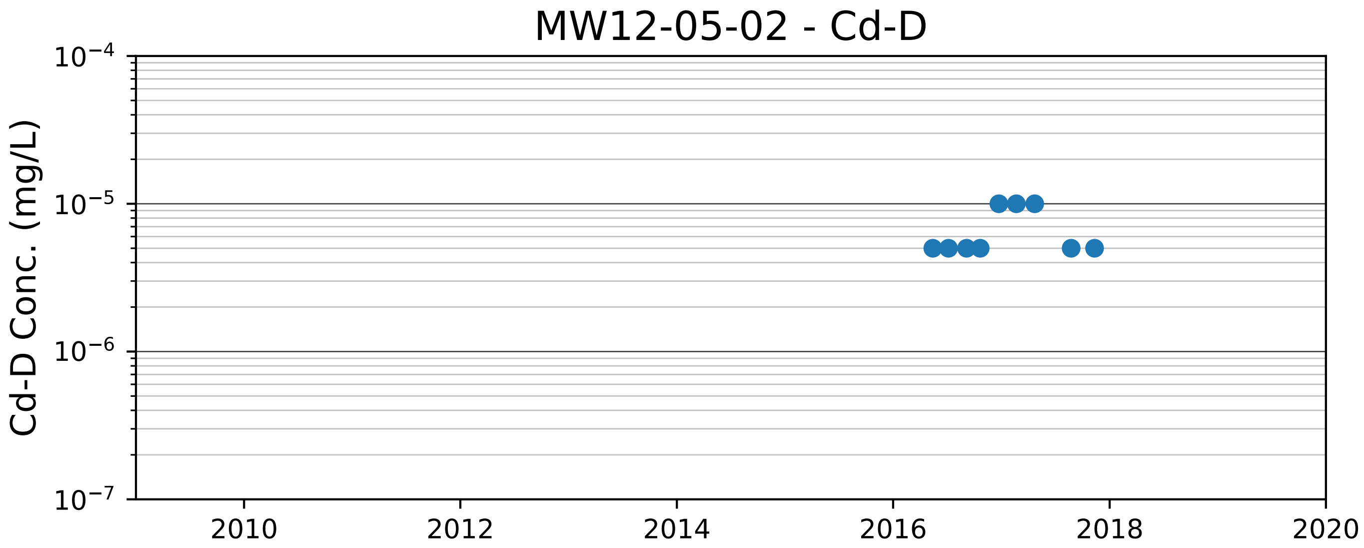

MW12-05-01 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

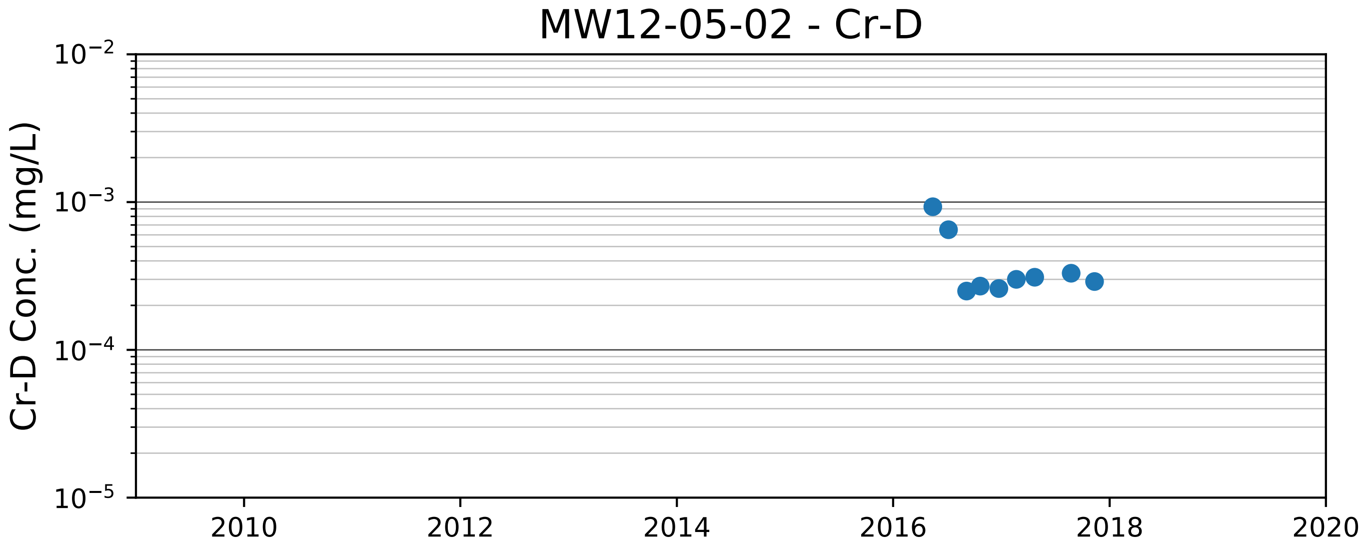

MW12-05-01 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

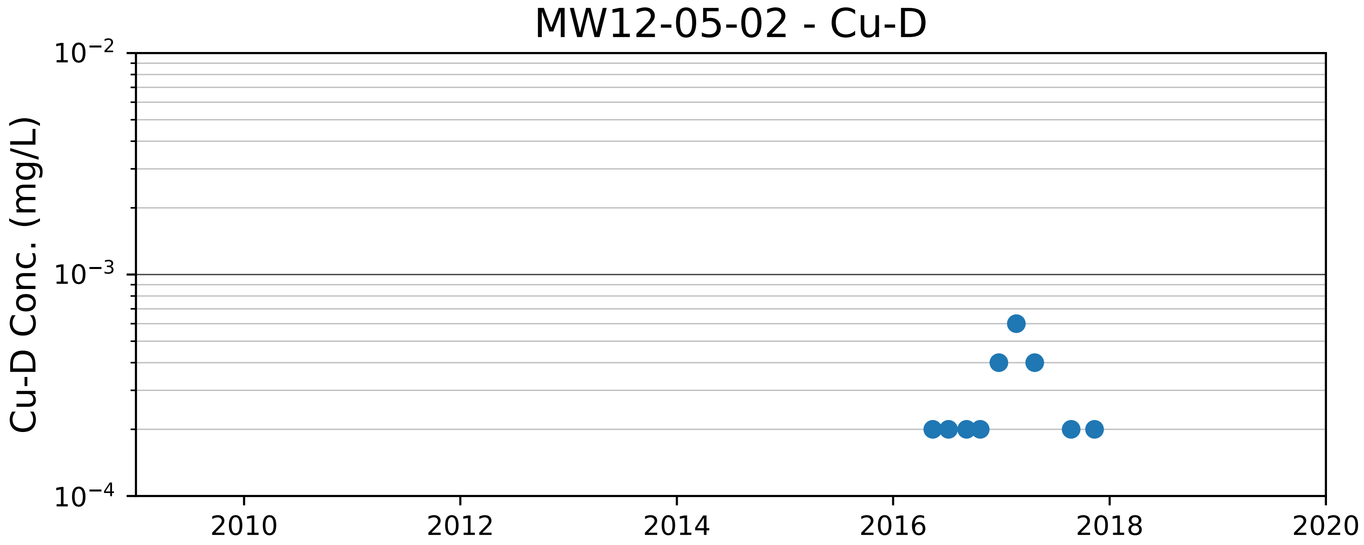

MW12-05-02 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

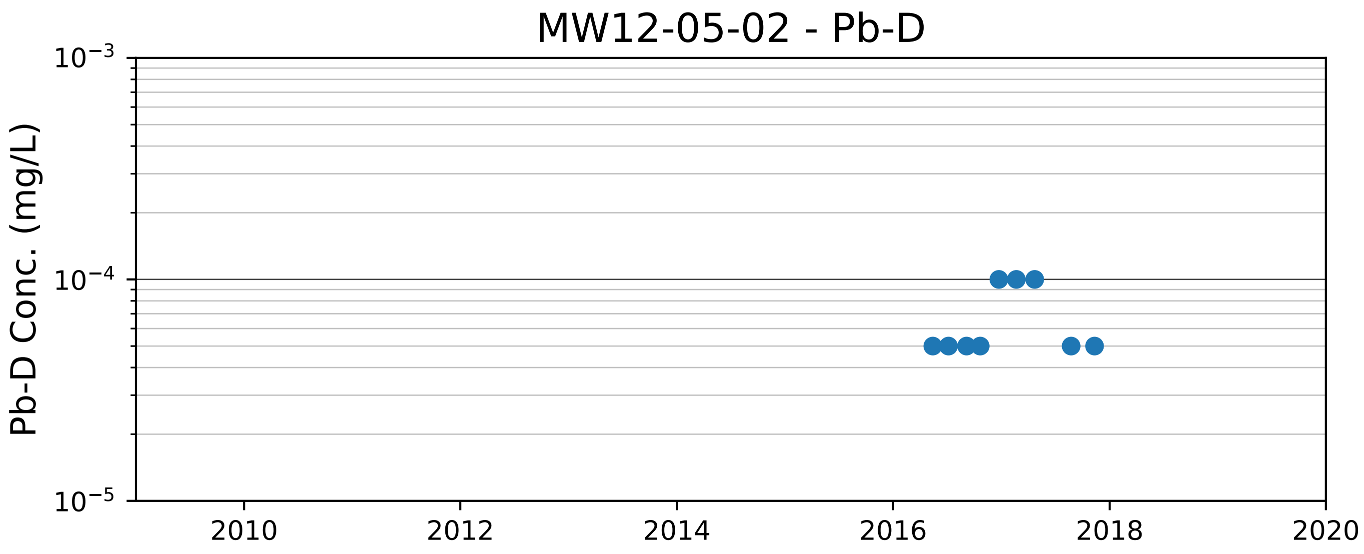

MW12-05-02 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

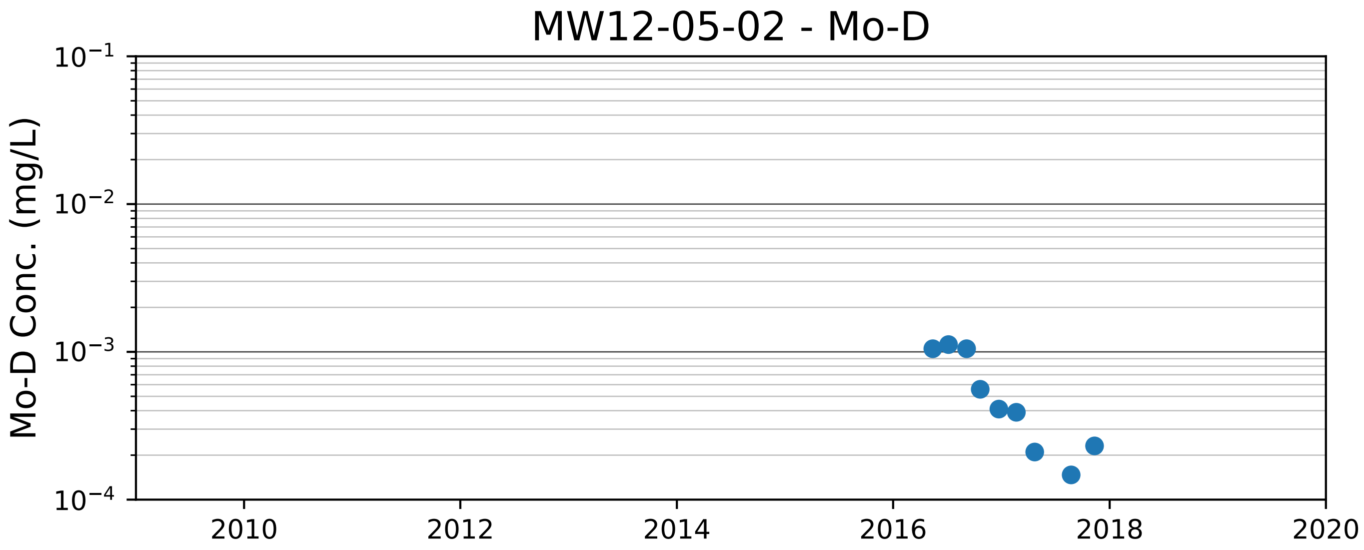

MW12-05-02 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

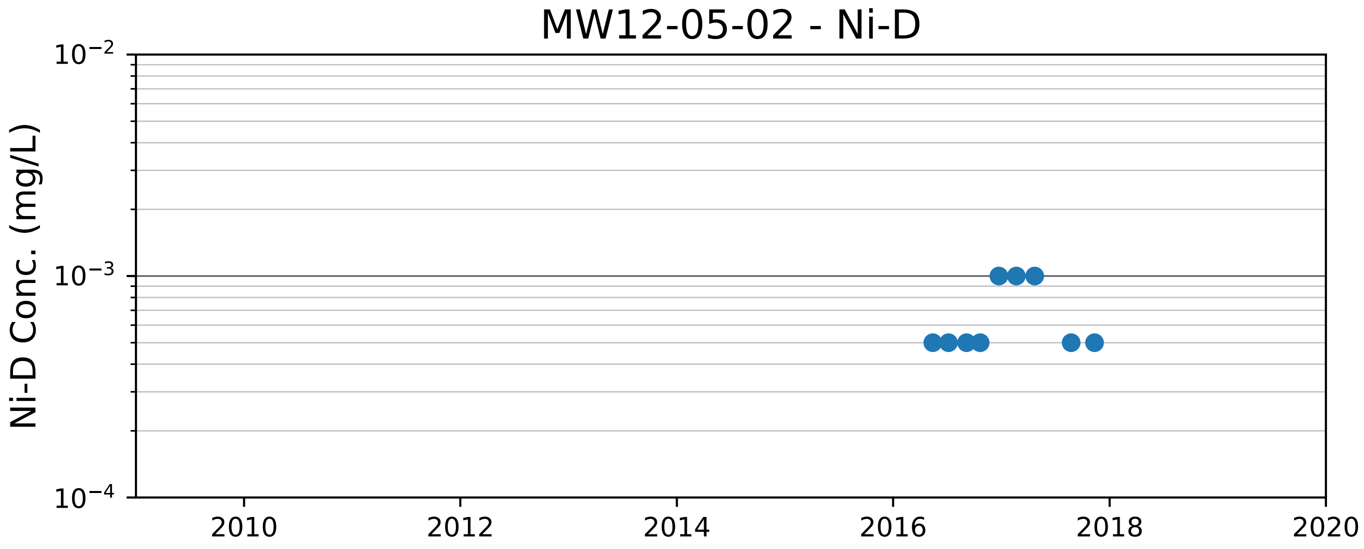

MW12-05-02 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

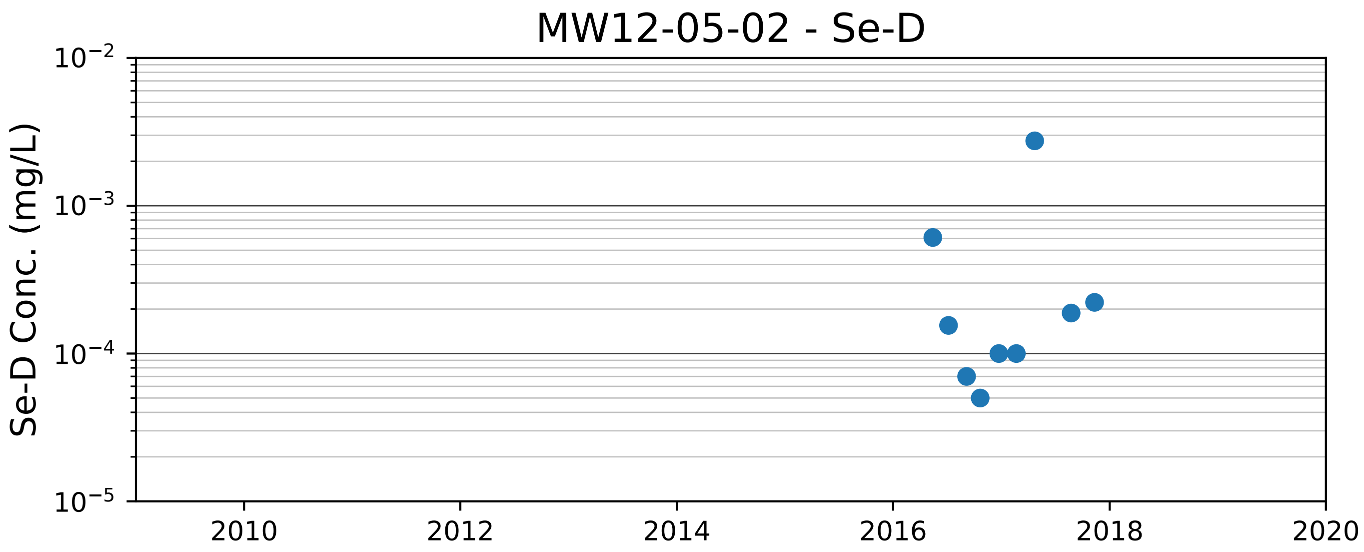

MW12-05-02 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

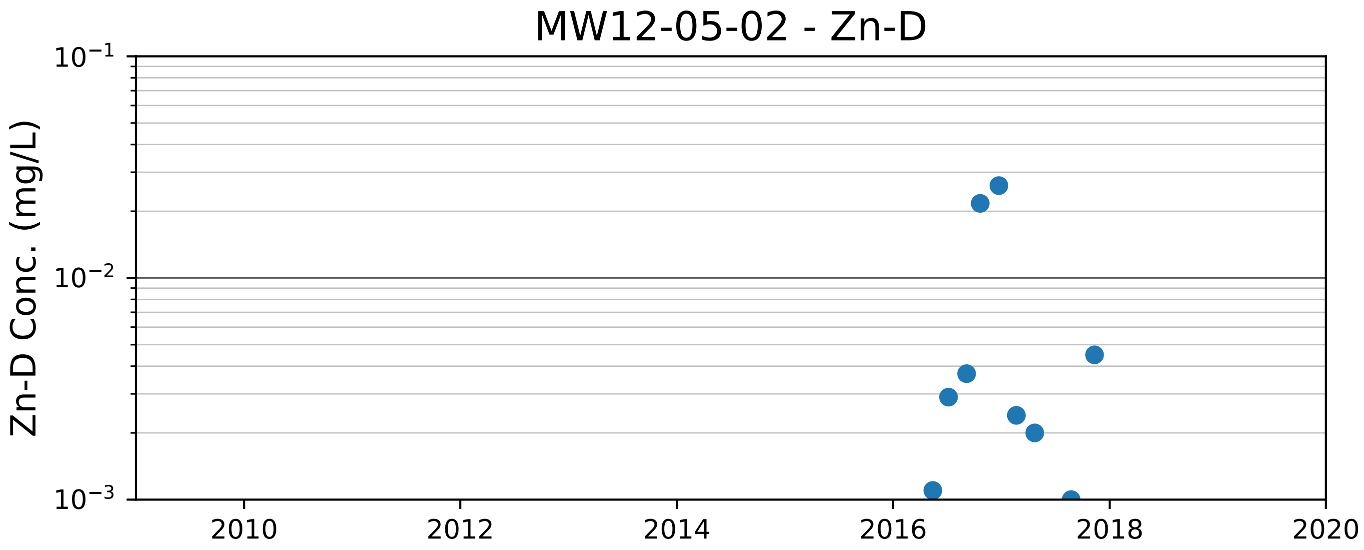

MW12-05-02 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

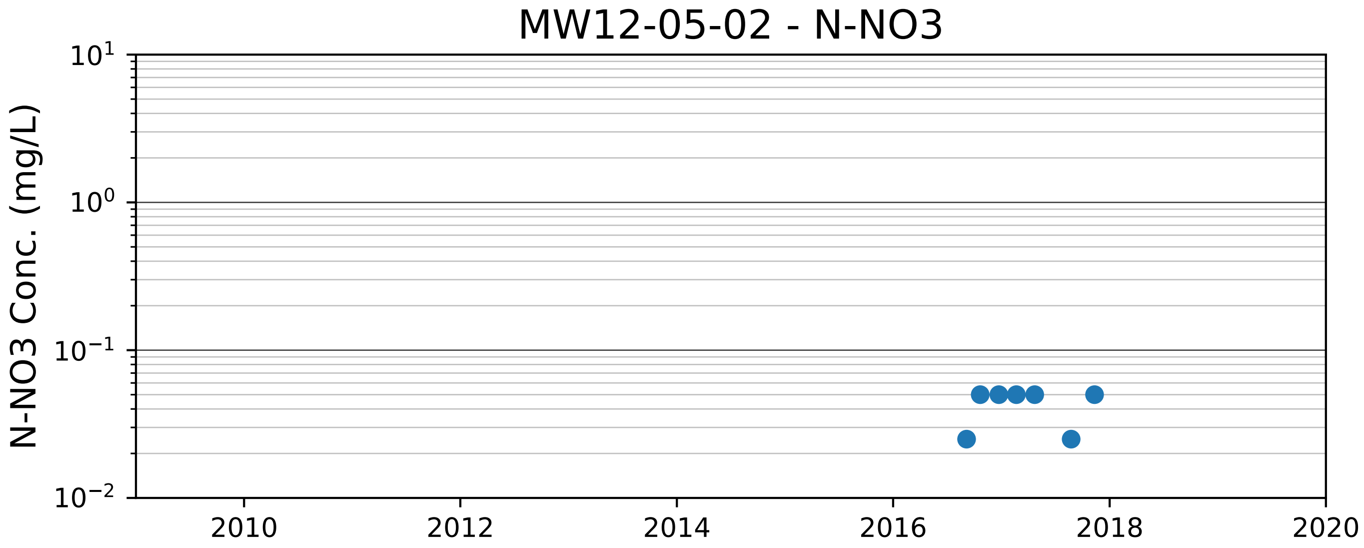

MW12-05-02 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

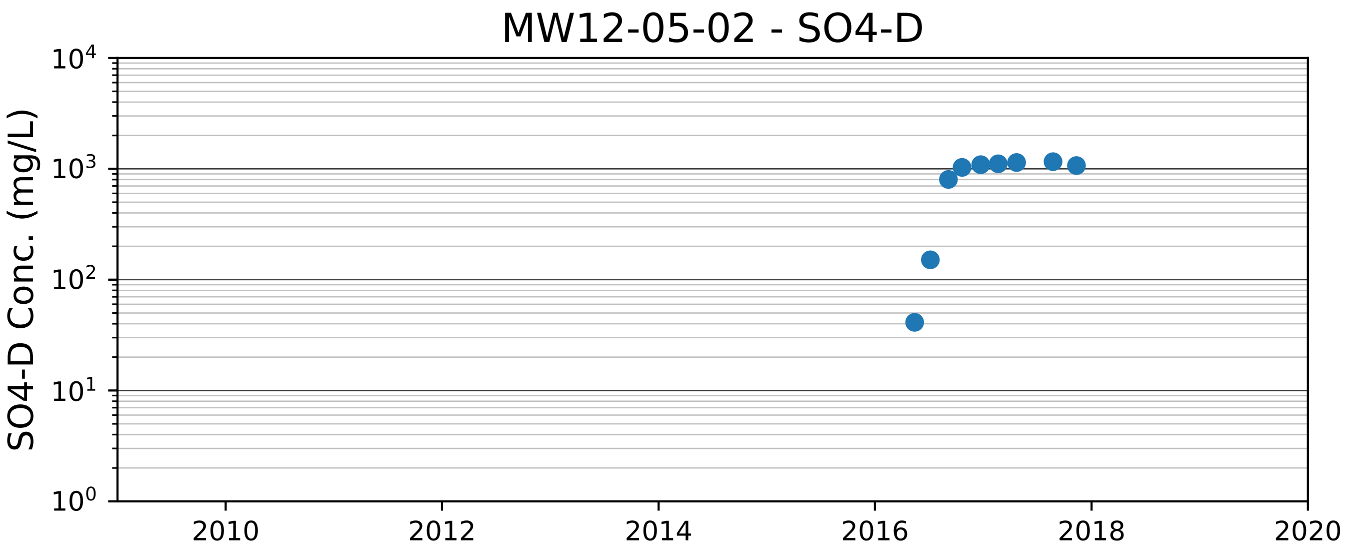

MW12-05-02 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

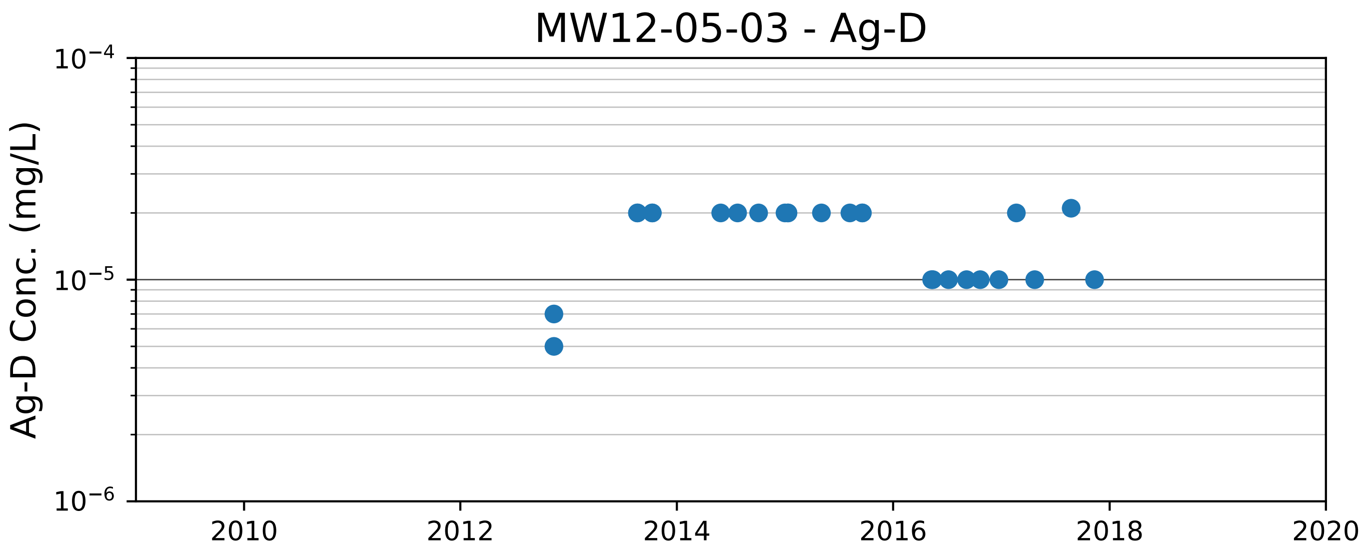

MW12-05-02 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

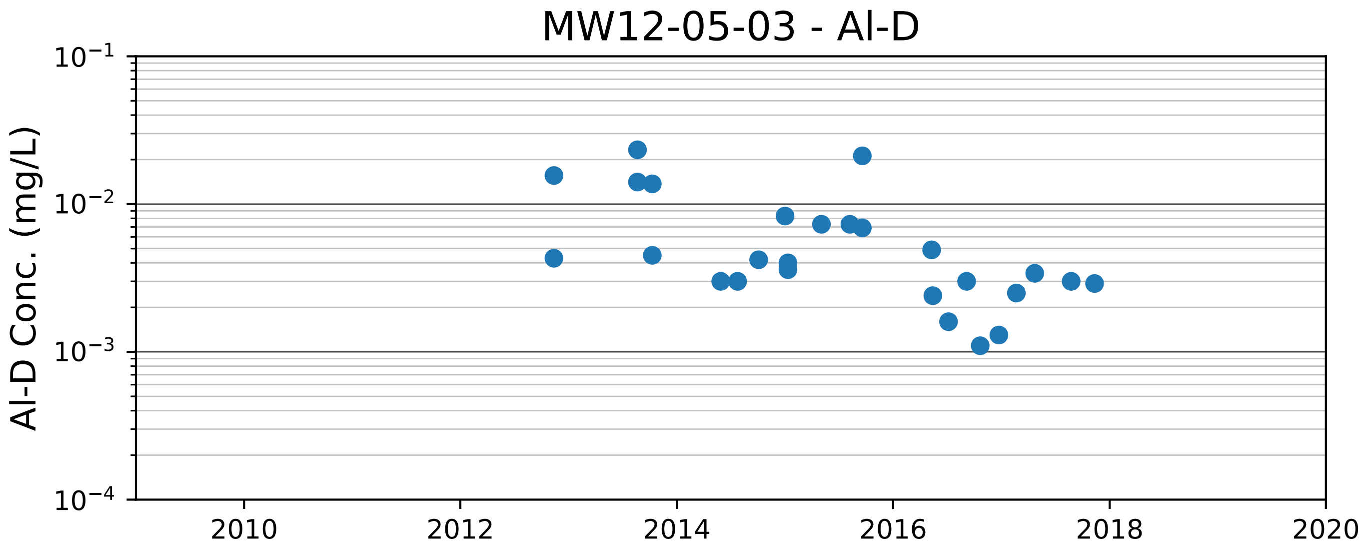

MW12-05-02 - Se-D

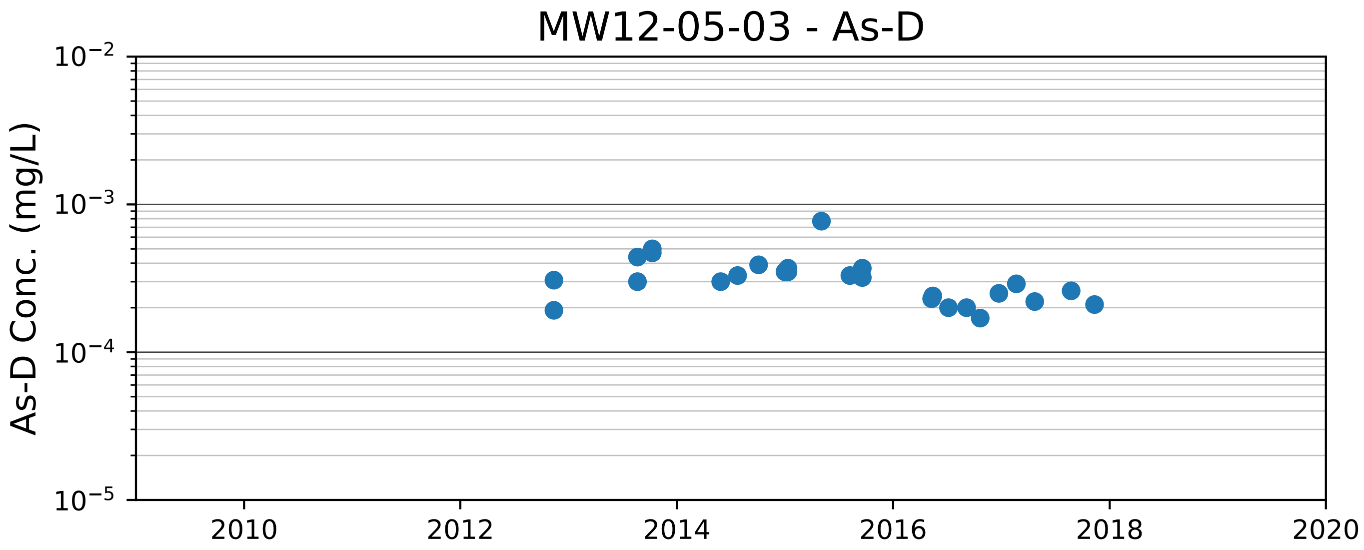

MW12-05-02 - Zn-D

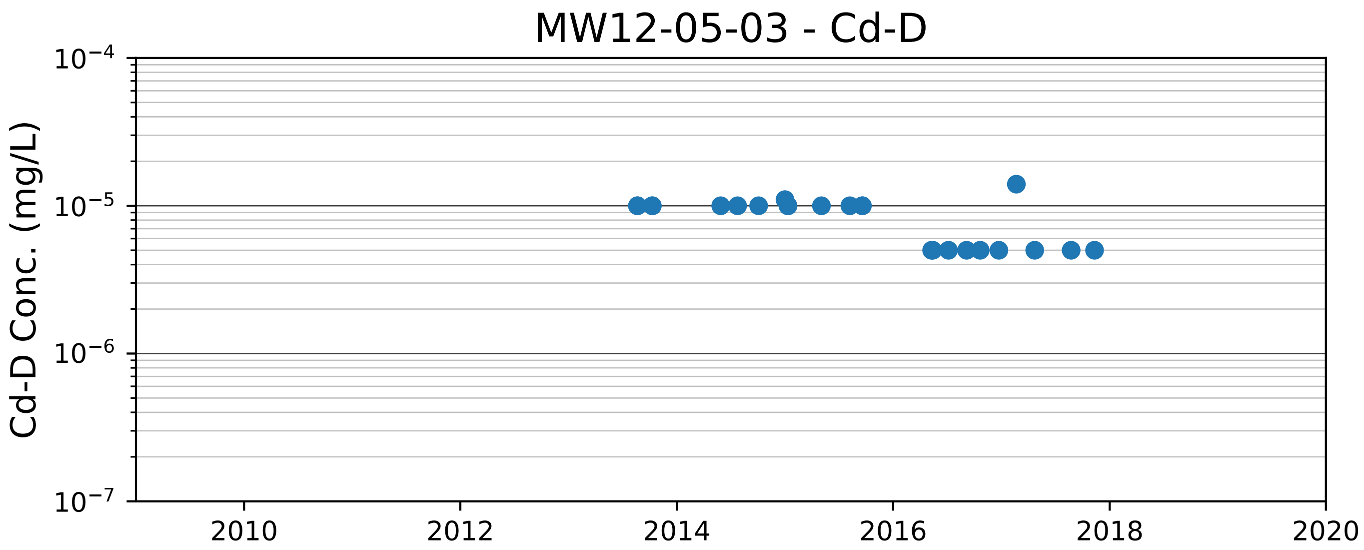

MW12-05-02 - N-NO3

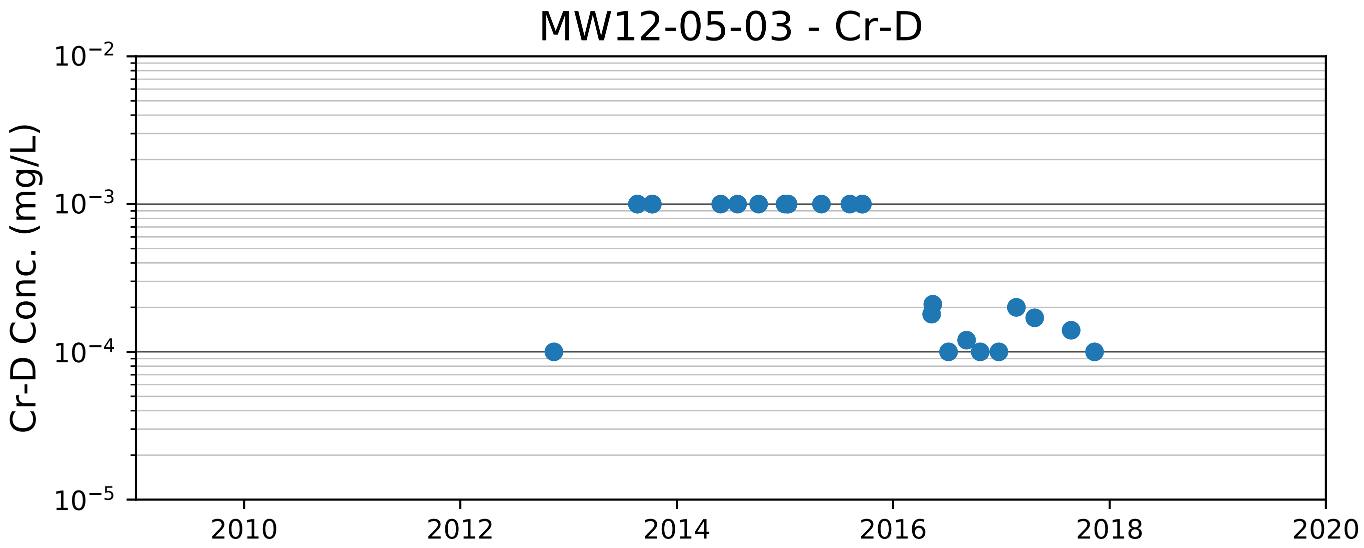

MW12-05-02 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

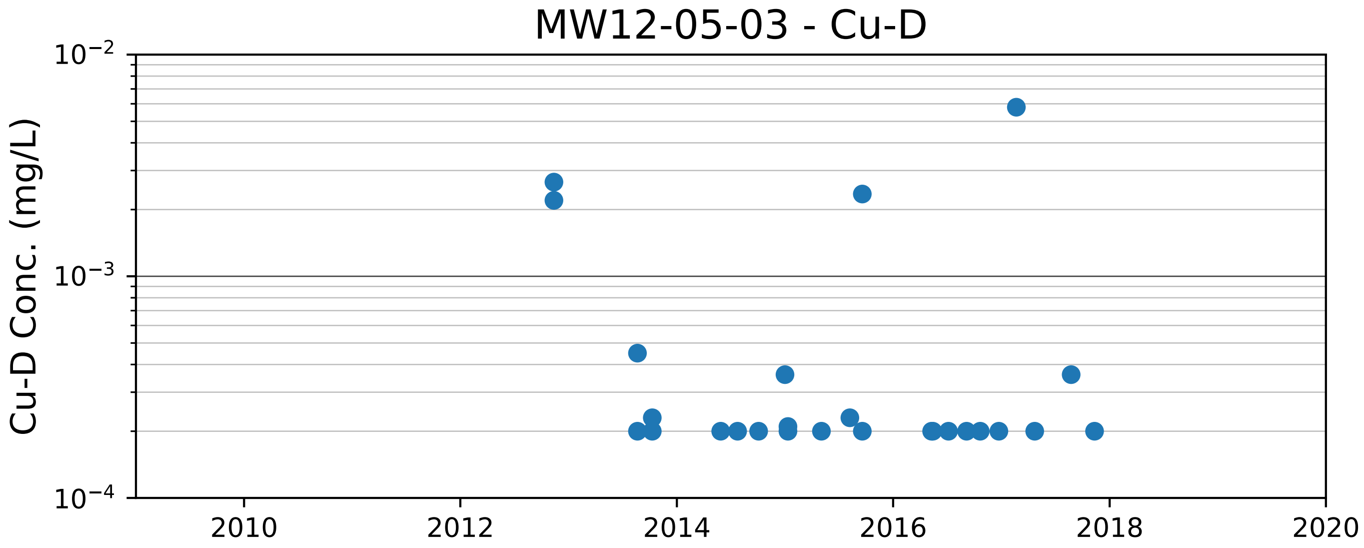

MW12-05-03 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

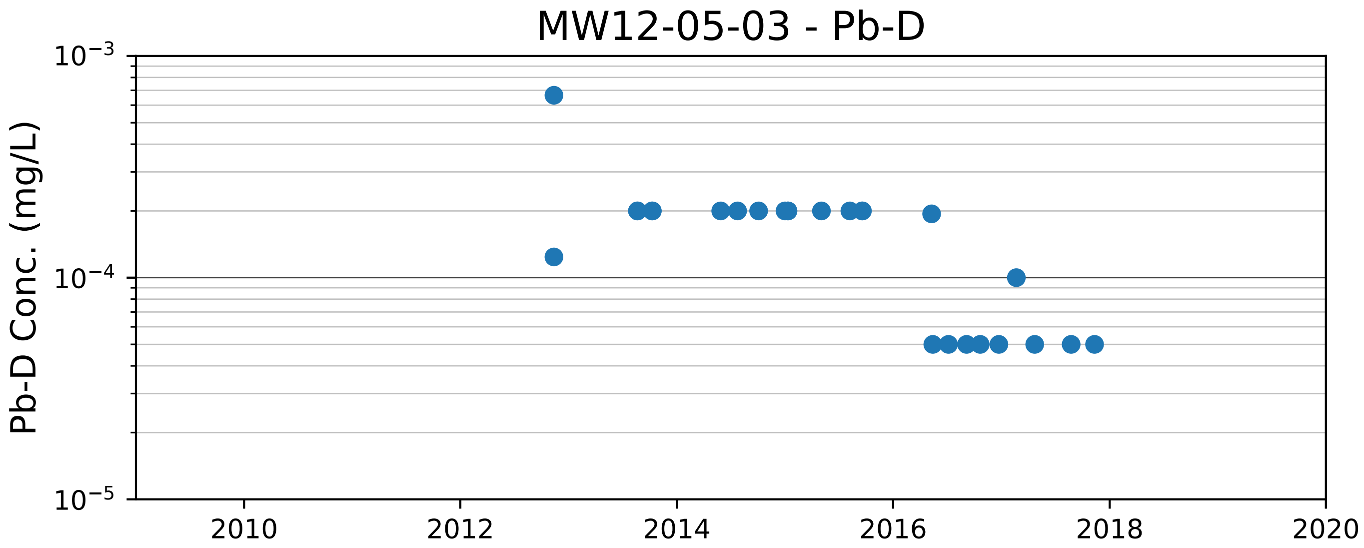

MW12-05-03 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

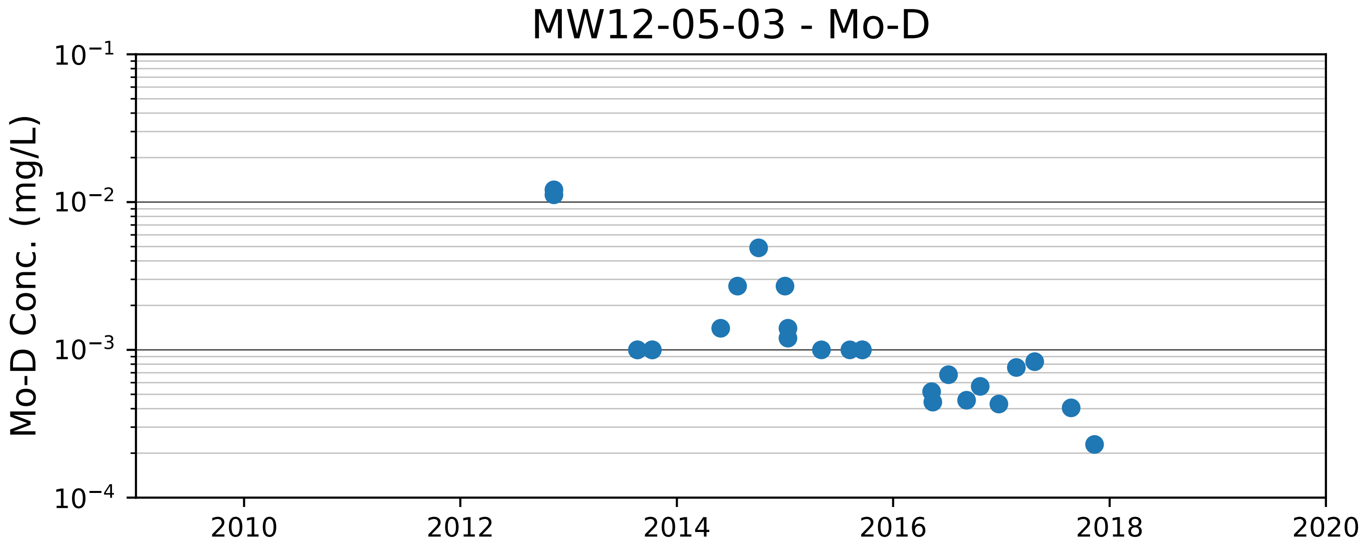

MW12-05-03 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

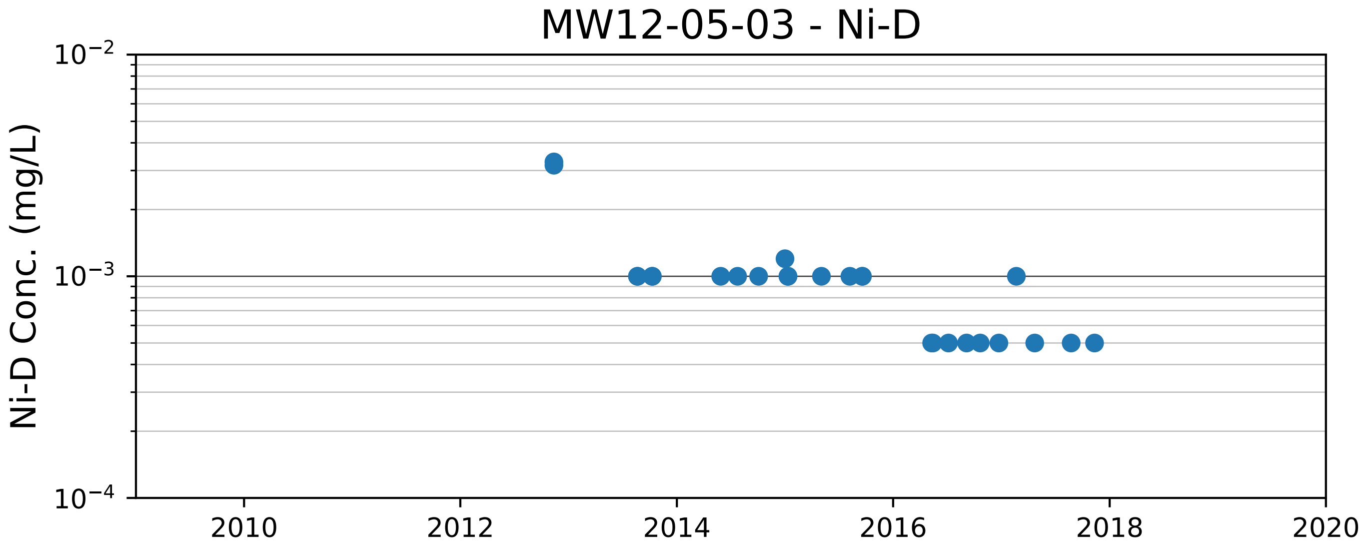

MW12-05-03 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

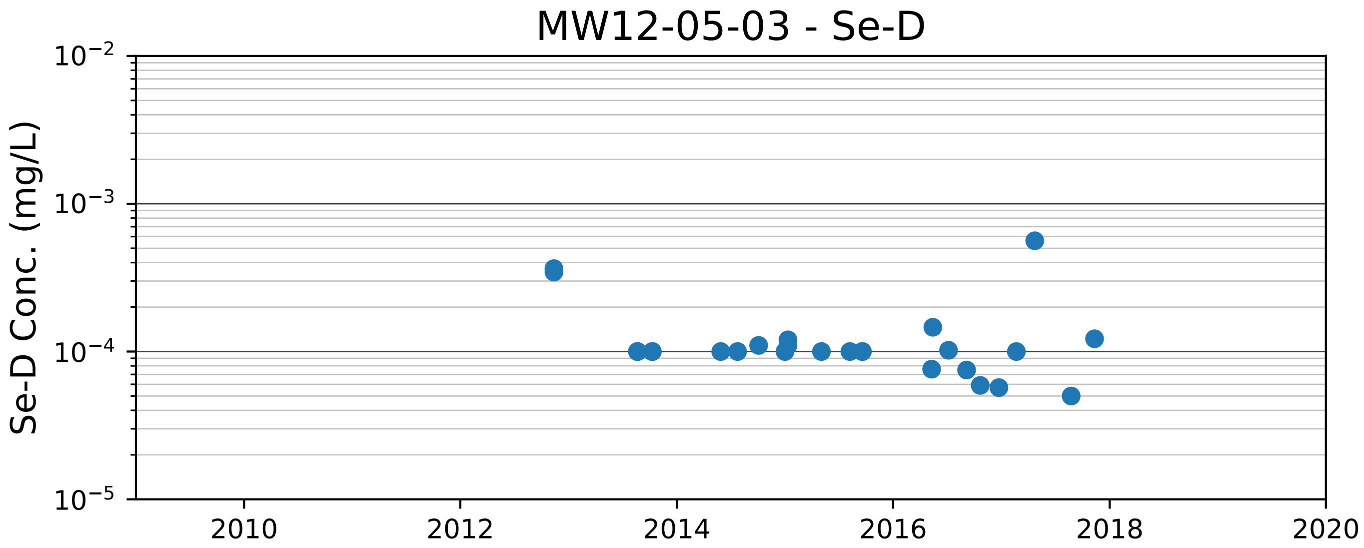

MW12-05-03 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

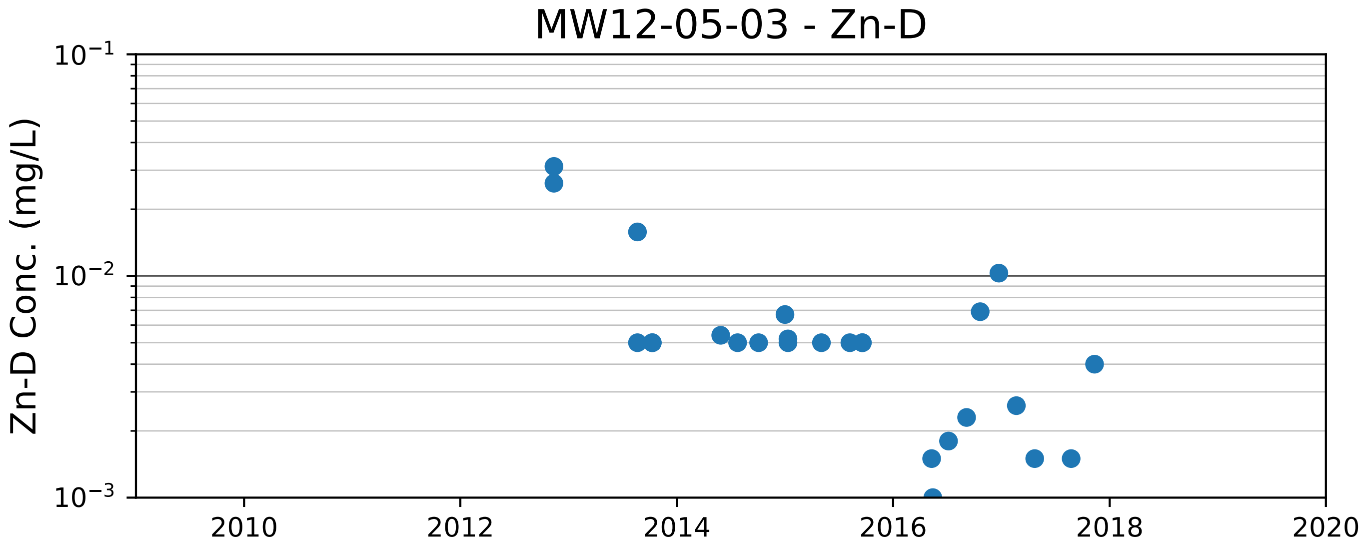

MW12-05-03 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

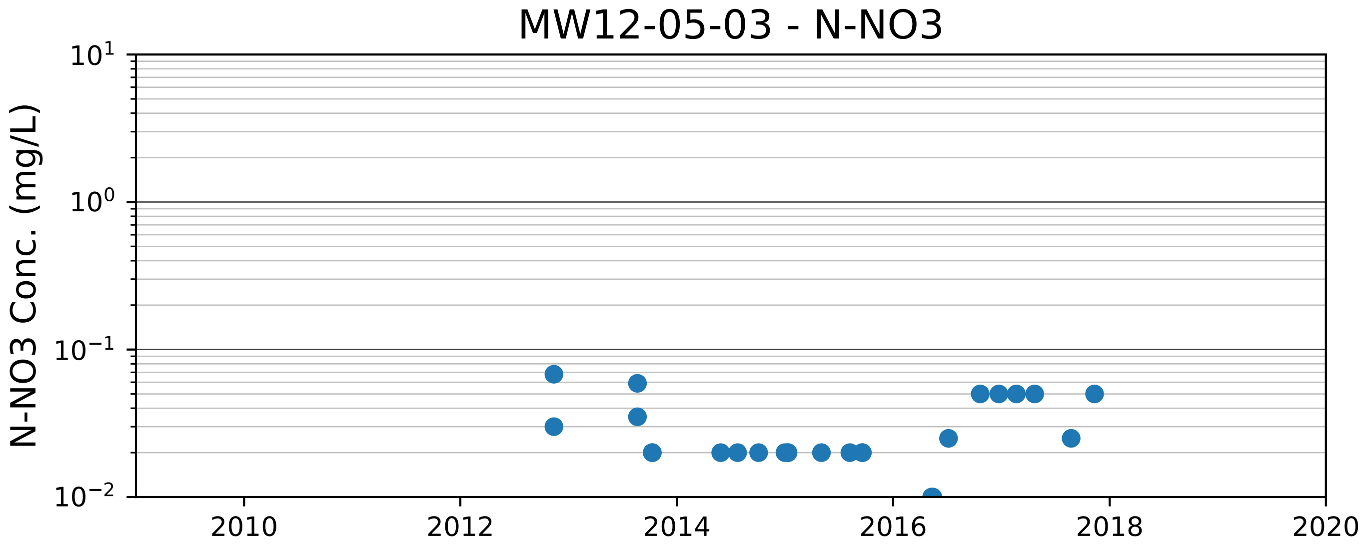

MW12-05-03 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

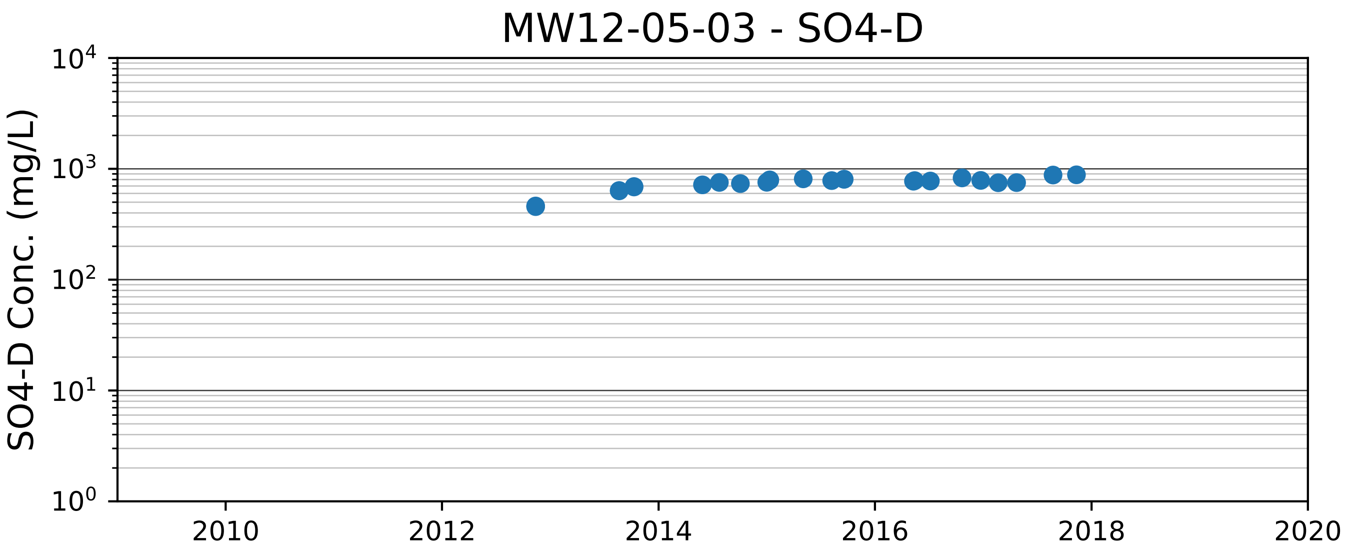

MW12-05-03 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020


MW12-05-03 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

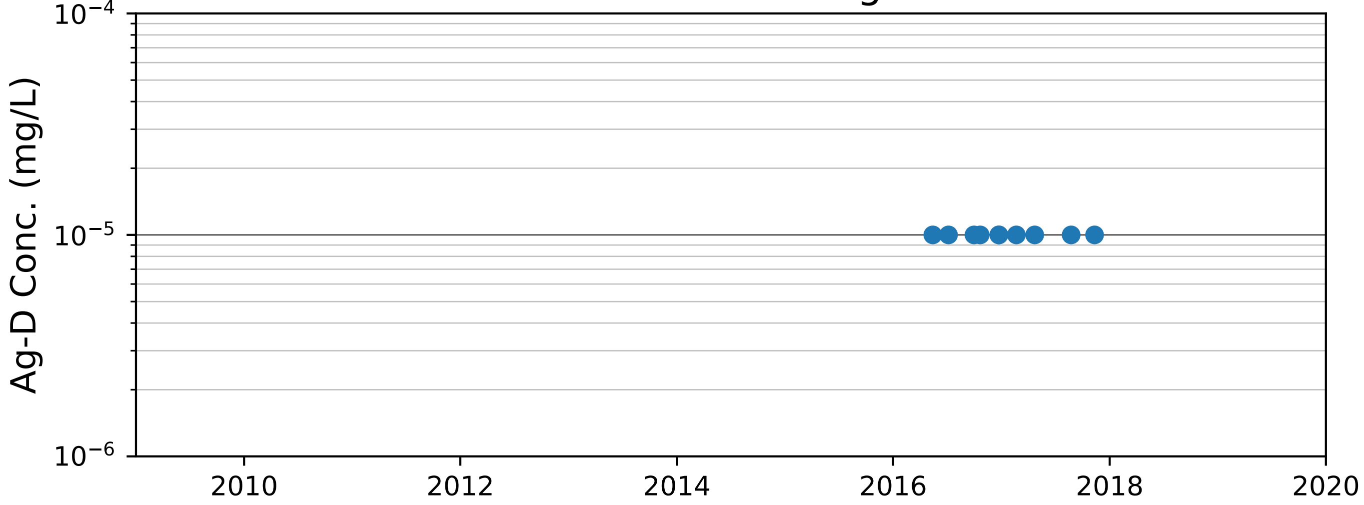

MW12-05-03 - Se-D


MW12-05-03 - Zn-D

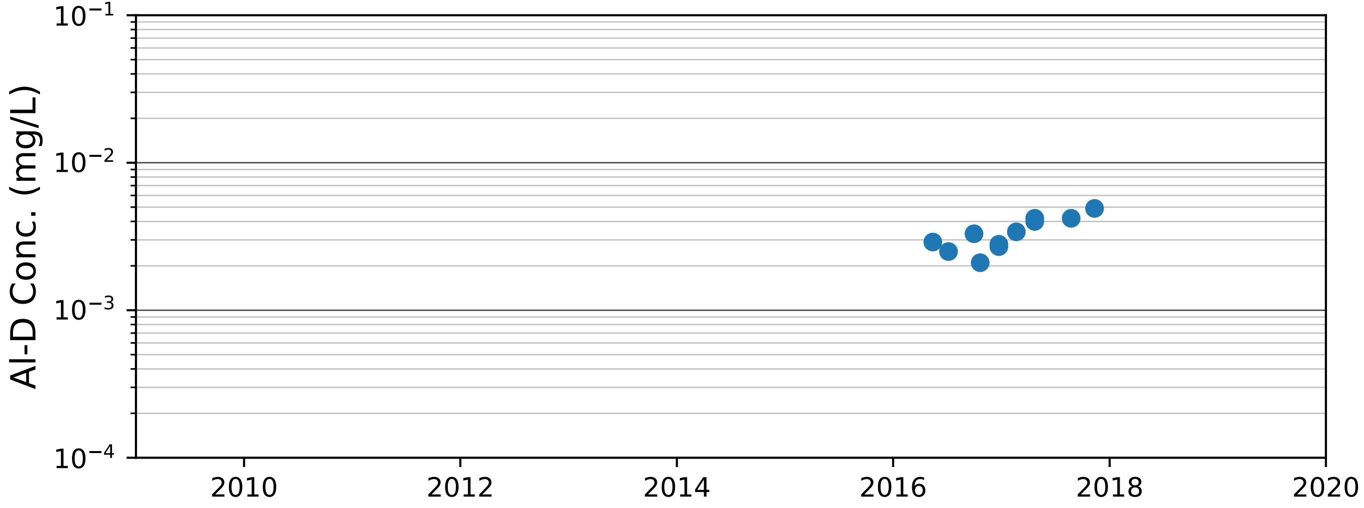

MW12-05-03 - N-NO3


MW12-05-03 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

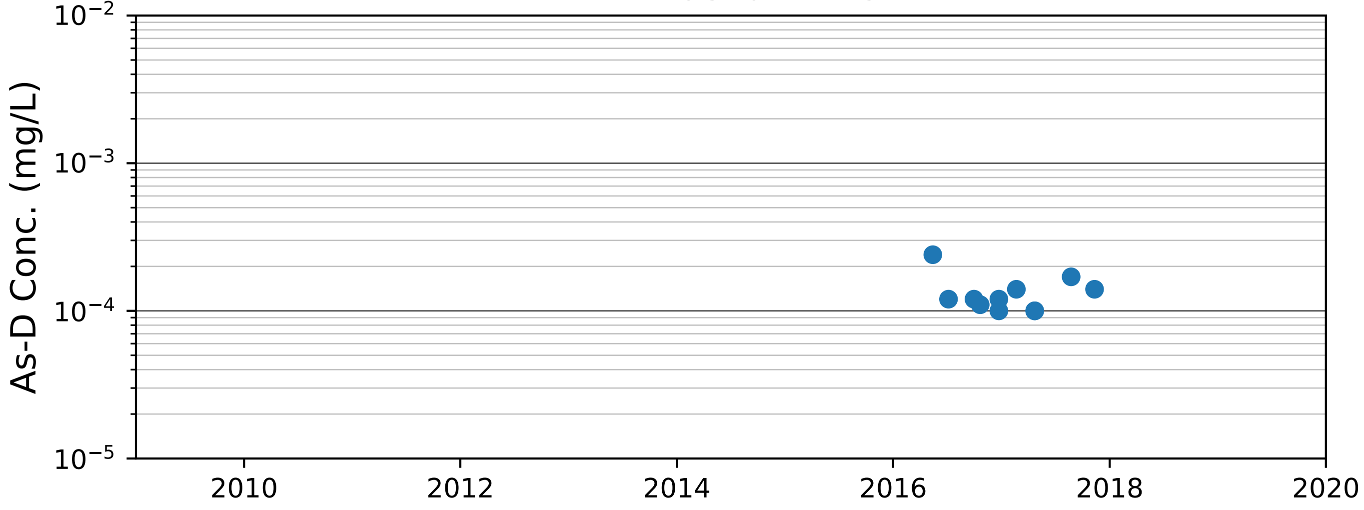
MW12-05-04 - Ag-D

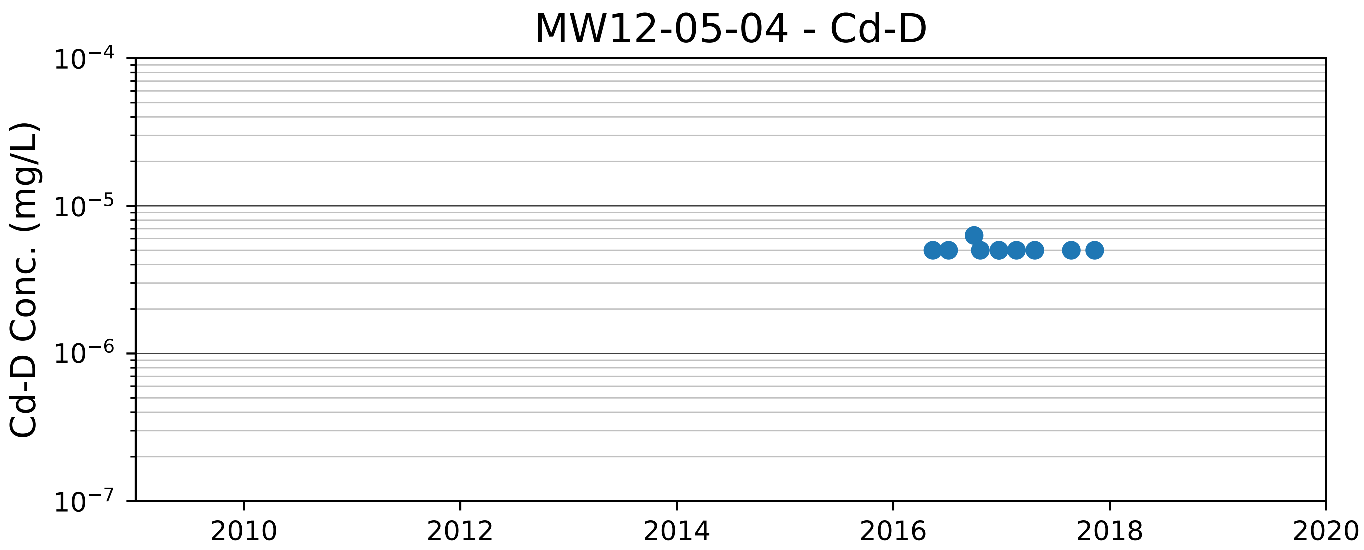


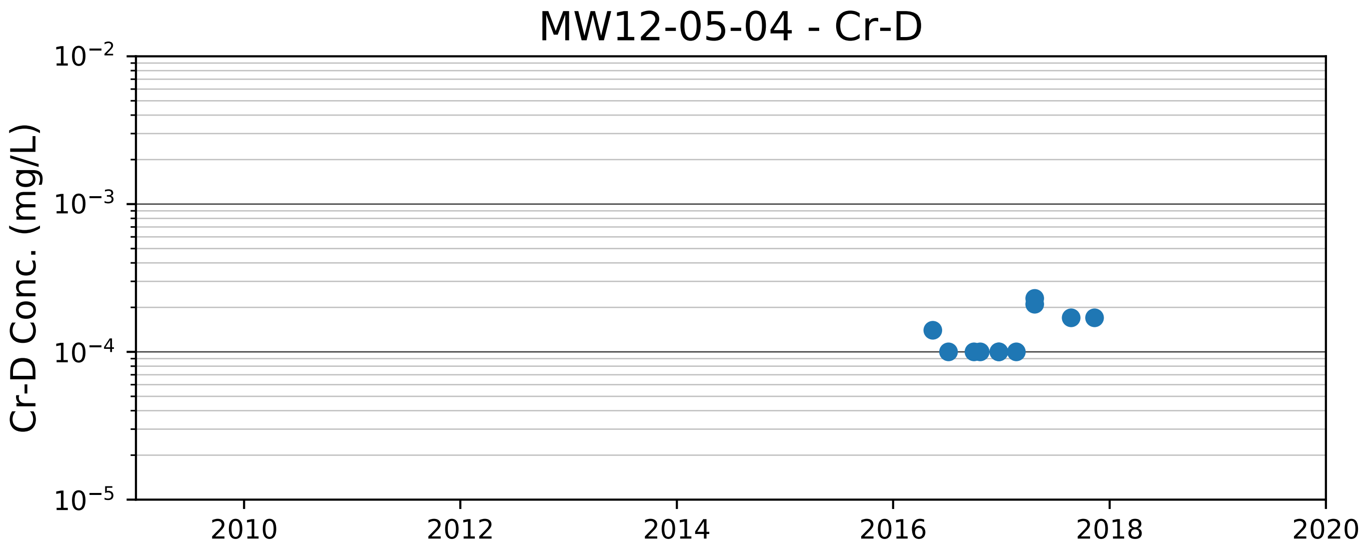
MW12-05-04 - Al-D

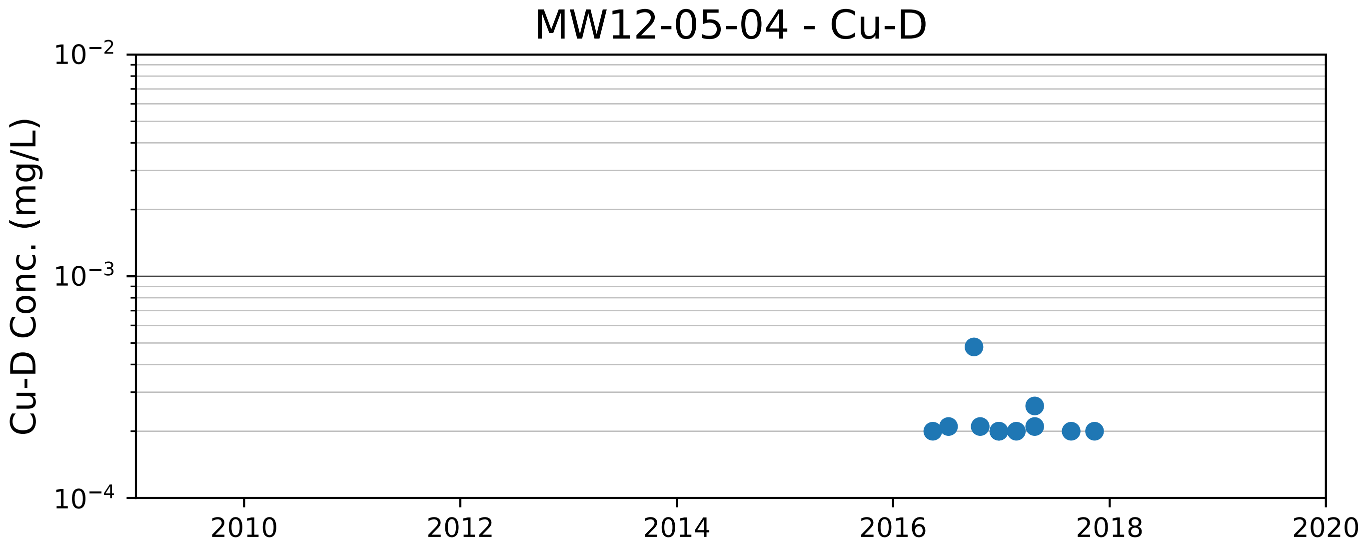


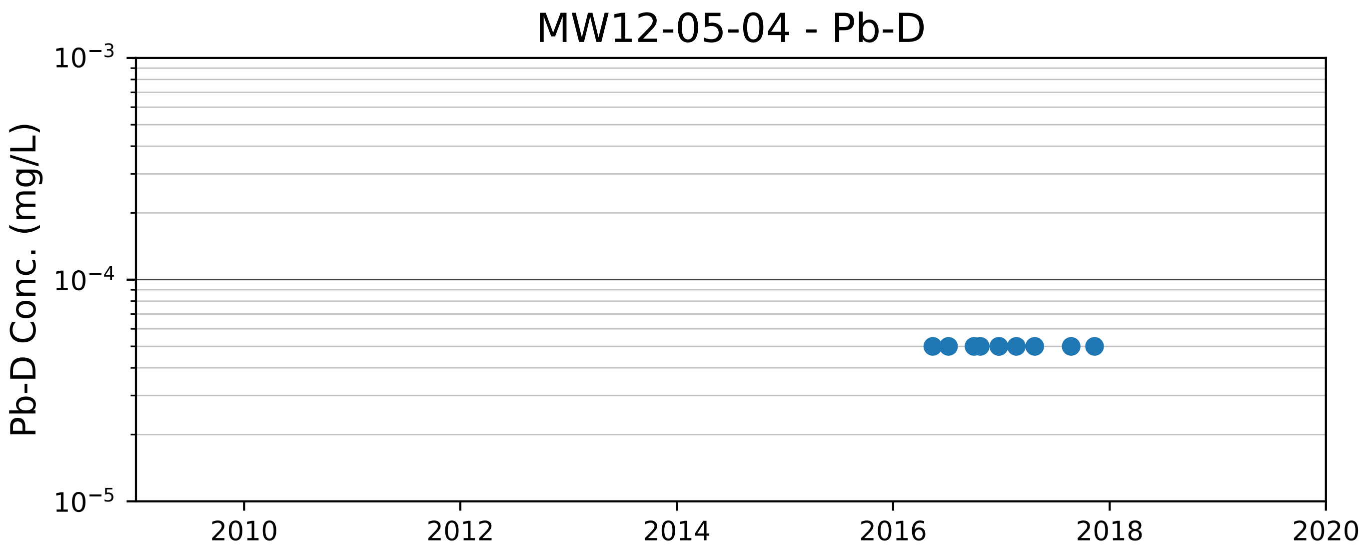
MW12-05-04 - As-D

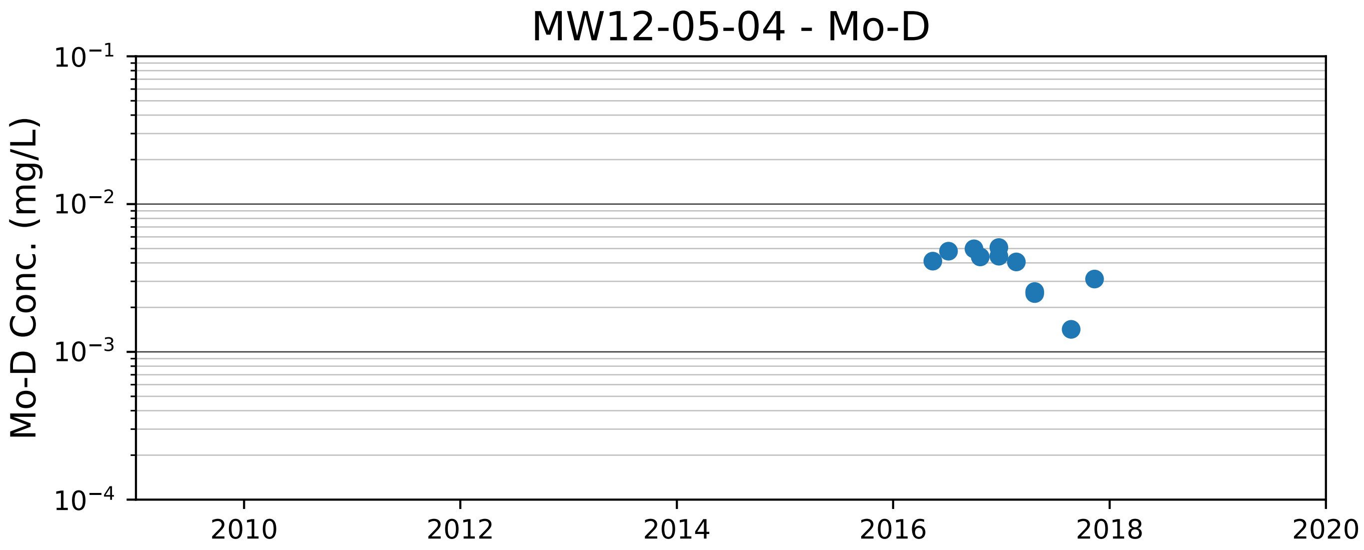


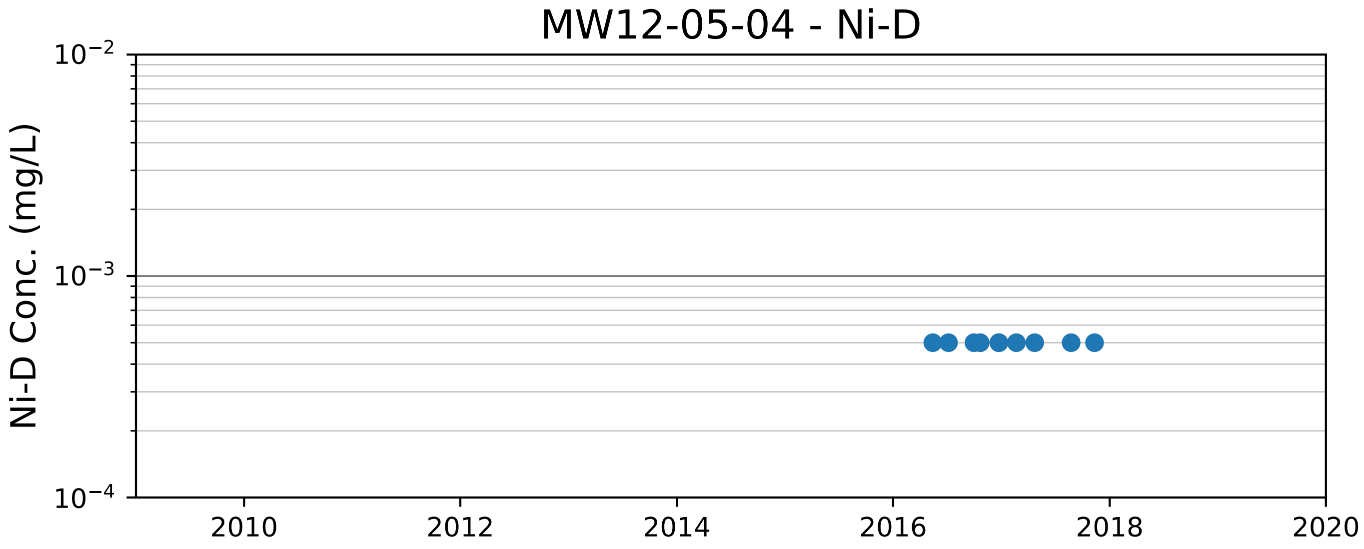

MW12-05-04 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

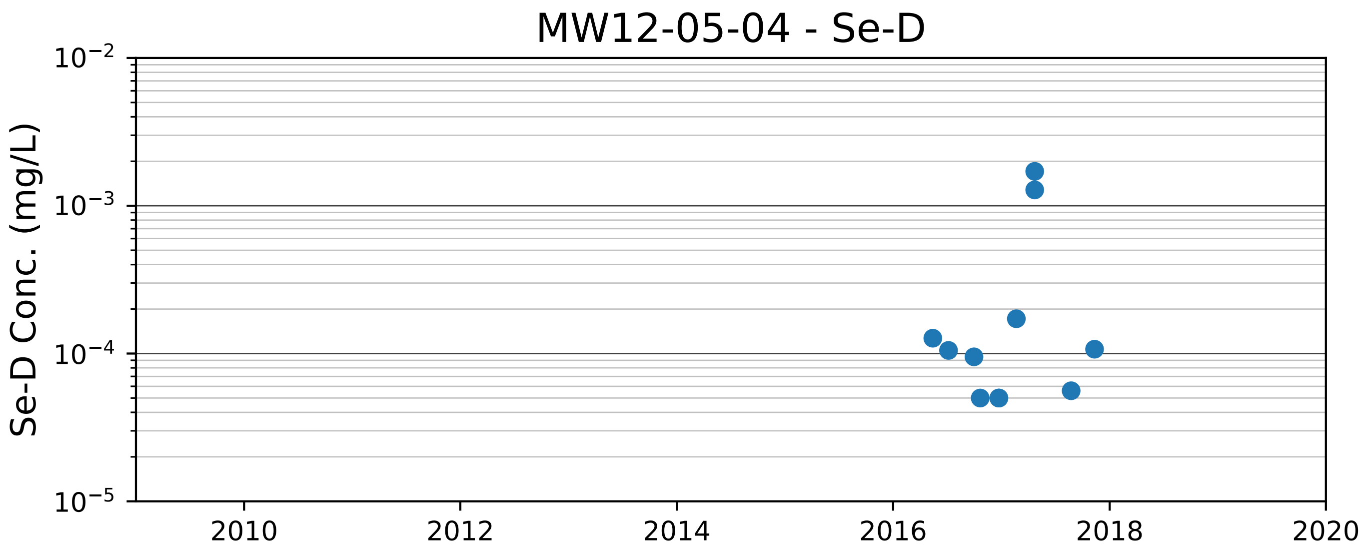

MW12-05-04 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

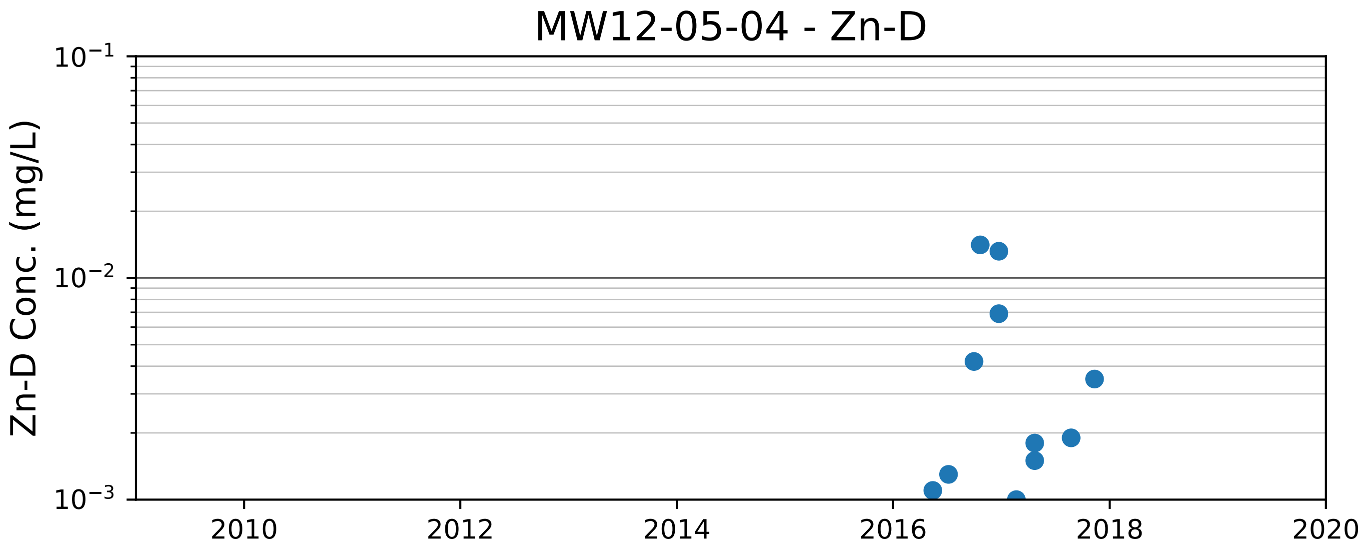

MW12-05-04 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

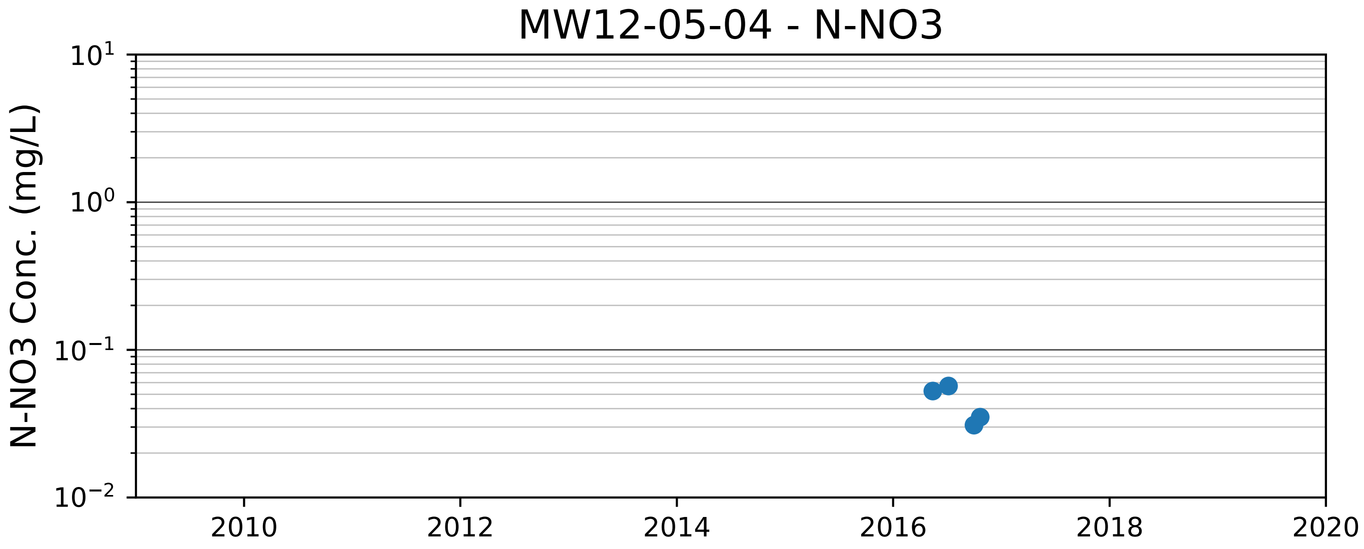

MW12-05-04 - Pb-D

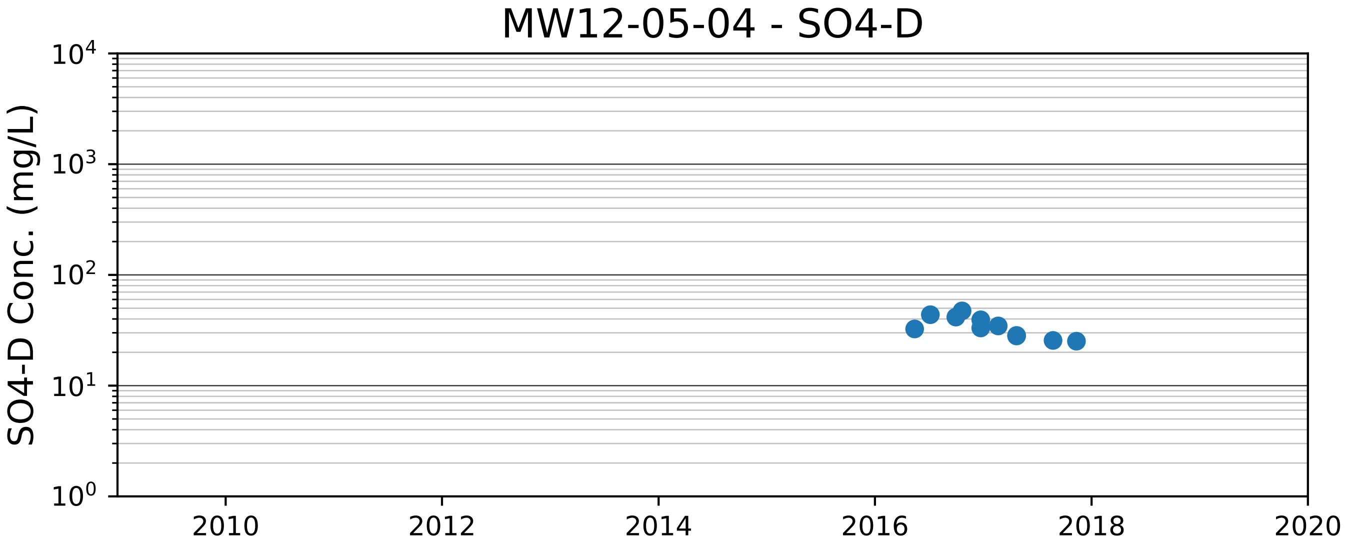

MW12-05-04 - Mo-D

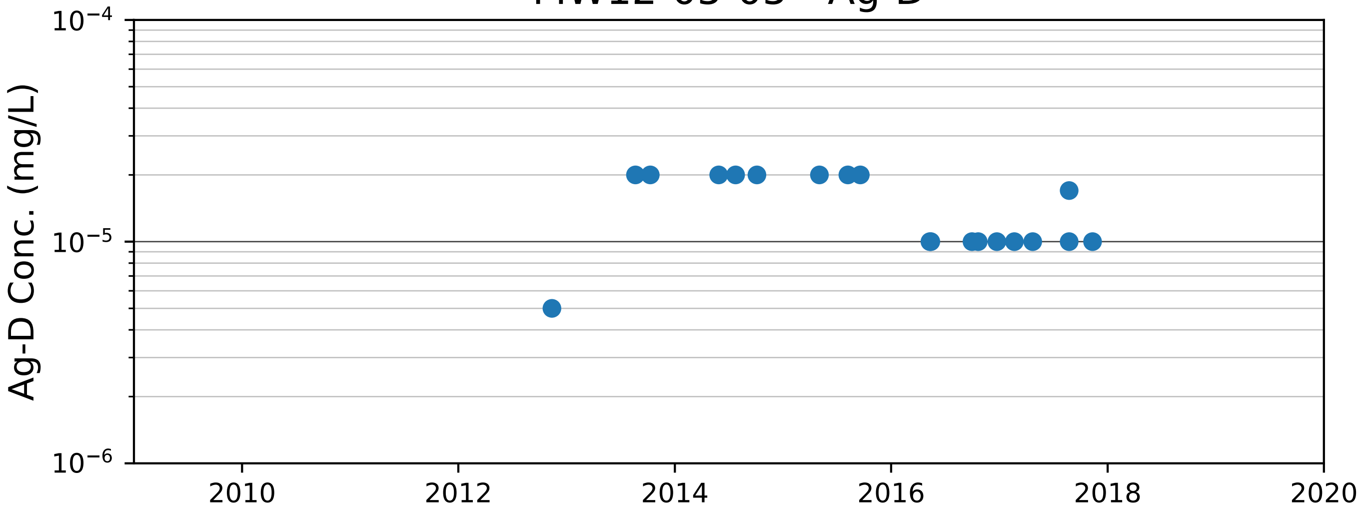

MW12-05-04 - Ni-D


MW12-05-04 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

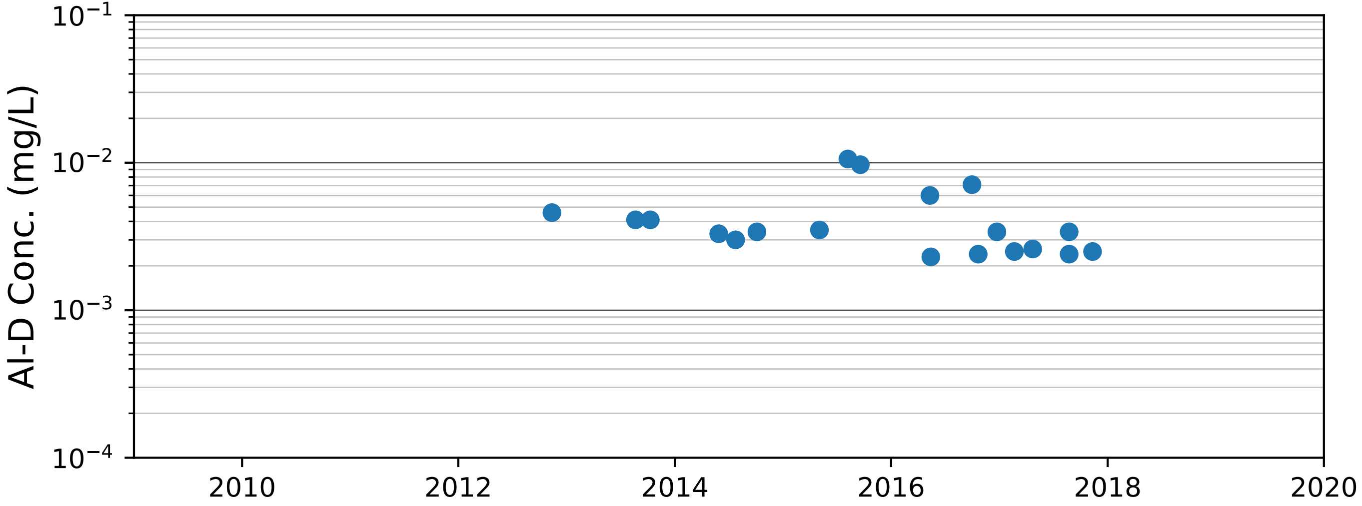

MW12-05-04 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020


MW12-05-04 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

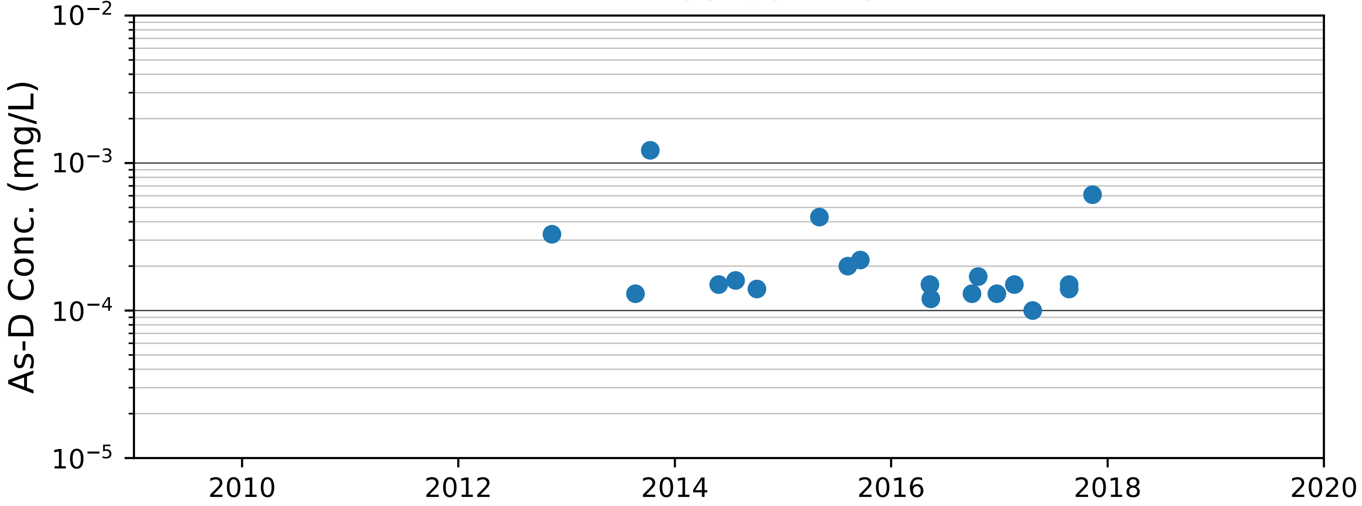

MW12-05-04 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020



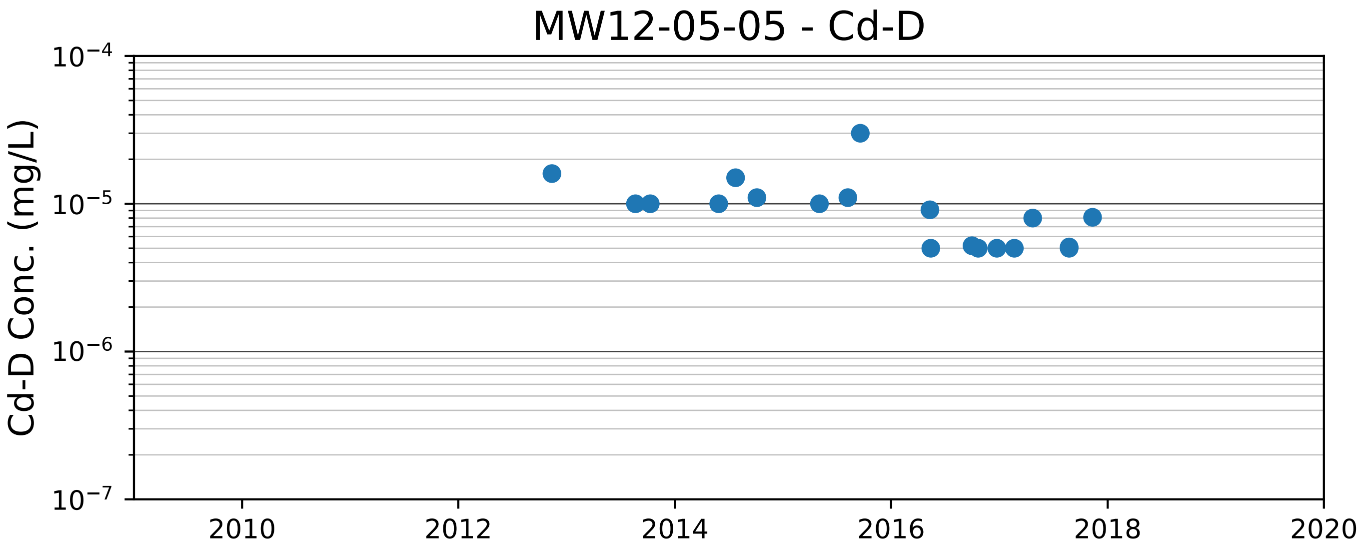
MW12-05-05 - Ag-D

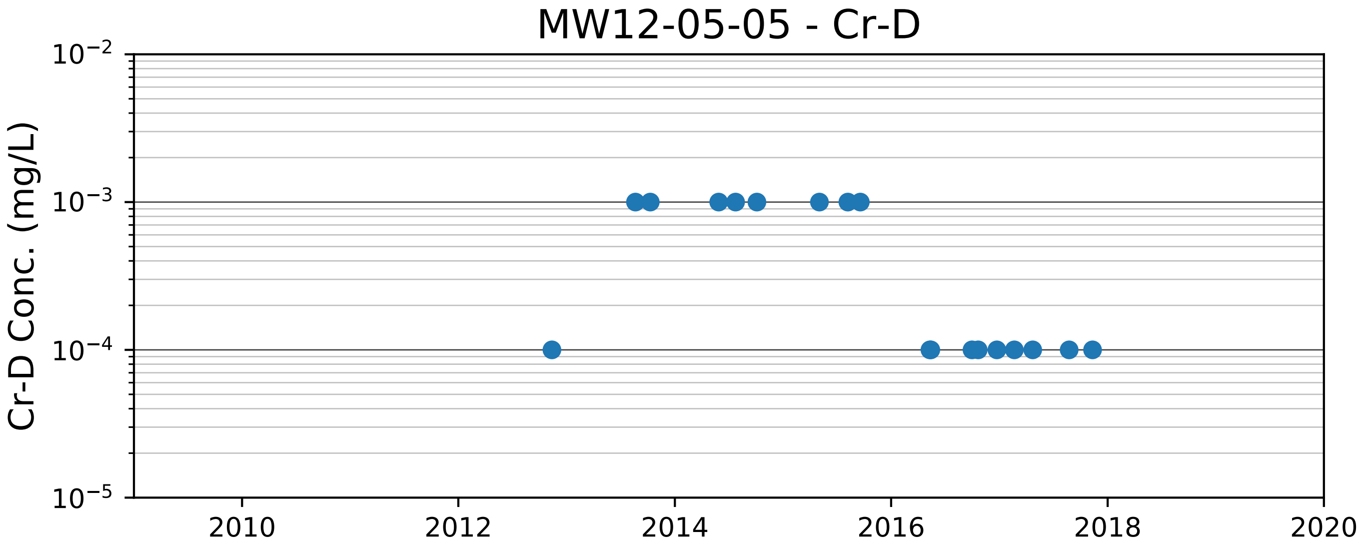


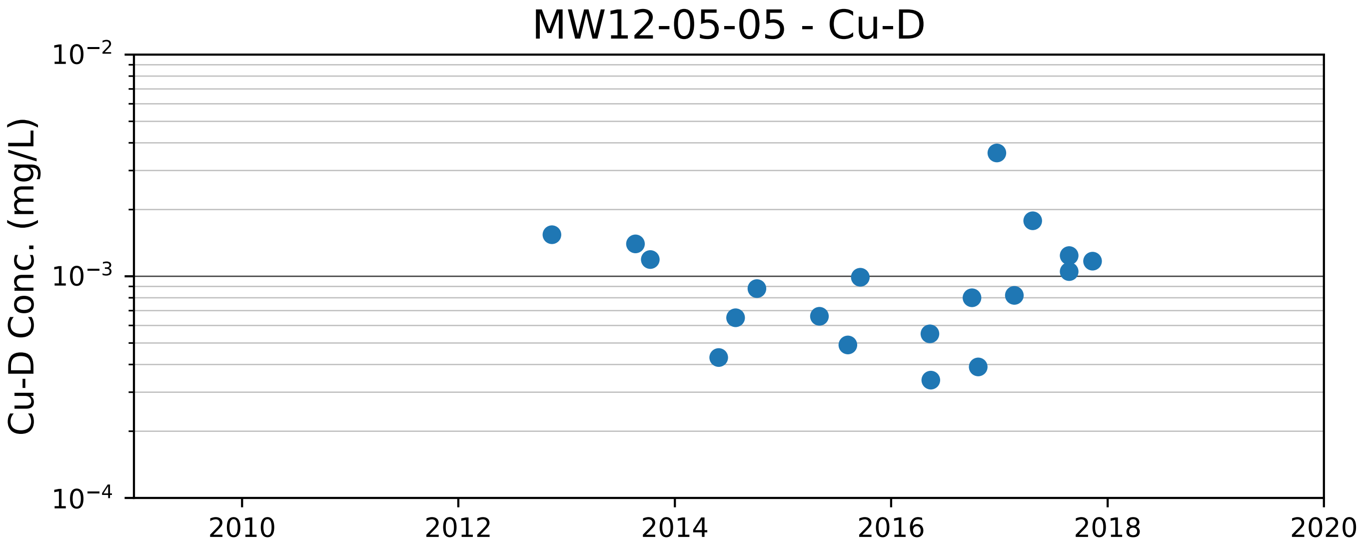
MW12-05-05 - Al-D

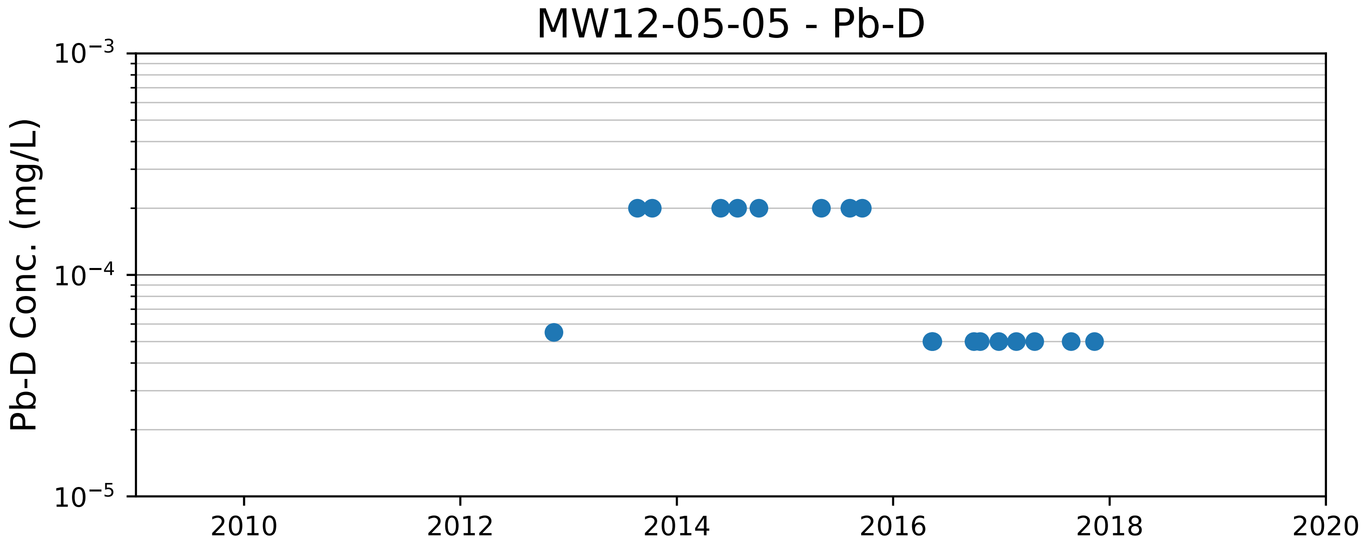


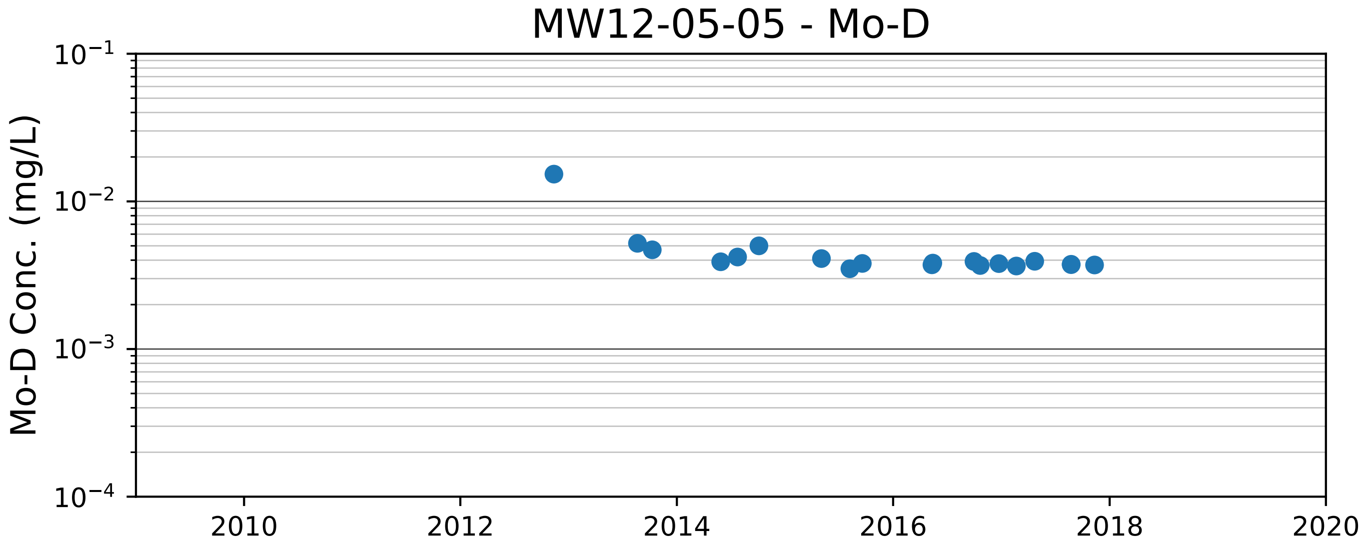
MW12-05-05 - As-D

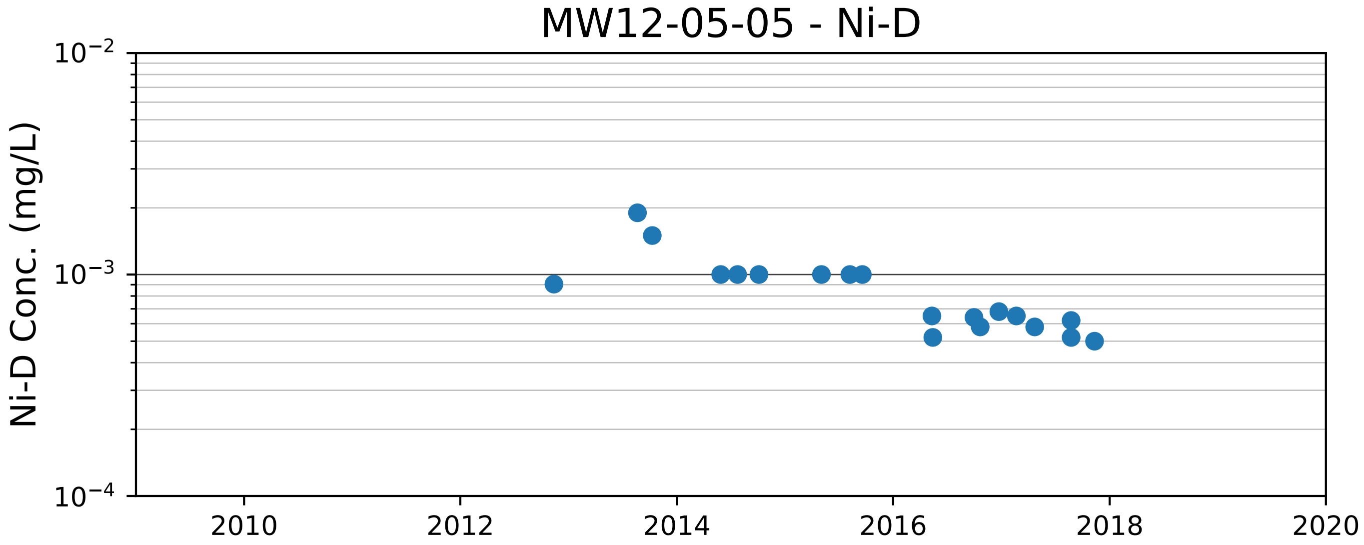

MW12-05-05 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

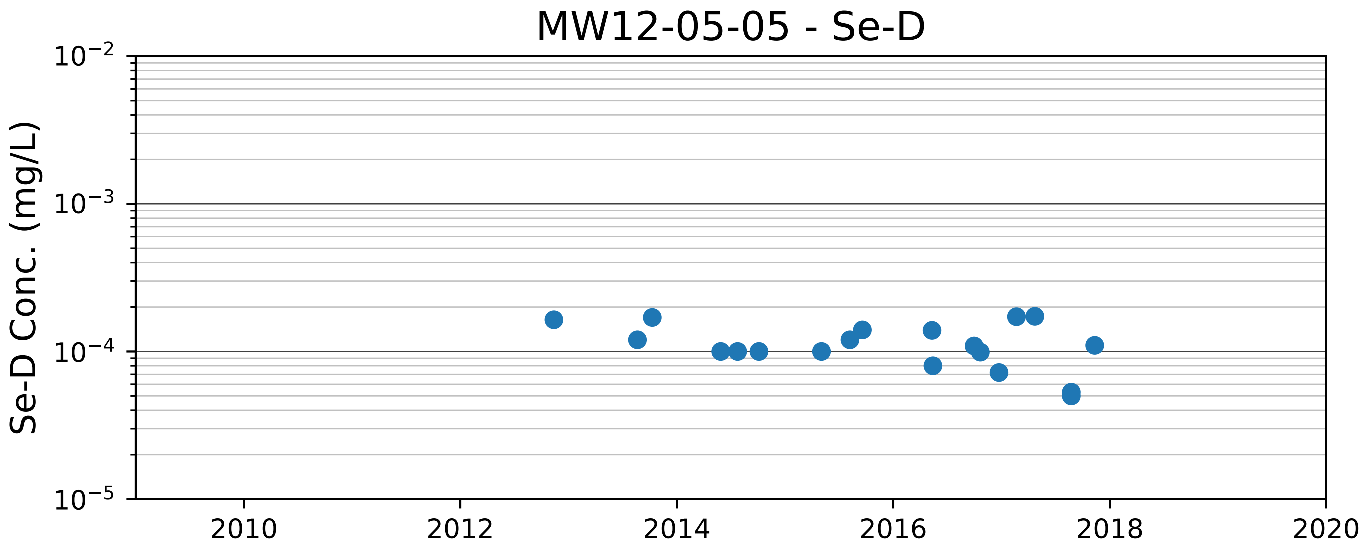

MW12-05-05 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

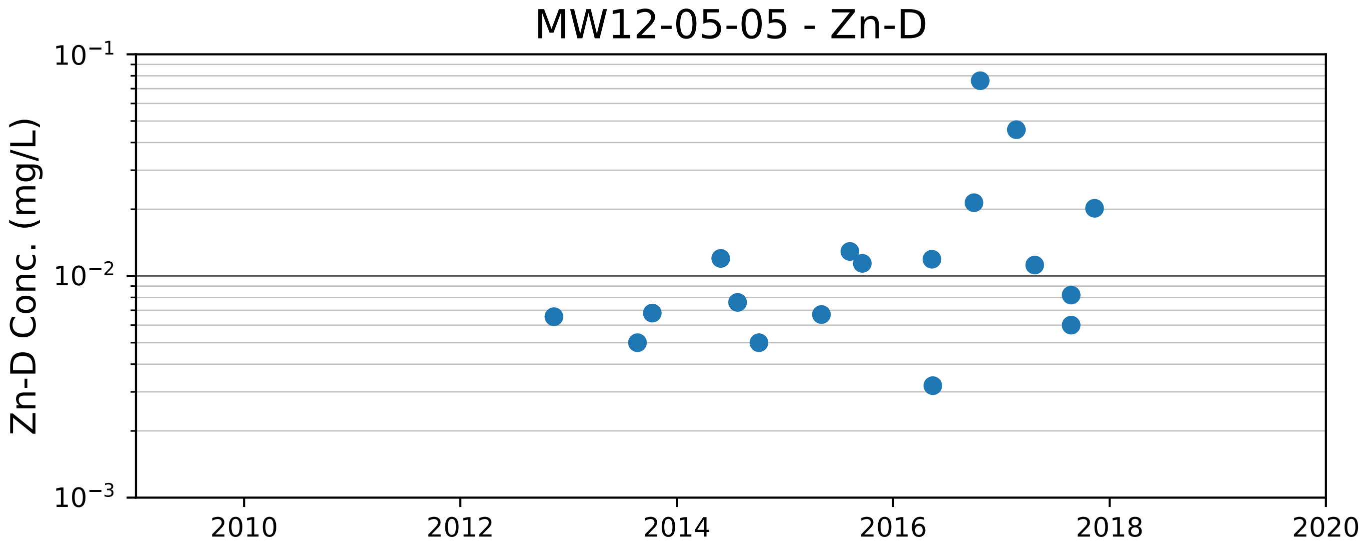

MW12-05-05 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

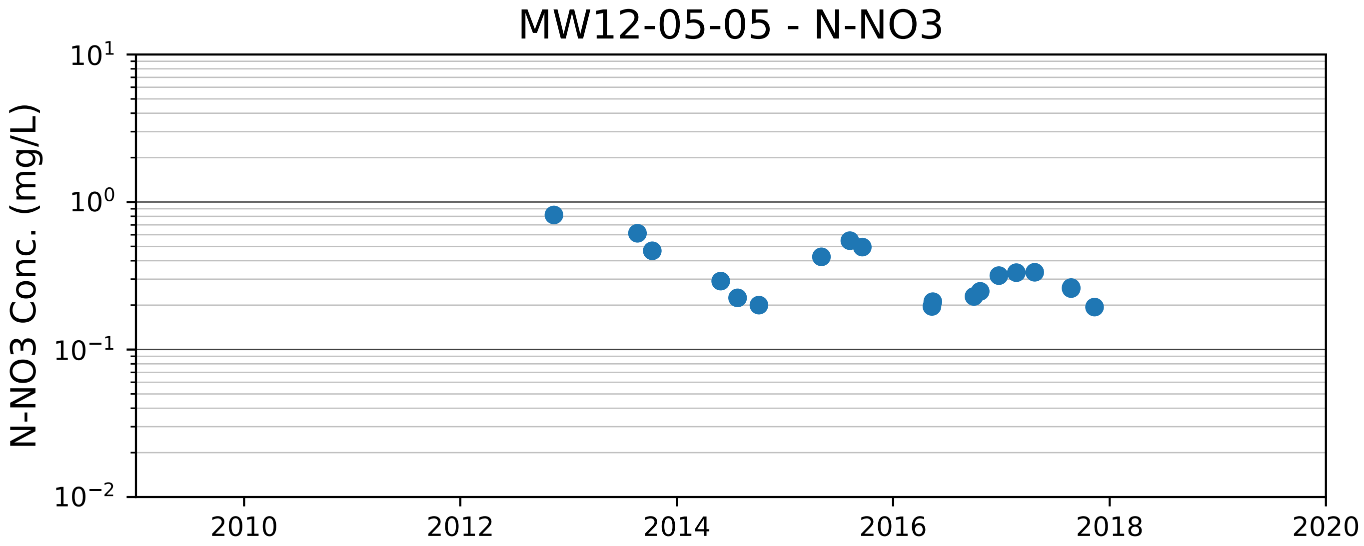

MW12-05-05 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

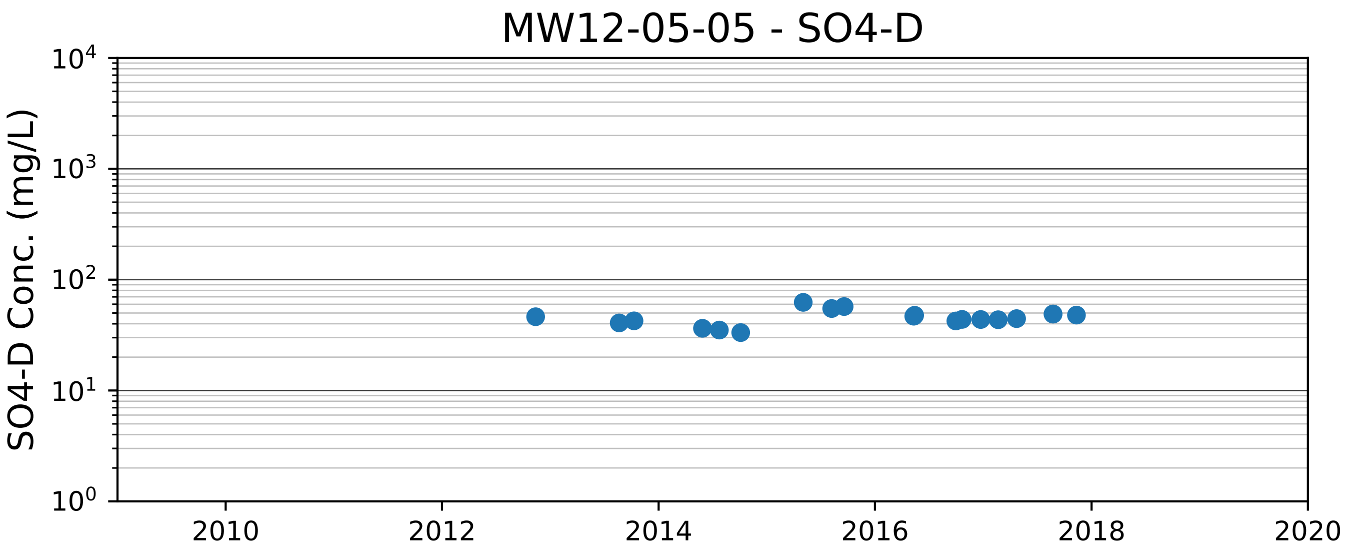

MW12-05-05 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

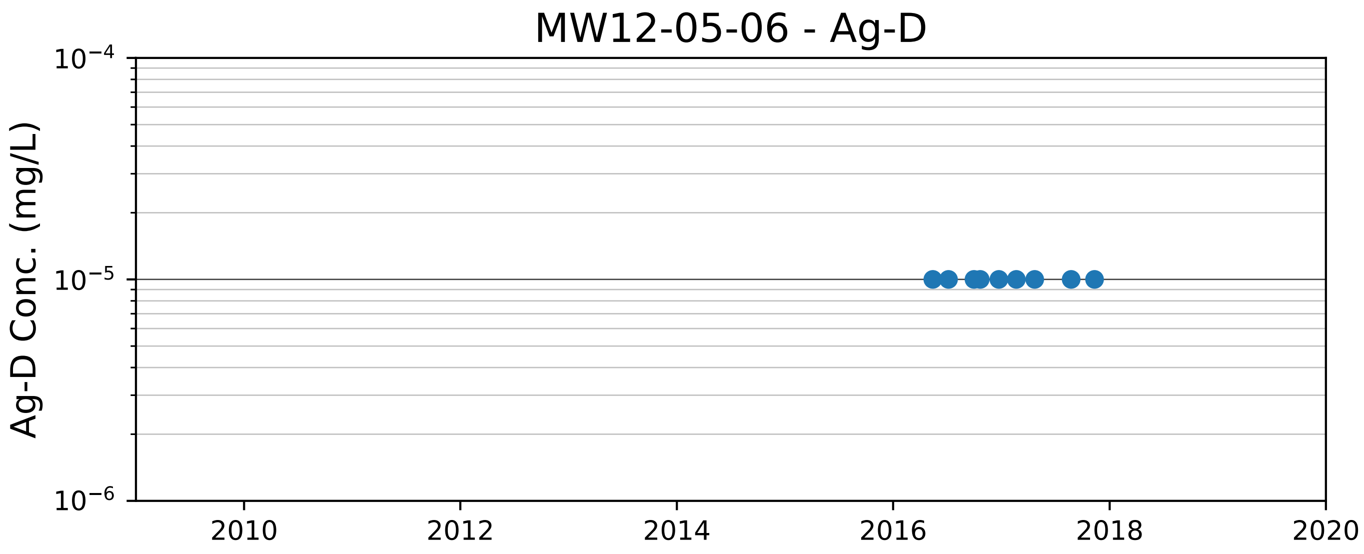

MW12-05-05 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

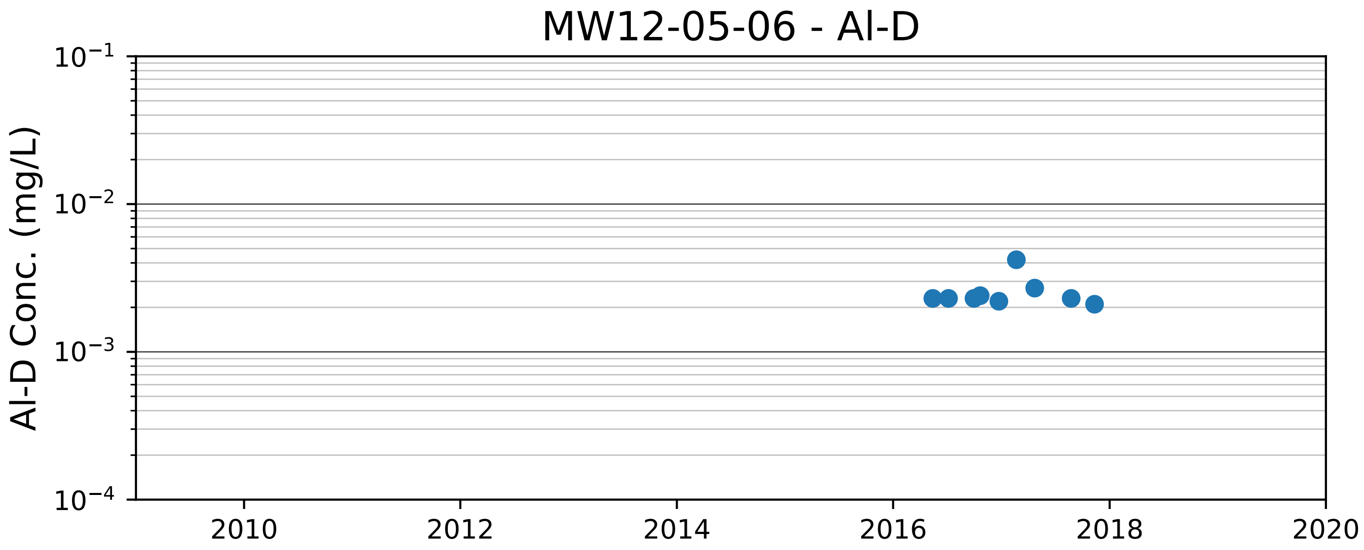

MW12-05-05 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

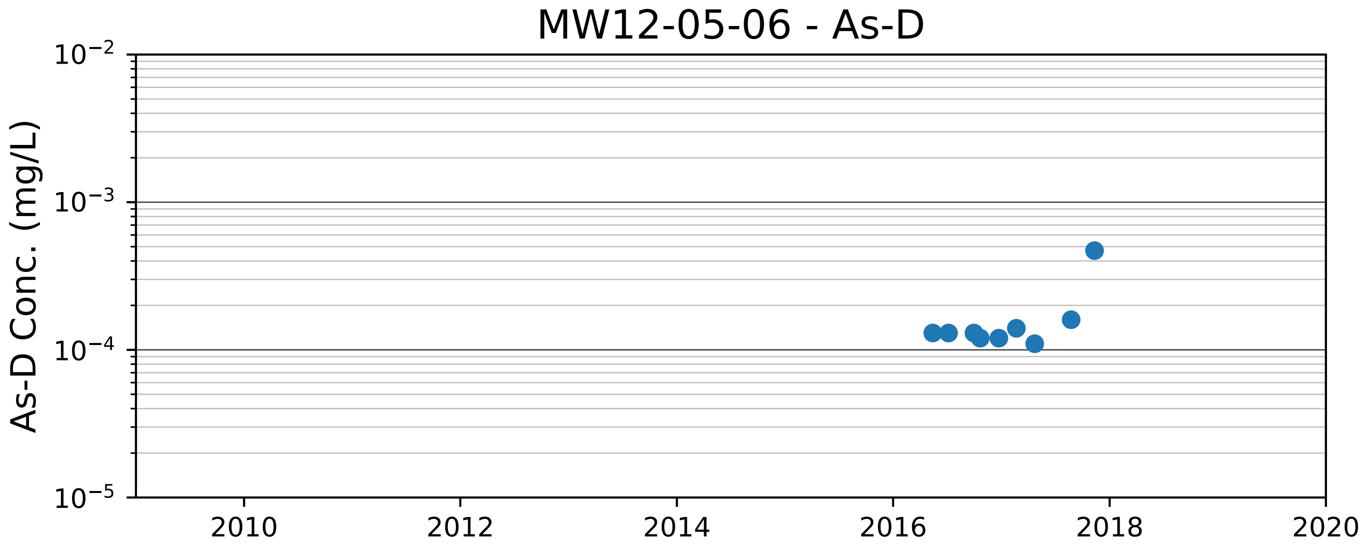

MW12-05-05 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

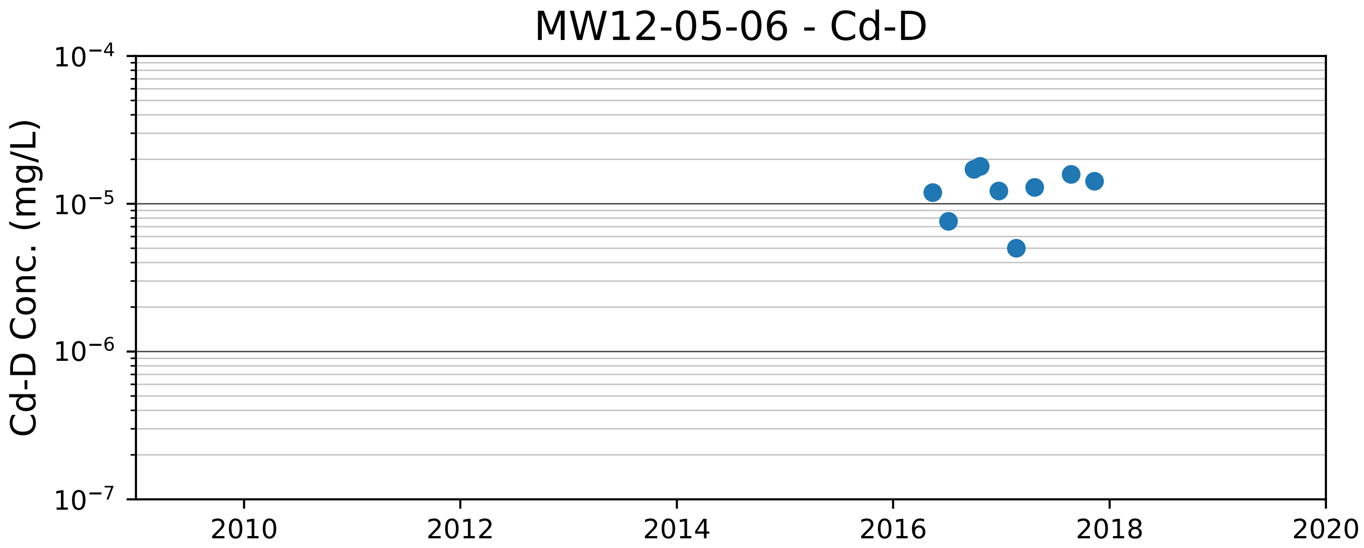

MW12-05-05 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

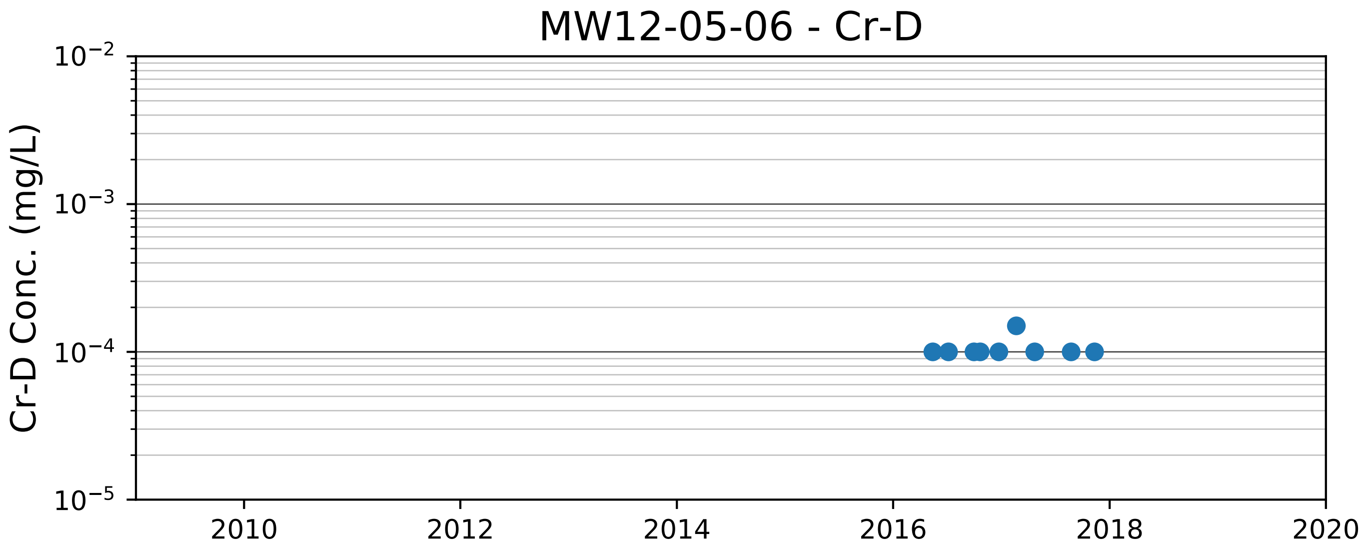

MW12-05-05 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

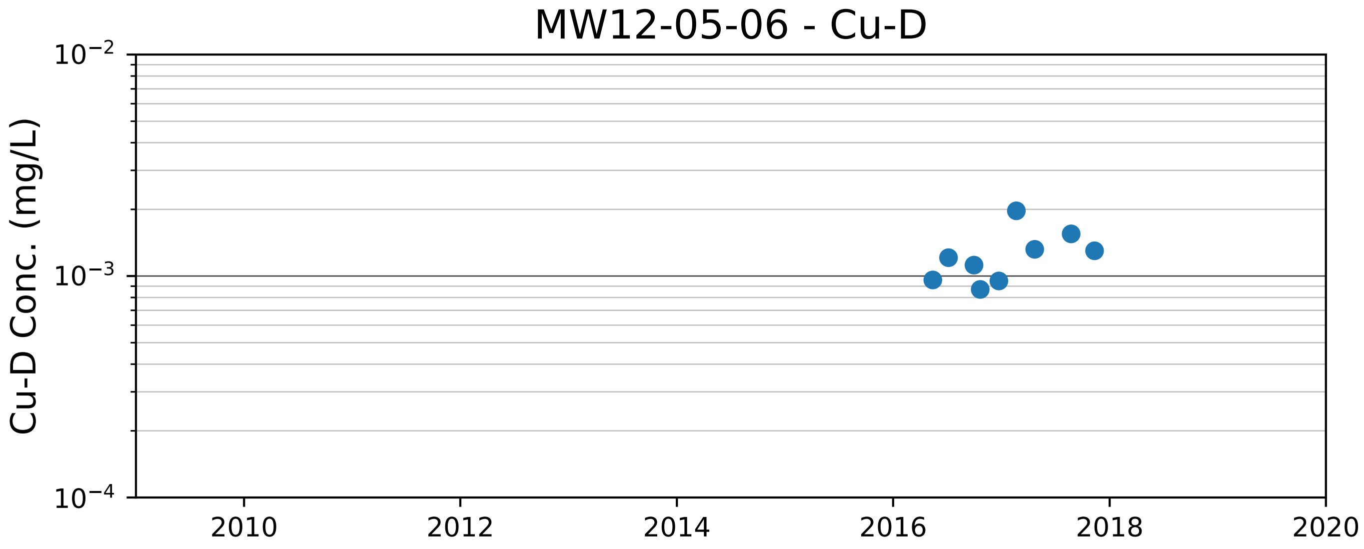

MW12-05-06 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

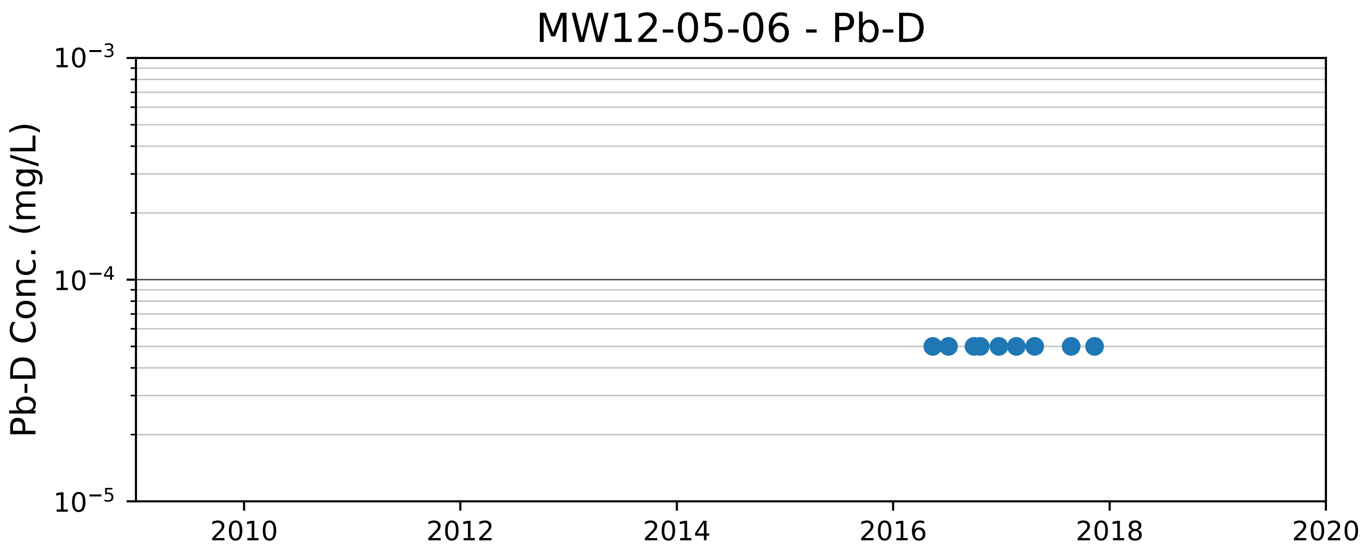

MW12-05-06 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

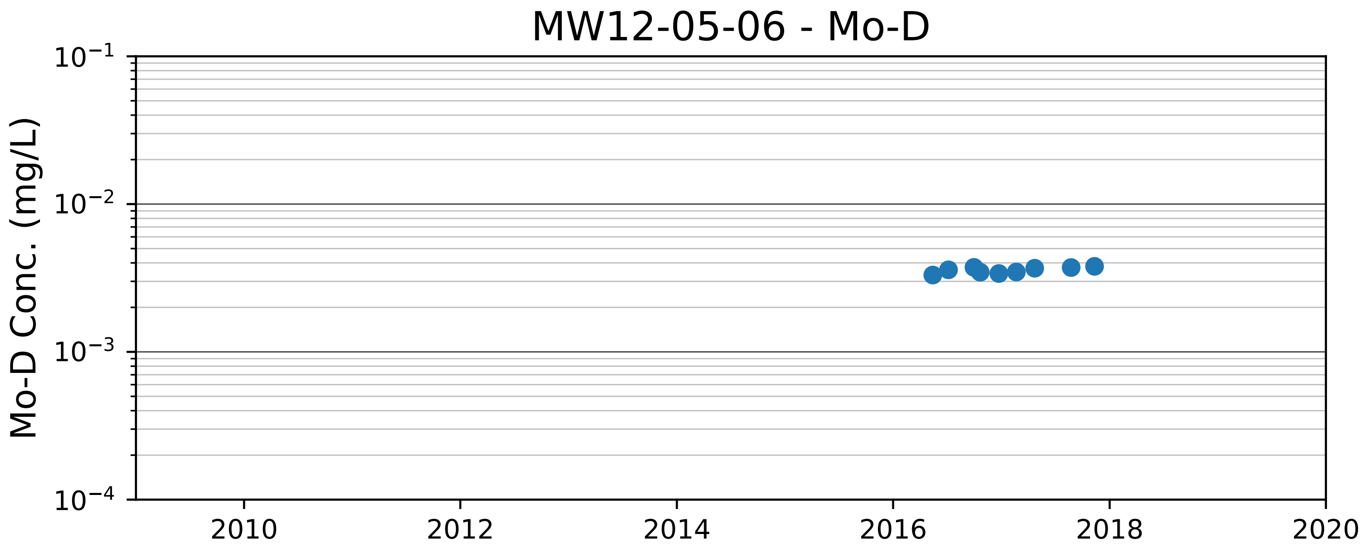

MW12-05-06 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

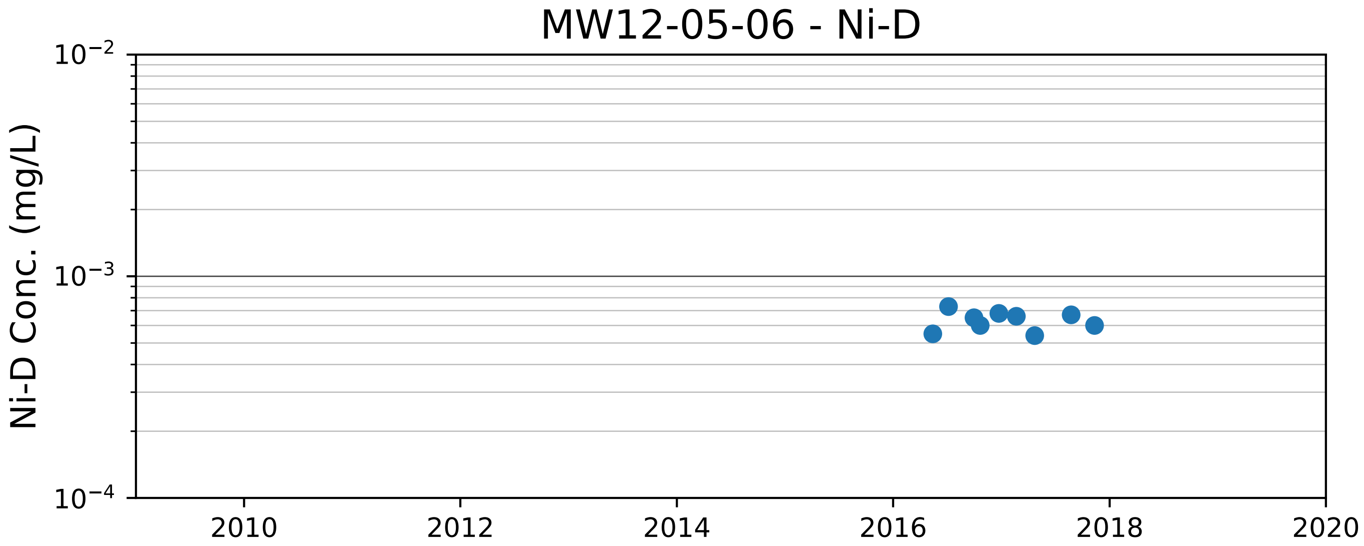

MW12-05-06 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

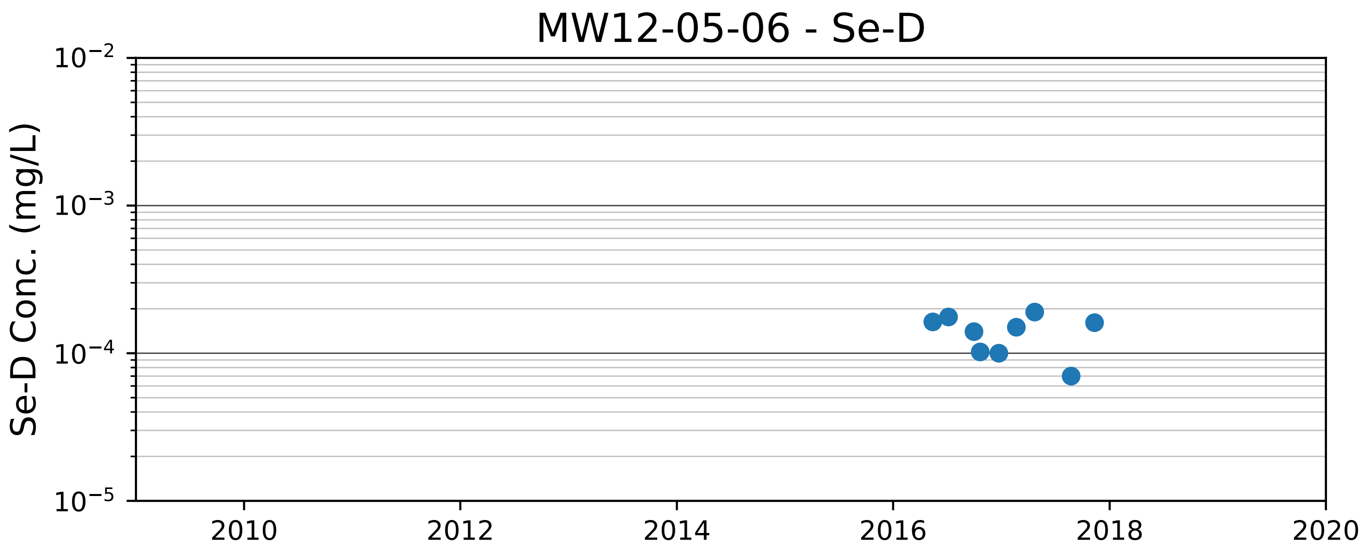

MW12-05-06 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

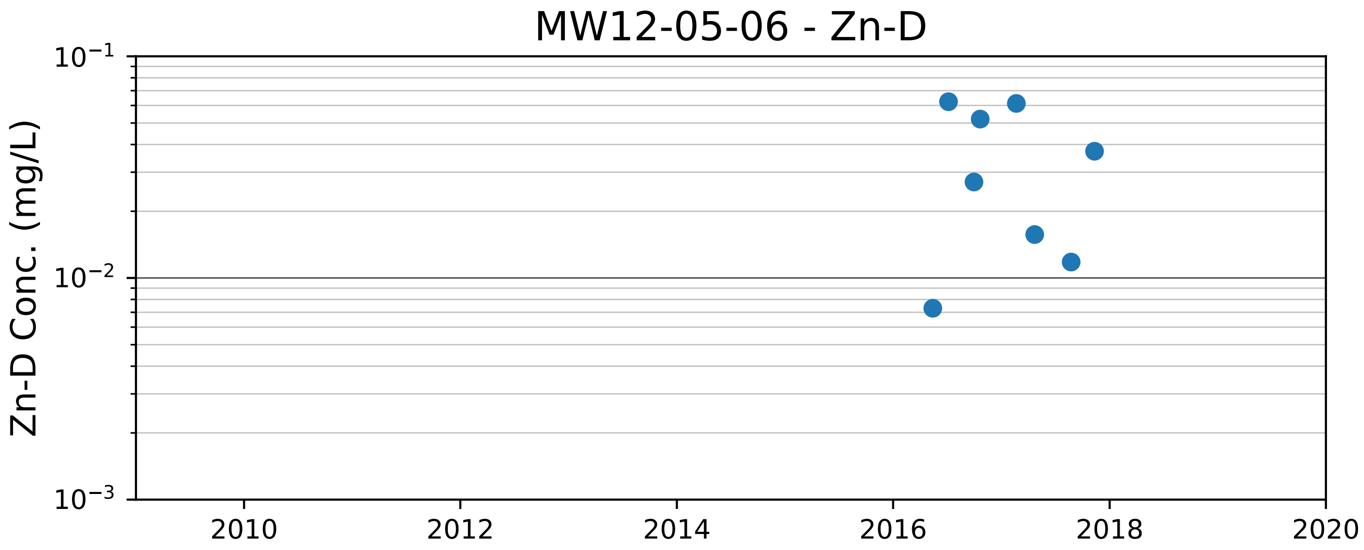

MW12-05-06 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

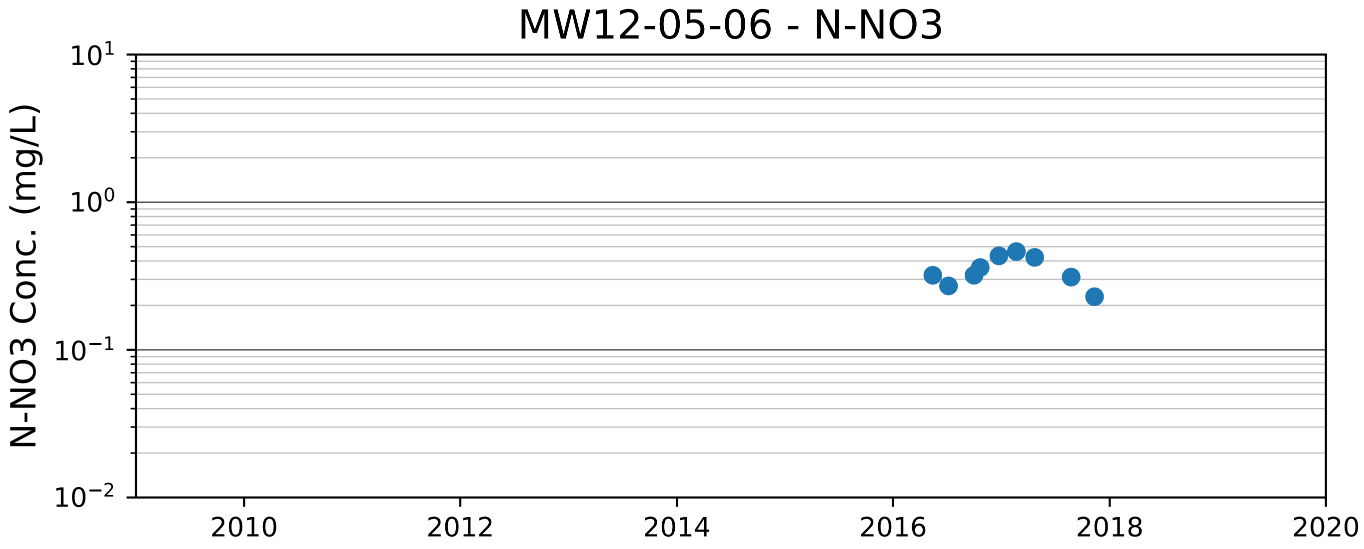

MW12-05-06 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

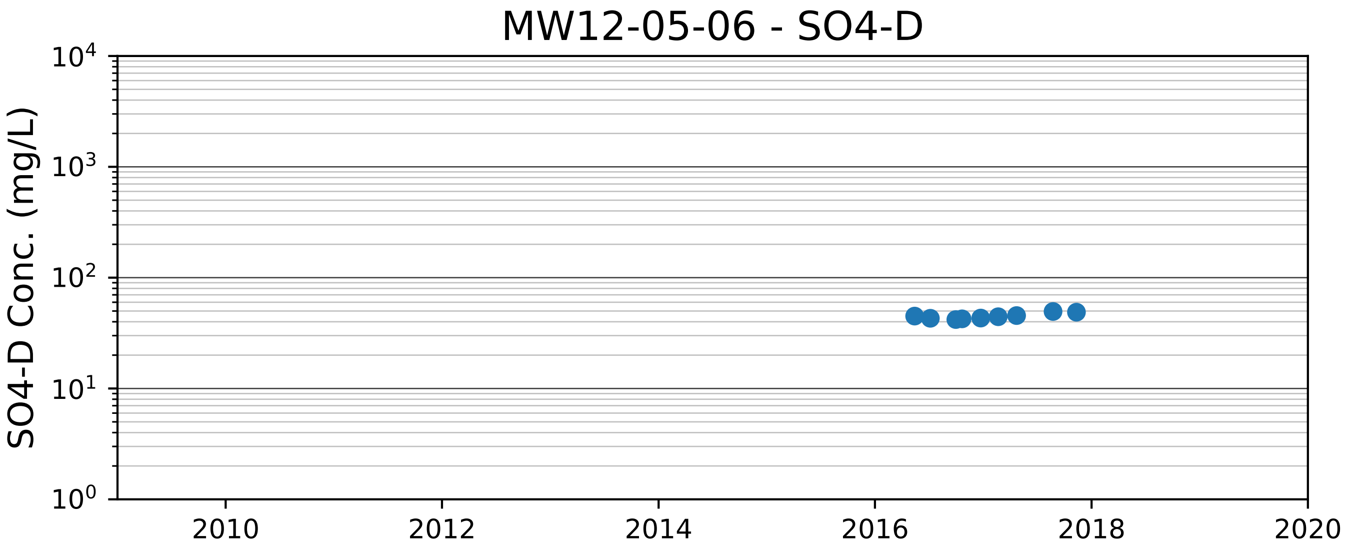

MW12-05-06 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

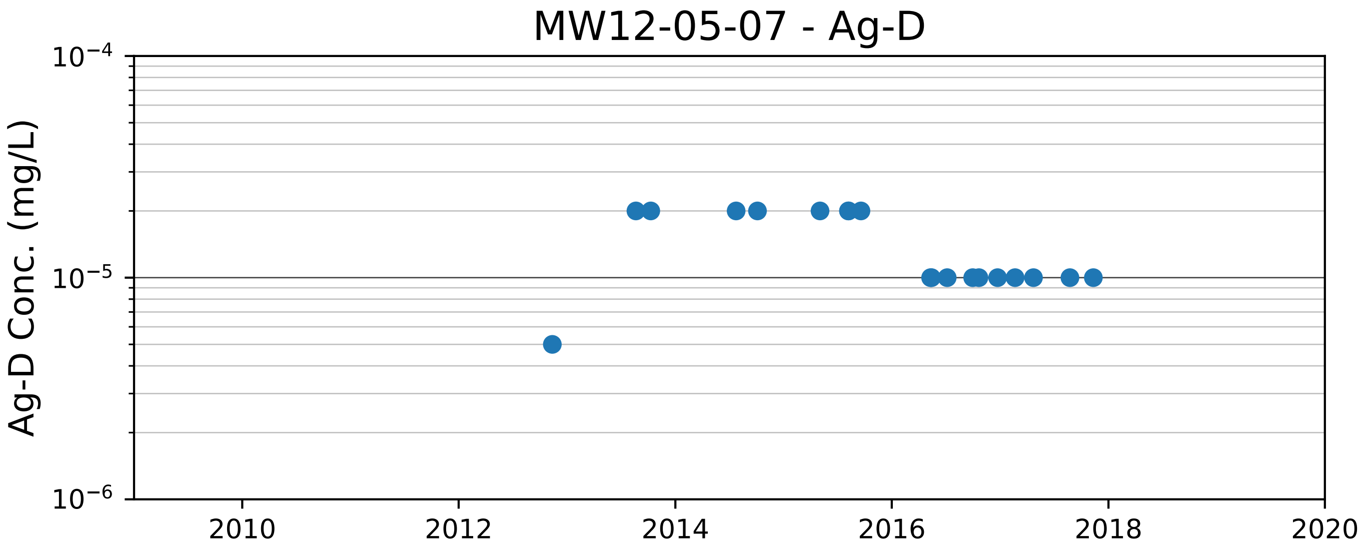

MW12-05-06 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

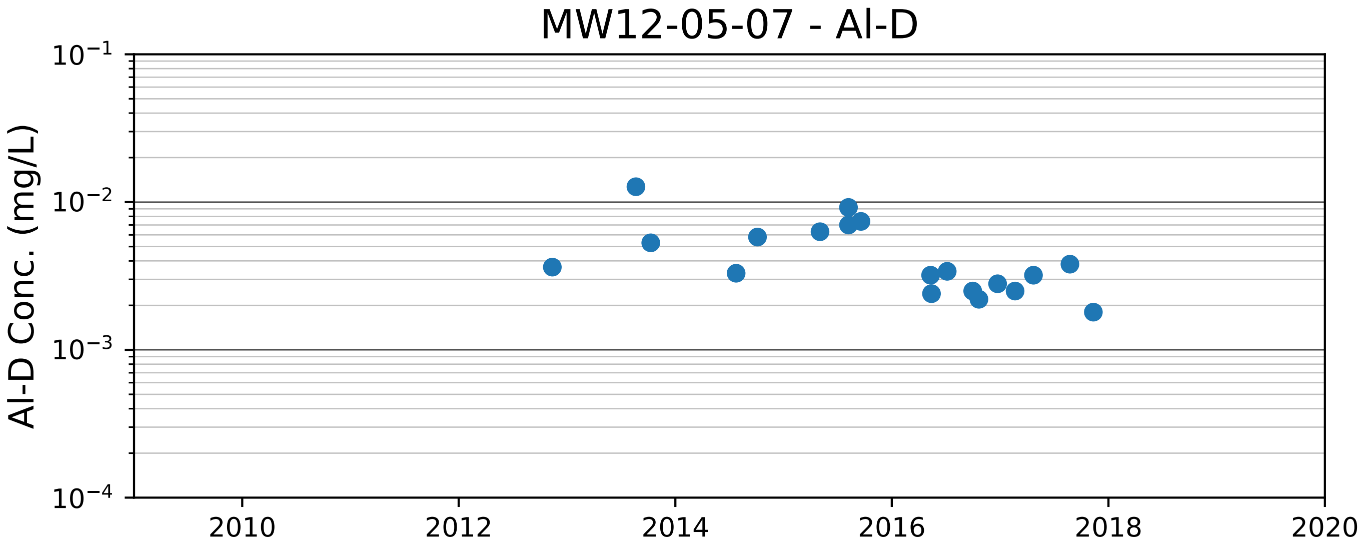

MW12-05-06 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

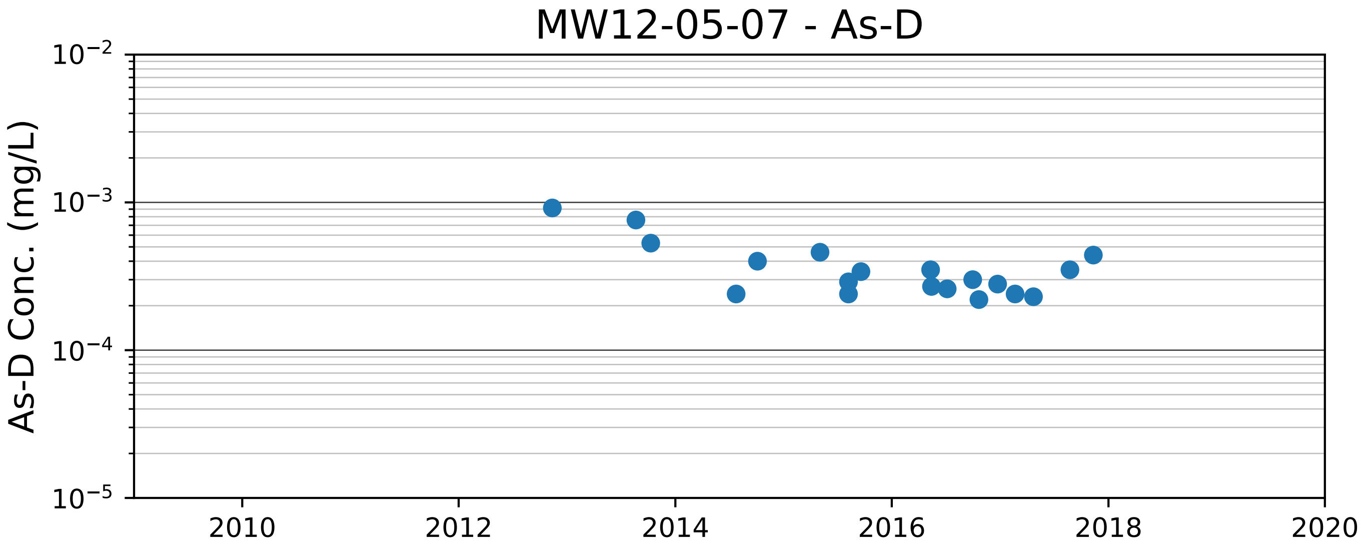

MW12-05-06 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

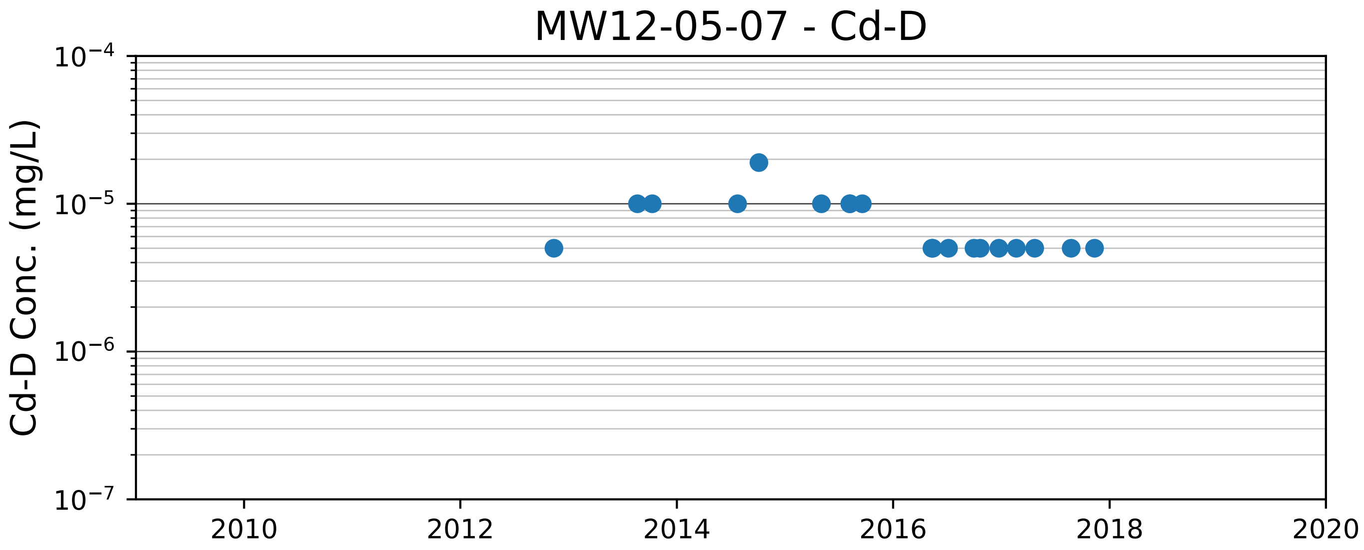

MW12-05-06 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

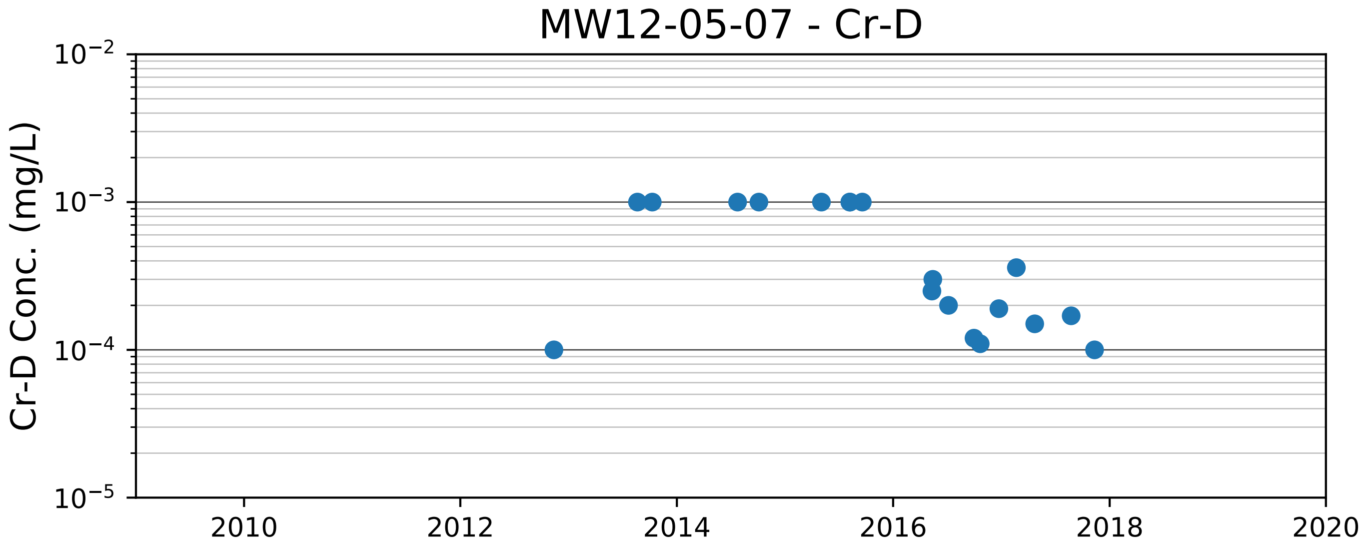

MW12-05-06 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

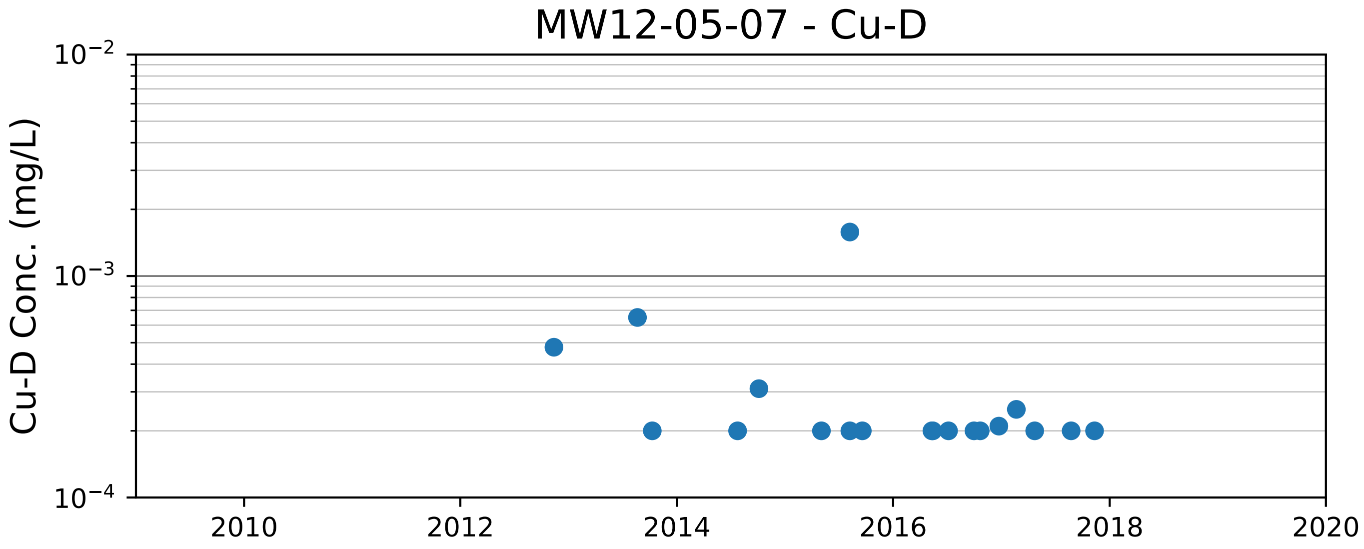

MW12-05-07 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

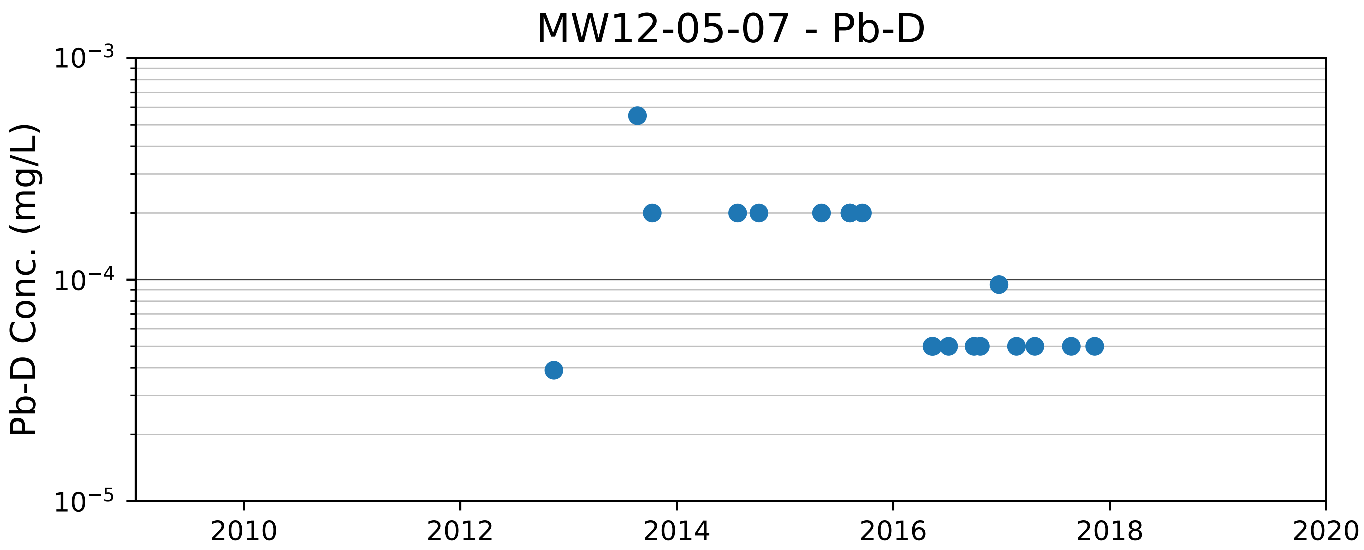

MW12-05-07 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

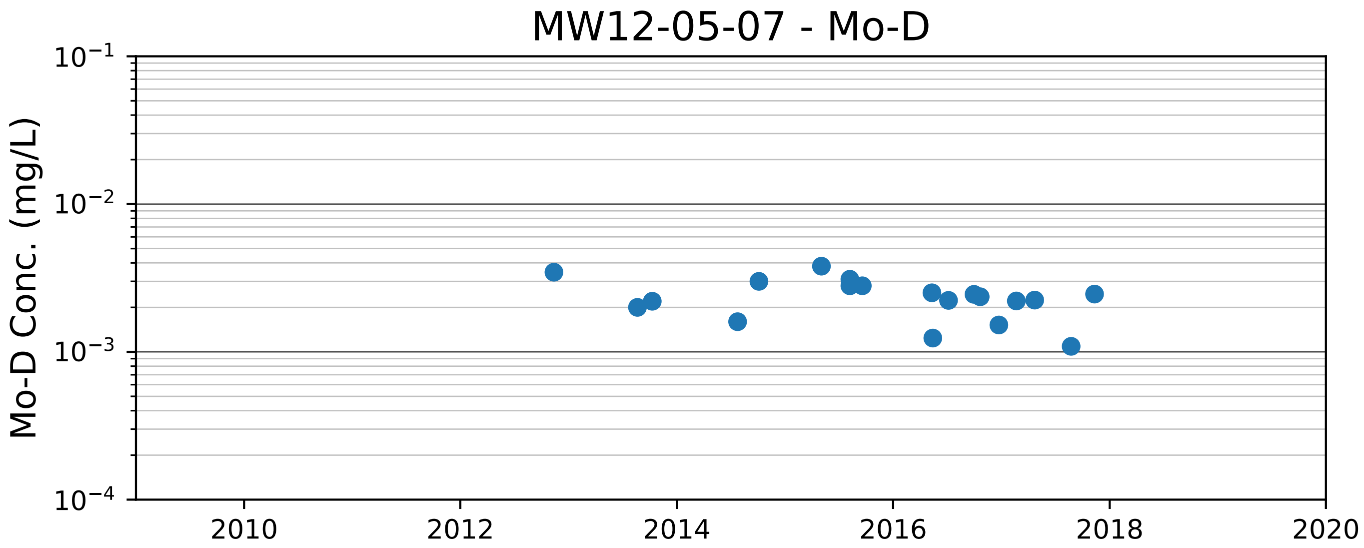

MW12-05-07 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

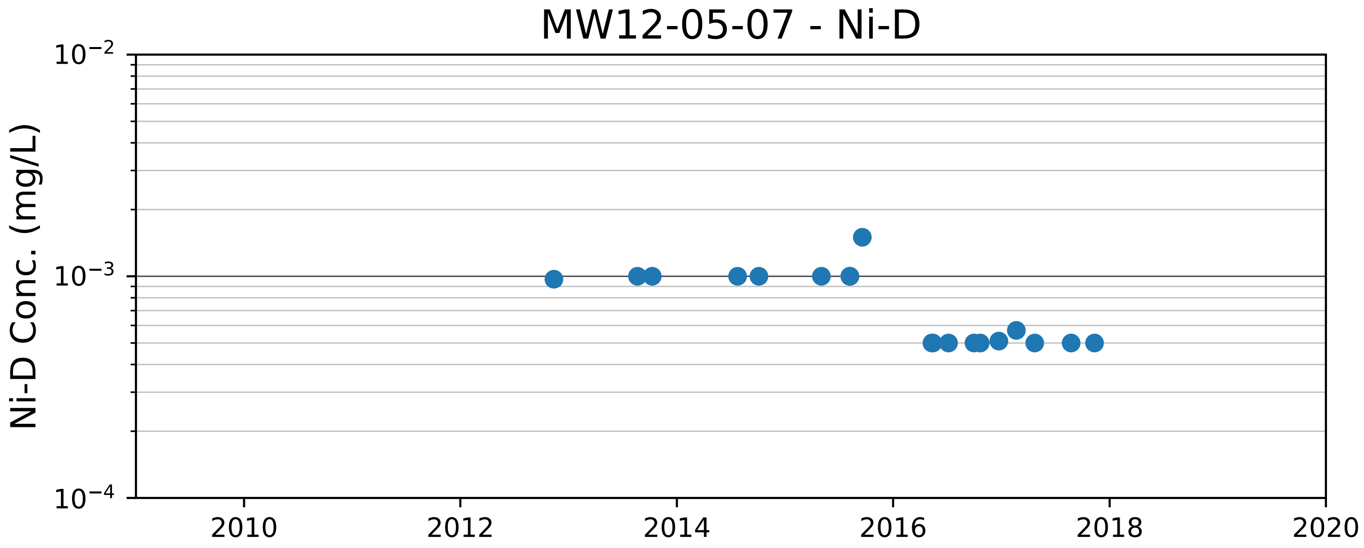

MW12-05-07 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

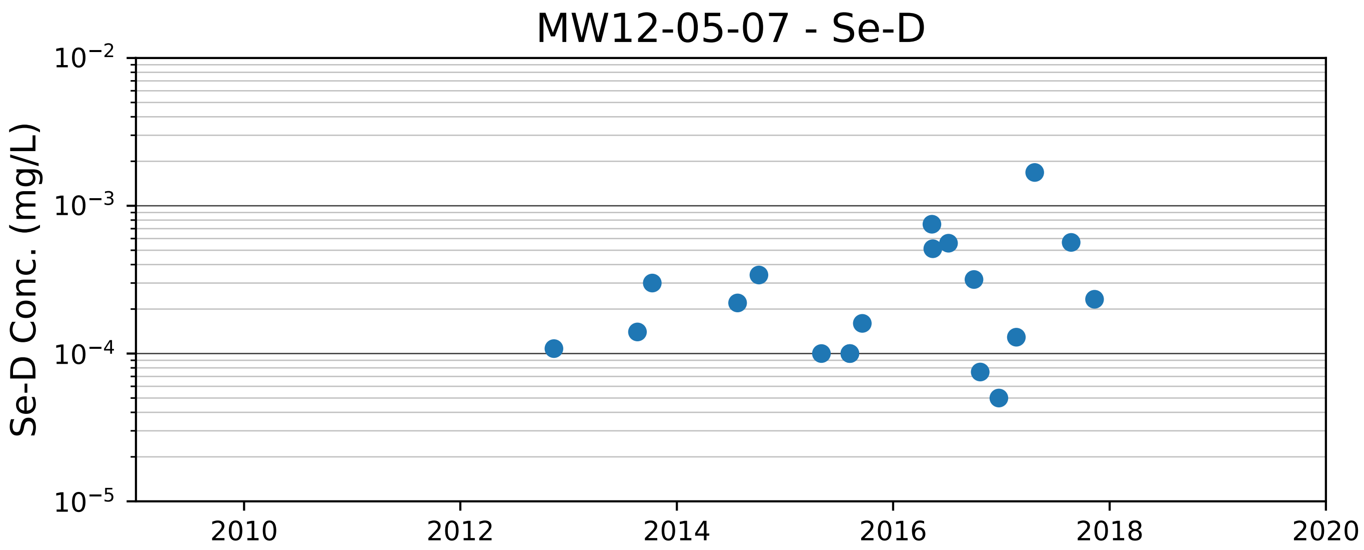

MW12-05-07 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

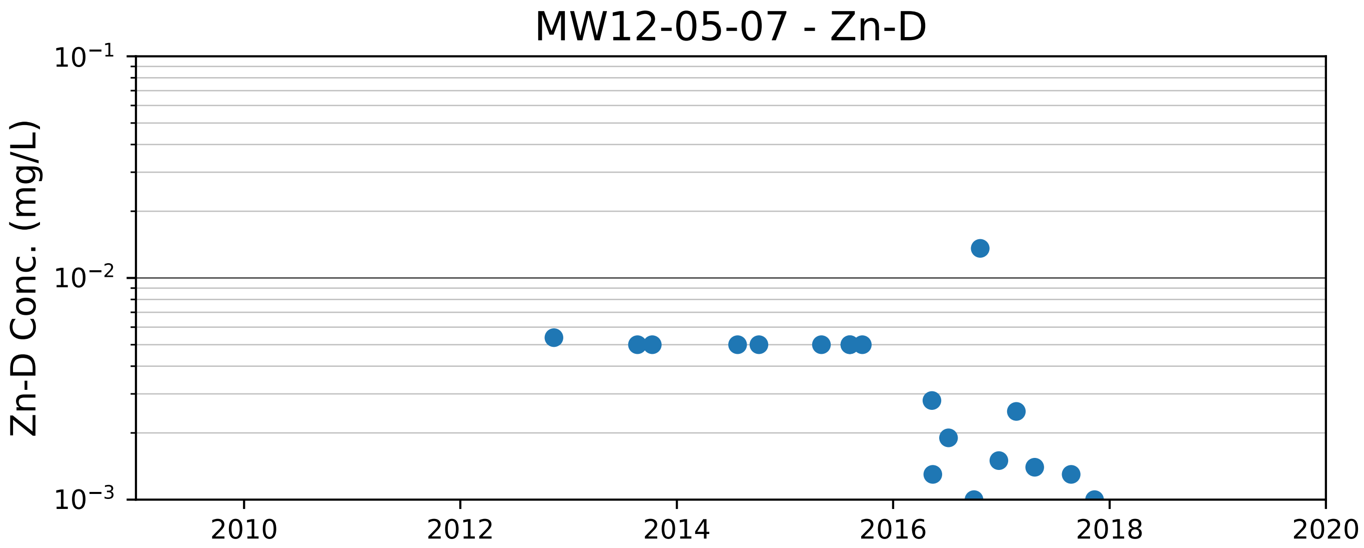

MW12-05-07 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

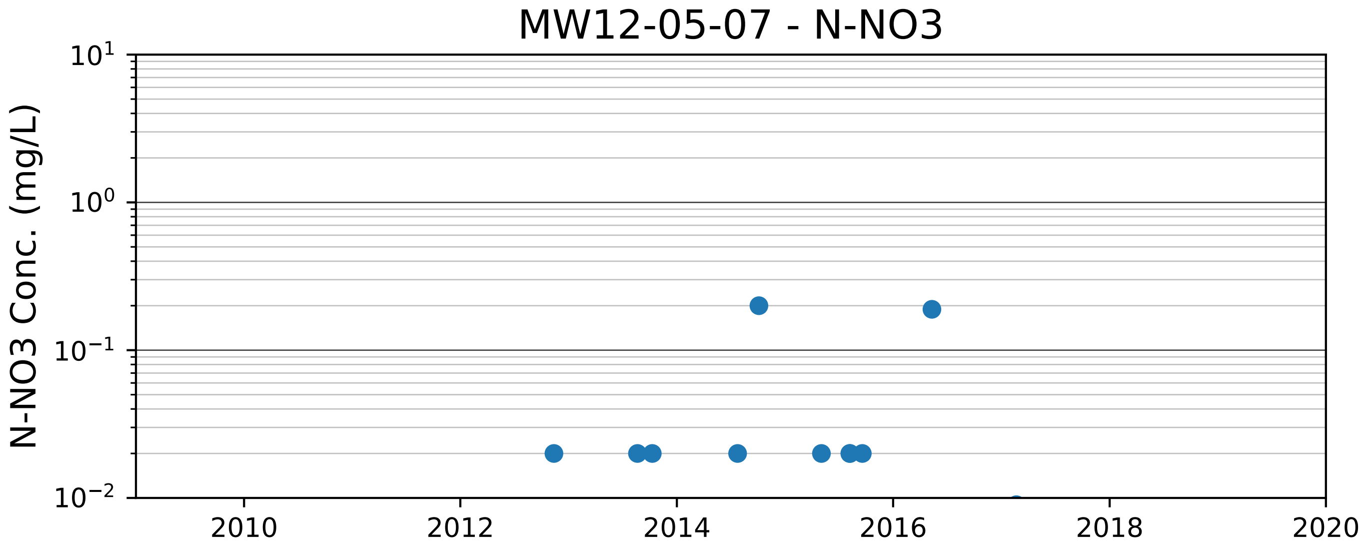

MW12-05-07 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

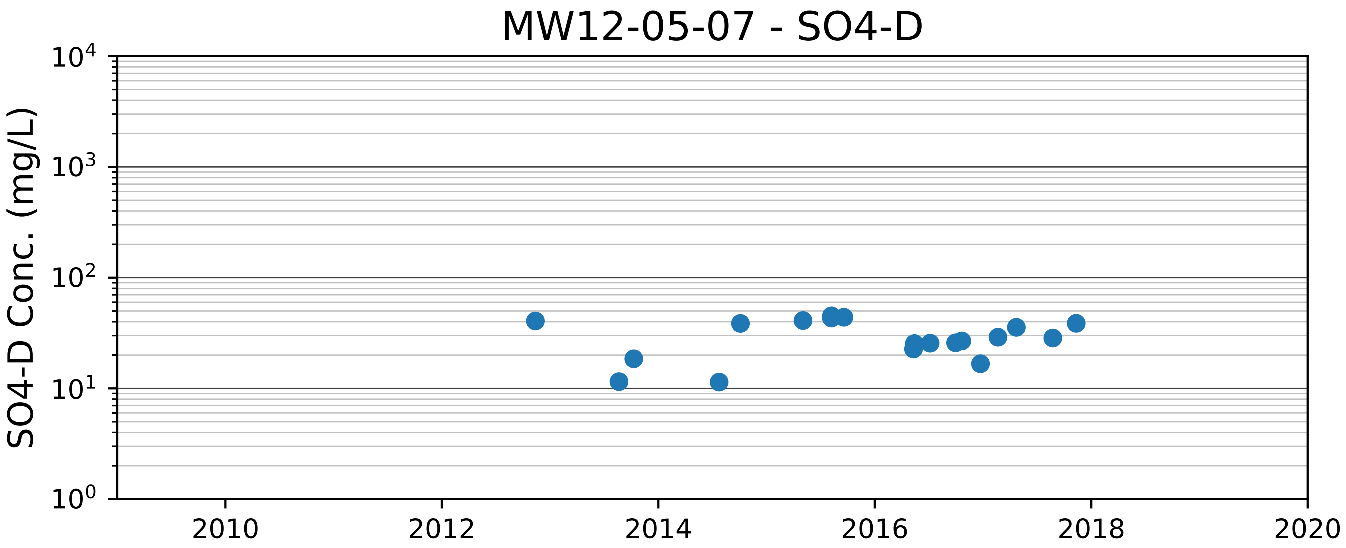

MW12-05-07 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

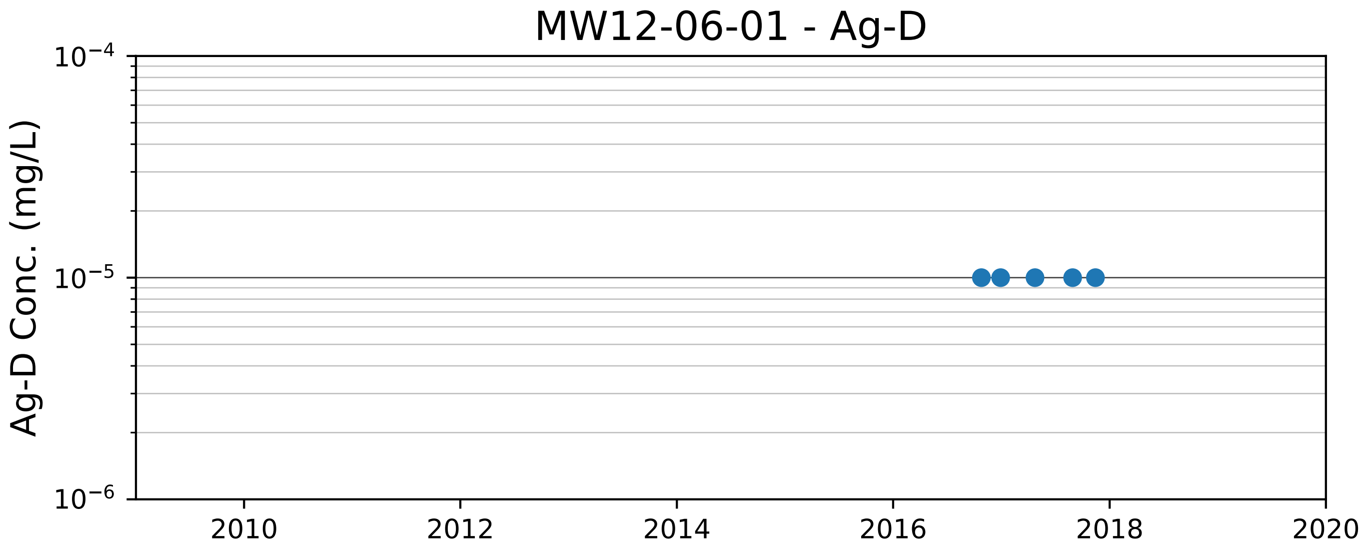

MW12-05-07 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

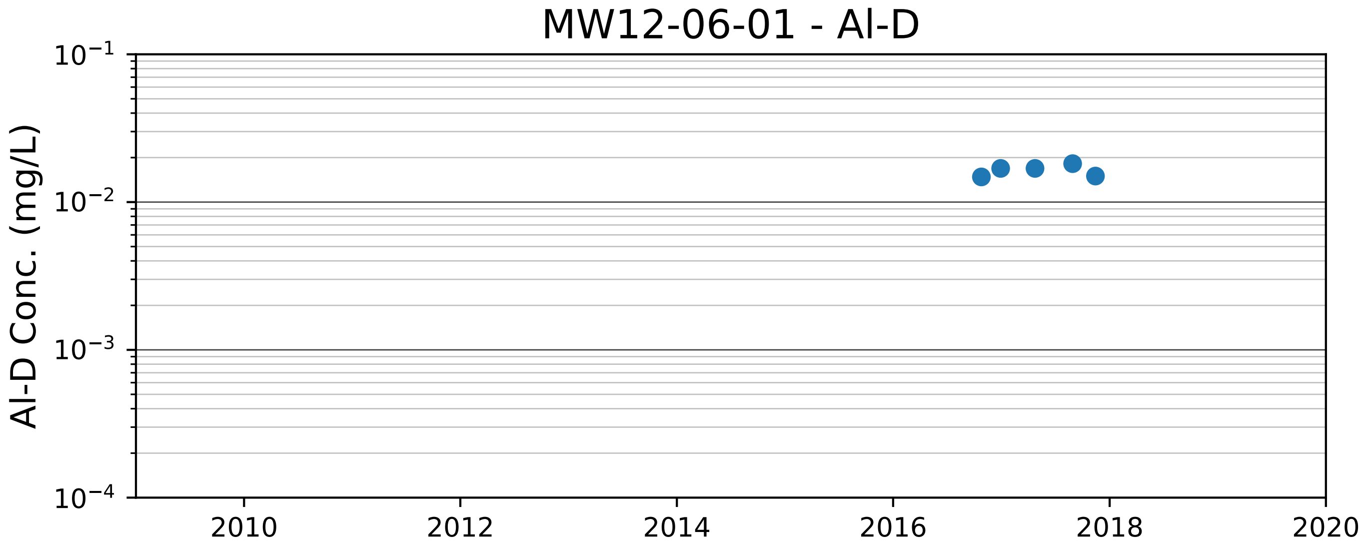

MW12-05-07 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

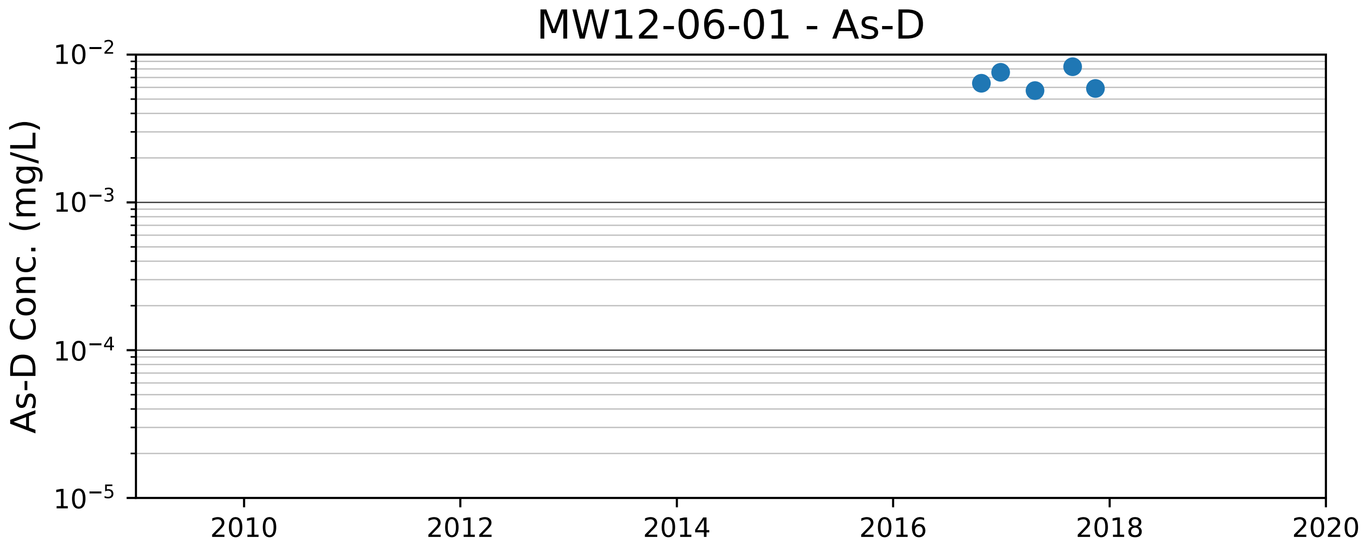

MW12-05-07 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

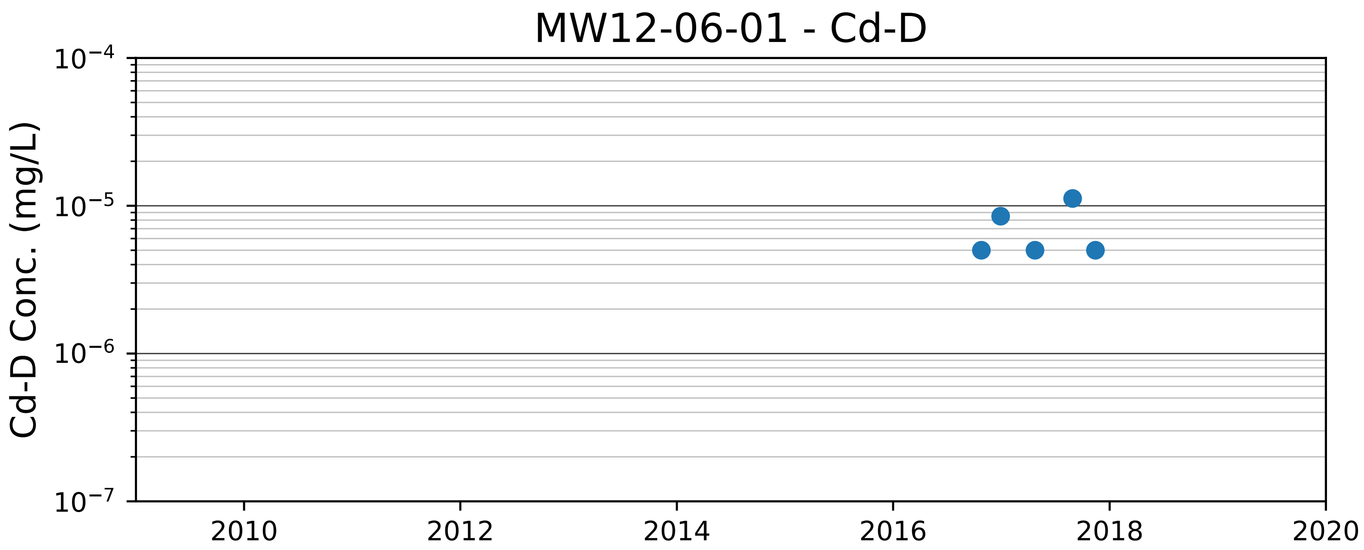

MW12-05-07 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

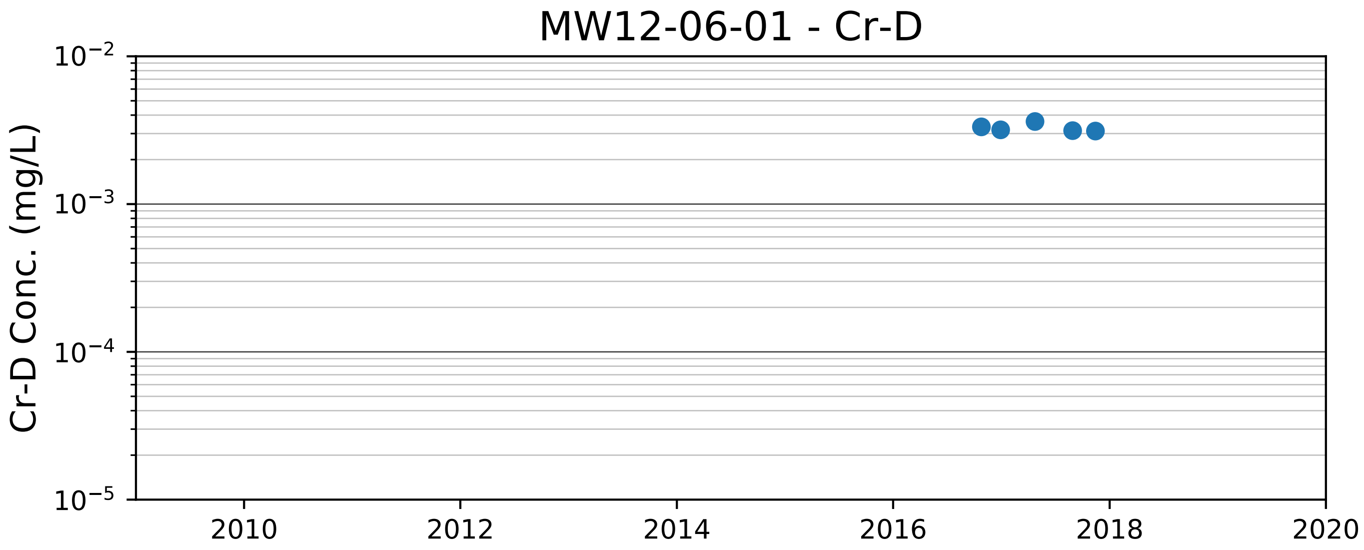

MW12-05-07 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

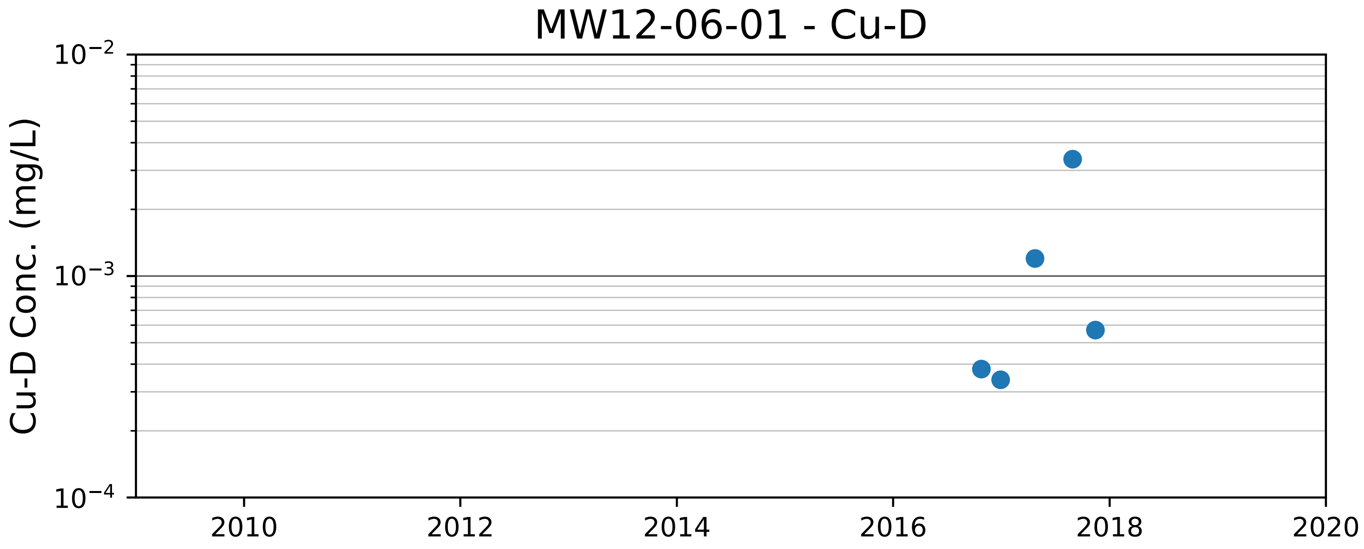

MW12-06-01 - Ag-D

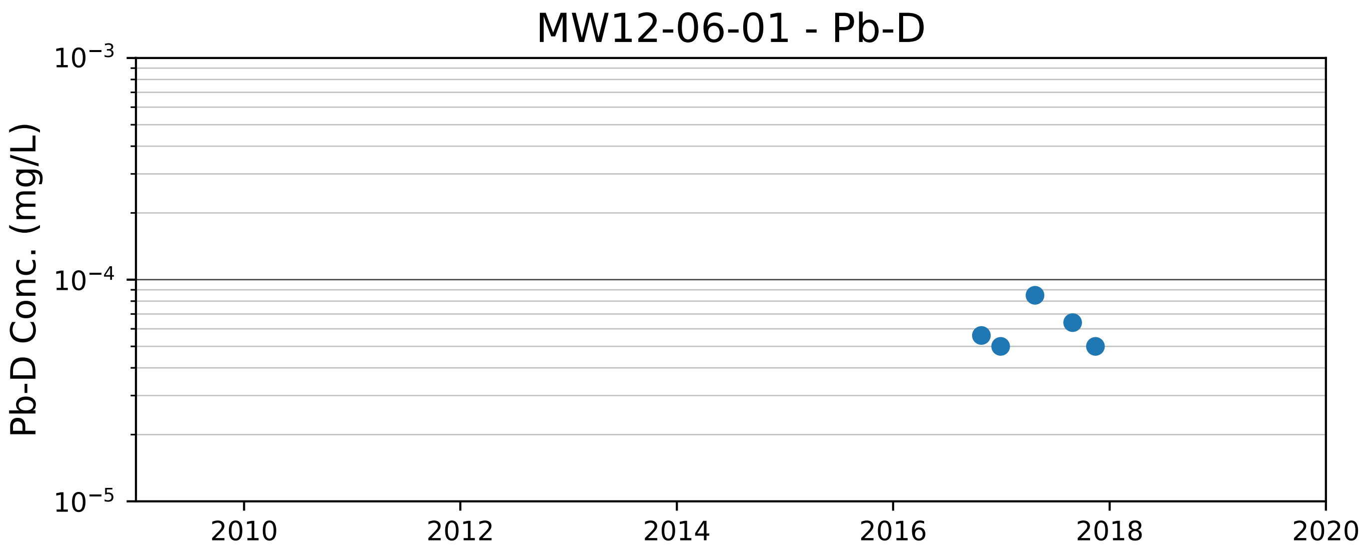

MW12-06-01 - Al-D

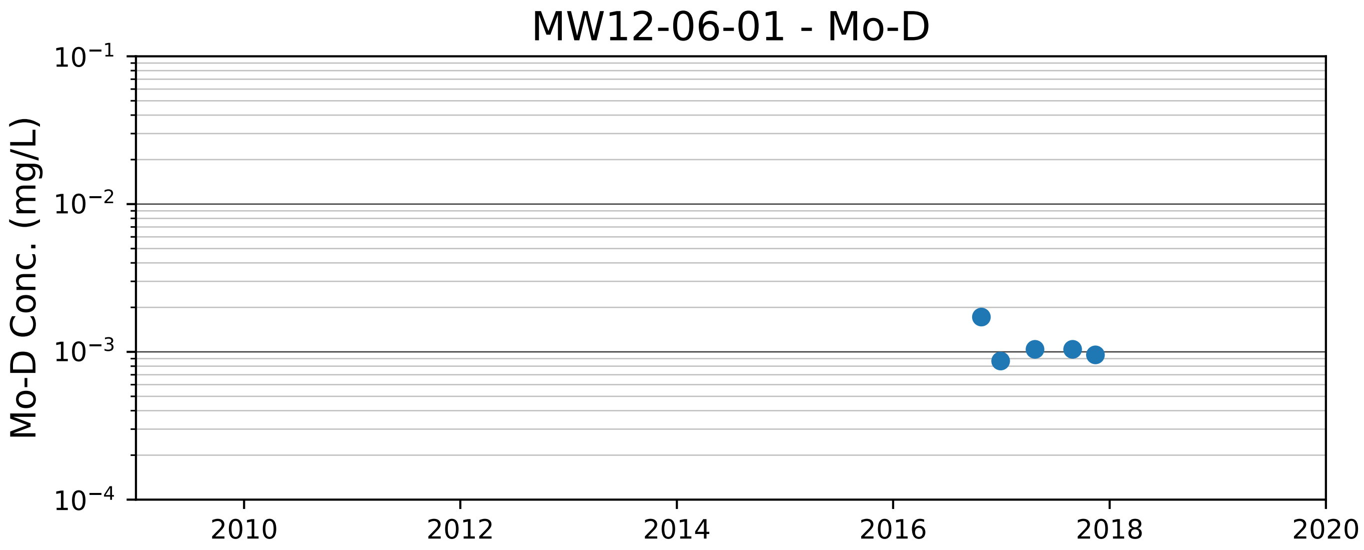

MW12-06-01 - As-D

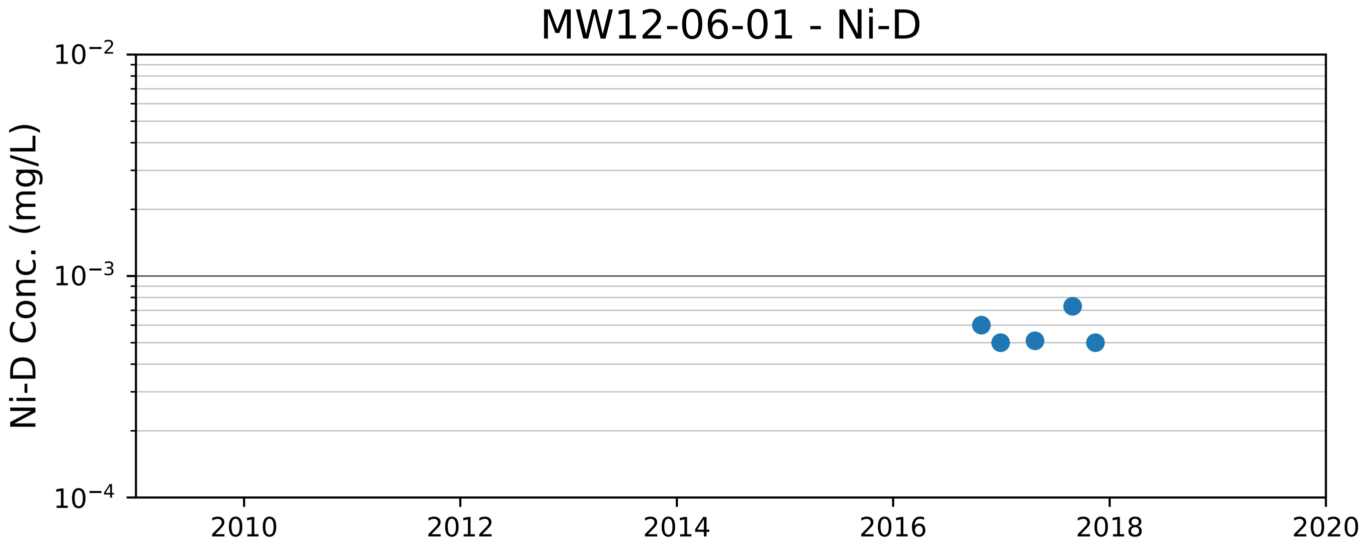

MW12-06-01 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

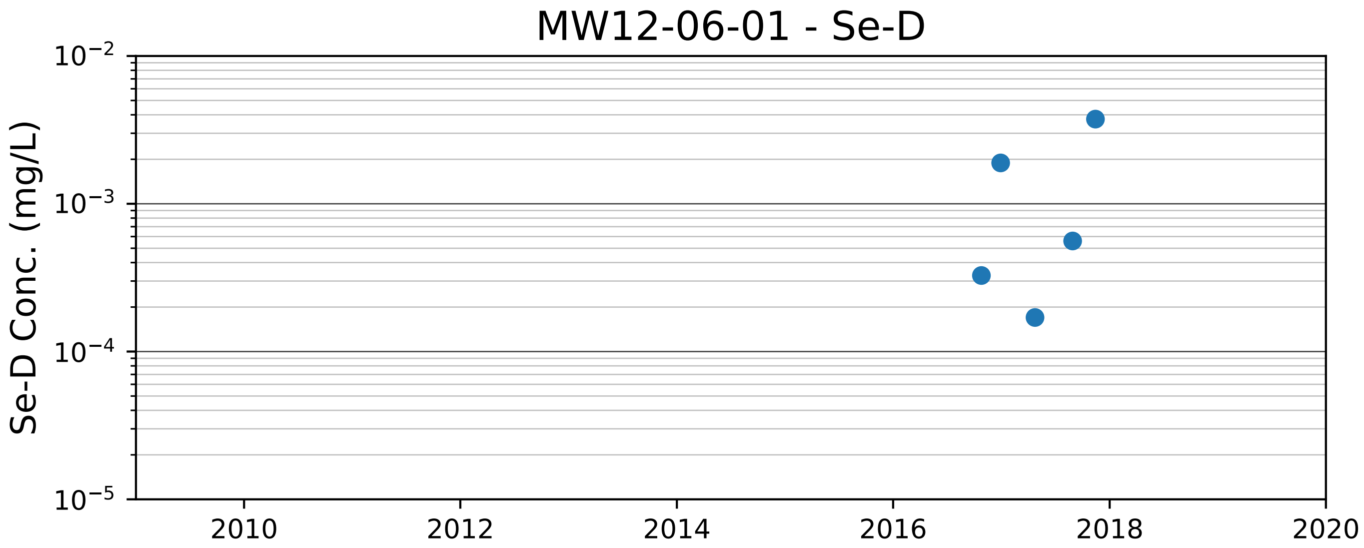

MW12-06-01 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

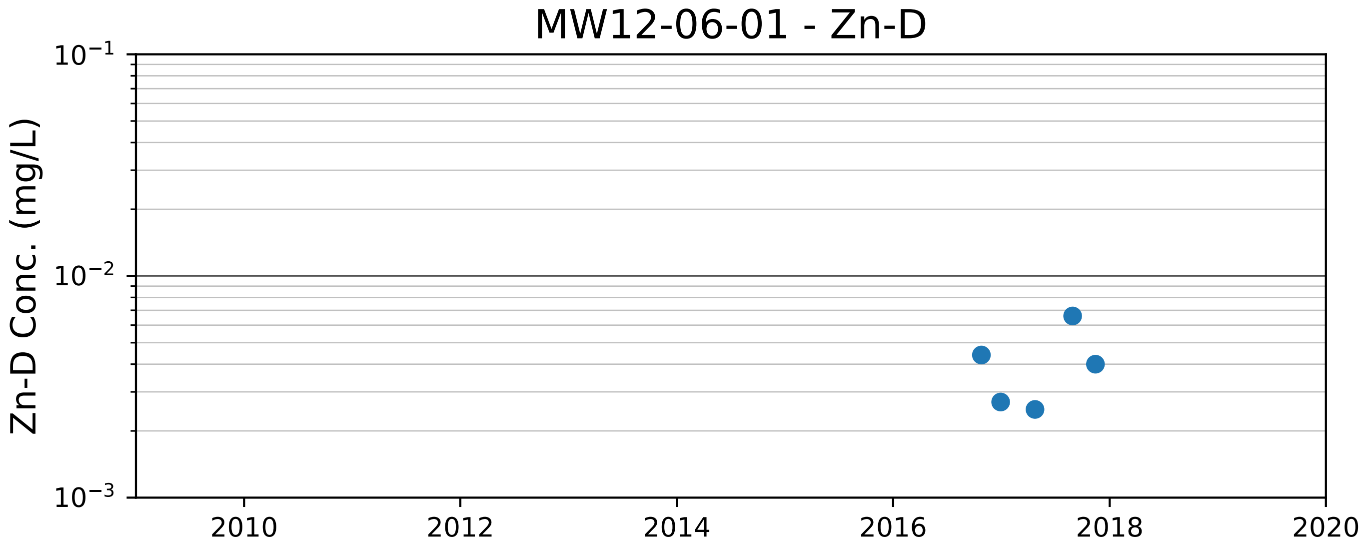

MW12-06-01 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

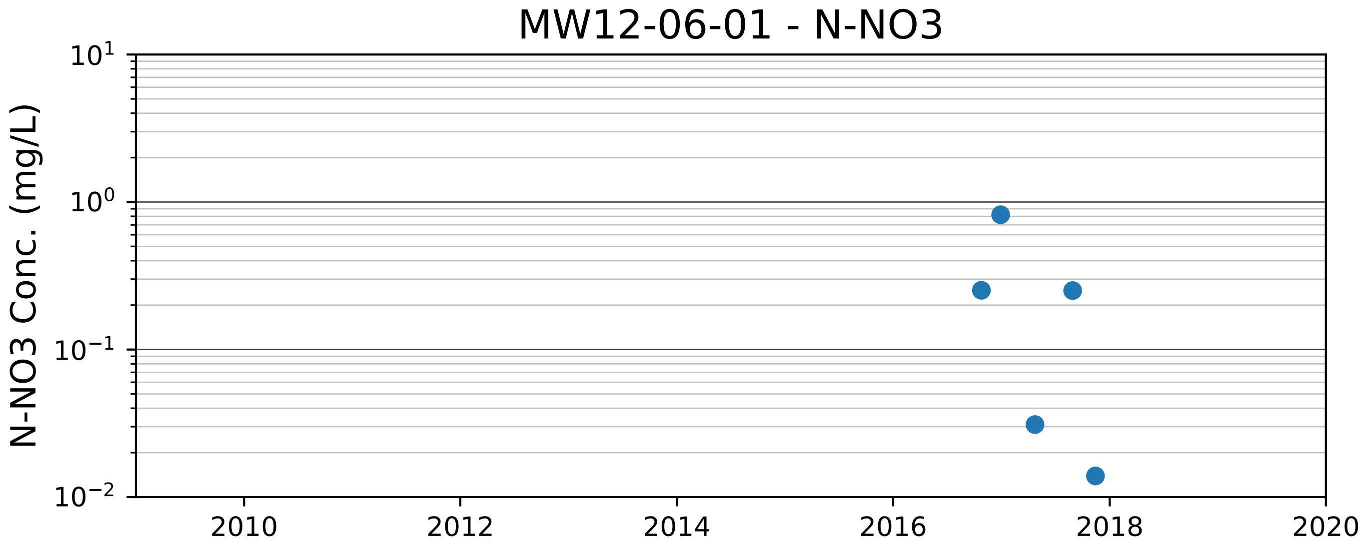

MW12-06-01 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

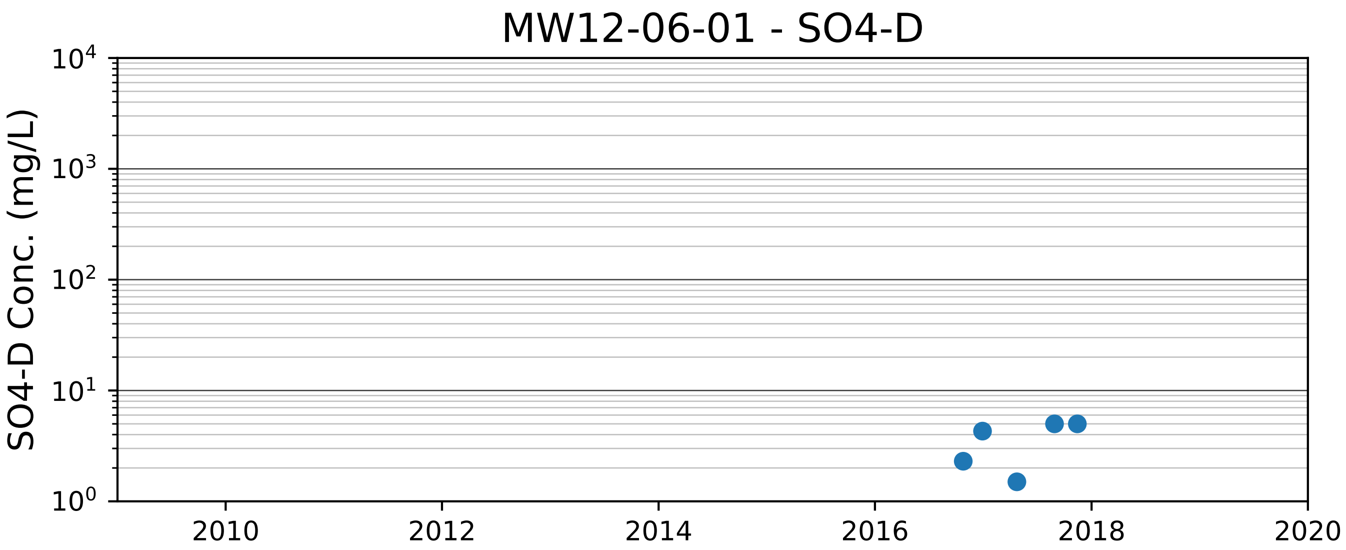

MW12-06-01 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

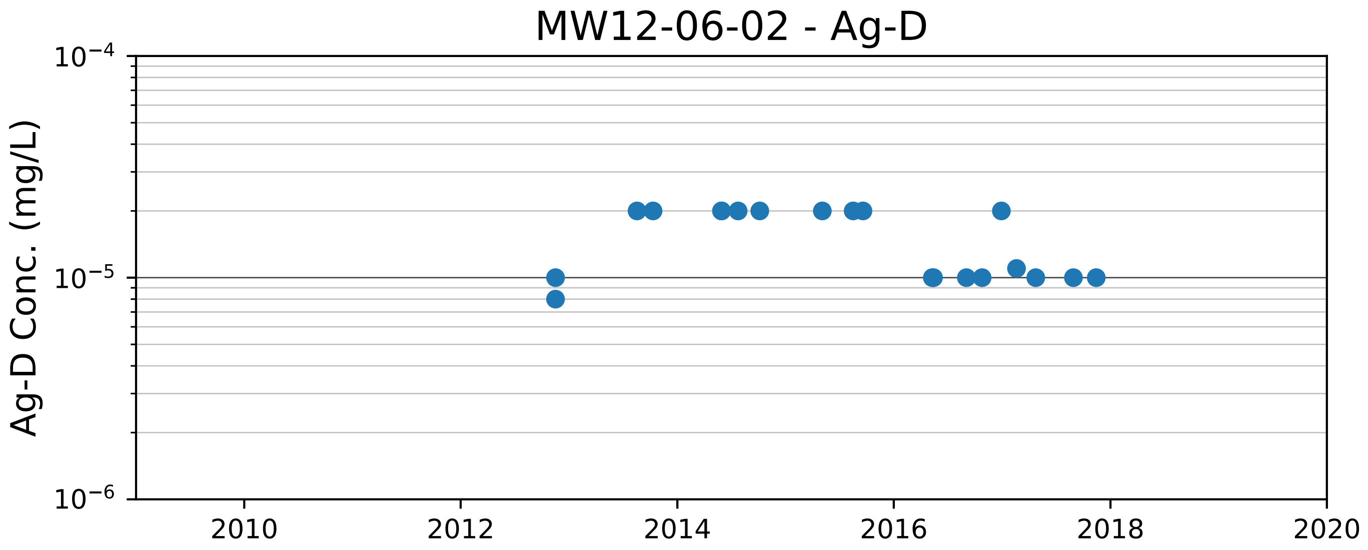

MW12-06-01 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

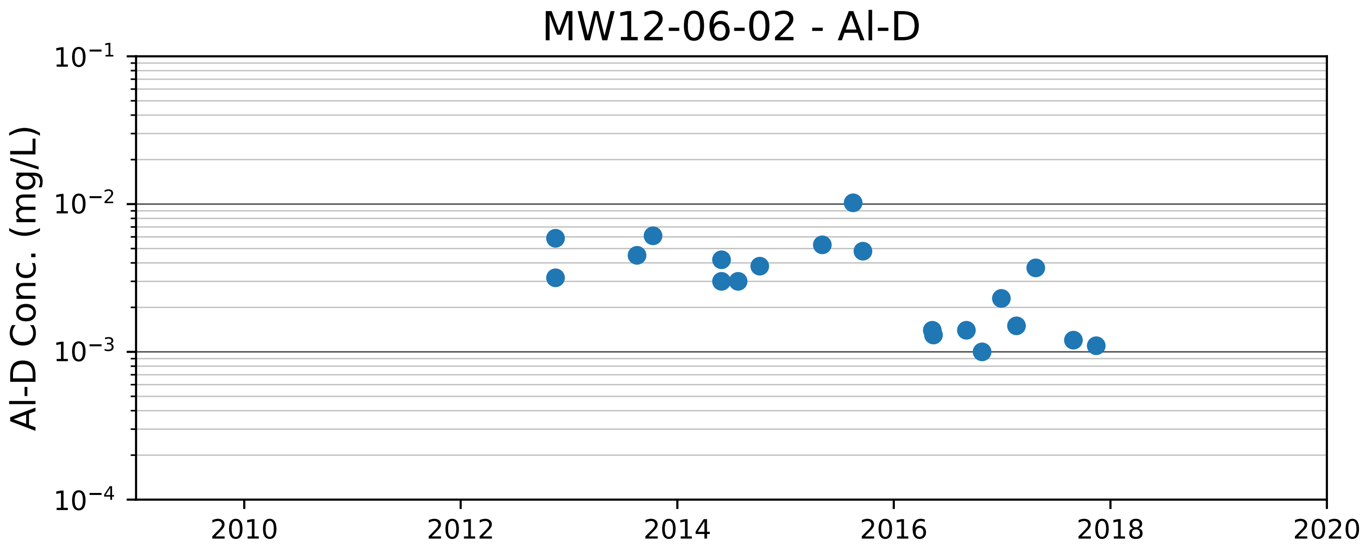

MW12-06-01 - Se-D

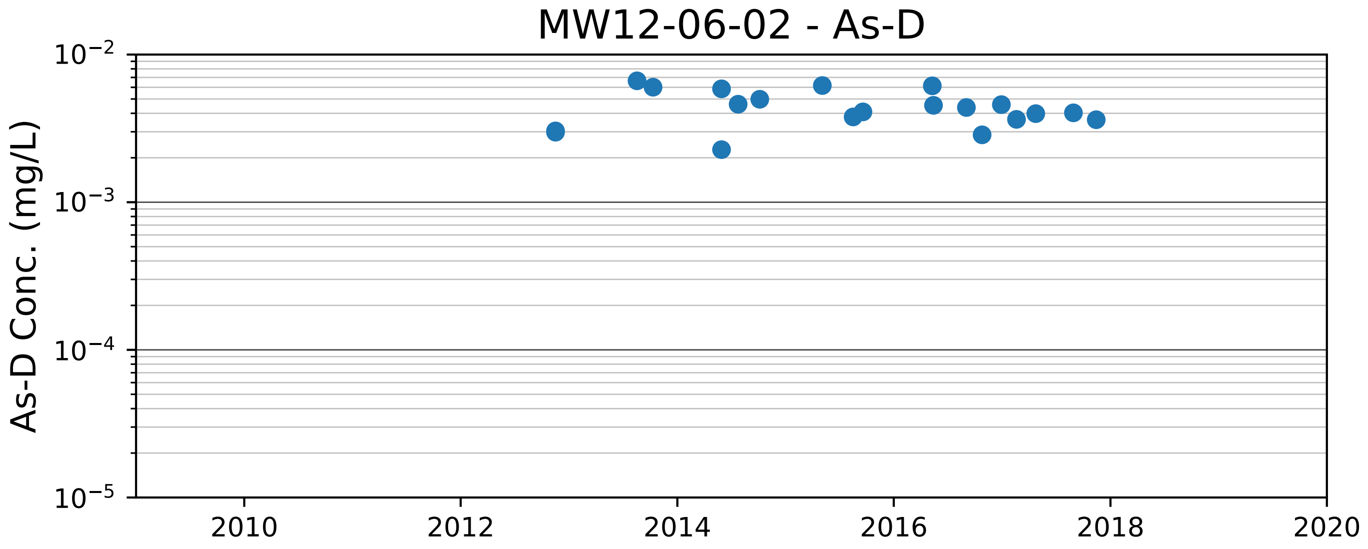

MW12-06-01 - Zn-D

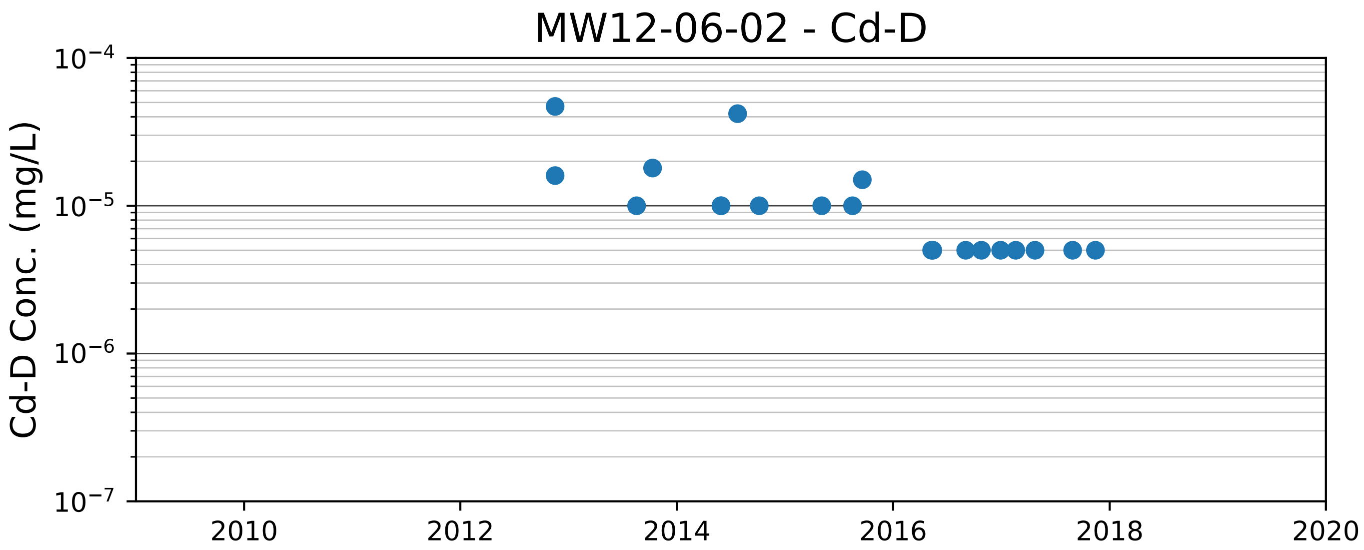

MW12-06-01 - N-NO3

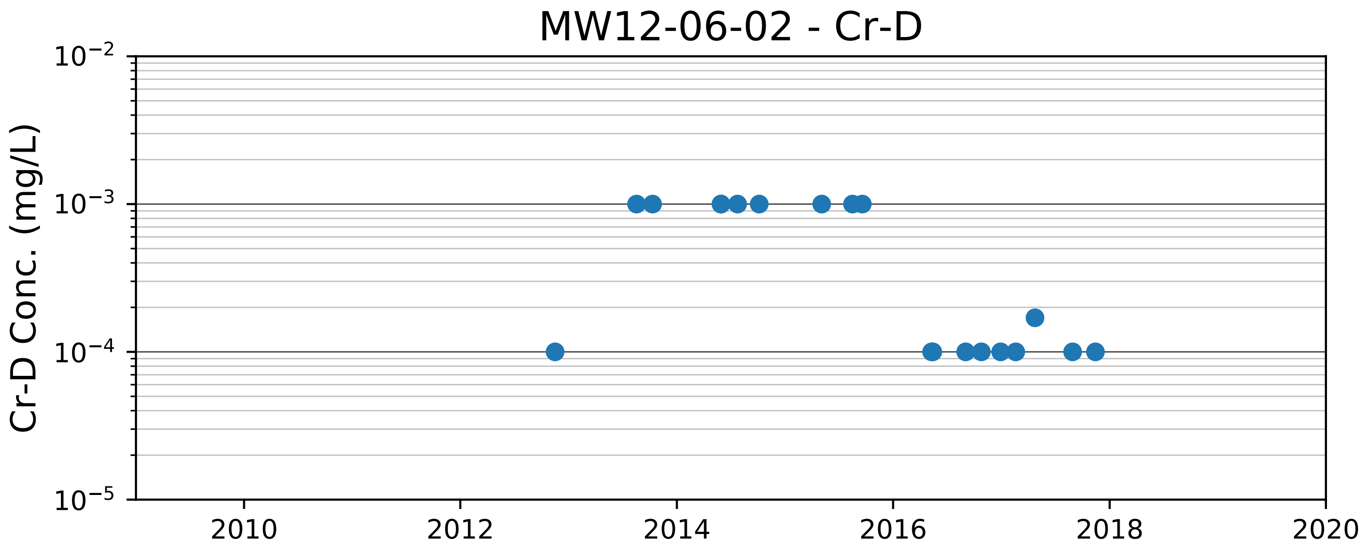

MW12-06-01 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

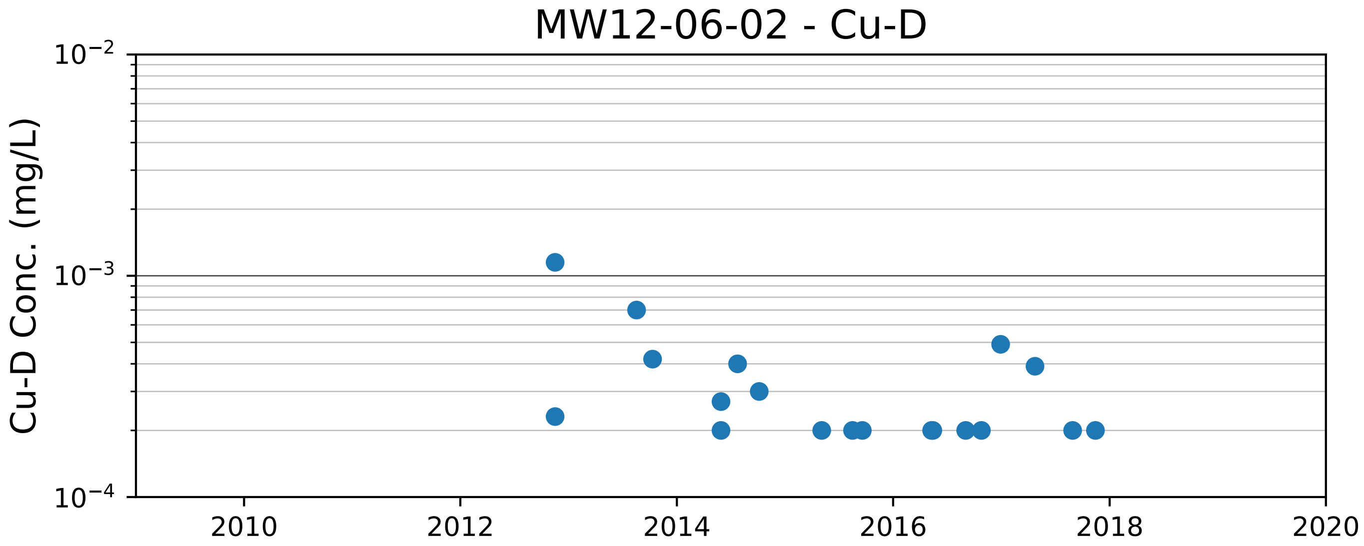

MW12-06-02 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

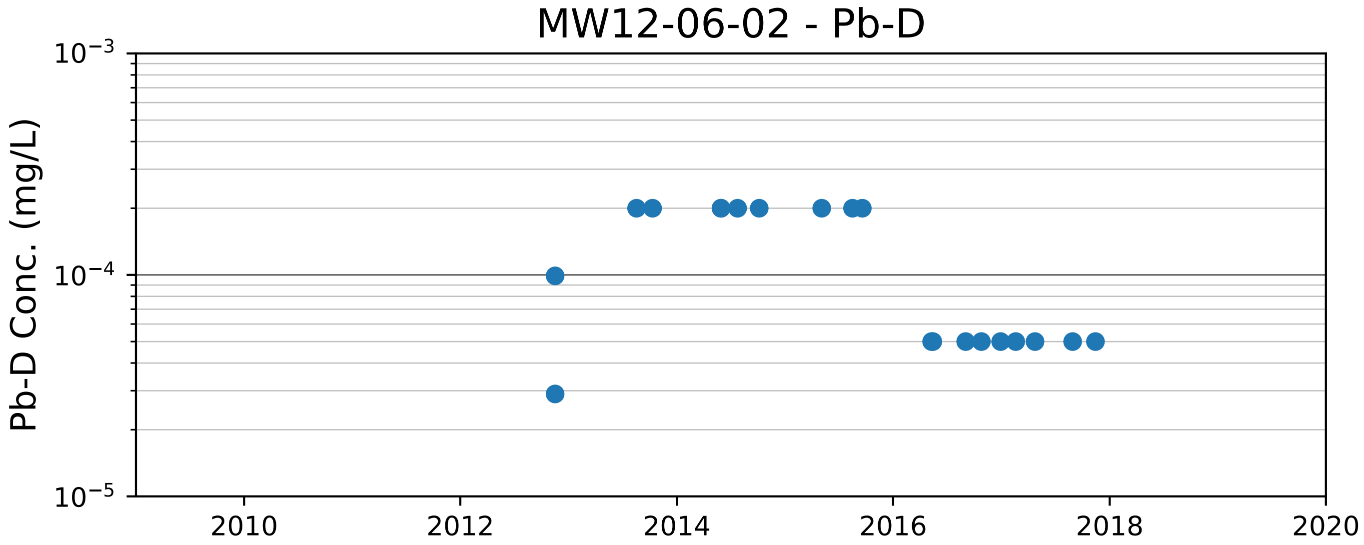

MW12-06-02 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

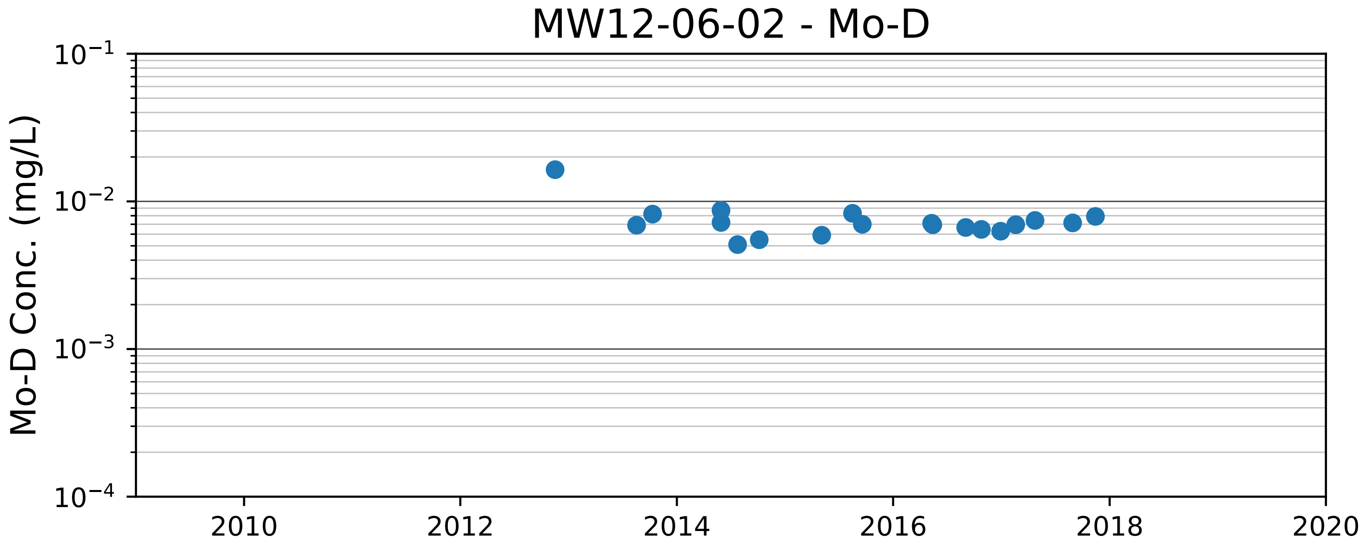

MW12-06-02 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

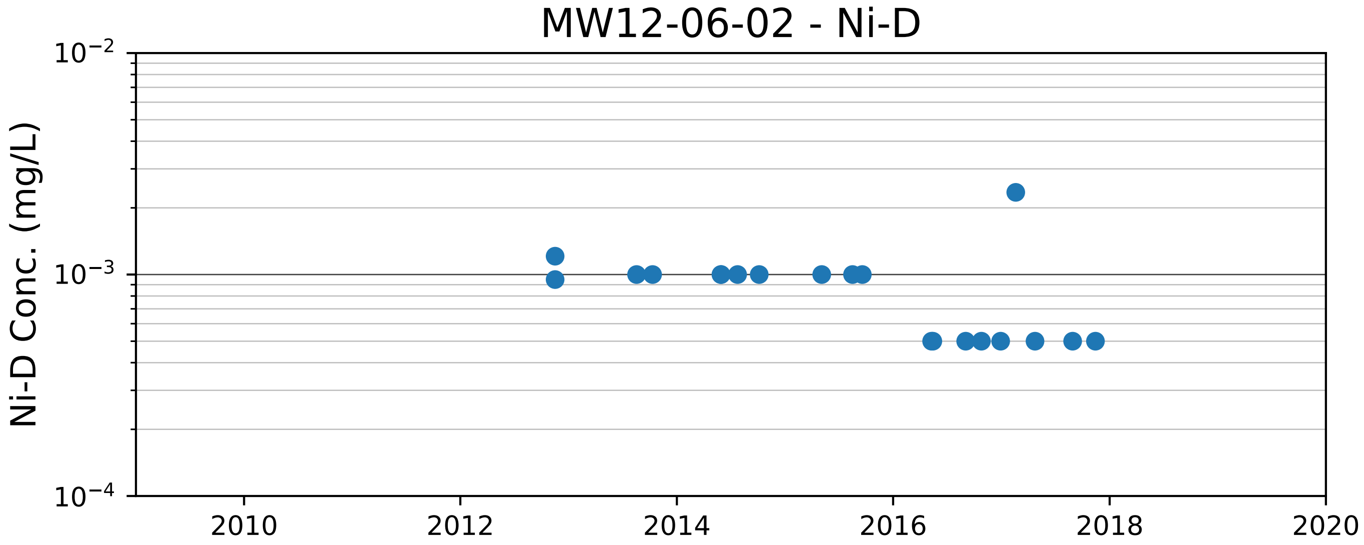

MW12-06-02 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

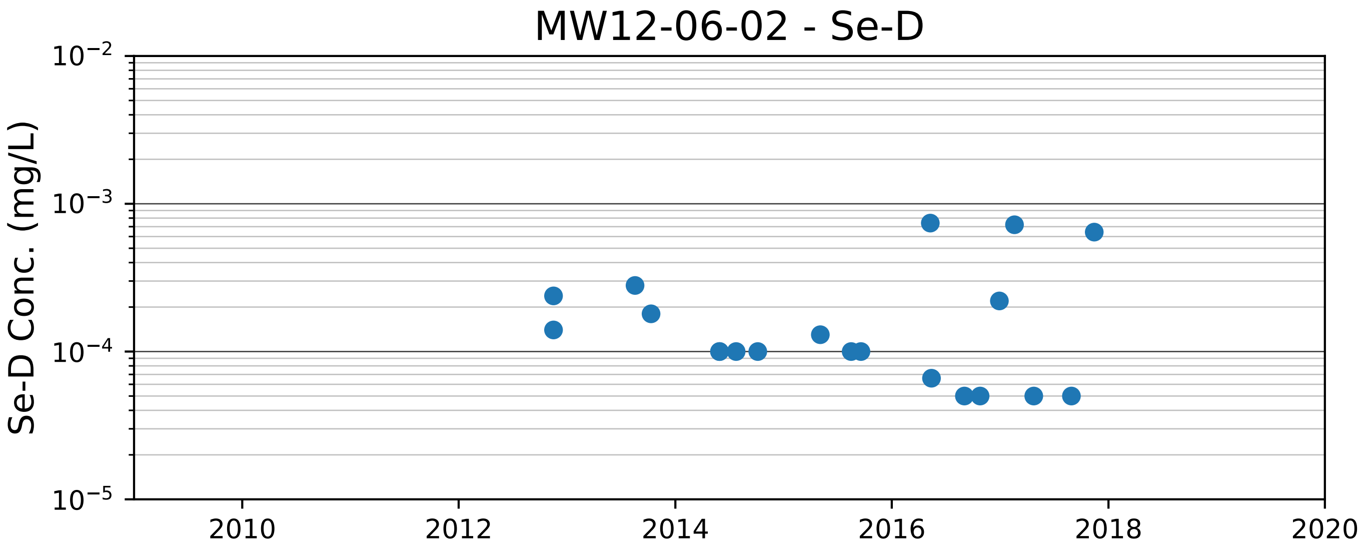

MW12-06-02 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

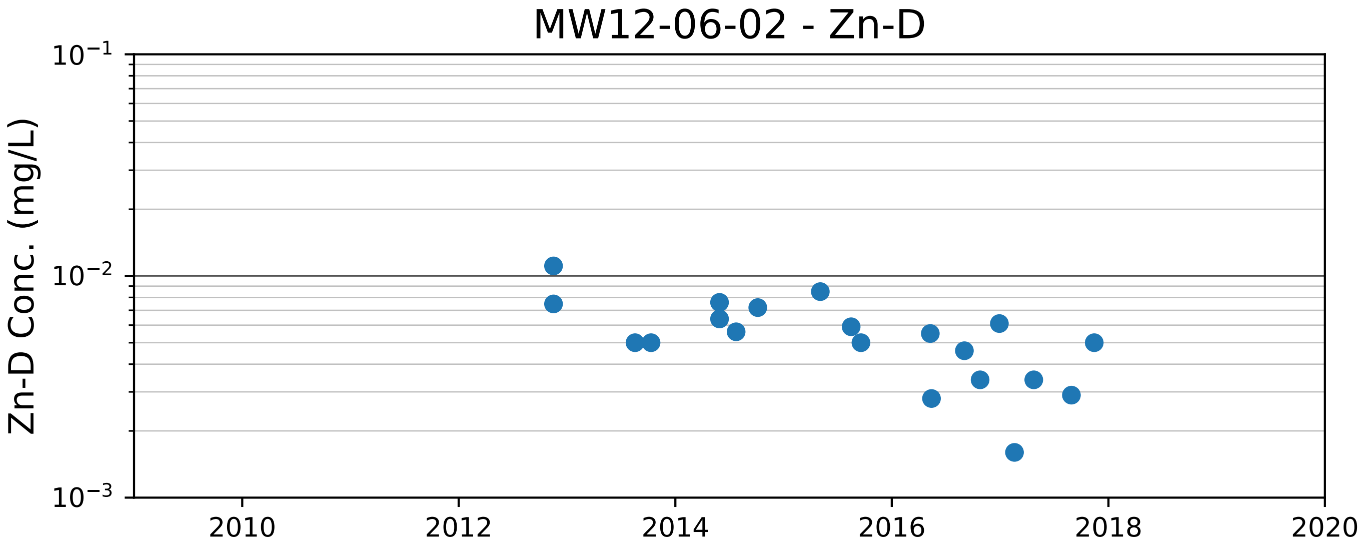

MW12-06-02 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

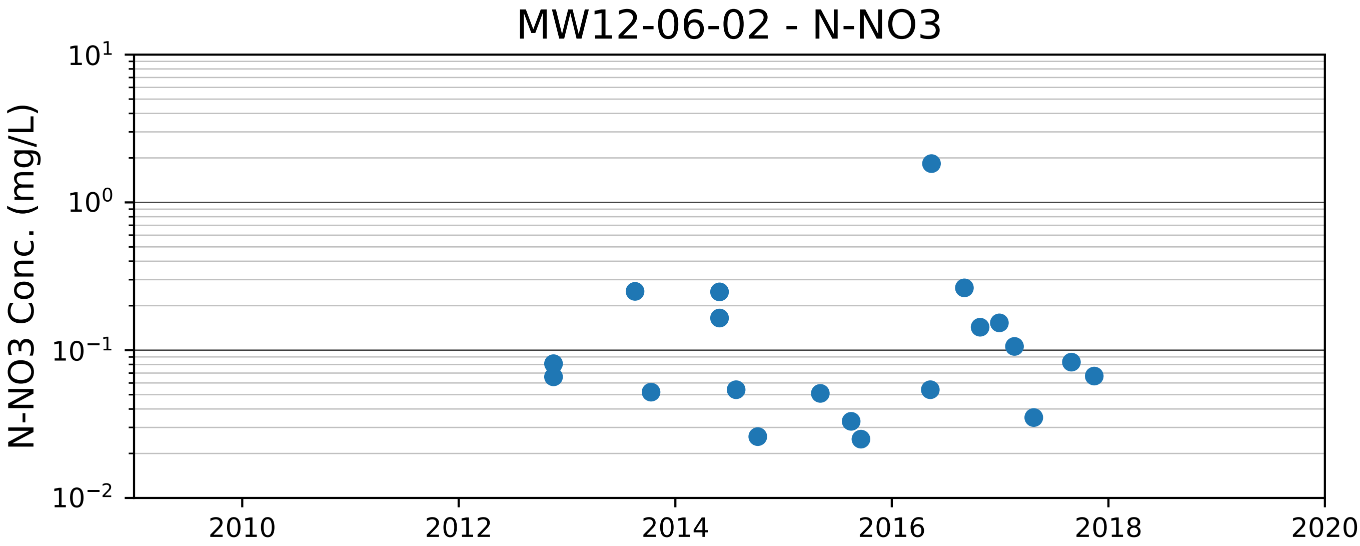

MW12-06-02 - Pb-D

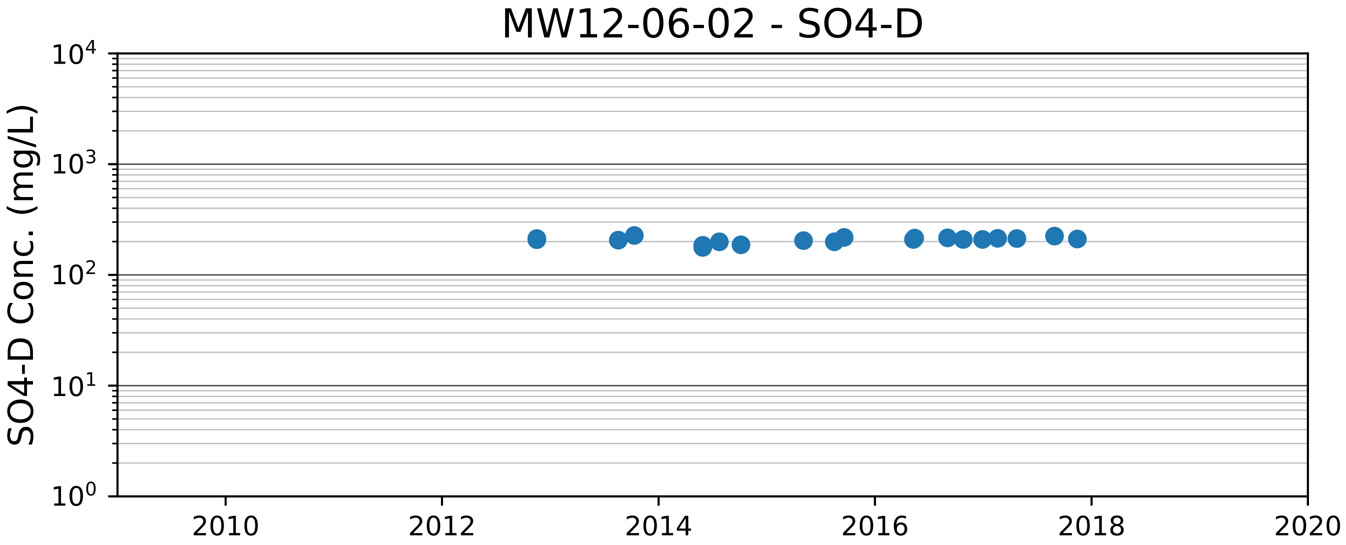

MW12-06-02 - Mo-D

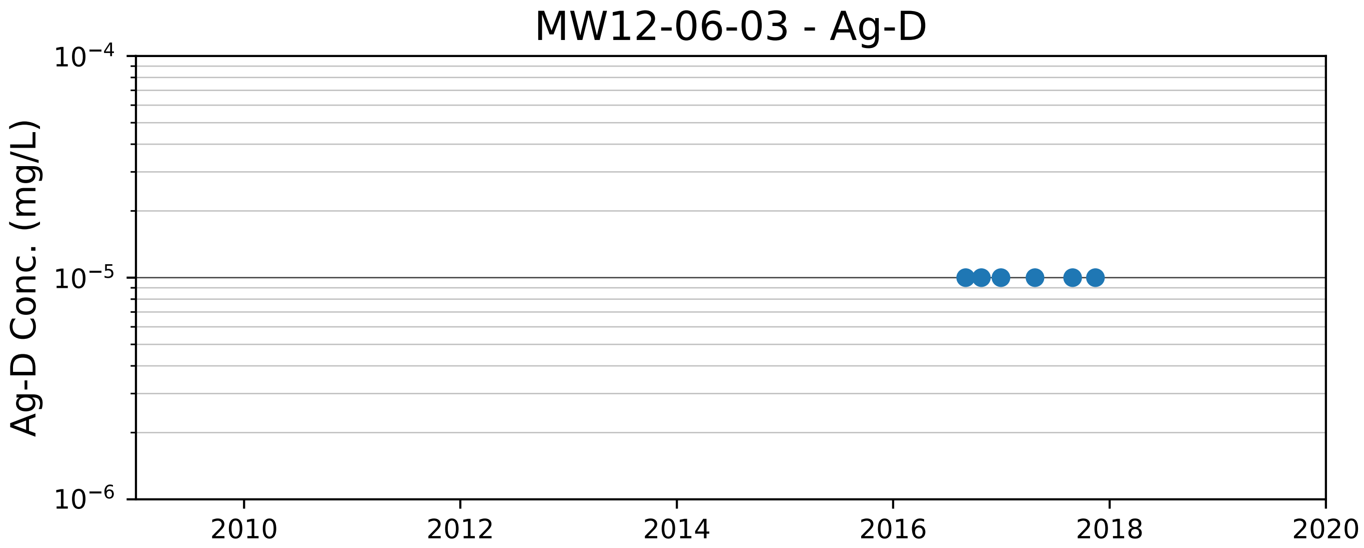

MW12-06-02 - Ni-D

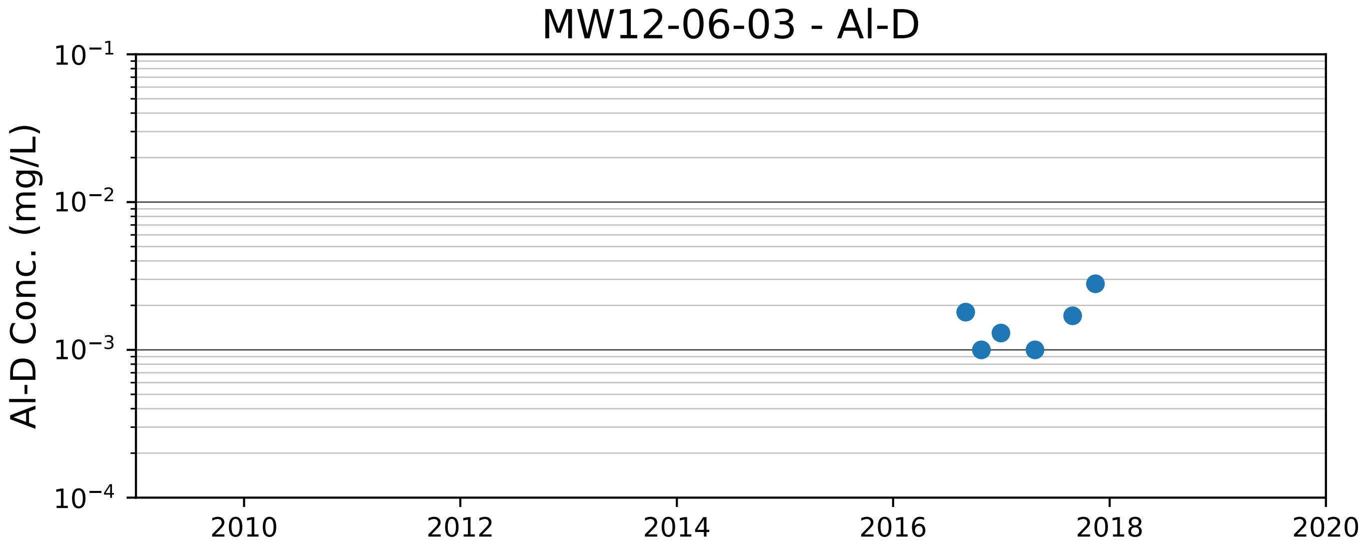

MW12-06-02 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

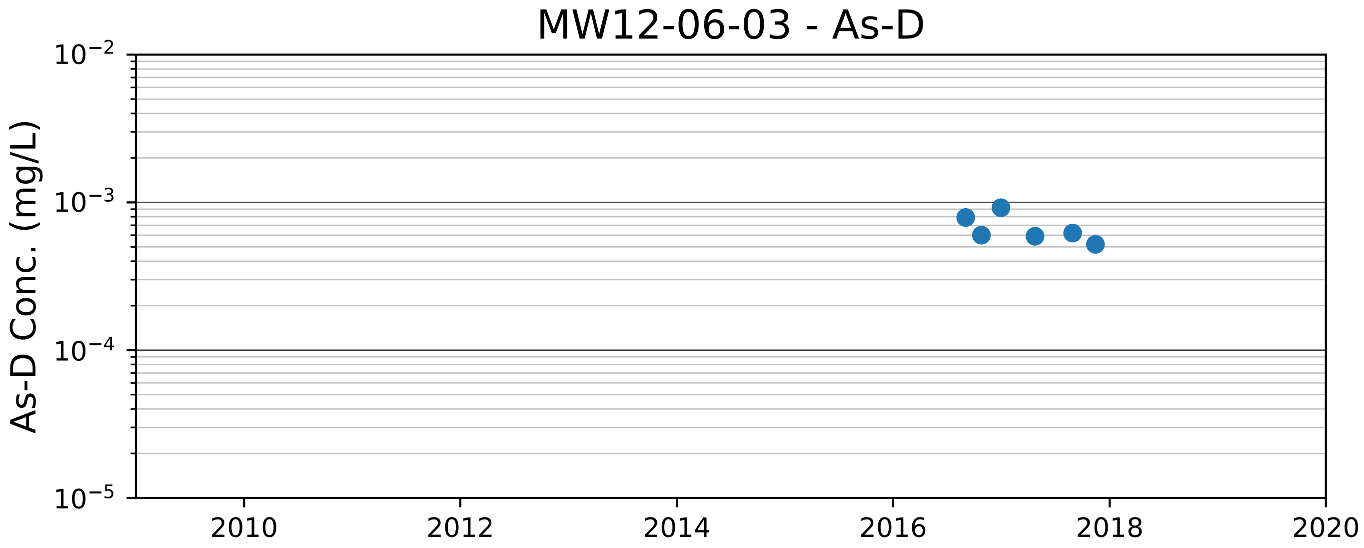

MW12-06-02 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020


MW12-06-02 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

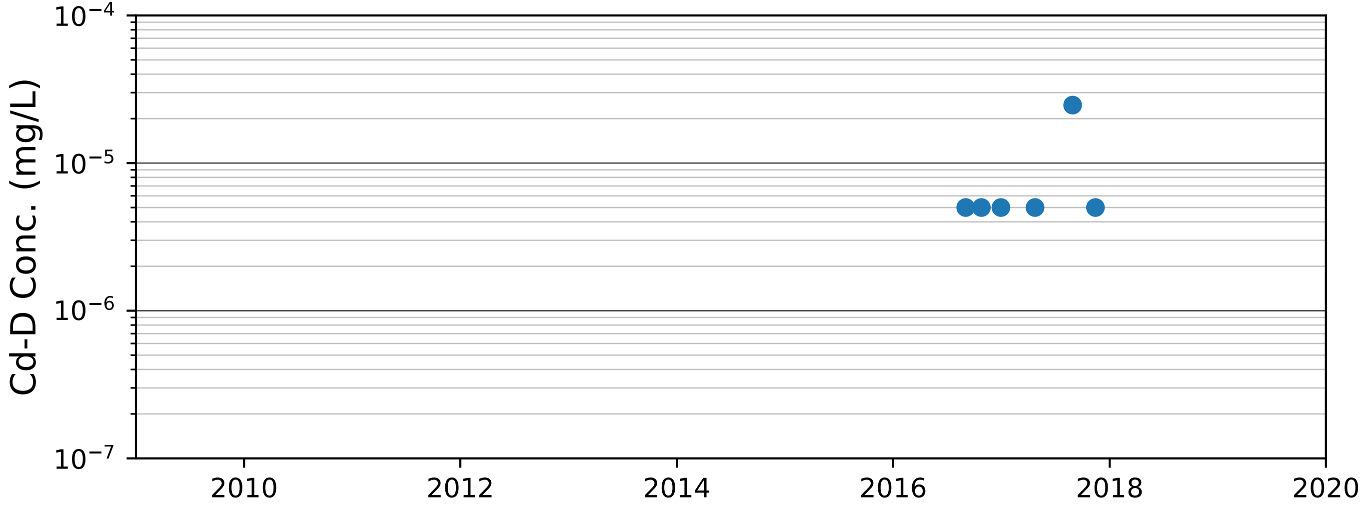

MW12-06-02 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020


MW12-06-03 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

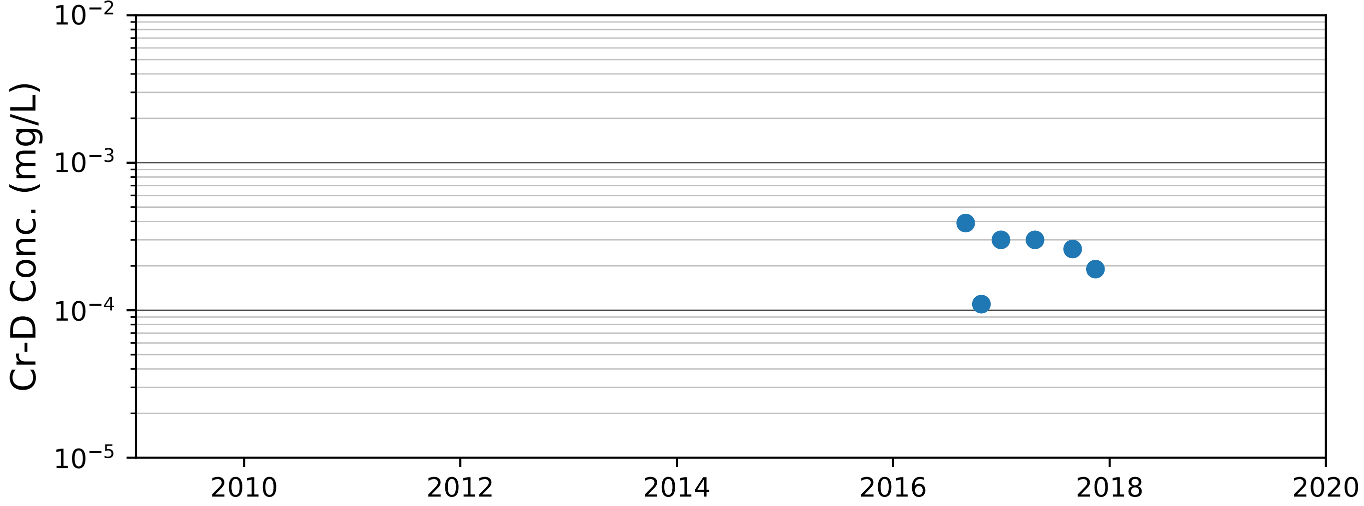

MW12-06-03 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020


MW12-06-03 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

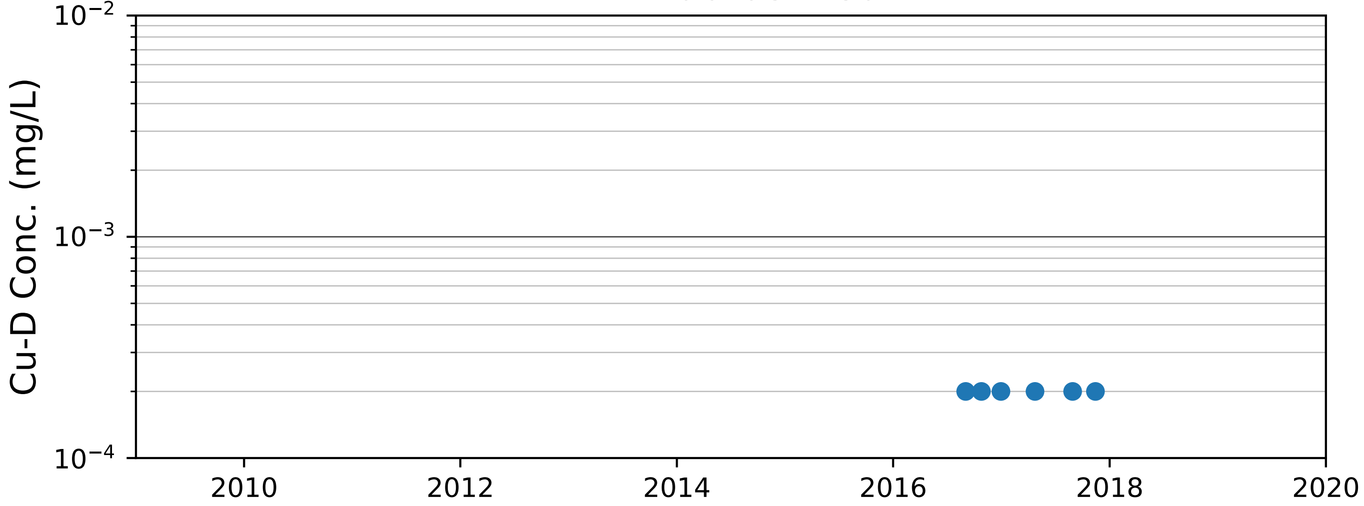
MW12-06-03 - Cd-D

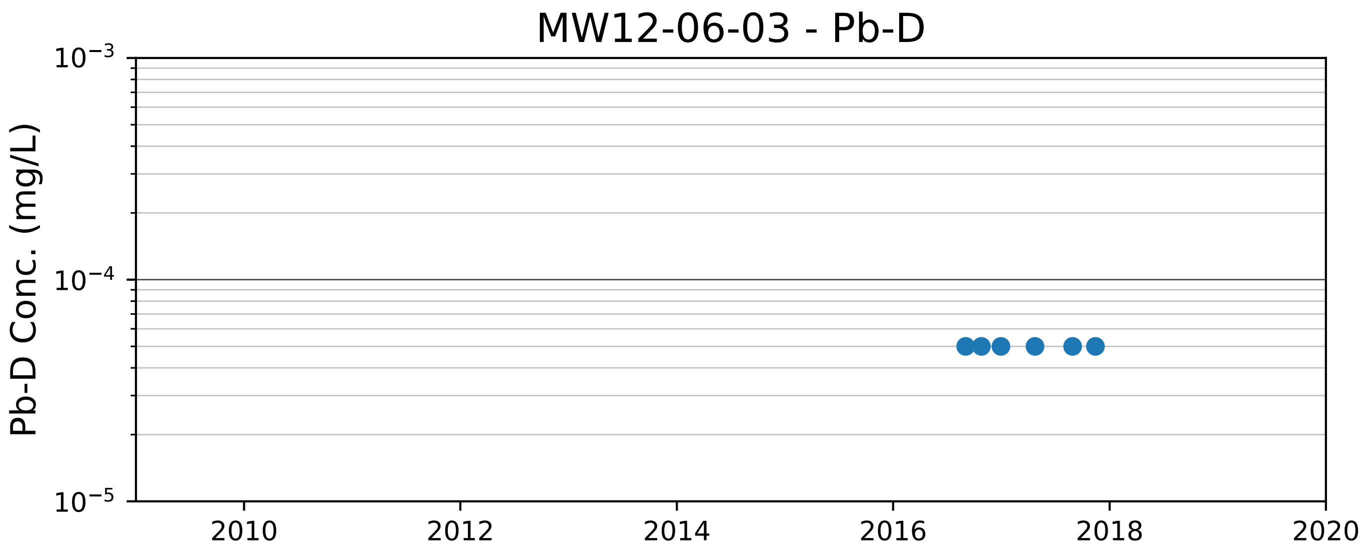


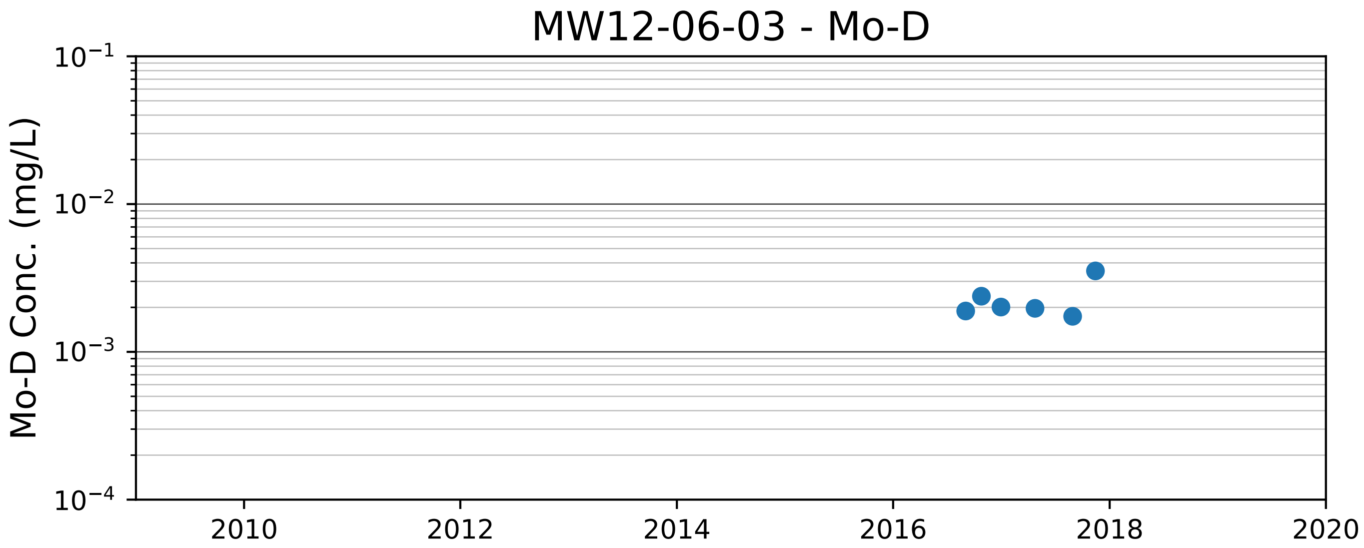
MW12-06-03 - Cr-D

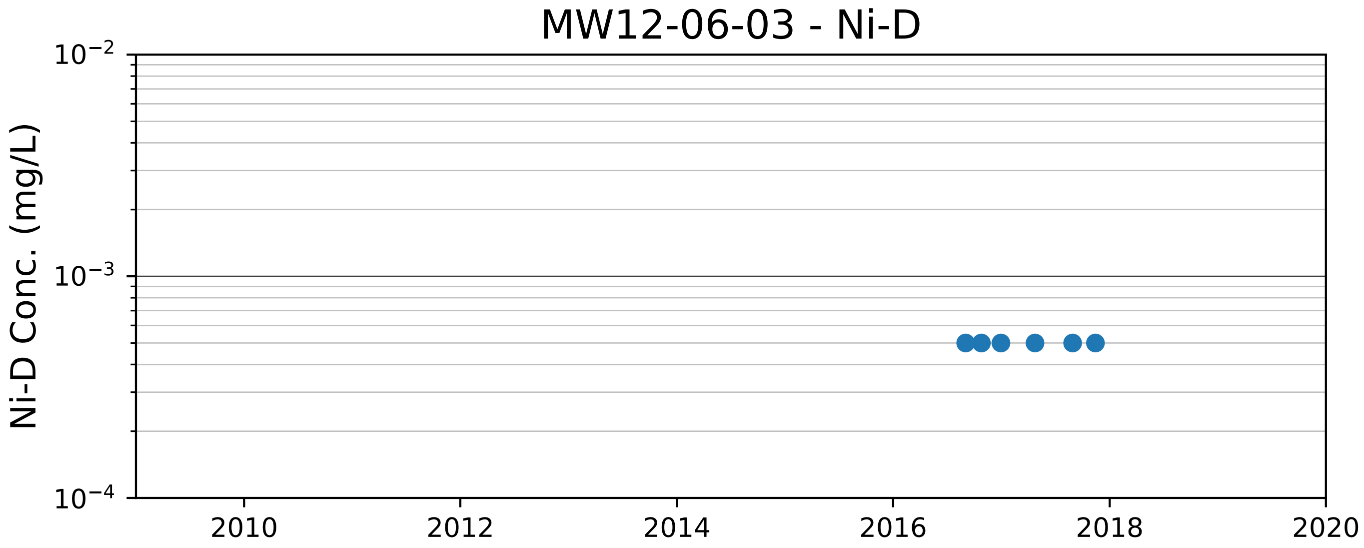


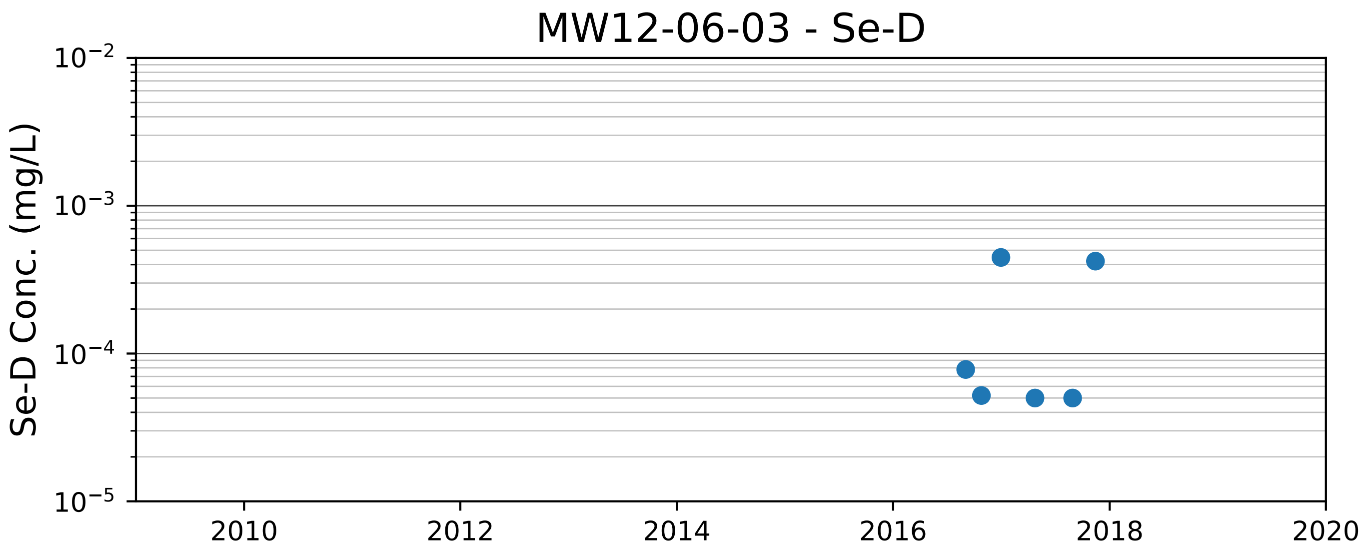
MW12-06-03 - Cu-D

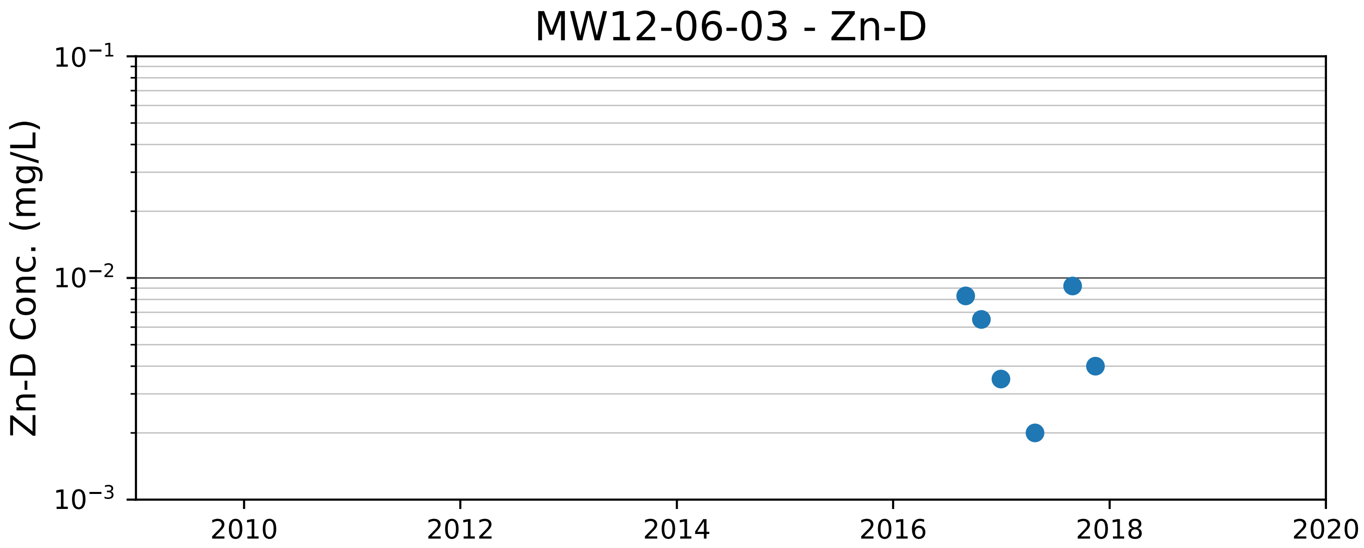


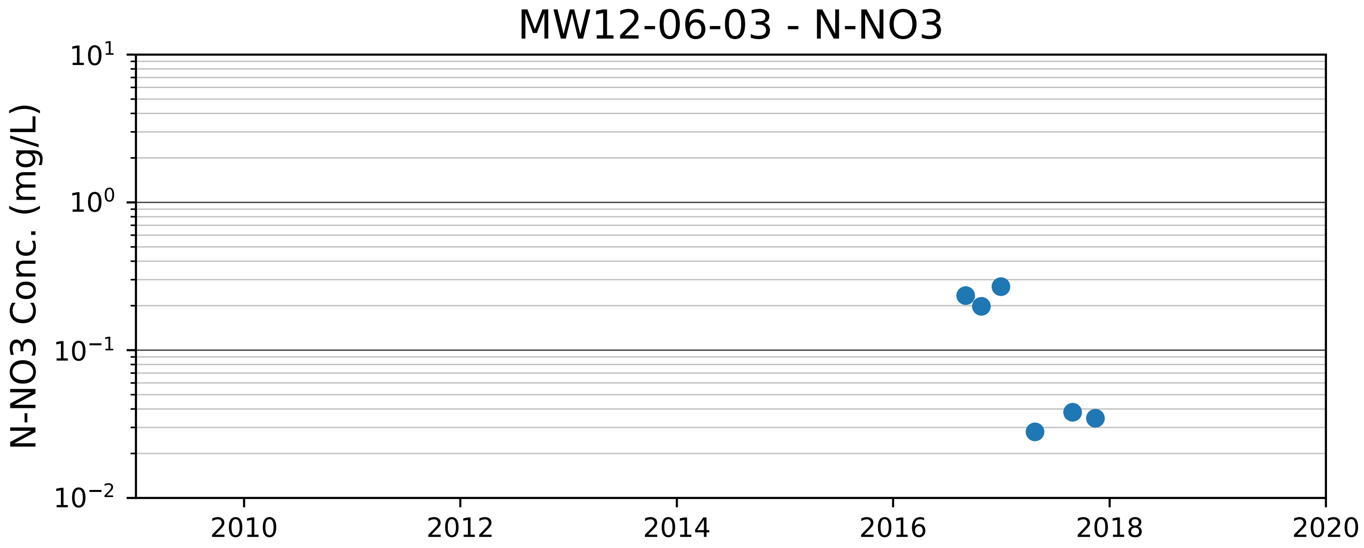

MW12-06-03 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

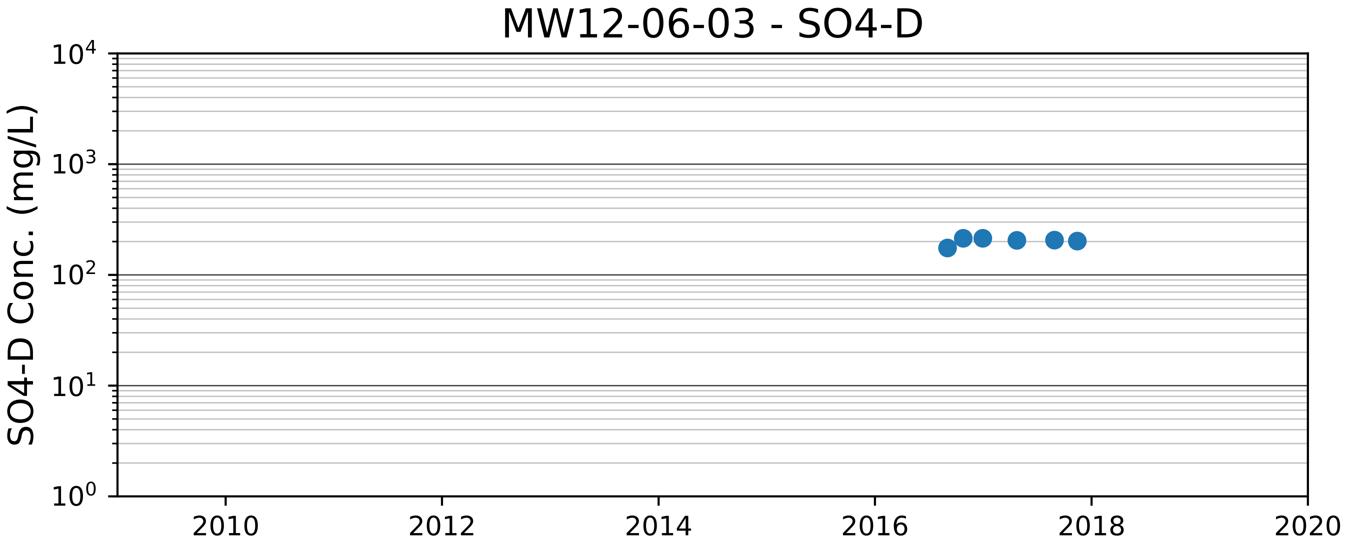

MW12-06-03 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

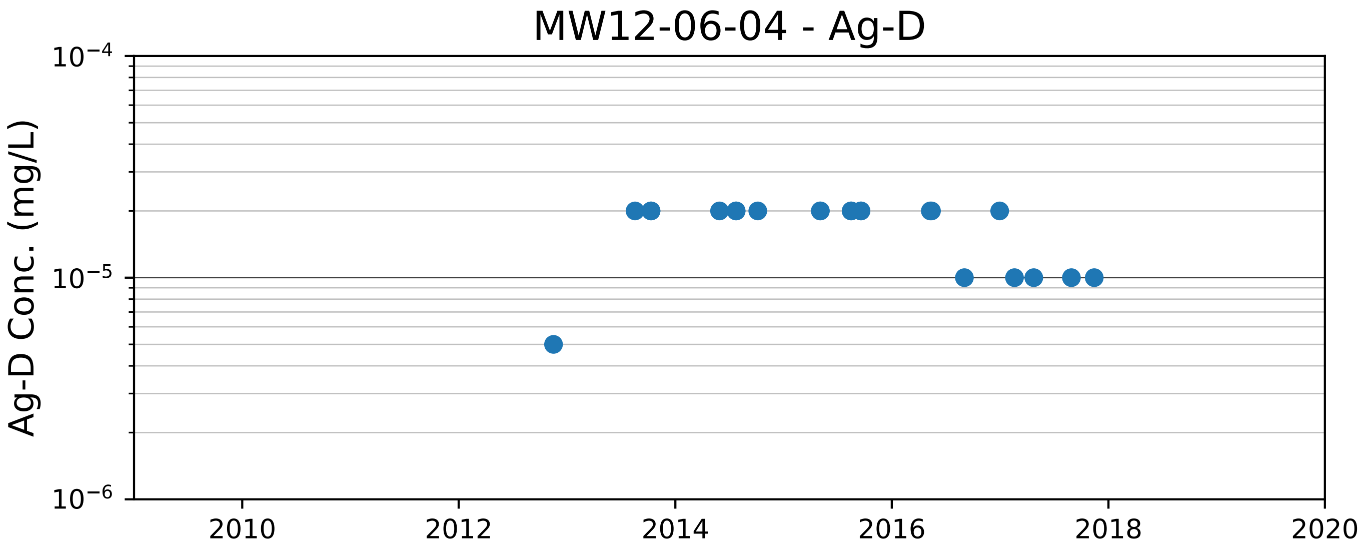

MW12-06-03 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

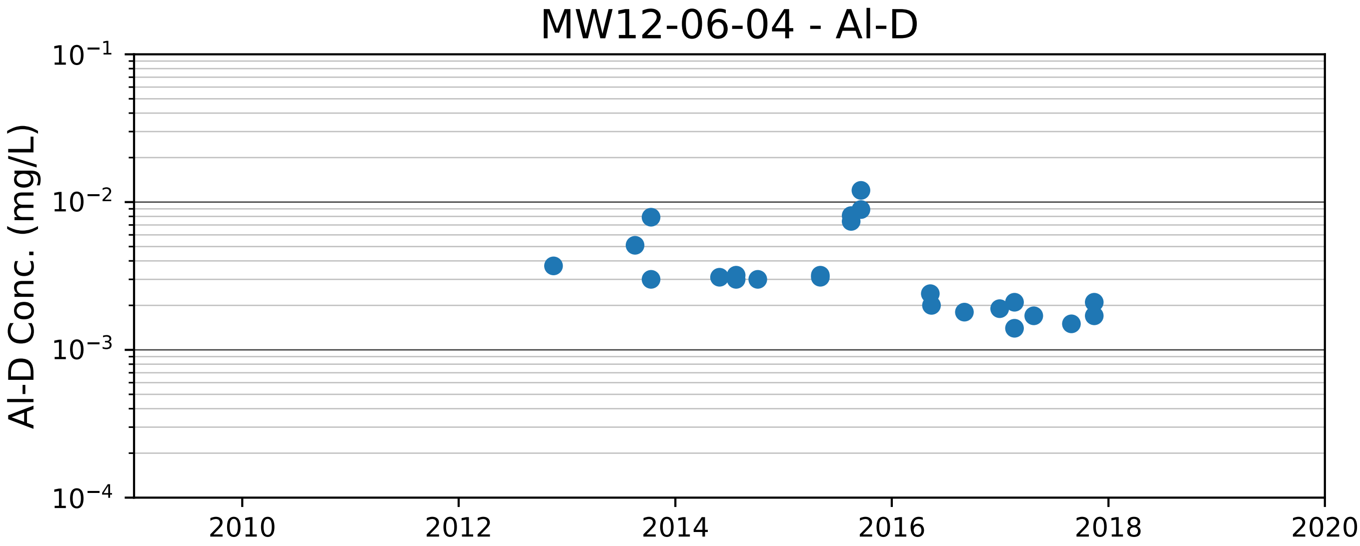

MW12-06-03 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

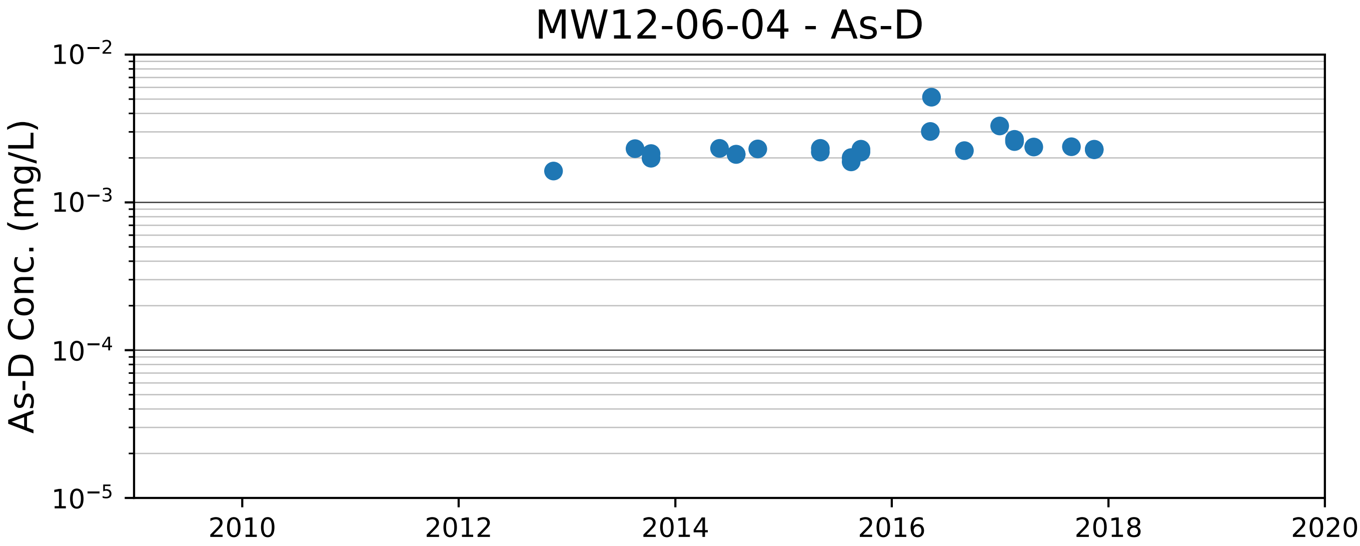

MW12-06-03 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020

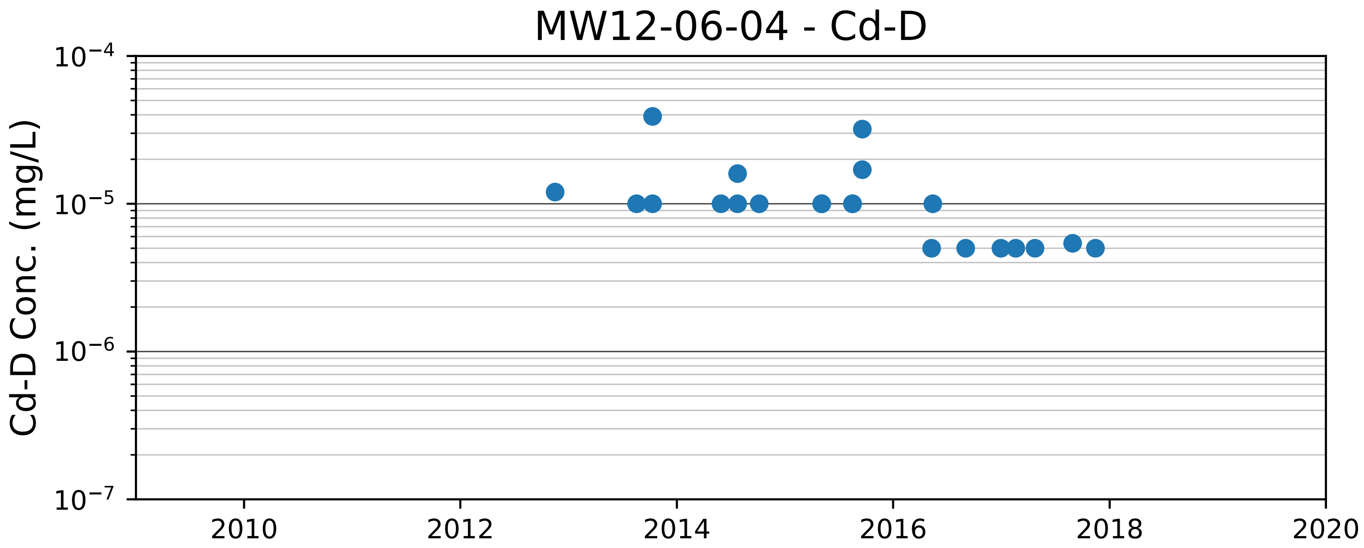

MW12-06-03 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

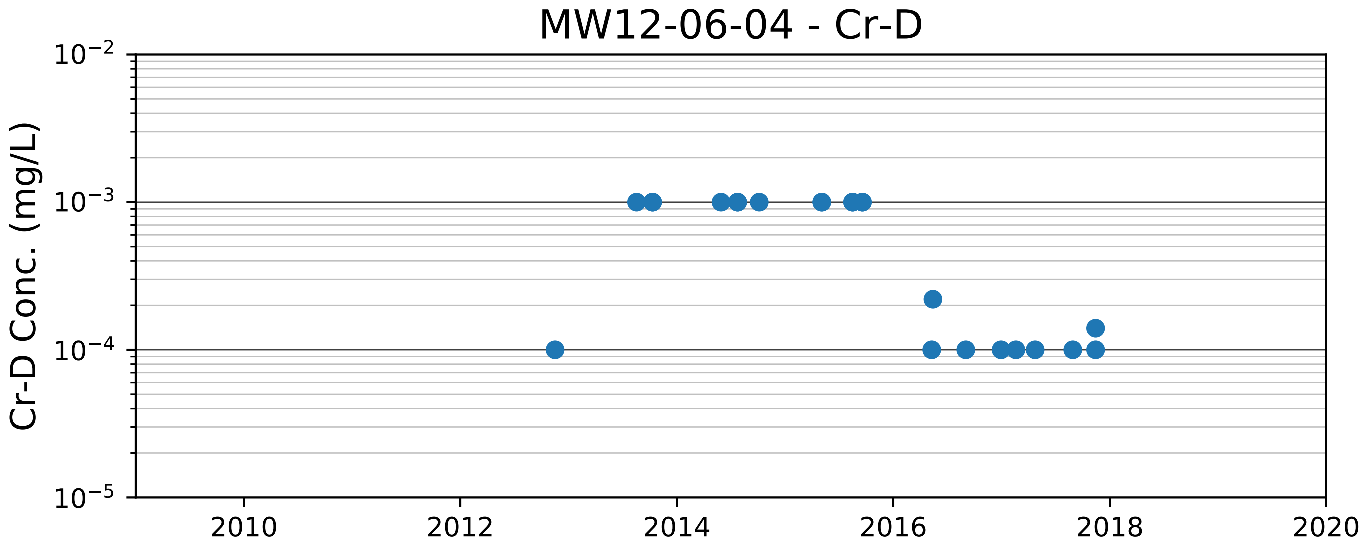

MW12-06-03 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

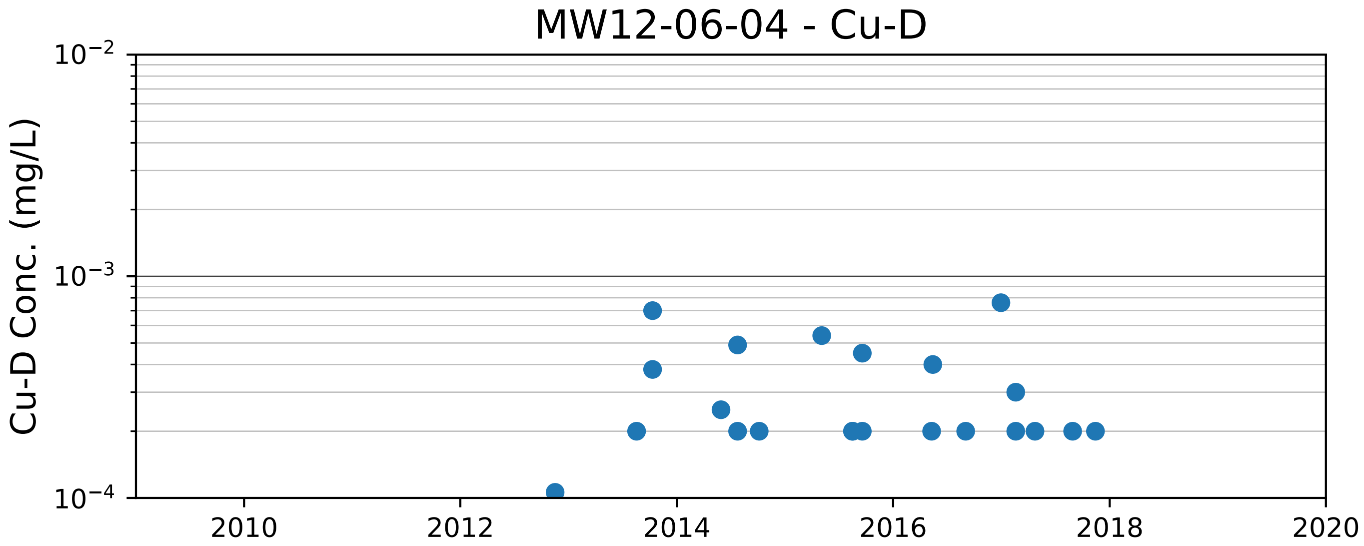

MW12-06-04 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

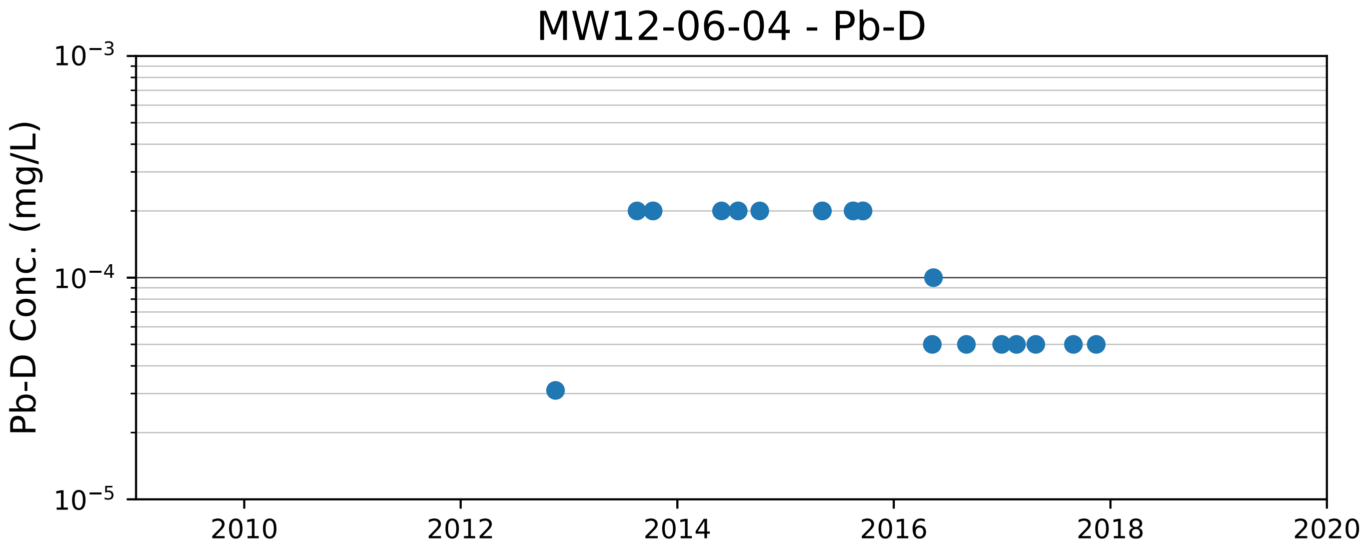

MW12-06-04 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

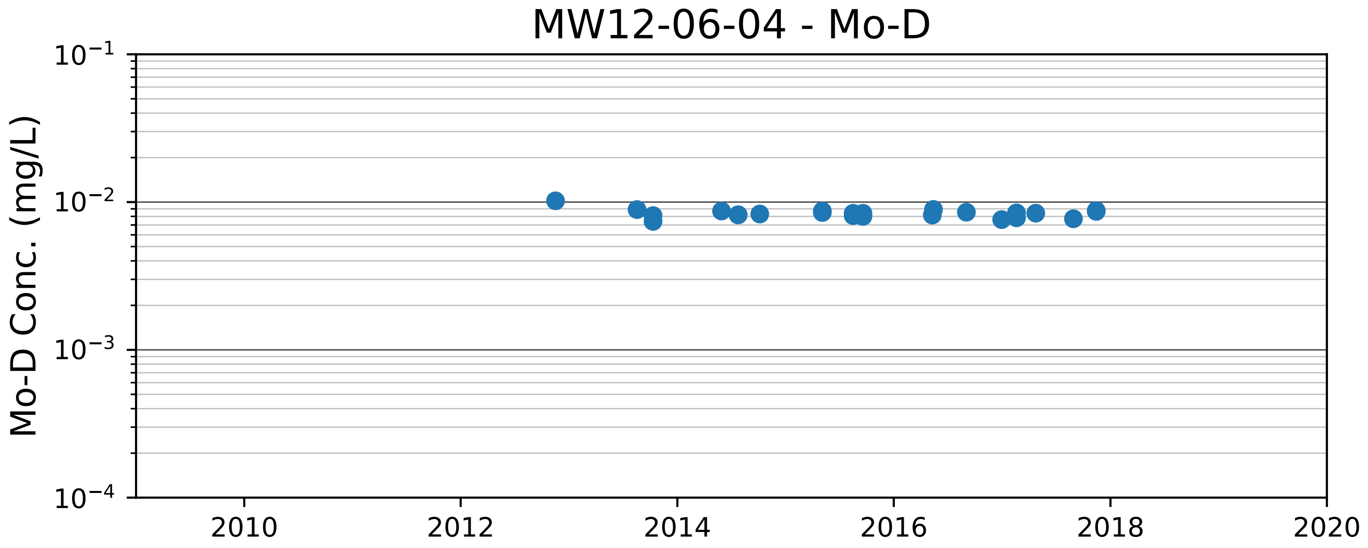

MW12-06-04 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

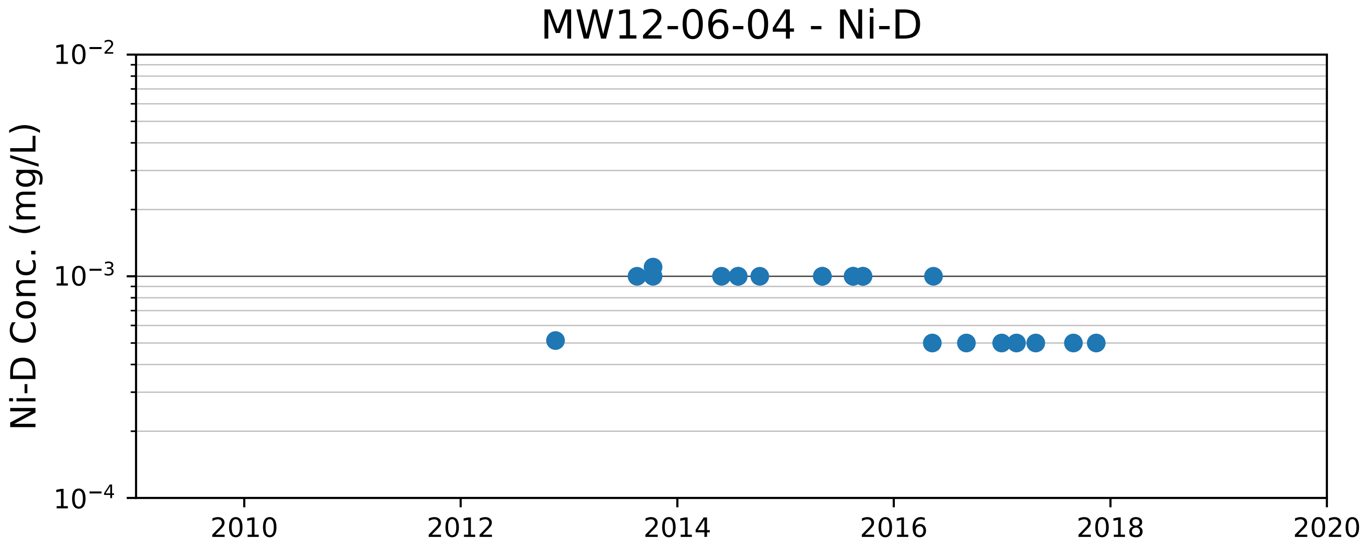

MW12-06-04 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

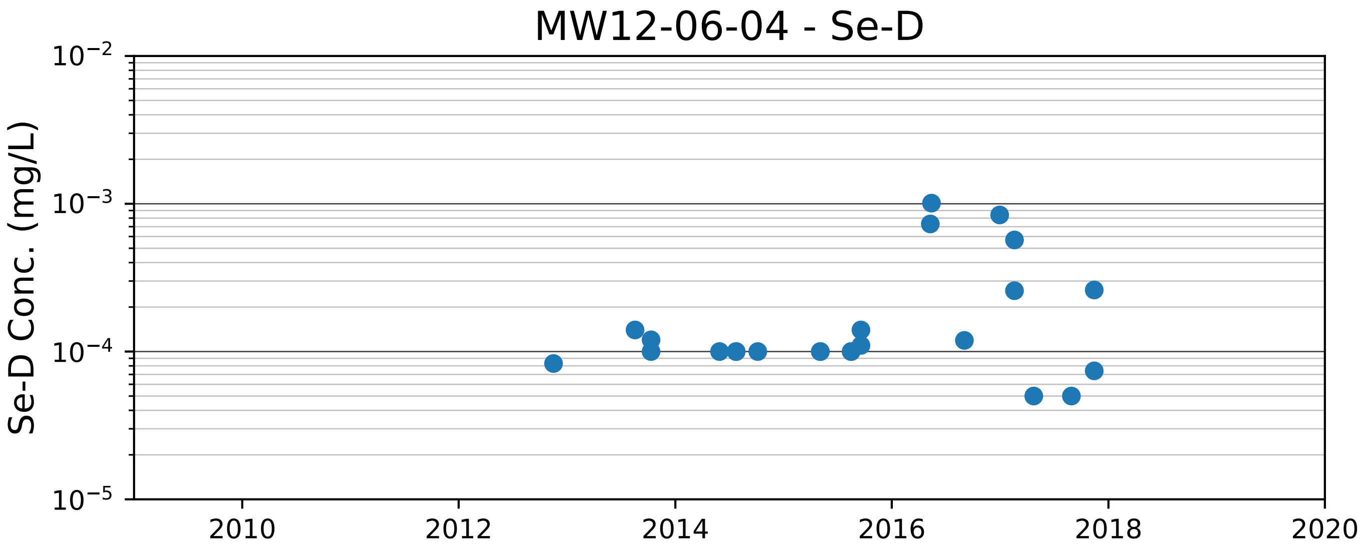

MW12-06-04 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

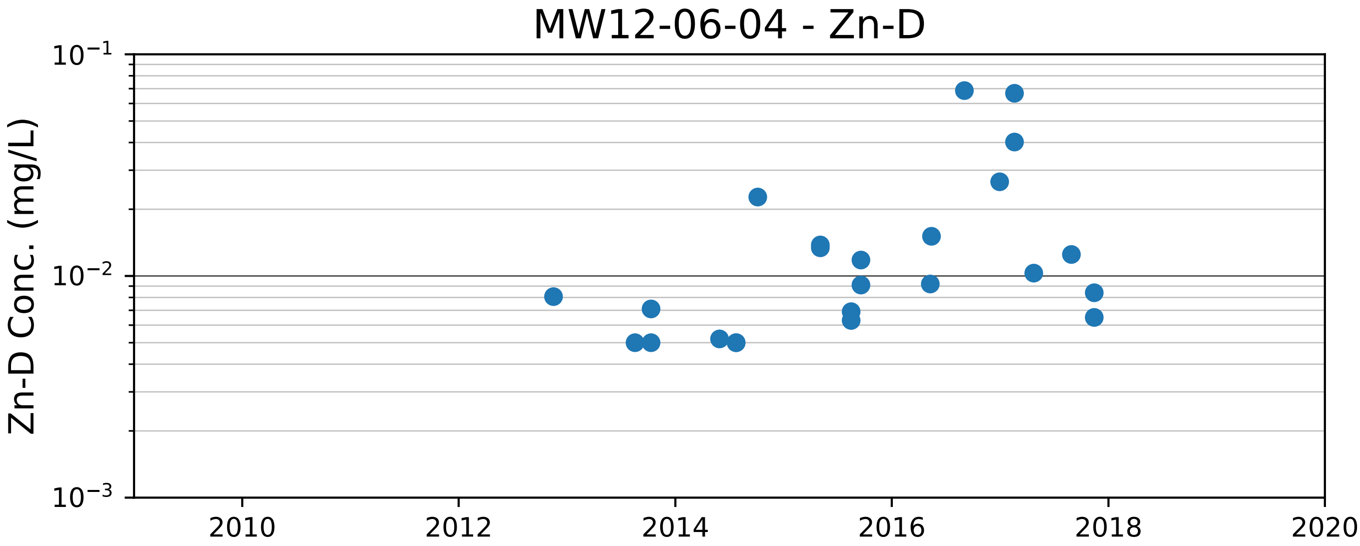

MW12-06-04 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

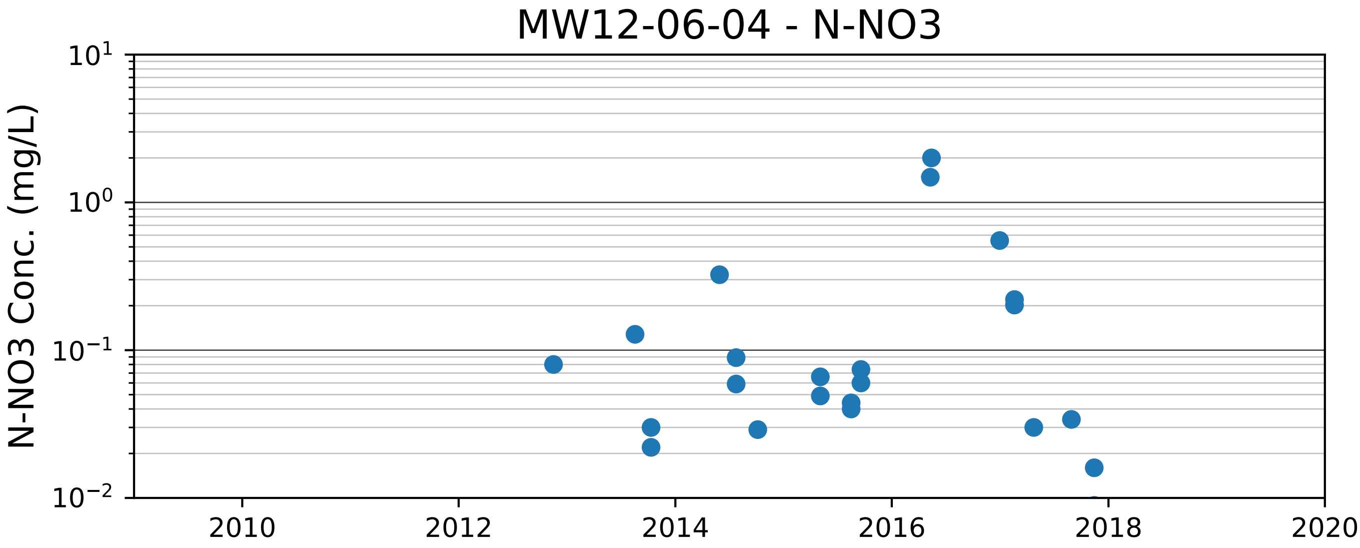

MW12-06-04 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

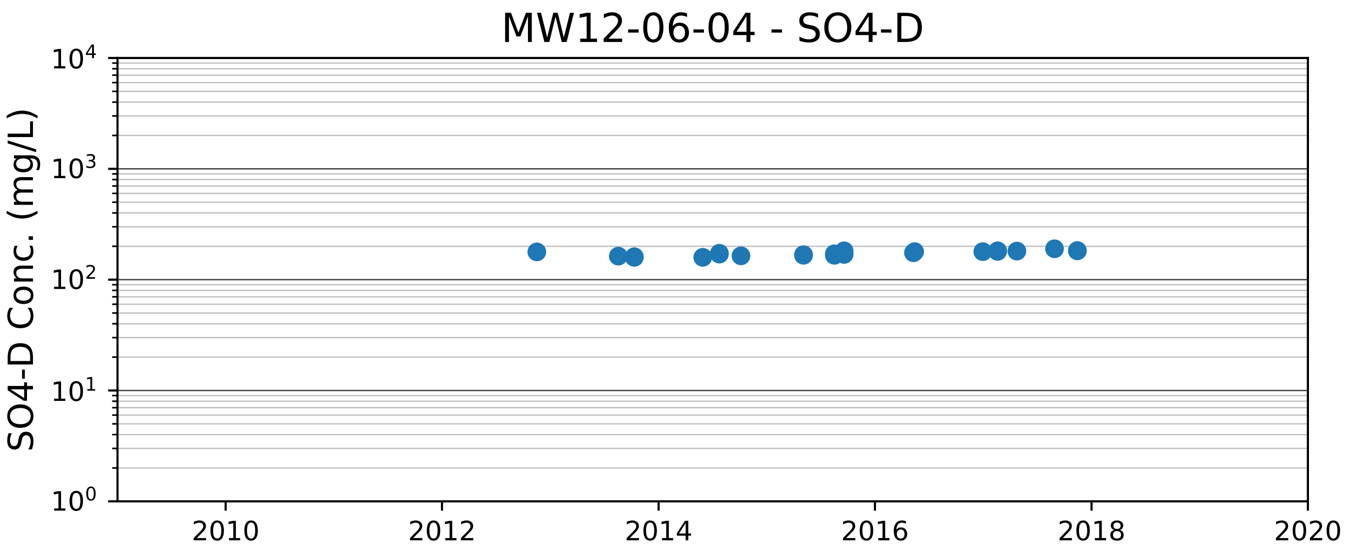

MW12-06-04 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

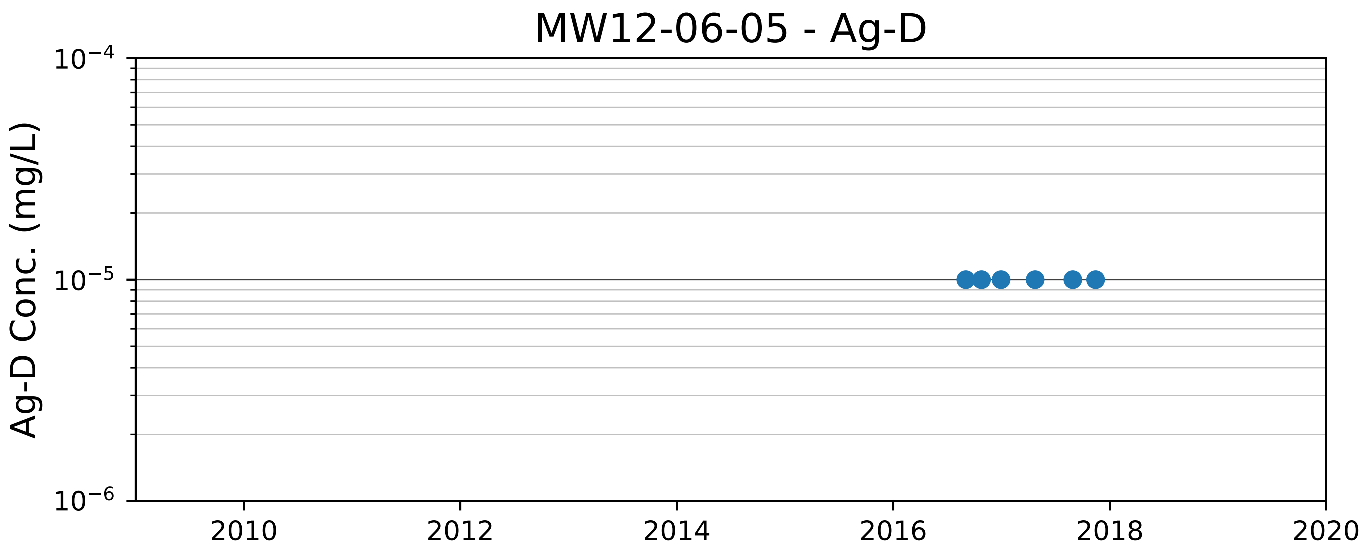

MW12-06-04 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020


MW12-06-04 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

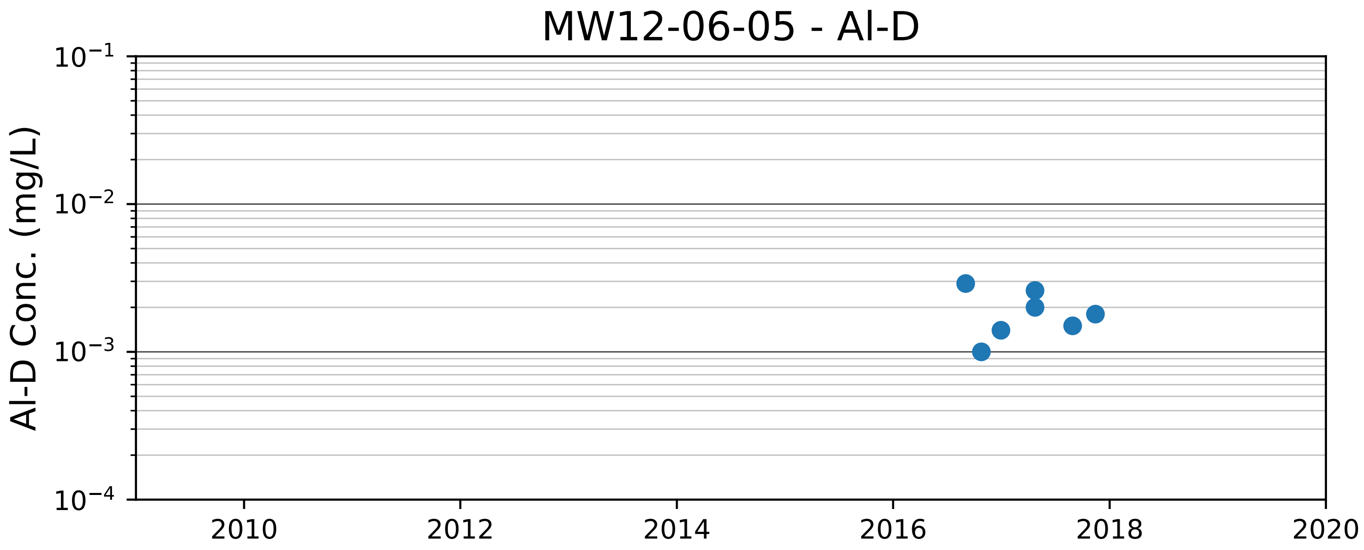

MW12-06-04 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020


MW12-06-04 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020

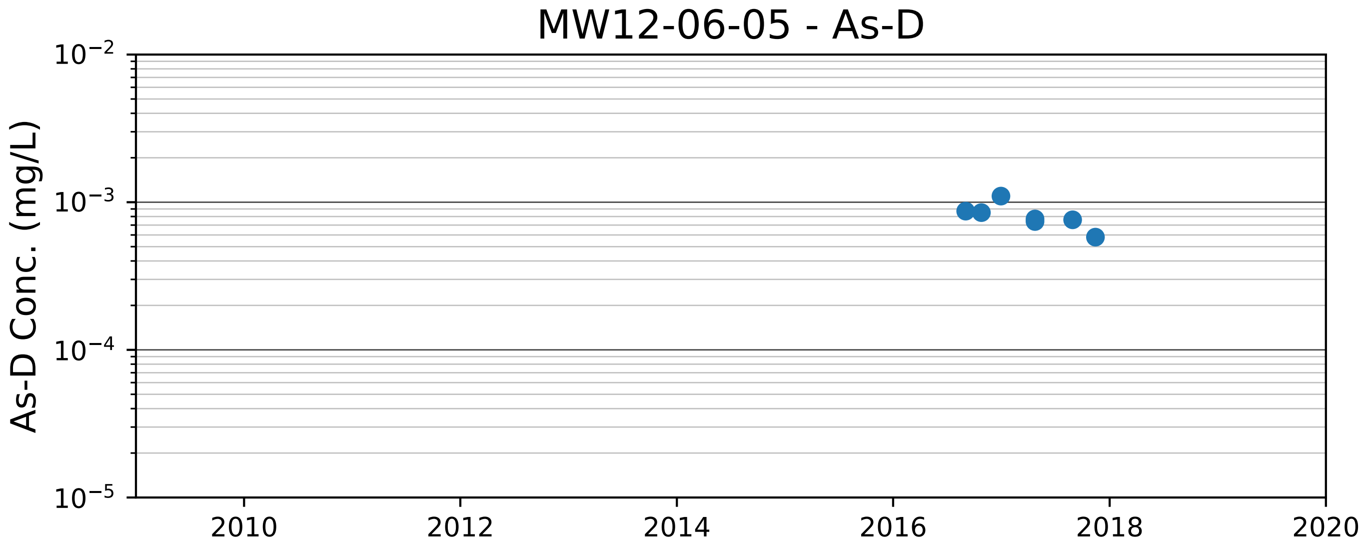

MW12-06-04 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020



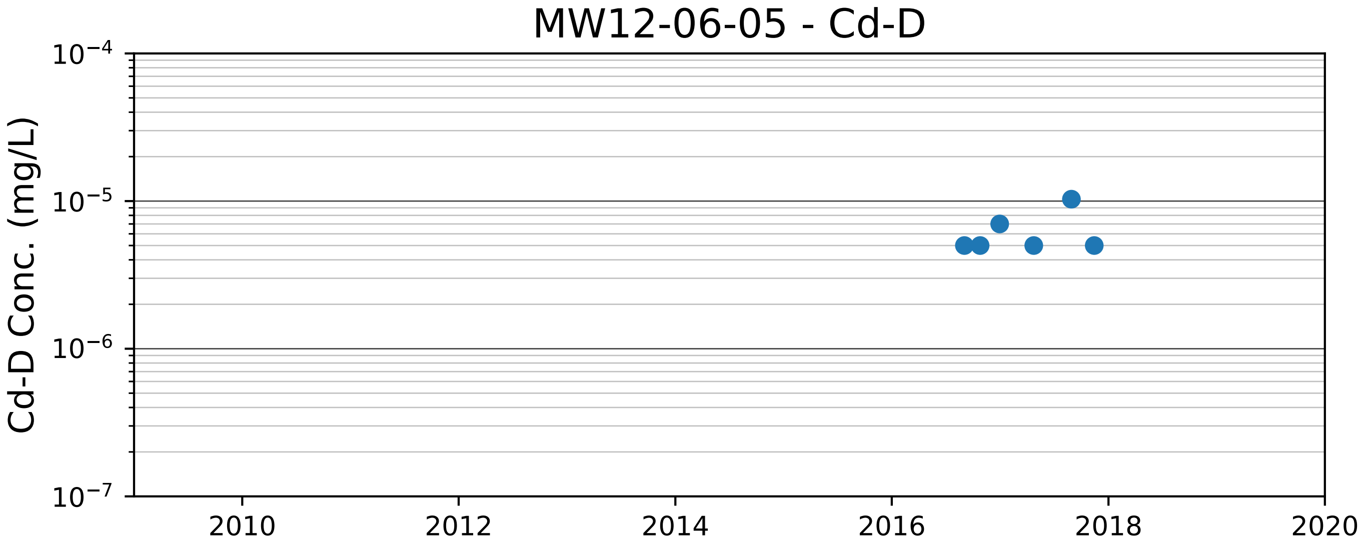
MW12-06-05 - Ag-D

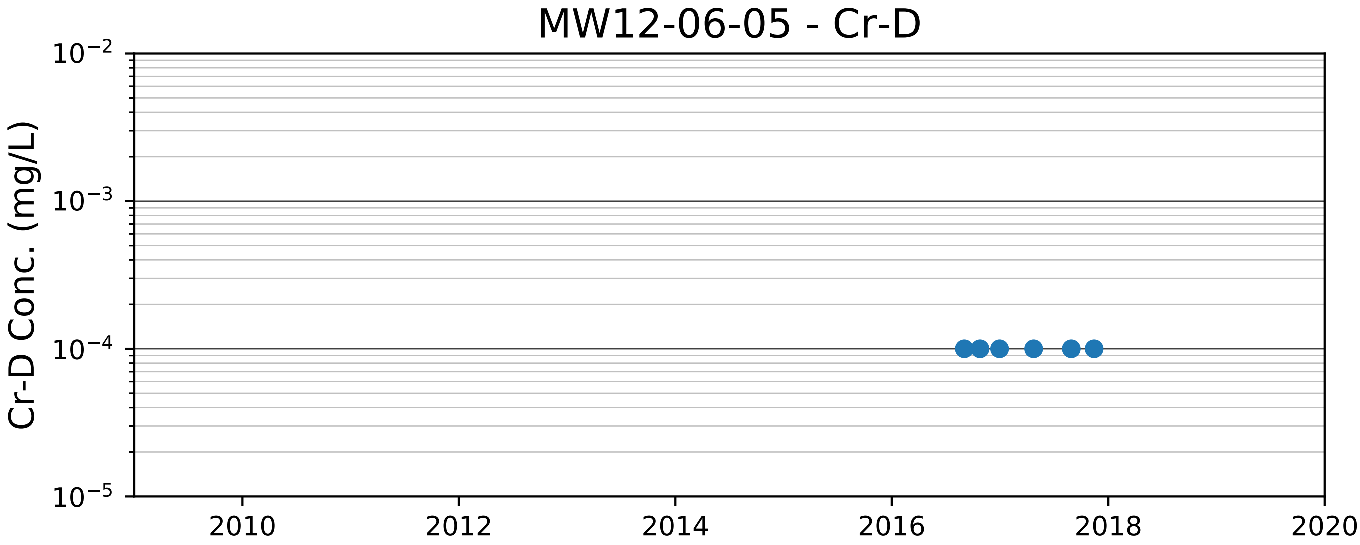


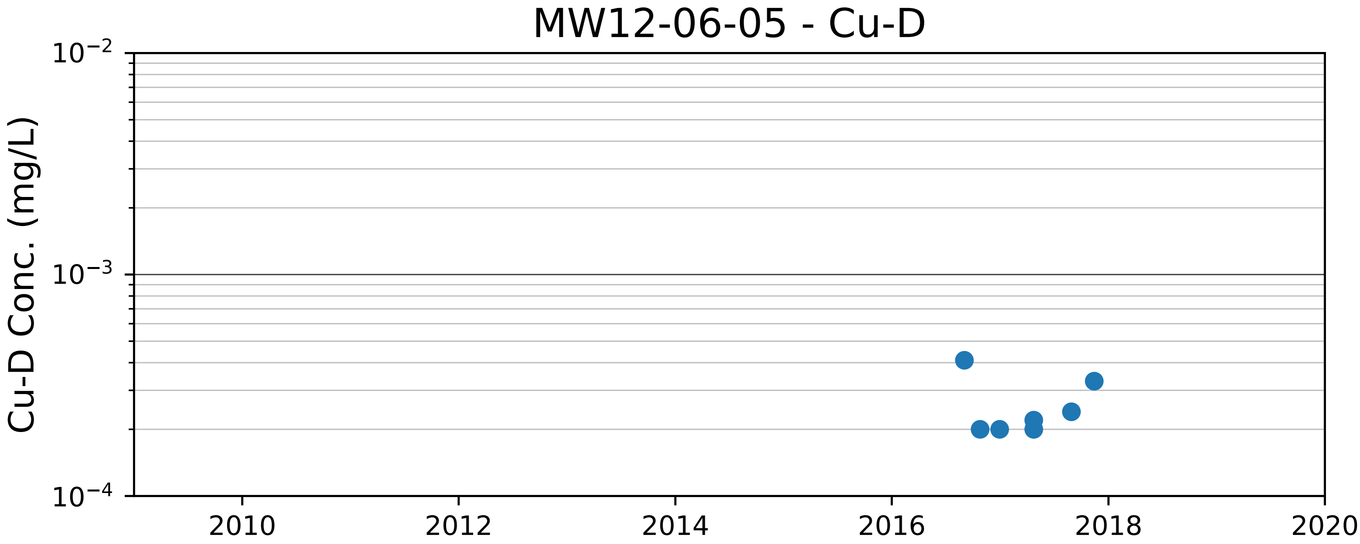
MW12-06-05 - Al-D

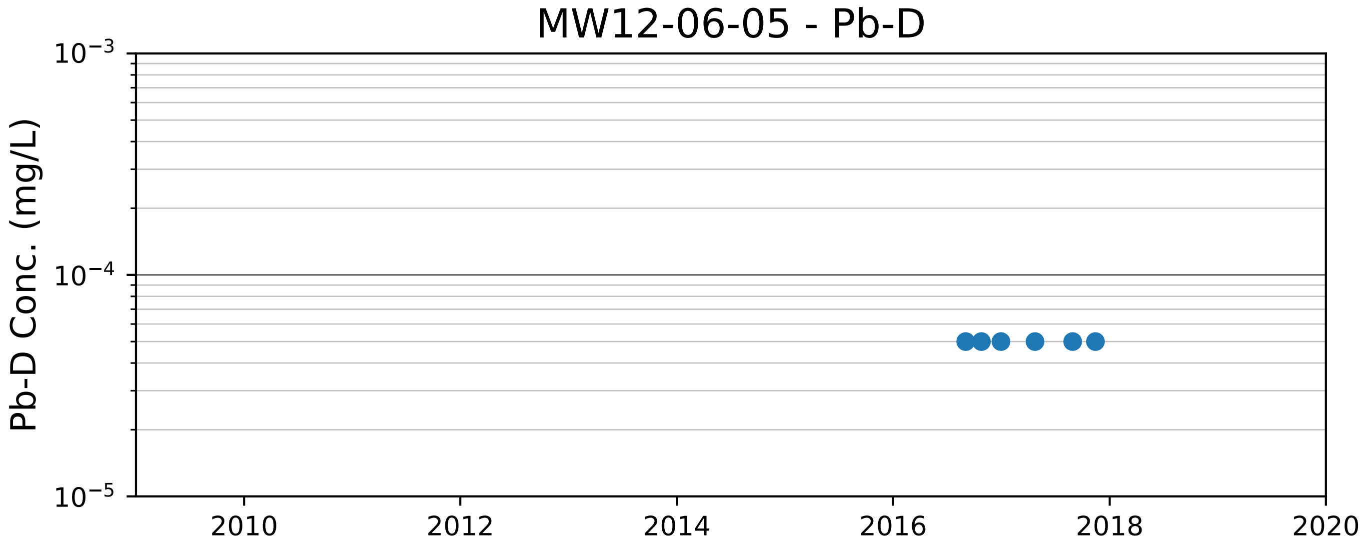


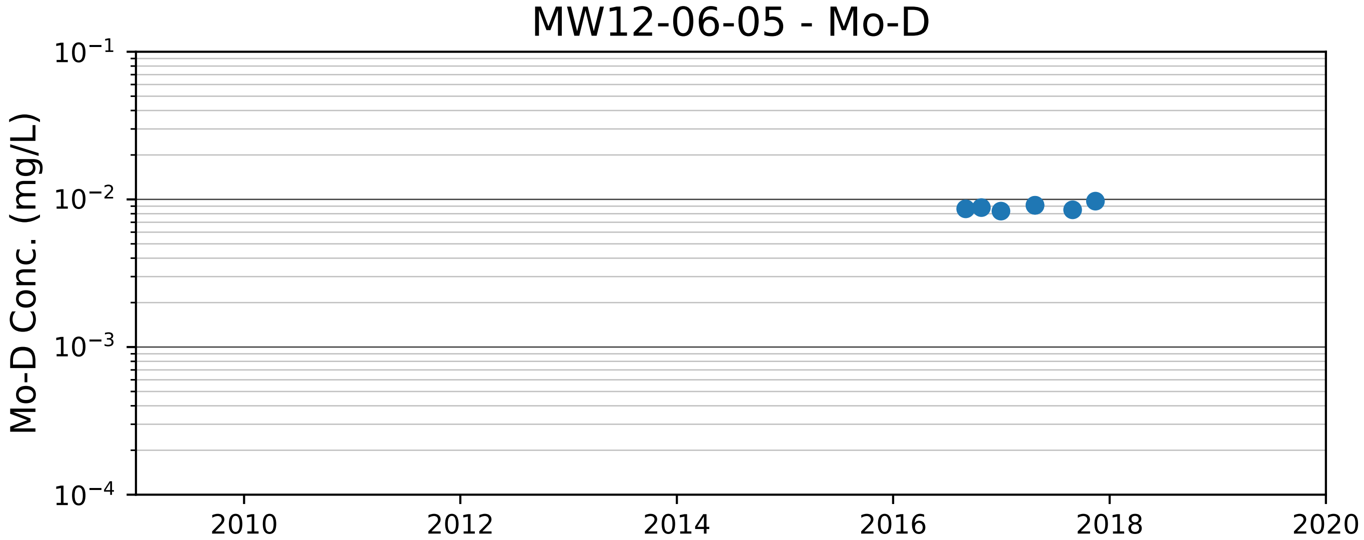
MW12-06-05 - As-D

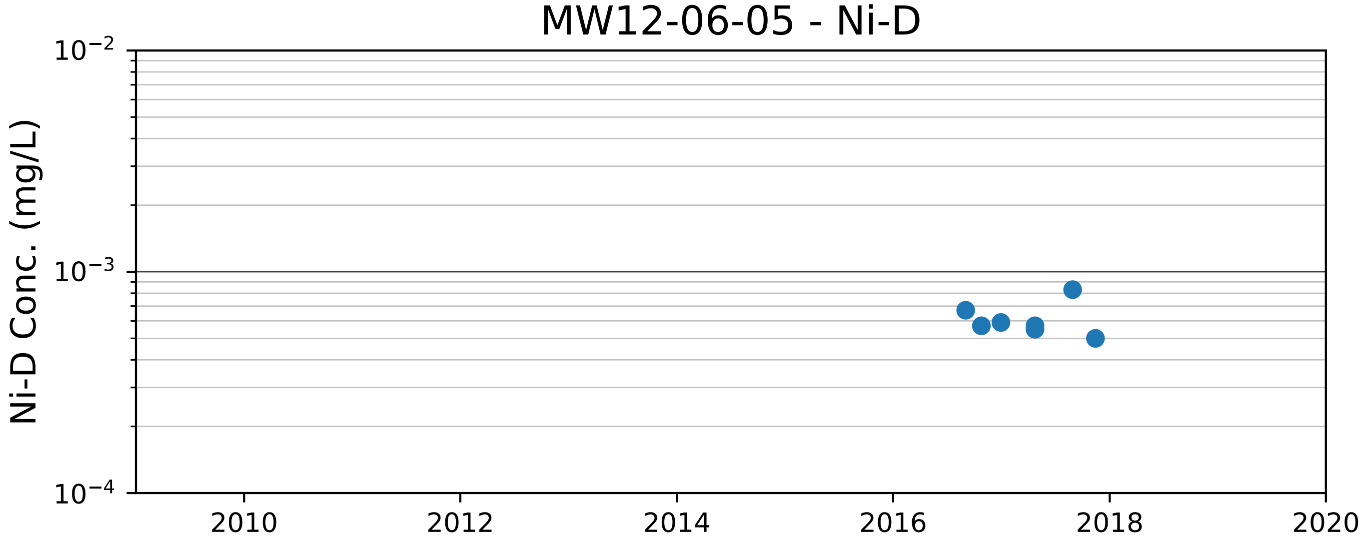

MW12-06-05 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

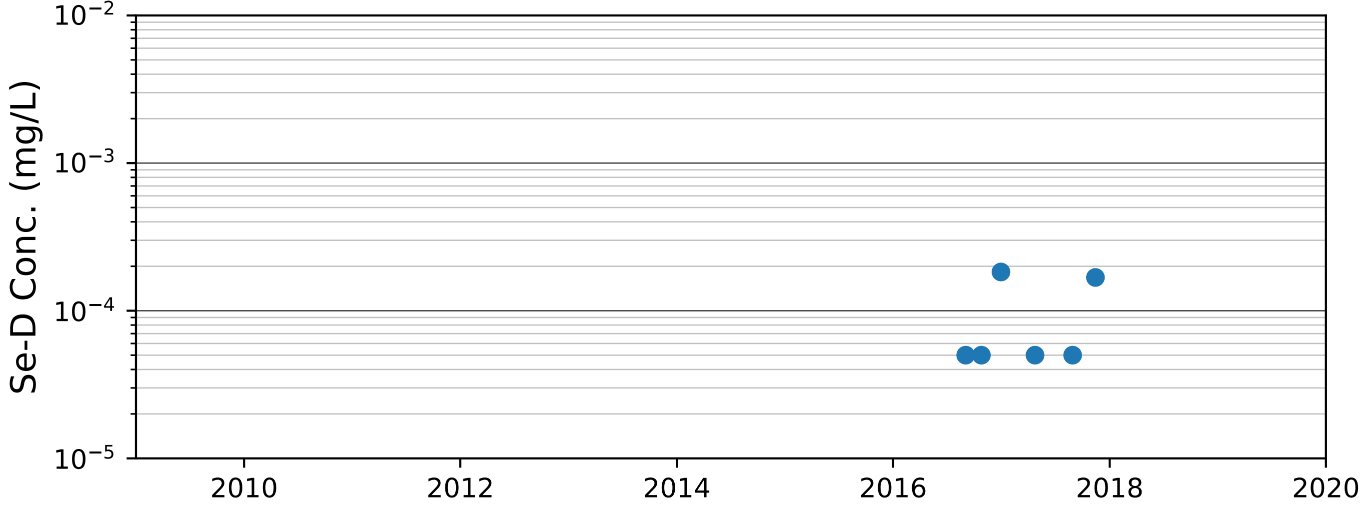

MW12-06-05 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020


MW12-06-05 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

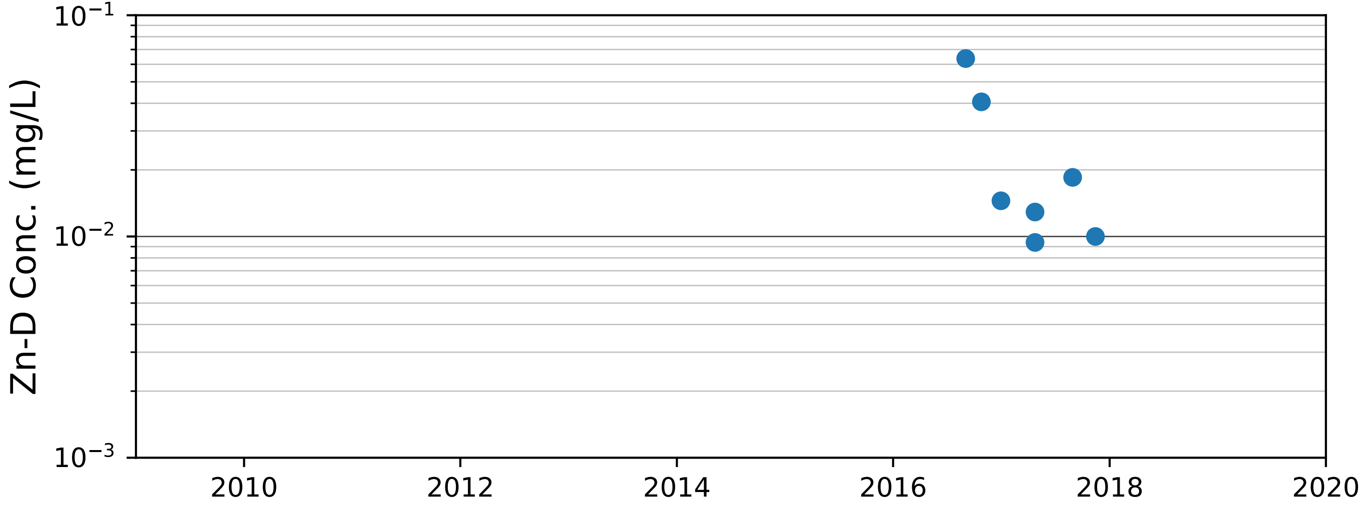

MW12-06-05 - Pb-D


MW12-06-05 - Mo-D

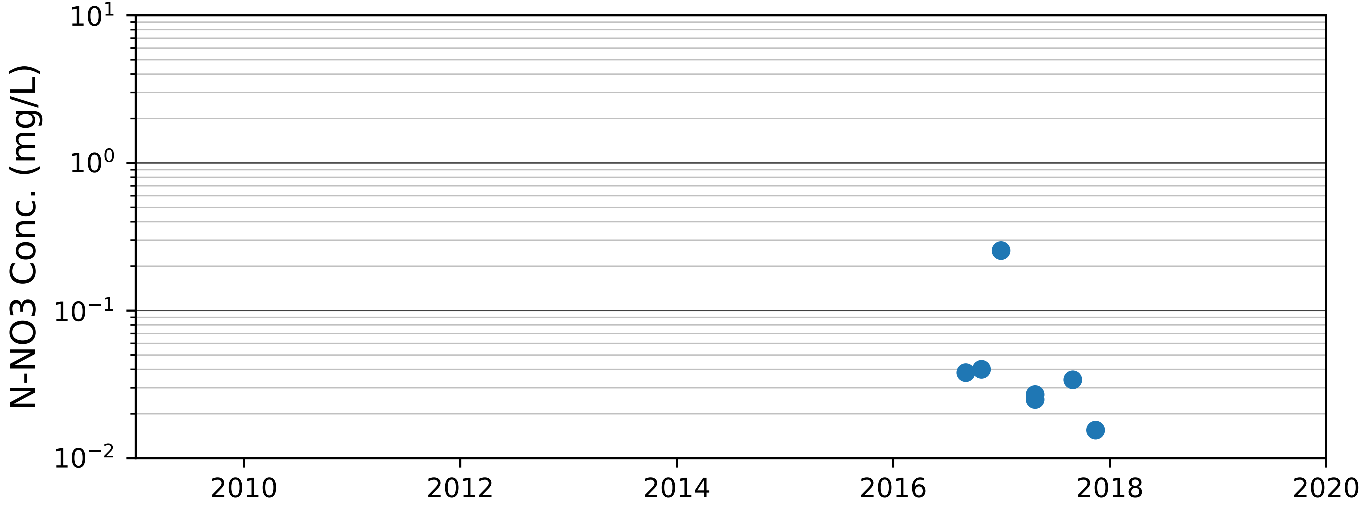

MW12-06-05 - Ni-D



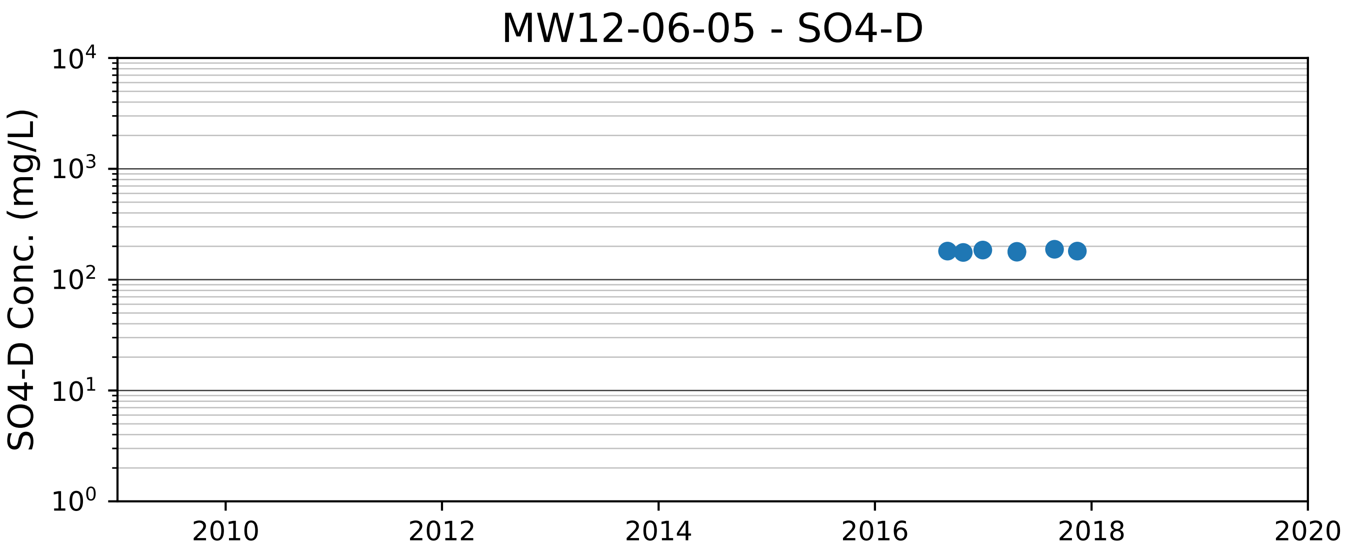
MW12-06-05 - Se-D

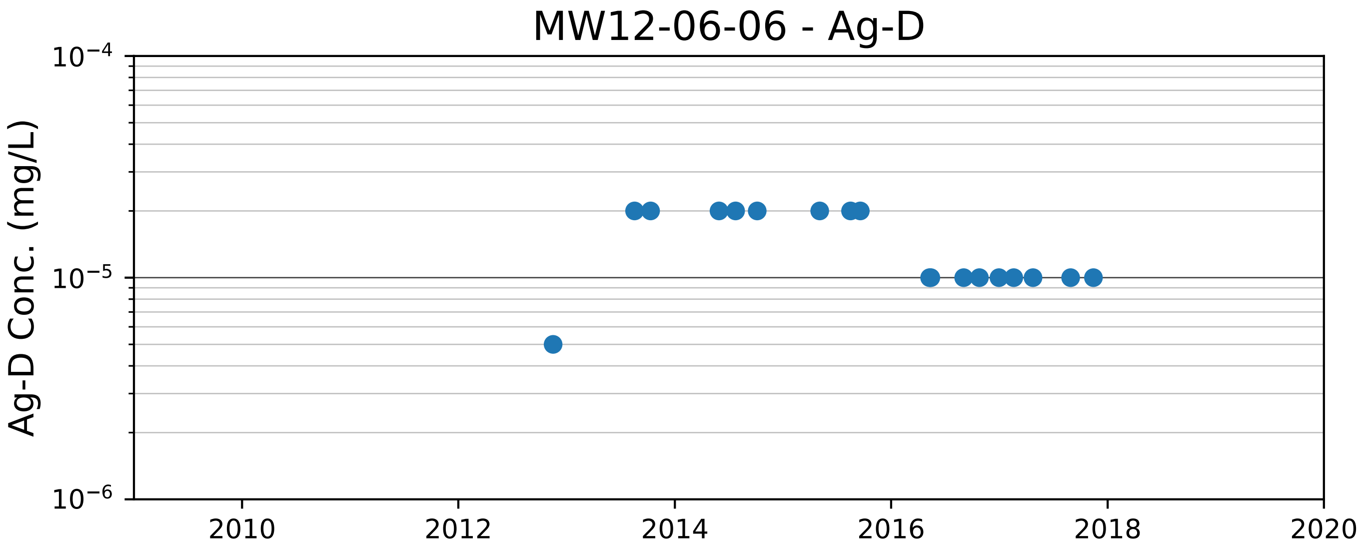


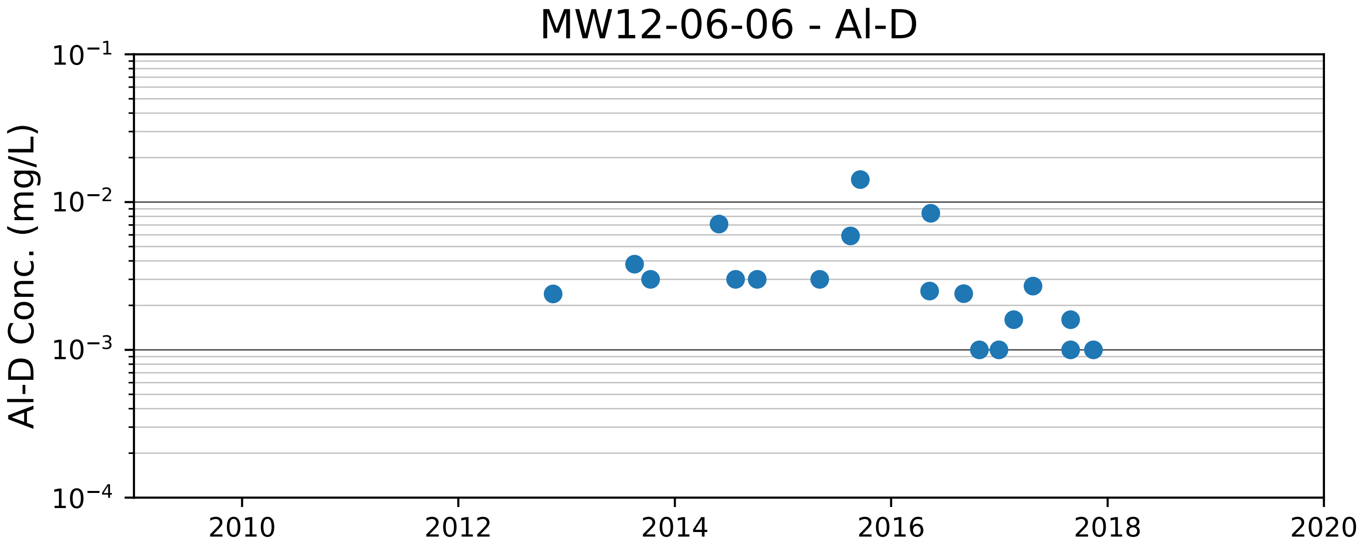
MW12-06-05 - Zn-D

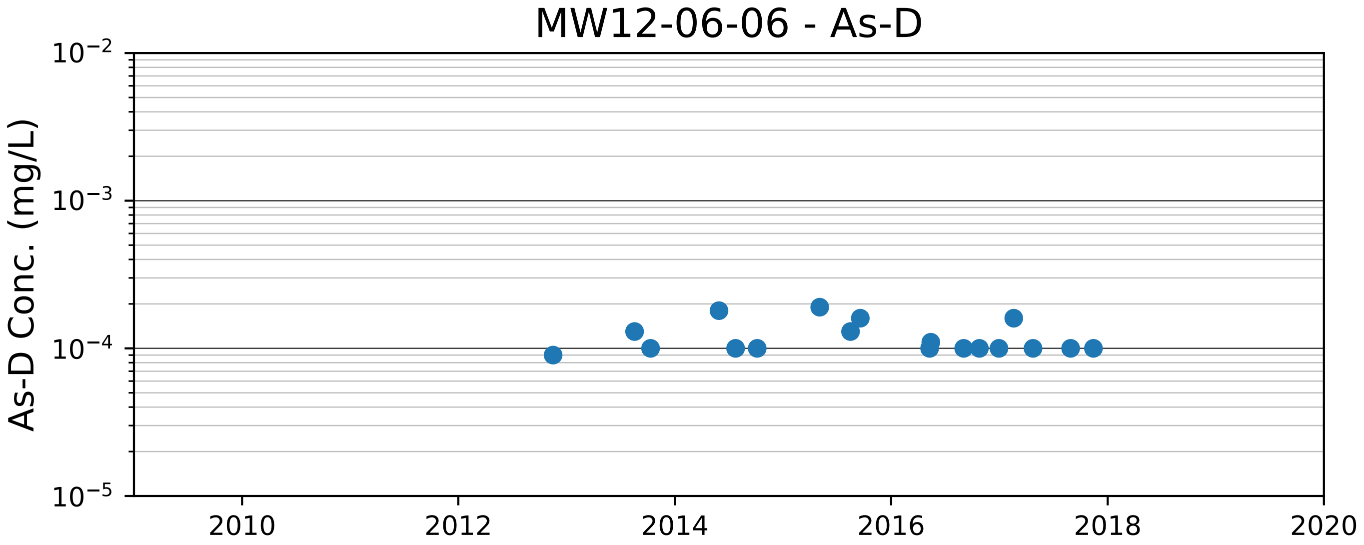


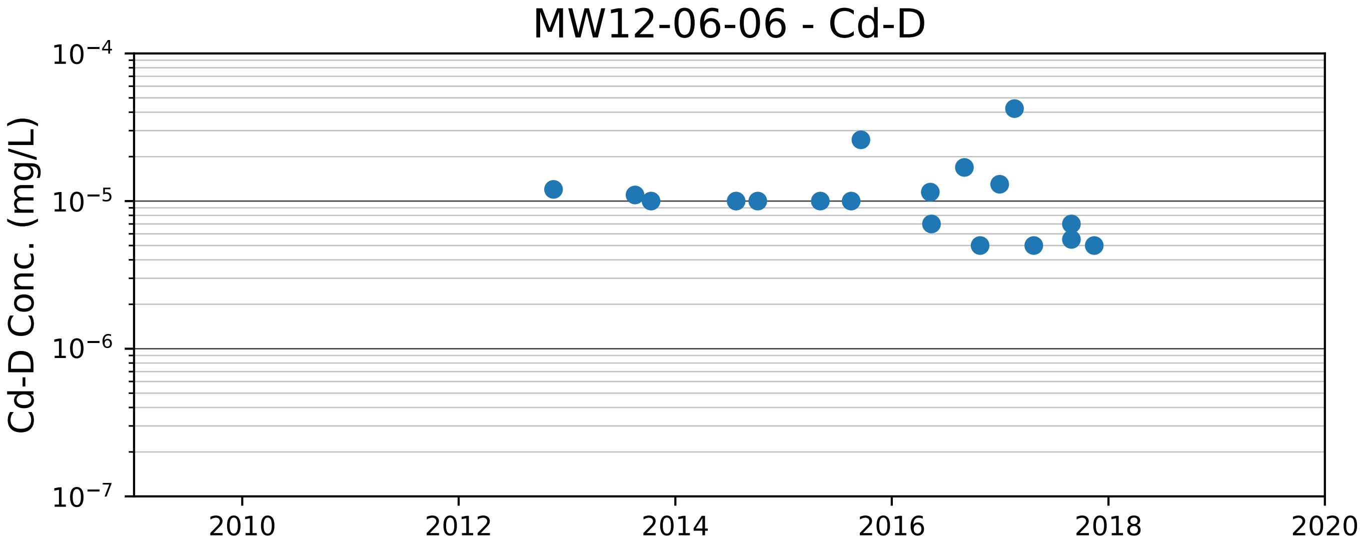
MW12-06-05 - N-NO3

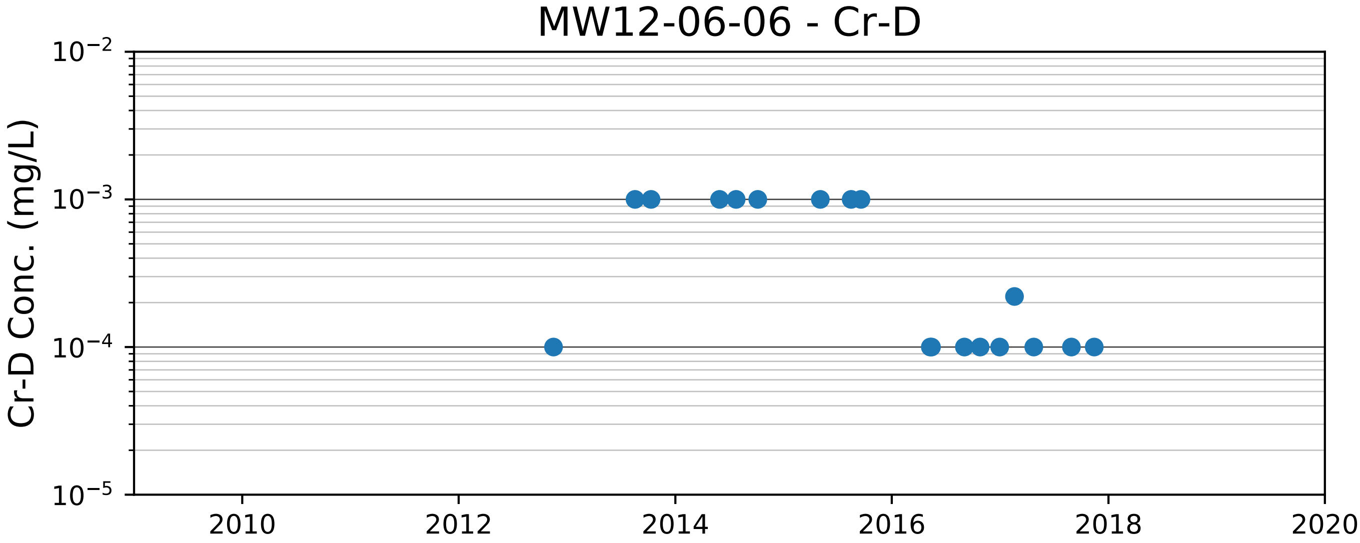

MW12-06-05 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

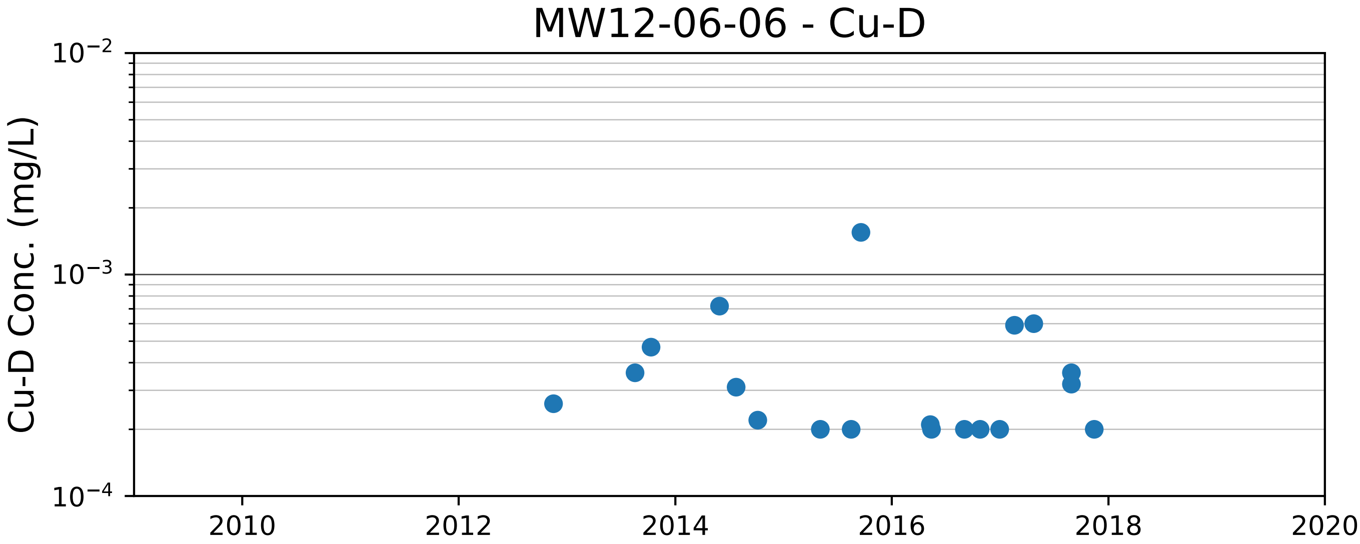

MW12-06-06 - Ag-D
Ag-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
2010
2012
2014
2016
2018
2020

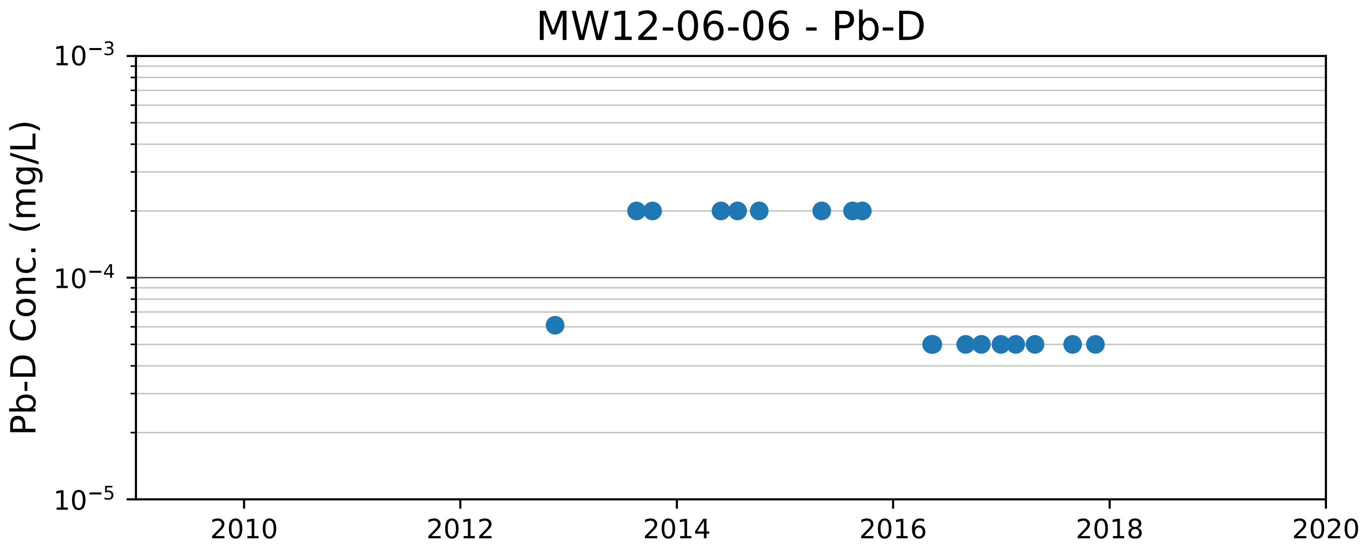

MW12-06-06 - Al-D
Al-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

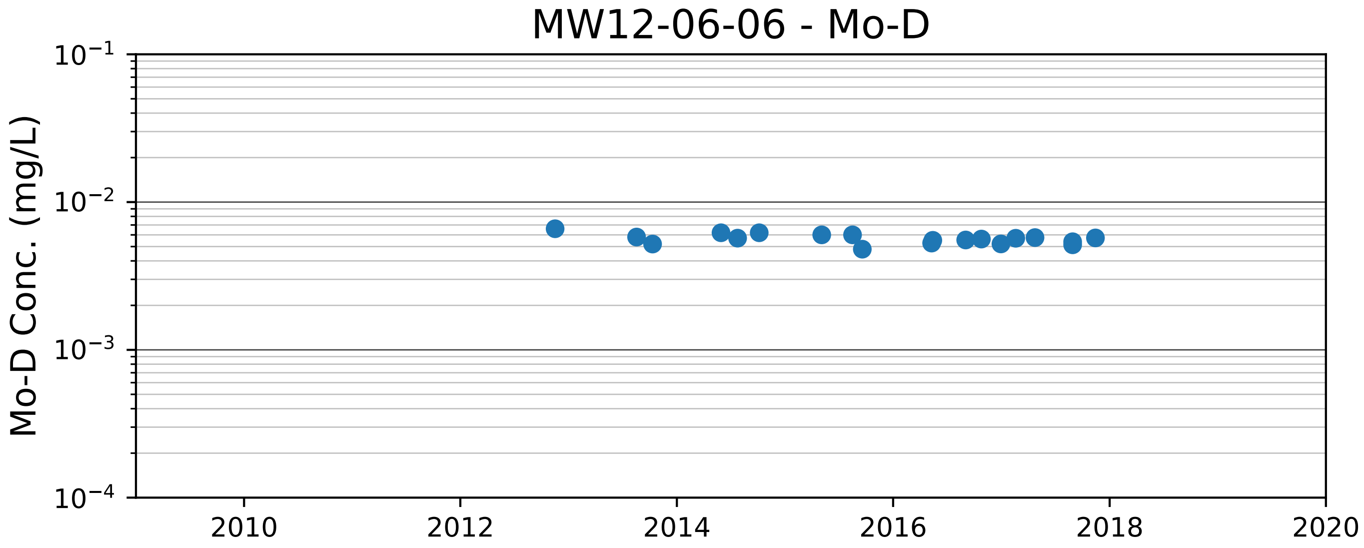

MW12-06-06 - As-D
As-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

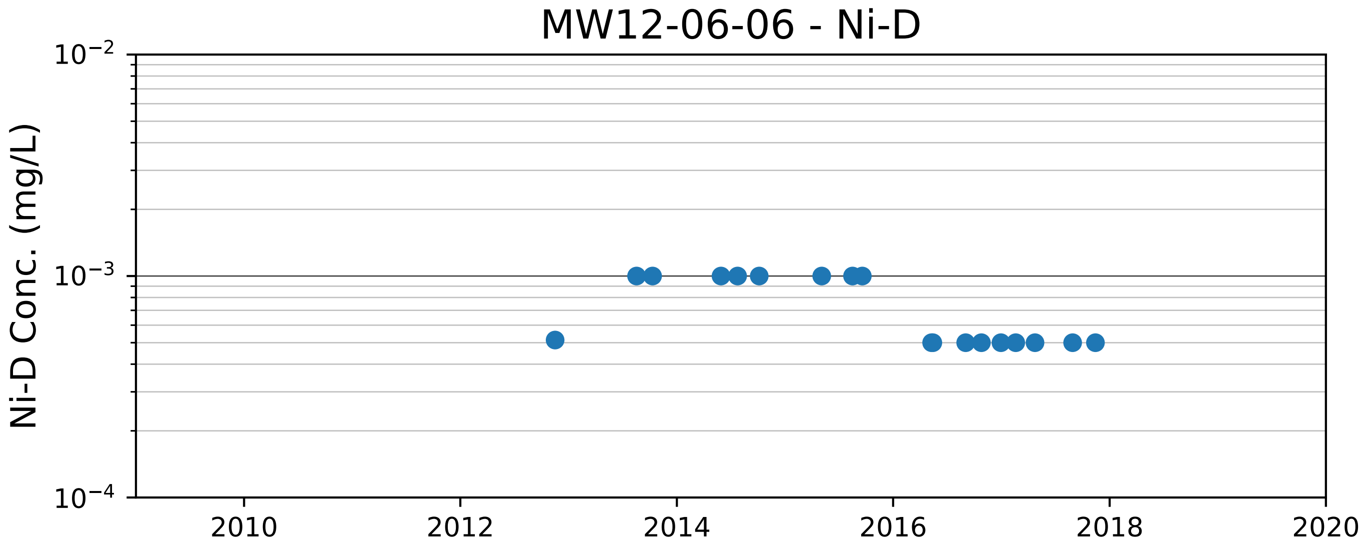

MW12-06-06 - Cd-D
Cd-D Conc. (mg/L)
10^{-4}
10^{-5}
10^{-6}
10^{-7}
2010
2012
2014
2016
2018
2020

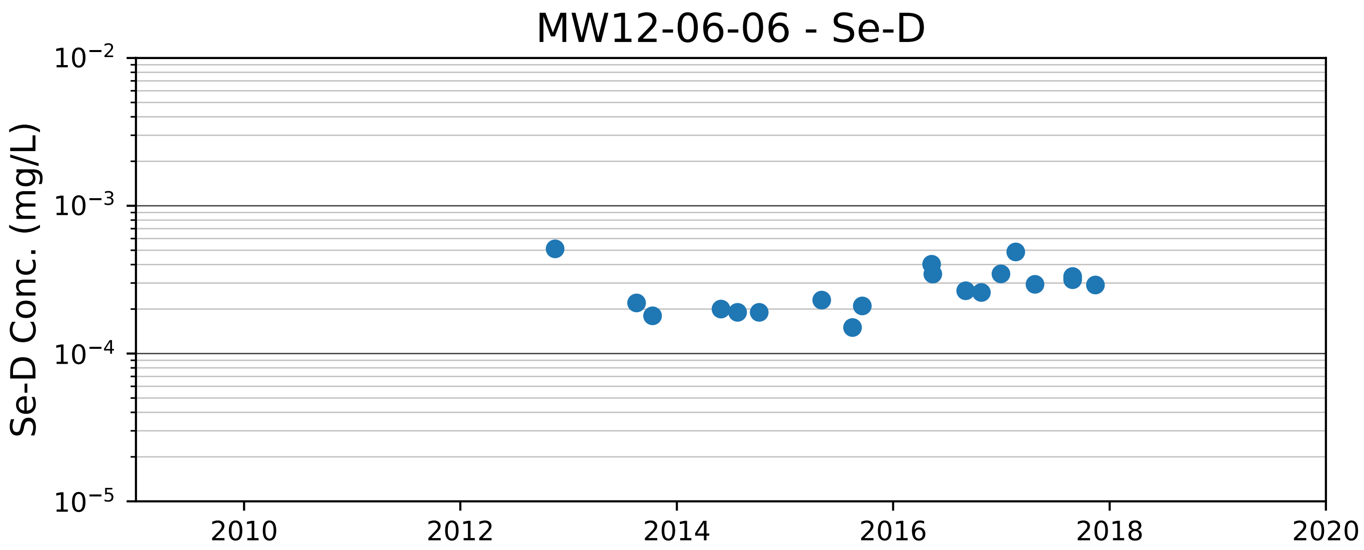

MW12-06-06 - Cr-D
Cr-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

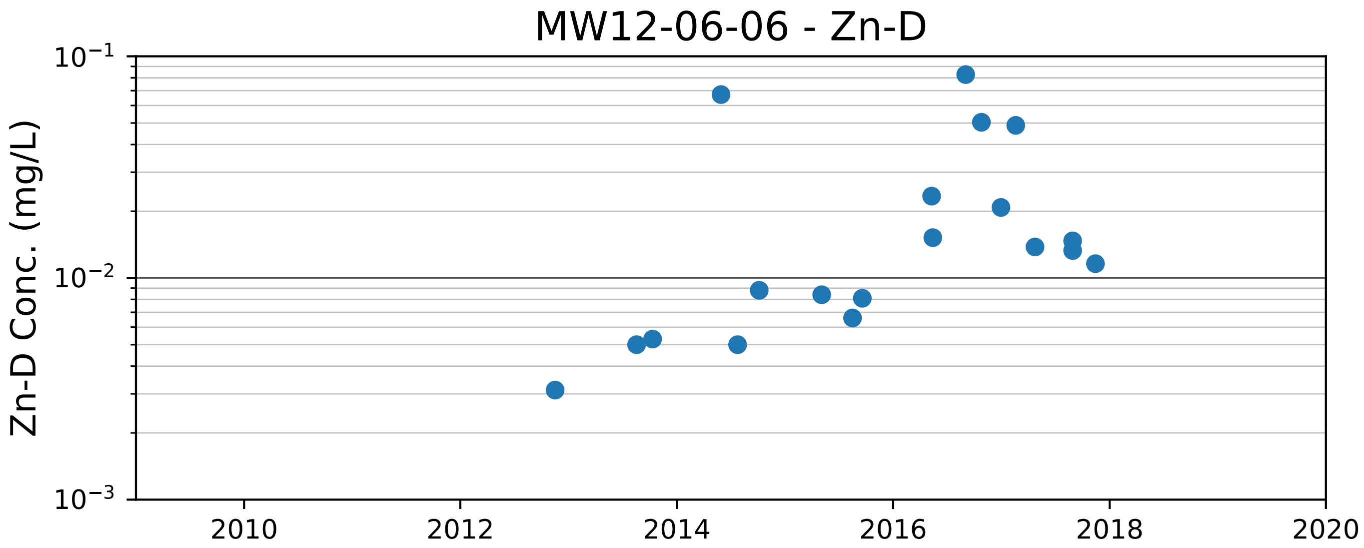

MW12-06-06 - Cu-D
Cu-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020

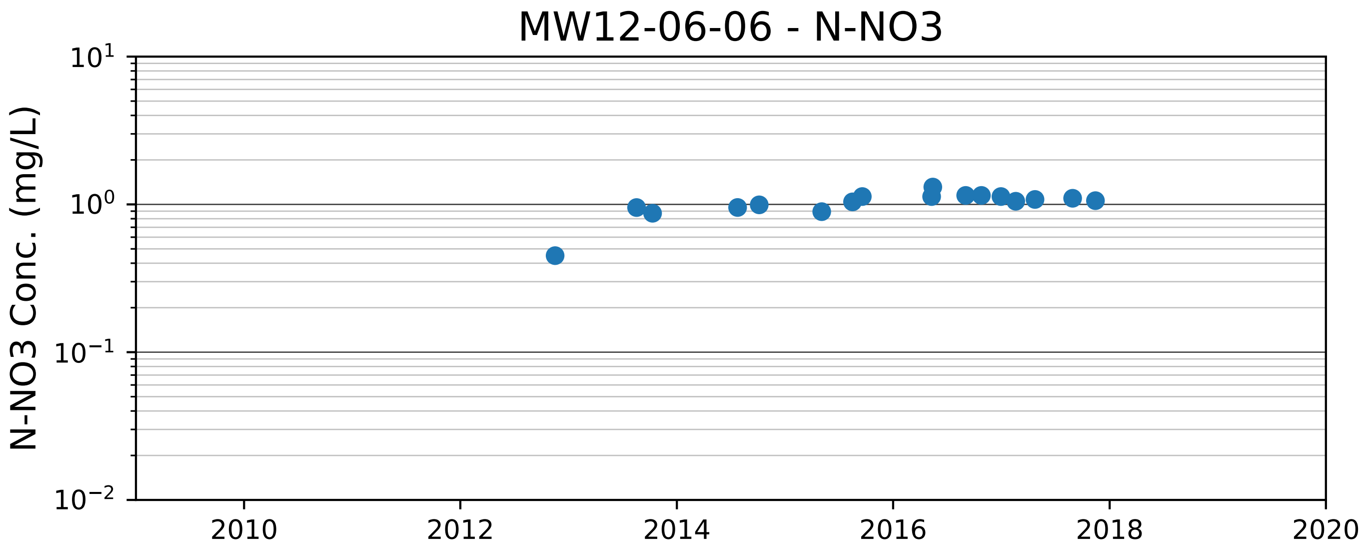

MW12-06-06 - Pb-D
Pb-D Conc. (mg/L)
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020

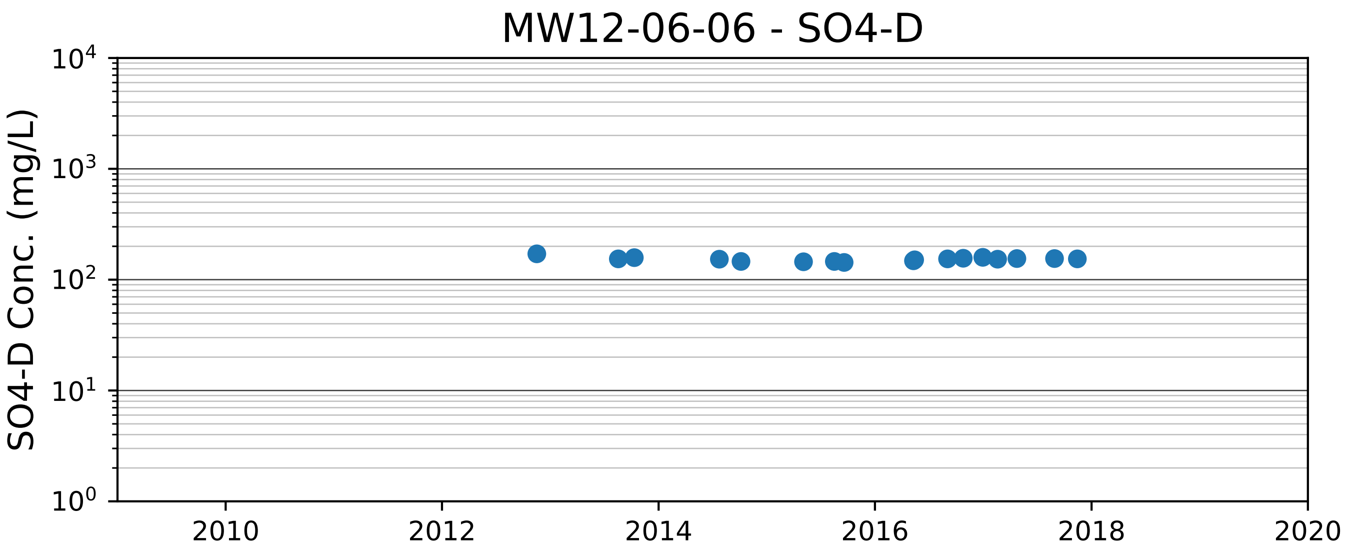

MW12-06-06 - Mo-D
Mo-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020


MW12-06-06 - Ni-D
Ni-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
2010
2012
2014
2016
2018
2020


MW12-06-06 - Se-D
Se-D Conc. (mg/L)
10^{-2}
10^{-3}
10^{-4}
10^{-5}
2010
2012
2014
2016
2018
2020


MW12-06-06 - Zn-D
Zn-D Conc. (mg/L)
10^{-1}
10^{-2}
10^{-3}
2010
2012
2014
2016
2018
2020


MW12-06-06 - N-NO3
N-NO3 Conc. (mg/L)
10^{1}
10^{0}
10^{-1}
10^{-2}
2010
2012
2014
2016
2018
2020


MW12-06-06 - SO4-D
SO4-D Conc. (mg/L)
10^4
10^3
10^2
10^1
10^0
2010
2012
2014
2016
2018
2020

Appendix I – MMER Effluent Monitoring and Environmental Effects Monitoring Water Quality 2017 Submissions

Environment Canada Environnement Canada

Canada

Environment Canada

User Information

Site User

User: PYmmSCC469

Region: Pacific-Yukon

Regulation: MMER

- Home
- Del. Sub. & pH Data
- Bioassay Data
- EEM
- Annual Report
- Submission
  - Regulatory Data - Quarterly Report
  - EEM - Annual Report
  - Regulatory Data - Annual Report
- Queries & Downloads
- Graphs & Tables
- Company Information
- Password Change
- Comments: Submit
- Publications
- RISS Web Service
- Logout

Data Submitted

Your EEM data has been successfully submitted.

Facility Name: Minto Explorations Limited - Minto Mine (Pelly Crossing, YT)

Date and Time Submitted (GMT): 2018-03-17 22:30:52

Tracking ID: PYmmSCC469-2018-03-17-22-30-52-87597

Reporting Period: 2017

This is the official receipt of your submission.
You may wish to print and retain this receipt for your records.

Signature: ______________________

Date Modified: 2014-03-27

Top of Page

Important Notices

Environment Canada Environnement Canada Canada

Environment Canada

User Information

Site User

User: PYmmSCC469

Region: Pacific-Yukon

Regulation: MMER

- Home
- Del. Sub. & pH Data
- Bioassay Data
- EEM
- Annual Report
- Submission
  - Regulatory Data - Quarterly Report
  - EEM - Annual Report
  - Regulatory Data - Annual Report
- Queries & Downloads
- Graphs & Tables
- Company Information
- Password Change
- Comments: Submit
- Publications
- RISS Web Service
- Logout

Data Submitted

Your data has been successfully submitted.

Facility Name:	Minto Explorations Limited - Minto Mine (Pelly Crossing, YT)
Date and Time Submitted (GMT):	2018-03-17 22:06:01
Tracking ID:	PYmmSCC469-2018-03-17-22-06-01-09709
Reporting Period:	2017

This is the official receipt of your submission.

You may wish to print and retain this receipt for your records.

Signature:

Back

Date Modified: 2014-03-27

Top of Page

Important Notices

Environment Canada Environnement Canada Canada

View Annual Report

Facility:	Minto Explorations Limited - Minto Mine (Pelly Crossing, YT)
Final Discharge Point:	Mi.W3 - Runoff Main Water Dam
Reporting Period:	2017
Facility Name on Submission:	
Submission Tracking ID:	

Facility Information

Mine Name: Minto Explorations Limited - Minto Mine (Pelly Crossing, YT)
Mine Operator: Minto Explorations Ltd.
Address:
PO Box 11
Whitehorse, YT
Y1A5X9
Telephone: 604-759-0860
E-mail: minto_environment@mintomine.com

Location of Final Discharge Point

Name:	Mi.W3 - Runoff Main Water Dam
Latitude:	62º 37' 32" N
Longitude:	137º 12' 11" W

Monthly Mean Concentrations, pH Range and Volume of Effluent (Generated)

Month	As (mg/L)	Cu (mg/L)	CN (mg/L)	Pb (mg/L)	Ni (mg/L)	Zn (mg/L)	TSS (mg/L)	Ra 226 (Bq/L)	Lowest pH	Highest pH	Effluent Volume (m^3)
January	0.00034	0.004592	NMR	0.000079	0.001192	0.00242	5.94	NMR	7.92	8.17	6964
February	0.000308	0.005485	NMR	0.000056	0.00105	0.003075	4.575	NMR	8.1	8.24	6048
March	0.000265	0.003705	NMR	0.000025	0.001173	0.003725	3	0.07	8	8.3	5775
April	0.000228	0.00323	NMR	0.000025	0.00087	0.001	3	NMR	8.03	8.3	6480
May	0.00031	0.01268	NMR	0.00003	0.000856	0.00092	5.78	NMR	8.04	8.32	43800
June	0.00031	0.016053	NMR	0.000025	0.001078	0.000925	3.775	0.0082	8.03	8.21	46320
July	0.000308	0.00523	NMR	0.000042	0.001128	0.00205	3.6	NMR	8.11	8.33	15441
August	0.000306	0.005698		0.000025	0.001064	0.0015	3	0.0048	8.05	8.38	15632
September	0.00026	0.002935		0.000025	0.000995	0.0015	3		8.3	8.5	5270
October	0.000246	0.002868	NMR	0.000025	0.000996	0.0015	3	0.00425	8.2	8.42	5952
November	0.00028	0.002795	NMR	0.000025	0.001025	0.0015	3.425	NMR	7.94	8.22	7770
December	0.000303	0.018483	NMR	0.000057	0.000985	0.002375	3.775	NMR	8.03	8.23	6740

Results of Acute Lethality Tests and Daphnia magna Monitoring Tests (Generated)

Date Sample Collected	Results for Rainbow Trout Acute Lethality Tests (mean percentage mortality in 100% effluent test concentration)	Results for Daphnia magna Monitoring Tests (mean percentage mortality in 100% effluent test concentration)
2017-03-14		0
2017-03-14	0	
2017-06-06	0	0
2017-08-08	0	0
2017-10-24	0	0
2017-10-24		

Non-Compliance Information

If effluent was non-compliant with the authorized limits set out in Schedule 4, indicate the cause(s) of non-compliance and remedial measures planned or implemented in response to the failure of acute lethality tests.

Notes:

Date Modified: 2014-03-27

Close

This section summarizes data collected for MMER requirements during the 2017 reporting year. Table 1 to 4 Present the EEM results from 2017, and Table 5 presents the Radon 226 results from quarterly samples collected in 2017. And finally, ALS Laboratory Results files are presented at the end.

Table 1: EEM Sample Results (1 of 4) - May 16th, 2017

Station		W2	W3	W7
Lab Report No.		L1928294		
Parameters	Unit			
Hard-D	mg/L	107	170	78.4
Alk-T	mg/L	98.6	143	76.3
N-NH3	mg/L	0.0062	0.0069	0.0070
N-NO3	mg/L	0.0935	1.56	0.0050
Chloride	mg/L	1.69	4.88	0.56
C-DOC	mg/L	20.7	30.0	25.6
TSS	mg/L	6.7	<3.0	<3.0
pH-F	pH units	7.69	7.25	7.58
Temp-F	C	1.5	6.6	-0.1
O-DO	mg/L	14.56	10.22	14.96
Cond-F	µS/cm	117.6	252.3	79.7
Al-D	mg/L	0.0173	0.0080	0.0279
As-T	mg/L	0.00068	0.00030	0.00049
Ca-T	mg/L	26.7	42.0	19.1
Cd-T	mg/L	1.58E-05	<0.0000050	8.2E-06
Cu-T	mg/L	0.00705	0.0138	0.00620
Fe-T	mg/L	0.438	0.069	0.233
Hg-T	mg/L	<0.0000050	<0.0000050	<0.0000050
Mg-T	mg/L	9.40	16.1	7.42
Mn-T	mg/L	0.0350	0.0279	0.0331
Mo-D	mg/L	0.00106	0.00331	0.000846
Na-T	mg/L	6.48	14.7	4.77
Ni-T	mg/L	0.00178	0.00090	0.00177
P-T	mg/L	<0.050	<0.050	<0.050
Pb-T	mg/L	0.000083	<0.000050	<0.000050
Se-T	mg/L	0.000178	0.000537	0.000131
Tl-T	mg/L	<0.000010	<0.000010	<0.000010
U-T	mg/L	0.000667	0.00130	0.000400
Zn-T	mg/L	0.0056	<0.0030	<0.0030

Table 2: EEM Sample Results (2 of 4) – June 27th, 2017

Station		W2	W3	W7
Lab Report No.		L1950514		
Parameters	Unit			
Hard-D	mg/L	156	234	111
Alk-T	mg/L	150	214	118
N-NH3	mg/L	0.0133	0.0078	0.0114
N-NO3	mg/L	0.307	0.232	0.144
Chloride	mg/L	2.10	4.70	<0.50
C-DOC	mg/L	12.4	8.26	13.1
TSS	mg/L	7.4	3.4	22.0
pH-F	pH units	7.96	7.82	8.13
Temp-F	C	6	5.2	2.3
O-DO	mg/L	10.88	10.24	12.49
Cond-F	µS/cm	211.9	315.1	132.8
Al-D	mg/L	0.0079	0.0045	0.0101
As-T	mg/L	0.00061	0.00027	0.00059
Ca-T	mg/L	42.6	57.8	29.8
Cd-T	mg/L	<0.0000050	<0.0000050	1.04E-05
Cu-T	mg/L	0.00322	0.00533	0.00288
Fe-T	mg/L	0.279	0.026	0.659
Hg-T	mg/L	<0.0000050	<0.0000050	<0.0000050
Mg-T	mg/L	13.6	24.8	10.6
Mn-T	mg/L	0.0225	0.0414	0.0464
Mo-D	mg/L	0.00163	0.00401	0.00140
Na-T	mg/L	8.92	16.2	6.49
Ni-T	mg/L	0.00138	0.00107	0.00196
P-T	mg/L	<0.050	<0.050	<0.050
Pb-T	mg/L	0.000077	<0.000050	0.000192
Se-T	mg/L	0.000169	0.000283	0.000164
Tl-T	mg/L	<0.000010	<0.000010	<0.000010
U-T	mg/L	0.00164	0.00261	0.00110
Zn-T	mg/L	<0.0030	<0.0030	<0.0030

Table 3: EEM Sample Results (3 of 4) – August 1st, 2017

Station		W2	W3	W7
Lab Report No.		L1969064		
Parameters	Unit			
Hard-D	mg/L	173	223	125
Alk-T	mg/L	168	185	127
N-NH3	mg/L	0.0061	0.0069	0.0140
N-NO3	mg/L	0.196	1.32	0.115
Chloride	mg/L	1.79	5.06	0.28
C-DOC	mg/L	11.5	12.2	12.4
TSS	mg/L	34.8	3.0	21.4
pH-F	pH units	7.81	7.63	7.58
Temp-F	C	6.7	11.3	4
O-DO	mg/L	11.84	9.7	11.86
Cond-F	µS/cm	224.2	338.8	149.4
Al-D	mg/L	0.0096	0.0026	0.0171
As-T	mg/L	0.00114	0.00044	0.00071
Ca-T	mg/L	42.9	53.7	30.2
Cd-T	mg/L	0.0000150	<0.0000050	1.07E-05
Cu-T	mg/L	0.00618	0.0142	0.00280
Fe-T	mg/L	1.18	0.053	0.847
Hg-T	mg/L	<0.0000050	<0.0000050	<0.0000050
Mg-T	mg/L	16.6	21.2	11.8
Mn-T	mg/L	0.0556	0.0296	0.0418
Mo-D	mg/L	0.00175	0.00387	0.00131
Na-T	mg/L	11.0	15.5	7.58
Ni-T	mg/L	0.00282	0.00123	0.00214
P-T	mg/L	0.057	<0.050	<0.050
Pb-T	mg/L	0.000317	<0.000050	0.000210
Se-T	mg/L	0.000164	0.000435	0.000152
Tl-T	mg/L	<0.000010	<0.000010	<0.000010
U-T	mg/L	0.00175	0.00160	0.00104
Zn-T	mg/L	0.0042	<0.0030	0.0032

Table 4: EEM Sample Results (4 of 4) – October 3rd, 2017

Station		W2	W3	W7
Lab Report No.		L2002445		
Parameters	Unit			
Hard-D	mg/L	174	261	139
Alk-T	mg/L	174	242	150
N-NH3	mg/L	<0.0050	0.0053	0.0148
N-NO3	mg/L	0.0162	0.180	0.118
Chloride	mg/L	1.90	4.36	<0.50
C-DOC	mg/L	8.91	5.80	8.44
TSS	mg/L	23.9	<3.0	4.9
pH-F	pH units	7.47	7.41	7.5
Temp-F	C	0.8	0.8	0.8
O-DO	mg/L	14.4	13	13.72
Cond-F	µS/cm	192.8	291.1	164.3
Al-D	mg/L	0.0045	0.0025	0.0053
As-T	mg/L	0.00038	0.00022	0.00075
Ca-T	mg/L	45.2	56.1	35.5
Cd-T	mg/L	6.8E-06	<0.0000050	1.39E-05
Cu-T	mg/L	0.00171	0.00257	0.00230
Fe-T	mg/L	0.078	0.026	1.36
Hg-T	mg/L	<0.0000050	<0.0000050	<0.0000050
Mg-T	mg/L	15.8	29.4	13.8
Mn-T	mg/L	0.0197	0.0494	0.0994
Mo-D	mg/L	0.00130	0.00456	0.00137
Na-T	mg/L	10.3	18.7	8.19
Ni-T	mg/L	0.00104	0.00097	0.00278
P-T	mg/L	<0.050	<0.050	0.108
Pb-T	mg/L	<0.000050	<0.000050	0.000385
Se-T	mg/L	0.000085	0.000369	0.000108
Tl-T	mg/L	<0.000010	<0.000010	<0.000010
U-T	mg/L	0.00225	0.00299	0.00153
Zn-T	mg/L	<0.0030	<0.0030	0.0055

Table 5: Ra^{226} Results for W3 in 2017

Sample Date		**14-Mar-2017**	**6-Jun-2017**	**1-Aug-2017**	**24-Oct-2017**
Lab Report No		**L1901651**	**L1938367**	**L1969064**	**L2013230**
Parameter	**Units**				
Ra-226	Bq/L	0.070	0.0082	<0.0096	<0.0085

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	05-JAN-17
Report Date:	13-JAN-17 16:50 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #:	L1876399
Project P.O. #:	223322 (WUL)
Job Reference:	
C of C Numbers:	2017-01-04 A
Legal Site Desc:	

Ariel McDonnell

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1876399-1	L1876399-2	L1876399-3	L1876399-4	L1876399-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-JAN-17	02-JAN-17	02-JAN-17	02-JAN-17	02-JAN-17
	Sampled Time	10:50	11:15	14:15	14:25	15:25
	Client ID	W10	W45	W14	W12	W8A
WATER						
Physical Tests	Conductivity (uS/cm)	635	2840	2160	2000	1570
	Hardness (as CaCO3) (mg/L)	321	1380	787	792	812
	pH (pH)	7.02	7.98	8.15	7.83	7.46
	Total Suspended Solids (mg/L)	128	17.8	63.9	4.3	36.5
	TDS (Calculated) (mg/L)	377	2600	1730	1570	1070
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	351	130	135	171	638
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	351	130	135	171	638
	Ammonia, Total (as N) (mg/L)	1.36	7.76	3.83	5.40	0.420
	Chloride (Cl) (mg/L)	0.99	41	40	35.6	16.1
	Nitrate and Nitrite (as N) (mg/L)	0.738	38.5	35.7	29.9	6.24
	Nitrate (as N) (mg/L)	0.665	35.5	33.0	27.3	5.86
	Nitrite (as N) (mg/L)	0.0723	2.95	2.74	2.65	0.374
	Sulfate (SO4) (mg/L)	20.5	1540	910	834	297
	Anion Sum (meq/L)	7.52	38.6	25.3	23.9	19.8
	Cation Sum (meq/L)	7.60	36.8	24.8	22.7	18.8
	Cation - Anion Balance (%)	0.5	-2.4	-1.0	-2.7	-2.7
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)	0.0836	0.235		0.0790	0.0198
	Antimony (Sb)-Total (mg/L)	0.00049	0.00034		0.00035	0.00015
	Arsenic (As)-Total (mg/L)	0.00098	0.00055		0.00052	0.00052
	Barium (Ba)-Total (mg/L)	0.471	0.165		0.112	0.198
	Beryllium (Be)-Total (mg/L)	<0.000020	DLA <0.000040		<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	DLA <0.00010		<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.013	0.260		0.241	0.039
	Cadmium (Cd)-Total (mg/L)	0.0000087	0.000088		0.0000865	0.000311
	Calcium (Ca)-Total (mg/L)	100	523		284	238
	Chromium (Cr)-Total (mg/L)	0.00035	DLA <0.00020		<0.00010	0.00103
	Cobalt (Co)-Total (mg/L)	0.00189	0.00198		0.00065	0.00155
	Copper (Cu)-Total (mg/L)	0.00359	0.0385		0.0602	0.103
	Iron (Fe)-Total (mg/L)	11.5	0.397		0.155	1.98
	Lead (Pb)-Total (mg/L)	<0.000050	0.00016		0.000720	<0.000050
	Lithium (Li)-Total (mg/L)	0.0013	0.0159		0.0125	0.0048
	Magnesium (Mg)-Total (mg/L)	20.5	39.2		34.0	69.4
	Manganese (Mn)-Total (mg/L)	1.71	0.736		0.392	5.75

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1876399-6	L1876399-7	L1876399-8		
	Description	WATER	WATER	WATER		
	Sampled Date	03-JAN-17	03-JAN-17	03-JAN-17		
	Sampled Time	10:00	10:15	10:00		
	Client ID	W3	W17	T-BL		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	539	516	<2.0		
	Hardness (as CaCO3) (mg/L)	247	239	HTC <0.50		
	pH (pH)	7.92	8.06	5.41		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	TDS (Calculated) (mg/L)	310	299	<1.0		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	242	221	<1.0		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	242	221	<1.0		
	Ammonia, Total (as N) (mg/L)	0.0095	<0.0050	<0.0050		
	Chloride (Cl) (mg/L)	4.70	6.44	<0.50		
	Nitrate and Nitrite (as N) (mg/L)	0.364	0.803	<0.0051		
	Nitrate (as N) (mg/L)	0.364	0.803	<0.0050		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	57.5	55.3	<0.30		
	Anion Sum (meq/L)	6.20	5.81	<0.10		
	Cation Sum (meq/L)	5.75	5.50	<0.10		
	Cation - Anion Balance (%)	-3.8	-2.7	0.0		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.53	8.05			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0191	0.0064	<0.0030		
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00021	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00027	0.00036	<0.00010		
	Barium (Ba)-Total (mg/L)	0.0772	0.0783	<0.000050		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.026	0.036	<0.010		
	Cadmium (Cd)-Total (mg/L)	0.0000051	0.0000072	<0.0000050		
	Calcium (Ca)-Total (mg/L)	59.0	70.7	<0.050		
	Chromium (Cr)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00271	0.00618	<0.00050		
	Iron (Fe)-Total (mg/L)	0.045	<0.010	<0.010		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0031	0.0016	<0.0010		
	Magnesium (Mg)-Total (mg/L)	30.0	21.5	<0.10		
	Manganese (Mn)-Total (mg/L)	0.0829	0.0610	<0.00010		

	Sample ID	L1876399-1	L1876399-2	L1876399-3	L1876399-4	L1876399-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-JAN-17	02-JAN-17	02-JAN-17	02-JAN-17	02-JAN-17
	Sampled Time	10:50	11:15	14:15	14:25	15:25
	Client ID	W10	W45	W14	W12	W8A
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050		<0.0000050	0.0000064
	Molybdenum (Mo)-Total (mg/L)	0.000476	0.0923		0.0869	0.0121
	Nickel (Ni)-Total (mg/L)	0.00113	0.0049		0.00291	0.00218
	Phosphorus (P)-Total (mg/L)	0.068	<0.10 DLA		<0.050	0.056
	Potassium (K)-Total (mg/L)	2.87	75.6		47.8	9.13
	Selenium (Se)-Total (mg/L)	0.000094	0.0166		0.0145	0.00526
	Silicon (Si)-Total (mg/L)	7.57	2.67		3.40	8.53
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000020 DLA		0.000013	0.000025
	Sodium (Na)-Total (mg/L)	15.0	157		128	52.0
	Strontium (Sr)-Total (mg/L)	0.569	7.01		5.54	3.58
	Sulfur (S)-Total (mg/L)	7.83	580		326	106
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000020 DLA		<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00020 DLA		<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00429	0.0119		0.00306	0.00110
	Uranium (U)-Total (mg/L)	0.000135	0.00349		0.00364	0.00401
	Vanadium (V)-Total (mg/L)	0.00073	<0.0010 DLA		0.00053	0.00229
	Zinc (Zn)-Total (mg/L)	0.0057	<0.0060 DLA		0.0041	0.409
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00060 DLA		<0.00030	0.00083
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0101	0.0108	0.0242	0.0056	0.0074
	Antimony (Sb)-Dissolved (mg/L)	0.00035	0.00028	0.00021	0.00030	0.00011
	Arsenic (As)-Dissolved (mg/L)	0.00061	0.00043	0.00037	0.00048	0.00057
	Barium (Ba)-Dissolved (mg/L)	0.355	0.161	0.198	0.0962	0.184
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000040 DLA	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.226	0.156	0.207	0.036
	Cadmium (Cd)-Dissolved (mg/L)	0.0000067	0.000031	0.0000203	0.0000142	0.000267
	Calcium (Ca)-Dissolved (mg/L)	94.8	492	260	262	215
	Chromium (Cr)-Dissolved (mg/L)	0.00012	<0.00020 DLA	<0.00010	<0.00010	0.00068
	Cobalt (Co)-Dissolved (mg/L)	0.00189	0.00193	0.00114	0.00057	0.00151
	Copper (Cu)-Dissolved (mg/L)	0.00067	0.00100	0.00120	0.0117	0.0484
	Iron (Fe)-Dissolved (mg/L)	6.49	0.026	<0.010	0.024	0.410
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.000050	0.000061	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0012	0.0135	0.0212	0.0107	0.0041
	Magnesium (Mg)-Dissolved (mg/L)	20.5	36.7	33.6	33.6	66.9
	Manganese (Mn)-Dissolved (mg/L)	1.64	0.714	0.345	0.366	5.29

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1876399-6	L1876399-7	L1876399-8		
	Description	WATER	WATER	WATER		
	Sampled Date	03-JAN-17	03-JAN-17	03-JAN-17		
	Sampled Time	10:00	10:15	10:00		
	Client ID	W3	W17	T-BL		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00505	0.00559	<0.000050		
	Nickel (Ni)-Total (mg/L)	0.00088	0.00076	<0.00050		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Total (mg/L)	2.29	3.89	<0.10		
	Selenium (Se)-Total (mg/L)	0.000388	0.000391	<0.000050		
	Silicon (Si)-Total (mg/L)	6.53	5.35	<0.050		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	19.1	16.7	<0.050		
	Strontium (Sr)-Total (mg/L)	0.806	0.847	<0.00020		
	Sulfur (S)-Total (mg/L)	20.7	19.5	<0.50		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00081	<0.00030	<0.00030		
	Uranium (U)-Total (mg/L)	0.00276	0.00245	<0.000010		
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0016	0.0017			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00025	0.00035			
	Barium (Ba)-Dissolved (mg/L)	0.0758	0.0747			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.025	0.032			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000059	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	52.6	64.1			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00194	0.00738			
	Iron (Fe)-Dissolved (mg/L)	0.019	<0.010			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0027	0.0013			
	Magnesium (Mg)-Dissolved (mg/L)	28.1	19.2			
	Manganese (Mn)-Dissolved (mg/L)	0.0635	0.0265			

	Sample ID	L1876399-1	L1876399-2	L1876399-3	L1876399-4	L1876399-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-JAN-17	02-JAN-17	02-JAN-17	02-JAN-17	02-JAN-17
	Sampled Time	10:50	11:15	14:15	14:25	15:25
	Client ID	W10	W45	W14	W12	W8A
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000383	0.0851	0.0827	0.0775	0.0107
	Nickel (Ni)-Dissolved (mg/L)	0.00106	0.0048	0.00216	0.00268	0.00189
	Phosphorus (P)-Dissolved (mg/L)	<0.050	DLA <0.10	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.49	72.3	93.7	46.2	8.66
	Selenium (Se)-Dissolved (mg/L)	0.000123	0.0179	0.0218	0.0153	0.00594
	Silicon (Si)-Dissolved (mg/L)	7.35	2.16	2.23	3.09	8.40
	Silver (Ag)-Dissolved (mg/L)	<0.000010	DLA <0.000020	<0.000010	<0.000010	0.000011
	Sodium (Na)-Dissolved (mg/L)	14.2	156	148	121	47.8
	Strontium (Sr)-Dissolved (mg/L)	0.539	6.39	6.35	5.13	3.04
	Sulfur (S)-Dissolved (mg/L)	7.10	562	346	278	99.2
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	DLA <0.000020	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	DLA <0.00020	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00048	DLA <0.00060	<0.00030	<0.00030	0.00061
	Uranium (U)-Dissolved (mg/L)	0.000124	0.00323	0.00313	0.00341	0.00388
	Vanadium (V)-Dissolved (mg/L)	<0.00050	DLA <0.0010	<0.00050	<0.00050	0.00126
	Zinc (Zn)-Dissolved (mg/L)	0.0018	DLA <0.0020	0.0012	0.0031	0.376
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	DLA <0.00060	<0.00030	<0.00030	0.00078

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1876399-6	L1876399-7	L1876399-8		
	Description	WATER	WATER	WATER		
	Sampled Date	03-JAN-17	03-JAN-17	03-JAN-17		
	Sampled Time	10:00	10:15	10:00		
	Client ID	W3	W17	T-BL		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00451	0.00509			
	Nickel (Ni)-Dissolved (mg/L)	0.00080	0.00068			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.32	3.50			
	Selenium (Se)-Dissolved (mg/L)	0.000418	0.000460			
	Silicon (Si)-Dissolved (mg/L)	6.05	5.06			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	17.2	14.4			
	Strontium (Sr)-Dissolved (mg/L)	0.667	0.710			
	Sulfur (S)-Dissolved (mg/L)	18.9	18.2			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	0.00016			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00254	0.00232			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Total (as CaCO3)	B	L1876399-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1876399-6, -7
Matrix Spike	Boron (B)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1876399-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Total	MS-B	L1876399-1, -2, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1876399-1, -2, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1876399-1, -2, -4
Matrix Spike	Potassium (K)-Total	MS-B	L1876399-1, -2, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1876399-1, -2, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1876399-1, -2, -4
Matrix Spike	Sulfur (S)-Total	MS-B	L1876399-1, -2, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
DLA	Detection Limit adjusted for required dilution
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Reference Information

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

Reference Information

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-01-04 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Whitehorse Receive

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1876399-COFC

COC Number: 2017-01-04 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

nfirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐

EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 223322 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Contact: Ariel Tang

Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preserved	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved)	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)					Number of Containers
	W10	2-Jan-17	10:50	Water	R	R	R	R	R	R	R	R						6
	W45	2-Jan-17	11:15	Water	R	R	R	R	R	R	R	R						6
	W14	2-Jan-17	14:15	Water	R	R	R		R		R	R						4
	W12	2-Jan-17	14:25	Water	R	R	R	R	R	R	R	R						6
	W8A	2-Jan-17	15:25	Water	R	R	R	R	R	R	R	R						6
	W3	3-Jan-17	10:00	Water	R	R	R	R	R	R	R	R	R	R				7
	W17	3-Jan-17	10:15	Water	R	R	R	R	R	R	R	R	R	R				7
	T-BL	3-Jan-17	10:00	Water	R	R	R	R		R		R						6

Short Holding Time
@ Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
-3.0			2	5	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-01-04 9:00	Time:	Received by: EHF	Date: 4 Jan 2017	Time: 14:41	Received by: JC	Date: JAN - 5 2017	Time: 15:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 12-JAN-17
Report Date: 24-JAN-17 15:41 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1878946
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-01-11 A
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

	Sample ID	L1878946-1	L1878946-2	L1878946-3	L1878946-4
	Description	Water	Water	Water	Water
	Sampled Date	09-JAN-17	10-JAN-17	10-JAN-17	10-JAN-17
	Sampled Time	16:15	10:15	11:10	
	Client ID	W8A	W3	W17	F-BL
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	1580	540	527	<2.0
	Hardness (as CaCO3) (mg/L)	865	254	251	<0.50
	pH (pH)	7.60	7.97	8.04	5.48
	Total Suspended Solids (mg/L)	39.6	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	1070	308	306	<1.0
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	725	236	225	<1.0
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	725	236	225	<1.0
	Ammonia, Total (as N) (mg/L)	0.434	0.0113	<0.0050	<0.0050
	Chloride (Cl) (mg/L)	16.7	4.68	6.46	<0.50
	Nitrate and Nitrite (as N) (mg/L)	2.54	0.358	0.703	<0.0051
	Nitrate (as N) (mg/L)	2.09	0.358	0.703	<0.0050
	Nitrite (as N) (mg/L)	0.442	<0.0010	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	236	57.0	55.2	<0.30
	Anion Sum (meq/L)	20.0	6.07	5.87	<0.10
	Cation Sum (meq/L)	20.2	5.91	5.80	<0.10
	Cation - Anion Balance (%)	0.3	-1.3	-0.6	0.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		4.41	8.53	<0.50
Total Metals	Aluminum (Al)-Total (mg/L)	0.316	0.0173	0.0120	<0.0030
	Antimony (Sb)-Total (mg/L)	0.00024	<0.00010	0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00079	0.00024	0.00034	<0.00010
	Barium (Ba)-Total (mg/L)	0.237	0.0764	0.0809	<0.000050
	Beryllium (Be)-Total (mg/L)	0.000032	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.039	0.025	0.034	<0.010
	Cadmium (Cd)-Total (mg/L)	0.000368	0.0000051	0.0000083	<0.0000050
	Calcium (Ca)-Total (mg/L)	229	55.8	68.9	<0.050
	Chromium (Cr)-Total (mg/L)	0.00142	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Total (mg/L)	0.00199	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.241	0.00393	0.00899	<0.00050
	Iron (Fe)-Total (mg/L)	7.28	0.049	0.015	<0.010
	Lead (Pb)-Total (mg/L)	0.000212	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0056	0.0042	0.0022	<0.0010
	Magnesium (Mg)-Total (mg/L)	74.0	29.6	22.0	<0.10
	Manganese (Mn)-Total (mg/L)	6.50	0.0787	0.166	<0.00010

	Sample ID	L1878946-1	L1878946-2	L1878946-3	L1878946-4
	Description	Water	Water	Water	Water
	Sampled Date	09-JAN-17	10-JAN-17	10-JAN-17	10-JAN-17
	Sampled Time	16:15	10:15	11:10	
	Client ID	W8A	W3	W17	F-BL
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000058	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.0106	0.00510	0.00540	<0.000050
	Nickel (Ni)-Total (mg/L)	0.00203	0.00091	0.00081	<0.00050
	Phosphorus (P)-Total (mg/L)	0.127	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	8.75	2.20	3.81	<0.10
	Selenium (Se)-Total (mg/L)	0.00419	0.000353	0.000363	<0.000050
	Silicon (Si)-Total (mg/L)	10.3	6.42	5.45	<0.050
	Silver (Ag)-Total (mg/L)	0.000088	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	54.8	18.5	16.8	<0.050
	Strontium (Sr)-Total (mg/L)	3.45	0.760	0.792	<0.00020
	Sulfur (S)-Total (mg/L)	91.1	19.9	19.6	<0.50
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0186	0.00054	0.00037	<0.00030
	Uranium (U)-Total (mg/L)	0.00447	0.00297	0.00268	<0.000010
	Vanadium (V)-Total (mg/L)	0.00527	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	0.438	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00096	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0157	0.0022	0.0021	<0.0010
	Antimony (Sb)-Dissolved (mg/L)	0.00012	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00098	0.00022	0.00029	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.208	0.0760	0.0792	RRV 0.000239
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.036	0.023	0.032	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.000252	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	225	54.1	65.8	<0.050
	Chromium (Cr)-Dissolved (mg/L)	0.00073	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00175	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0456	0.00262	0.00559	RRV 0.00071
	Iron (Fe)-Dissolved (mg/L)	0.564	0.024	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0053	0.0035	0.0018	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	73.9	28.8	21.0	<0.10
	Manganese (Mn)-Dissolved (mg/L)	6.37	0.0653	0.0382	<0.00010

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1878946-1	L1878946-2	L1878946-3	L1878946-4
	Description	Water	Water	Water	Water
	Sampled Date	09-JAN-17	10-JAN-17	10-JAN-17	10-JAN-17
	Sampled Time	16:15	10:15	11:10	
	Client ID	W8A	W3	W17	F-BL
Grouping	**Analyte**				
WATER					
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00992	0.00484	0.00543	<0.000050
	Nickel (Ni)-Dissolved (mg/L)	0.00183	0.00082	0.00067	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	8.77	2.14	3.68	<0.10
	Selenium (Se)-Dissolved (mg/L)	0.00409	0.000338	0.000368	<0.000050
	Silicon (Si)-Dissolved (mg/L)	9.27	6.29	5.22	<0.050
	Silver (Ag)-Dissolved (mg/L)	0.000017	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	53.9	18.0	16.0	<0.050
	Strontium (Sr)-Dissolved (mg/L)	3.36	0.734	0.767	<0.00020
	Sulfur (S)-Dissolved (mg/L)	89.9	19.7	19.0	<0.50
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	RRV 0.00085
	Titanium (Ti)-Dissolved (mg/L)	0.00084	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00428	0.00284	0.00248	<0.000010
	Vanadium (V)-Dissolved (mg/L)	0.00169	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.238	<0.0010	<0.0010	RRV 0.0062
	Zirconium (Zr)-Dissolved (mg/L)	0.00096	<0.00030	<0.00030	<0.00030

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1878946-2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Boron (B)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Silicon (Si)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Total	MS-B	L1878946-1, -2, -3, -4
Matrix Spike	Uranium (U)-Total	MS-B	L1878946-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Reference Information

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-01-11 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1878946-COFC

COC Number: 2017-01-11 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224162 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Tang
Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preserved)	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved)	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)					Number of Containers
	W8A	9-Jan-17	16:15	Water	R	R	R	R	R	R	R	R						6
	W3	10-Jan-17	10:15	Water	R	R	R	R	R	R	R	R	R					7
	W17	10-Jan-17	11:10	Water	R	R	R	R	R	R	R	R	R					7
	F-BL	10-Jan-17		Water	R	R	R	R	R	R	R	R	R					7

RUSH

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
-1.0			4.3		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-01-11 9:00	Time:	Received by: EHF	Date: 11 Jan 2017	Time: 15:40	Received by: Shayan	Date: Jan.12	Time: 1510

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 18-JAN-17
Report Date: 30-JAN-17 17:22 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1880962

Project P.O. #: 224162(WUL)
Job Reference:
C of C Numbers: 2017-01-18A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1880962-1	L1880962-2	L1880962-3		
	Description	WATER	WATER	WATER		
	Sampled Date	17-JAN-17	17-JAN-17	17-JAN-17		
	Sampled Time	10:55	11:10	11:25		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	542	523	1590		
	Hardness (as CaCO3) (mg/L)	264	258	882		
	pH (pH)	8.17	8.24	7.83		
	Total Suspended Solids (mg/L)	<3.0	<3.0	54.3		
	TDS (Calculated) (mg/L)	313	308	1080		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	237	223	741		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	237	223	741		
	Ammonia, Total (as N) (mg/L)	0.0203	<0.0050	0.423		
	Chloride (Cl) (mg/L)	4.75	6.49	17.7		
	Nitrate and Nitrite (as N) (mg/L)	0.323	0.614	2.42		
	Nitrate (as N) (mg/L)	0.323	0.614	1.92		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.500		
	Sulfate (SO4) (mg/L)	56.5	54.8	226		
	Anion Sum (meq/L)	6.06	5.83	20.2		
	Cation Sum (meq/L)	6.16	5.97	20.5		
	Cation - Anion Balance (%)	0.8	1.2	0.8		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.59	8.11			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0233	0.0053	0.0312		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00017		
	Arsenic (As)-Total (mg/L)	0.00027	0.00036	0.00066		
	Barium (Ba)-Total (mg/L)	0.0794	0.0780	0.217		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000022		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.025	0.034	0.040		
	Cadmium (Cd)-Total (mg/L)	0.0000087	<0.0000050	0.000336		
	Calcium (Ca)-Total (mg/L)	57.5	68.4	235		
	Chromium (Cr)-Total (mg/L)	0.00013	0.00013	0.00113		
	Cobalt (Co)-Total (mg/L)	0.00012	<0.00010	0.00156		
	Copper (Cu)-Total (mg/L)	0.00308	0.00616	0.127		
	Iron (Fe)-Total (mg/L)	0.094	<0.010	2.10		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000076		
	Lithium (Li)-Total (mg/L)	0.0033	0.0017	0.0053		
	Magnesium (Mg)-Total (mg/L)	29.6	21.3	74.3		
	Manganese (Mn)-Total (mg/L)	0.160	0.0453	6.23		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1880962-1	L1880962-2	L1880962-3		
	Description	WATER	WATER	WATER		
	Sampled Date	17-JAN-17	17-JAN-17	17-JAN-17		
	Sampled Time	10:55	11:10	11:25		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00480	0.00567	0.0104		
	Nickel (Ni)-Total (mg/L)	0.00101	0.00070	0.00200		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.089		
	Potassium (K)-Total (mg/L)	2.31	3.83	9.14		
	Selenium (Se)-Total (mg/L)	0.000298	0.000357	0.00375		
	Silicon (Si)-Total (mg/L)	6.77	5.52	9.60		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000037		
	Sodium (Na)-Total (mg/L)	18.7	16.2	54.8		
	Strontium (Sr)-Total (mg/L)	0.740	0.781	3.37		
	Sulfur (S)-Total (mg/L)	20.3	19.4	90.4		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	0.00021		
	Titanium (Ti)-Total (mg/L)	0.00110	<0.00030	0.00209		
	Uranium (U)-Total (mg/L)	0.00277	0.00252	0.00431		
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	0.00323		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.250		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00088		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0016	<0.0010	0.0095		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00026	0.00033	0.00057		
	Barium (Ba)-Dissolved (mg/L)	0.0823	0.0811	0.218		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.021	0.029	0.033		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000076	0.0000052	0.000311		
	Calcium (Ca)-Dissolved (mg/L)	57.3	68.0	234		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00075		
	Cobalt (Co)-Dissolved (mg/L)	0.00011	<0.00010	0.00156		
	Copper (Cu)-Dissolved (mg/L)	0.00251	0.00525	0.0587		
	Iron (Fe)-Dissolved (mg/L)	0.046	<0.010	0.285		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0032	0.0017	0.0049		
	Magnesium (Mg)-Dissolved (mg/L)	29.3	21.3	72.6		
	Manganese (Mn)-Dissolved (mg/L)	0.150	0.0425	6.37		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1880962-1	L1880962-2	L1880962-3		
	Description	WATER	WATER	WATER		
	Sampled Date	17-JAN-17	17-JAN-17	17-JAN-17		
	Sampled Time	10:55	11:10	11:25		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00441	0.00518	0.00938		
	Nickel (Ni)-Dissolved (mg/L)	0.00092	0.00074	0.00191		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	2.28	3.89	8.99		
	Selenium (Se)-Dissolved (mg/L)	0.000329	0.000446	DTC 0.00488		
	Silicon (Si)-Dissolved (mg/L)	6.02	5.10	8.75		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	18.9	16.6	54.4		
	Strontium (Sr)-Dissolved (mg/L)	0.734	0.780	3.38		
	Sulfur (S)-Dissolved (mg/L)	18.7	17.7	80.9		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00079		
	Uranium (U)-Dissolved (mg/L)	0.00249	0.00232	0.00396		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00144		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.255		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00087		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1880962-1, -2, -3
Matrix Spike	Aluminum (Al)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Iron (Fe)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Silicon (Si)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1880962-1, -2, -3
Matrix Spike	Titanium (Ti)-Total	MS-B	L1880962-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
		Hardness	APHA 2340B

Reference Information

HARDNESS-CALC-VA Water

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-01-18A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Whitehorse Receive

LOGGED IN

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1880962-COFC

COC Number: 2017-01-18 A

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐

EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel McDonnell Sampler: SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	17-Jan-17	10:55	Water	R	R	R	R	R	R	R	R	R					7
	W17	17-Jan-17	11:10	Water	R	R	R	R	R	R	R	R	R					7
	W8A	17-Jan-17	11:25	Water	R	R	R	R	R	R	R	R						6

Short Holding Time
Rush Processing

Some Frozen

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: -1.0

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-01-18	Time: 10:00	Received by: EHF	Date: 18 Jan 2017	Time: 15:28	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 25-JAN-17
Report Date: 06-FEB-17 17:36 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1883599

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-01-25 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1883599-1	L1883599-2	L1883599-3	L1883599-4
	Description	Water	Water	Water	Water
	Sampled Date	24-JAN-17	25-JAN-17	24-JAN-17	
	Sampled Time	11:05	11:20	13:00	
	Client ID	W3	W17	W8A	DUP
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	524	517	1540	519
	Hardness (as CaCO3) (mg/L)	256	256	891	248
	pH (pH)	8.01	8.12	7.79	8.07
	Total Suspended Solids (mg/L)	17.7	<3.0	37.3	<3.0
	TDS (Calculated) (mg/L)	308	310	1100	305
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	232	227	769	225
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	232	227	769	225
	Ammonia, Total (as N) (mg/L)	0.0219	<0.0050	0.375	<0.0050
	Chloride (Cl) (mg/L)	4.72	6.58	18.1	6.58
	Nitrate and Nitrite (as N) (mg/L)	0.311	0.535	2.07	0.536
	Nitrate (as N) (mg/L)	0.311	0.535	1.52	0.536
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.547	<0.0010
	Sulfate (SO4) (mg/L)	56.7	55.4	233	55.4
	Anion Sum (meq/L)	5.98	5.91	20.9	5.88
	Cation Sum (meq/L)	6.00	5.95	20.9	5.75
	Cation - Anion Balance (%)	0.2	0.3	0.0	-1.1
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.70	8.53		8.38
Total Metals	Aluminum (Al)-Total (mg/L)	0.598	0.0164	0.102	0.0343
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00012	0.00037	0.00015
	Arsenic (As)-Total (mg/L)	0.00057	0.00036	0.00069	0.00038
	Barium (Ba)-Total (mg/L)	0.0938	0.0806	0.218	0.0868
	Beryllium (Be)-Total (mg/L)	0.000024	<0.000020	0.000022	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.022	0.031	0.036	0.032
	Cadmium (Cd)-Total (mg/L)	0.0000329	0.0000117	0.000335	0.0000192
	Calcium (Ca)-Total (mg/L)	54.9	66.2	227	69.8
	Chromium (Cr)-Total (mg/L)	0.00103	<0.00010	0.00128	0.00049
	Cobalt (Co)-Total (mg/L)	0.00059	0.00010	0.00178	0.00017
	Copper (Cu)-Total (mg/L)	0.00989	0.00655	0.148	0.00962
	Iron (Fe)-Total (mg/L)	1.04	0.021	2.93	0.050
	Lead (Pb)-Total (mg/L)	0.000296	<0.000050	0.000121	<0.000050
	Lithium (Li)-Total (mg/L)	0.0027	<0.0010	0.0043	0.0017
	Magnesium (Mg)-Total (mg/L)	28.6	21.2	73.8	20.8
	Manganese (Mn)-Total (mg/L)	0.441	0.222	6.77	0.503

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1883599-1	L1883599-2	L1883599-3	L1883599-4
	Description	Water	Water	Water	Water
	Sampled Date	24-JAN-17	25-JAN-17	24-JAN-17	
	Sampled Time	11:05	11:20	13:00	
	Client ID	W3	W17	W8A	DUP
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000058	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00480	0.00589	0.0101	0.00638
	Nickel (Ni)-Total (mg/L)	0.00230	0.00088	0.00206	0.00112
	Phosphorus (P)-Total (mg/L)	0.051	<0.050	0.084	<0.050
	Potassium (K)-Total (mg/L)	2.32	3.88	8.91	3.79
	Selenium (Se)-Total (mg/L)	0.000346	0.000354	0.00304	0.000378
	Silicon (Si)-Total (mg/L)	7.33	5.39	9.66	5.67
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000073	<0.000010
	Sodium (Na)-Total (mg/L)	18.5	16.5	55.6	15.9
	Strontium (Sr)-Total (mg/L)	0.738	0.800	3.48	0.795
	Sulfur (S)-Total (mg/L)	20.3	20.1	84.5	20.3
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	0.00011	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0261	0.00070	0.00550	0.00149
	Uranium (U)-Total (mg/L)	0.00267	0.00257	0.00437	0.00253
	Vanadium (V)-Total (mg/L)	0.00222	<0.00050	0.00372	0.00063
	Zinc (Zn)-Total (mg/L)	0.0061	<0.0030	0.254	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00102	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0024	0.0015	0.0087	0.0015
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00012	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00026	0.00031	0.00058	0.00031
	Barium (Ba)-Dissolved (mg/L)	0.0792	0.0778	0.218	0.0777
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.024	0.034	0.040	0.030
	Cadmium (Cd)-Dissolved (mg/L)	0.0000100	0.0000051	0.000248	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	56.0	67.2	232	64.7
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00092	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00014	<0.00010	0.00173	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00388	0.00542	0.0522	0.00508
	Iron (Fe)-Dissolved (mg/L)	0.058	<0.010	0.501	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0029	0.0013	0.0048	0.0019
	Magnesium (Mg)-Dissolved (mg/L)	28.3	21.4	75.4	21.1
	Manganese (Mn)-Dissolved (mg/L)	0.200	0.0627	6.98	0.0593

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1883599-1	L1883599-2	L1883599-3	L1883599-4	
	Description	Water	Water	Water	Water	
	Sampled Date	24-JAN-17	25-JAN-17	24-JAN-17		
	Sampled Time	11:05	11:20	13:00		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00434	0.00545	0.00937	0.00553	
	Nickel (Ni)-Dissolved (mg/L)	0.00103	0.00080	0.00201	0.00073	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.14	3.81	9.12	3.61	
	Selenium (Se)-Dissolved (mg/L)	0.000273	0.000336	0.00281	0.000399	
	Silicon (Si)-Dissolved (mg/L)	6.21	5.23	9.47	5.36	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000016	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	18.7	17.0	58.1	16.0	
	Strontium (Sr)-Dissolved (mg/L)	0.728	0.789	3.43	0.776	
	Sulfur (S)-Dissolved (mg/L)	19.3	18.7	80.8	19.2	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	0.00020	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00085	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00258	0.00247	0.00432	0.00253	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00192	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.219	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00102	<0.00030	

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Total (as CaCO3)	B	L1883599-4
Matrix Spike	Dissolved Organic Carbon	MS-B	L1883599-1, -2, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Aluminum (Al)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Potassium (K)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Silicon (Si)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Total	MS-B	L1883599-1, -2, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L1883599-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. All associated sample results are at least 5 times greater than blank levels and are considered reliable.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

Reference Information

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-01-25 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Whitehorse Receive

LOGGED IN

al

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1883599-COFC

COC Number: 2017-01-25 A

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
Company address below will appear on the final report		
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	**1 Business day [E1]**	☐
3 day [P3]	☐	**Same Day, Weekend or Statutory holiday [E0]**	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Tang **Sampler:** SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	24-Jan-17	11:05	Water	R	R	R	R	R	R	R	R	R					7
	W17	24-Jan-17	11:20	Water	R	R	R	R	R	R	R	R	R					7
	W8A	24-Jan-17	13:00	Water	R	R	R	R	R	R	R	R						6
	Dup	24-Jan-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5,0			4		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-01-25	Time: 12:00	Received by: EHF	Date: 25 Jan 2017	Time: 15:53	Received by: SF	Date: Jan 26	Time: 3:20

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-FEB-17
Report Date: 14-FEB-17 15:14 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1886060

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-02-01 A
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1886060-1	L1886060-2	L1886060-3	L1886060-4
	Description	Water	Water	Water	Water
	Sampled Date	31-JAN-17	31-JAN-17	31-JAN-17	31-JAN-17
	Sampled Time	10:00	10:15	13:45	
	Client ID	W3	W17	W8A	DUP
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	529	531	1630	542
	Hardness (as CaCO3) (mg/L)	250	252	907	253
	pH (pH)	8.12	8.15	7.44	8.02
	Total Suspended Solids (mg/L)	<3.0	<3.0	16.4	3.0
	TDS (Calculated) (mg/L)	311	309	1110	311
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	240	228	807	238
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	240	228	807	238
	Ammonia, Total (as N) (mg/L)	0.0102	<0.0050	0.420	0.0094
	Chloride (Cl) (mg/L)	4.64	6.52	17.7	4.65
	Nitrate and Nitrite (as N) (mg/L)	0.327	0.455	0.835	0.329
	Nitrate (as N) (mg/L)	0.327	0.455	0.512	0.329
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.323	<0.0010
	Sulfate (SO4) (mg/L)	57.1	55.7	213	57.3
	Anion Sum (meq/L)	6.14	5.93	21.1	6.11
	Cation Sum (meq/L)	5.88	5.85	21.3	5.95
	Cation - Anion Balance (%)	-2.2	-0.6	0.3	-1.3
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.22	8.48		4.59
Total Metals	Aluminum (Al)-Total (mg/L)	0.0350	0.0062	0.106	0.0280
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00014	0.00040	<0.00010
	Arsenic (As)-Total (mg/L)	0.00035	0.00038	0.00081	0.00035
	Barium (Ba)-Total (mg/L)	0.0771	0.0757	0.225	0.0770
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000028	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.030	0.039	0.046	0.030
	Cadmium (Cd)-Total (mg/L)	0.0000060	0.0000140	0.000344	0.0000081
	Calcium (Ca)-Total (mg/L)	56.8	68.9	237	56.7
	Chromium (Cr)-Total (mg/L)	0.00012	0.00011	0.00132	0.00011
	Cobalt (Co)-Total (mg/L)	0.00010	<0.00010	0.00234	<0.00010
	Copper (Cu)-Total (mg/L)	0.00335	0.00615	0.168	0.00339
	Iron (Fe)-Total (mg/L)	0.085	<0.010	2.79	0.072
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000142	<0.000050
	Lithium (Li)-Total (mg/L)	0.0048	0.0027	0.0066	0.0047
	Magnesium (Mg)-Total (mg/L)	31.2	21.5	77.4	29.4
	Manganese (Mn)-Total (mg/L)	0.0995	0.0700	7.41	0.0935

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1886060-1	L1886060-2	L1886060-3	L1886060-4	
	Description	Water	Water	Water	Water	
	Sampled Date	31-JAN-17	31-JAN-17	31-JAN-17	31-JAN-17	
	Sampled Time	10:00	10:15	13:45		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000067	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	0.00467	0.00600	0.0111	0.00477	
	Nickel (Ni)-Total (mg/L)	0.00086	0.00077	0.00191	0.00084	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.100	<0.050	
	Potassium (K)-Total (mg/L)	2.32	3.90	9.19	2.26	
	Selenium (Se)-Total (mg/L)	0.000310	0.000387	0.00246	0.000309	
	Silicon (Si)-Total (mg/L)	6.85	5.76	10.4	6.81	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000054	<0.000010	
	Sodium (Na)-Total (mg/L)	20.1	17.1	58.1	19.3	
	Strontium (Sr)-Total (mg/L)	0.778	0.818	3.60	0.775	
	Sulfur (S)-Total (mg/L)	21.6	20.6	80.6	21.0	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	0.00137	<0.00030	0.00643	0.00106	
	Uranium (U)-Total (mg/L)	0.00283	0.00261	0.00438	0.00290	
	Vanadium (V)-Total (mg/L)	0.00072	0.00056	0.00393	0.00069	
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.223	<0.0030	
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00113	<0.00030	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0013	0.0023	0.0099	0.0010	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00015	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00032	0.00039	0.00069	0.00030	
	Barium (Ba)-Dissolved (mg/L)	0.0771	0.0780	0.222	0.0771	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Dissolved (mg/L)	0.023	0.030	0.036	0.023	
	Cadmium (Cd)-Dissolved (mg/L)	0.0000052	0.0000089	0.000310	<0.0000050	
	Calcium (Ca)-Dissolved (mg/L)	56.2	68.0	242	56.4	
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00010	0.00092	<0.00010	
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00231	<0.00010	
	Copper (Cu)-Dissolved (mg/L)	0.00167	0.00633	0.0596	0.00169	
	Iron (Fe)-Dissolved (mg/L)	0.026	<0.010	0.651	0.026	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0036	0.0018	0.0053	0.0035	
	Magnesium (Mg)-Dissolved (mg/L)	26.7	19.9	73.3	27.3	
	Manganese (Mn)-Dissolved (mg/L)	0.0798	0.0567	7.88	0.0794	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1886060-1	L1886060-2	L1886060-3	L1886060-4	
	Description	Water	Water	Water	Water	
	Sampled Date	31-JAN-17	31-JAN-17	31-JAN-17	31-JAN-17	
	Sampled Time	10:00	10:15	13:45		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00451	0.00553	0.0106	0.00452	
	Nickel (Ni)-Dissolved (mg/L)	0.00059	0.00065	0.00180	0.00060	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	0.051	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.31	3.88	9.58	2.31	
	Selenium (Se)-Dissolved (mg/L)	0.000341	0.000436	0.00242	0.000382	
	Silicon (Si)-Dissolved (mg/L)	6.33	5.35	9.84	6.30	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000016	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	18.6	16.5	58.5	18.9	
	Strontium (Sr)-Dissolved (mg/L)	0.737	0.765	3.48	0.737	
	Sulfur (S)-Dissolved (mg/L)	20.3	19.7	80.9	20.0	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00096	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00272	0.00240	0.00430	0.00273	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00204	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.166	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00111	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Silicon (Si)-Total	MB-LOR	L1886060-1, -2, -3, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L1886060-1, -2, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L1886060-1, -2, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1886060-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1886060-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Reference Information

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-02-01 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Whitehorse Receive

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1886060-COFC

COC Number: 2017-02-01 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	**1 Business day [E1]**	☐
3 day [P3]	☐	**Same Day, Weekend or Statutory holiday [E0]**	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Mcdonnell **Sampler:** CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	31-Jan-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
	W17	31-Jan-17	10:15	Water	R	R	R	R	R	R	R	R	R					7
	W8A	31-Jan-17	13:45	Water	R	R	R	R	R	R	R	R						6
	DUP	31-Jan-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
-1.0	Frozen			3	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-02-01 8:45	Time:	Received by: 1 Feb 2017	Date: EHF	Time: 15:52	Received by: JC	Date: FEB - 2 2017	Time: 13:55

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 10-FEB-17
Report Date: 22-FEB-17 15:38 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1889375

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-02-08 A
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1889375-1	L1889375-2	L1889375-3		
	Description	Water	Water	Water		
	Sampled Date	07-FEB-17	07-FEB-17	07-FEB-17		
	Sampled Time	10:00	10:15	11:10		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	548	542	1610		
	Hardness (as CaCO3) (mg/L)	262	264	918		
	pH (pH)	8.16	8.28	7.83		
	Total Suspended Solids (mg/L)	9.3	<3.0	106		
	Total Dissolved Solids (mg/L)	339	336	1160		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	245	237	805		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	245	237	805		
	Ammonia, Total (as N) (mg/L)	0.0161	0.0060	0.432		
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.25 DLDS		
	Chloride (Cl) (mg/L)	4.82	6.70	18.9		
	Fluoride (F) (mg/L)	0.551	0.360	0.55		
	Nitrate and Nitrite (as N) (mg/L)	0.345	0.398	0.289		
	Nitrate (as N) (mg/L)	0.345	0.398	0.126		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.163		
	Sulfate (SO4) (mg/L)	57.8	57.1	213		
	Anion Sum (meq/L)	6.30	6.16	21.1		
	Cation Sum (meq/L)	6.12	6.10	21.5		
	Cation - Anion Balance (%)	-1.5	-0.5	0.8		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.33	8.61			
Total Metals	Aluminum (Al)-Total (mg/L)	0.244	0.0345	0.147		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00029		
	Arsenic (As)-Total (mg/L)	0.00037	0.00034	0.00081		
	Barium (Ba)-Total (mg/L)	0.0791	0.0842	0.235		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000028		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.023	0.031	0.035		
	Cadmium (Cd)-Total (mg/L)	0.0000126	0.0000152	0.000326		
	Calcium (Ca)-Total (mg/L)	54.6	67.5	234		
	Chromium (Cr)-Total (mg/L)	<0.00080 DLB	<0.00040 DLB	0.00151		
	Cobalt (Co)-Total (mg/L)	0.00023	0.00013	0.00313		
	Copper (Cu)-Total (mg/L)	0.00367	0.0145	0.198		
	Iron (Fe)-Total (mg/L)	0.357	0.053	5.10		
	Lead (Pb)-Total (mg/L)	0.000113	0.000055	0.000160		
	Lithium (Li)-Total (mg/L)	0.0038	0.0021	0.0050		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1889375-1	L1889375-2	L1889375-3		
	Description	Water	Water	Water		
	Sampled Date	07-FEB-17	07-FEB-17	07-FEB-17		
	Sampled Time	10:00	10:15	11:10		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Total Metals	Magnesium (Mg)-Total (mg/L)	28.2	21.0	74.1		
	Manganese (Mn)-Total (mg/L)	0.124	0.325	8.44		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00443	0.00584	0.0122		
	Nickel (Ni)-Total (mg/L)	0.00142	0.00122	0.00211		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.101		
	Potassium (K)-Total (mg/L)	2.11	3.62	8.48		
	Selenium (Se)-Total (mg/L)	0.000299	0.000321	0.00168		
	Silicon (Si)-Total (mg/L)	6.57	5.39	9.89		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000063		
	Sodium (Na)-Total (mg/L)	17.8	15.9	52.8		
	Strontium (Sr)-Total (mg/L)	0.735	0.781	3.47		
	Sulfur (S)-Total (mg/L)	18.5	18.5	71.8		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.0110	0.00161	0.00851		
	Uranium (U)-Total (mg/L)	0.00280	0.00262	0.00430		
	Vanadium (V)-Total (mg/L)	0.00104	0.00055	0.00449		
	Zinc (Zn)-Total (mg/L)	0.0056	<0.0030	0.320		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00102		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0018	0.0017	0.0080		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00011		
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00033	0.00069		
	Barium (Ba)-Dissolved (mg/L)	0.0782	0.0814	0.234		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.024	0.031	0.037		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000063	0.0000081	0.000230		
	Calcium (Ca)-Dissolved (mg/L)	56.5	69.5	242		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00081		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00317		
	Copper (Cu)-Dissolved (mg/L)	0.00186	0.00599	0.0450		
	Iron (Fe)-Dissolved (mg/L)	0.030	<0.010	1.60		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0033	0.0017	0.0048		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1889375-1	L1889375-2	L1889375-3		
	Description	Water	Water	Water		
	Sampled Date	07-FEB-17	07-FEB-17	07-FEB-17		
	Sampled Time	10:00	10:15	11:10		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Magnesium (Mg)-Dissolved (mg/L)	29.4	22.0	76.4		
	Manganese (Mn)-Dissolved (mg/L)	0.0906	0.0749	9.02		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00454	0.00578	0.0121		
	Nickel (Ni)-Dissolved (mg/L)	0.00087	0.00080	0.00210		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	0.053		
	Potassium (K)-Dissolved (mg/L)	2.25	3.85	9.22		
	Selenium (Se)-Dissolved (mg/L)	0.000318	0.000409	DTC 0.00232		
	Silicon (Si)-Dissolved (mg/L)	6.13	5.35	9.52		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000014		
	Sodium (Na)-Dissolved (mg/L)	18.8	16.6	55.7		
	Strontium (Sr)-Dissolved (mg/L)	0.778	0.813	3.60		
	Sulfur (S)-Dissolved (mg/L)	19.2	19.8	75.2		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	0.00011		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00097		
	Uranium (U)-Dissolved (mg/L)	0.00269	0.00246	0.00430		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00196		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.260		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00112		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Chromium (Cr)-Total	MB-LOR	L1889375-1, -2, -3
Matrix Spike	Dissolved Organic Carbon	MS-B	L1889375-1, -2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1889375-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1889375-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1889375-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1889375-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1889375-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1889375-1, -2, -3
Matrix Spike	Aluminum (Al)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Boron (B)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Iron (Fe)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Potassium (K)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Sulfur (S)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Uranium (U)-Total	MS-B	L1889375-1, -2, -3
Matrix Spike	Sulfate (SO4)	MS-B	L1889375-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-VA Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-02-08 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Whitehorse Receive

Not Logged In

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1889375-COFC

COC Number: 2017-02-08 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Mcdonnell

Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	7-Feb-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
	W17	7-Feb-17	10:15	Water	R	R	R	R	R	R	R	R	R					7
	W8A	7-Feb-17	11:10	Water	R	R	R	R	R	R	R	R						6

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: -2.0

FINAL COOLER TEMPERATURES °C: 2.6, 0.9, 1.3, 2.0, 0.4

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-02-08 8:30	Time:	Received by: EHF	Date: 8 Feb 2017	Time: 1525	Received by: Shayon	Date: Feb. 10	Time: 11am

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 15-FEB-17
Report Date: 27-FEB-17 15:54 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1891149

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-02-15 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1891149-1 Water 13-FEB-17 09:40 UG1	L1891149-2 Water 14-FEB-17 11:45 W15	L1891149-3 Water 14-FEB-17 13:30 W3	L1891149-4 Water 14-FEB-17 13:40 W17	L1891149-5 Water 14-FEB-17 13:55 W8A
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	2480	1960	537	526	1610
	Hardness (as CaCO3) (mg/L)	1270	1050	256	254	853
	pH (pH)	8.06	7.92	8.24	8.28	7.60
	Total Suspended Solids (mg/L)	21.5	6.1	<3.0	<3.0	46.3
	Total Dissolved Solids (mg/L)	2050	1520	340	340	1170
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	237	583	247	231	833
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	237	583	247	231	833
	Ammonia, Total (as N) (mg/L)	32.2	1.03	<0.0050	<0.0050	0.422
	Chloride (Cl) (mg/L)	<10 DLDS	26	5.04	6.67	20.0
	Nitrate and Nitrite (as N) (mg/L)	61.1	59.0	0.276	0.342	0.273
	Nitrate (as N) (mg/L)	59.6	58.8	0.274	0.342	0.194
	Nitrite (as N) (mg/L)	1.58	0.195	0.0019	<0.0010 HTD	0.079
	Sulfate (SO4) (mg/L)	1080	398	58.6	55.7	203
	Anion Sum (meq/L)	31.6	24.9	6.31	5.98	21.5
	Cation Sum (meq/L)	30.8	23.2	5.99	5.89	19.7
	Cation - Anion Balance (%)	-1.2	-3.6	-2.6	-0.8	-4.4
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	2.12	18.5	5.10	8.31	
Total Metals	Aluminum (Al)-Total (mg/L)	0.468	0.0257	0.0338	0.0062	0.0806
	Antimony (Sb)-Total (mg/L)	0.00075	<0.00020 DLA	0.00017	0.00010	0.00038
	Arsenic (As)-Total (mg/L)	0.00117	0.00058	0.00033	0.00039	0.00094
	Barium (Ba)-Total (mg/L)	0.0412	0.369	0.0787	0.0817	0.259
	Beryllium (Be)-Total (mg/L)	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020	0.000032
	Bismuth (Bi)-Total (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.708	0.033	0.024	0.032	0.039
	Cadmium (Cd)-Total (mg/L)	0.000394	0.000068	0.0000130	0.0000081	0.000316
	Calcium (Ca)-Total (mg/L)	429	300	56.7	67.5	239
	Chromium (Cr)-Total (mg/L)	0.00032	0.00024	0.00013	0.00011	0.00161
	Cobalt (Co)-Total (mg/L)	0.00279	0.00156	0.00012	<0.00010	0.00422
	Copper (Cu)-Total (mg/L)	0.0963	0.0471	0.0108	0.00616	0.144
	Iron (Fe)-Total (mg/L)	1.01	0.337	0.106	<0.010	4.07
	Lead (Pb)-Total (mg/L)	0.00243	<0.00010 DLA	<0.000050	<0.000050	0.000122
	Lithium (Li)-Total (mg/L)	0.0098	0.0038	0.0030	0.0014	0.0052
	Magnesium (Mg)-Total (mg/L)	49.1	81.6	27.1	20.2	75.8
	Manganese (Mn)-Total (mg/L)	0.181	3.06	0.163	0.104	9.90

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1891149-1	L1891149-2	L1891149-3	L1891149-4	L1891149-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	13-FEB-17	14-FEB-17	14-FEB-17	14-FEB-17	14-FEB-17
	Sampled Time	09:40	11:45	13:30	13:40	13:55
	Client ID	UG1	W15	W3	W17	W8A
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000068
	Molybdenum (Mo)-Total (mg/L)	0.0201	0.00699	0.00443	0.00604	0.0134
	Nickel (Ni)-Total (mg/L)	0.0063	0.0021	0.00091	0.00084	0.00215
	Phosphorus (P)-Total (mg/L)	0.31	<0.10 DLA	<0.050	<0.050	0.098
	Potassium (K)-Total (mg/L)	11.2	11.8	2.57	3.96	9.37
	Selenium (Se)-Total (mg/L)	0.00083	0.0121	0.000313	0.000324	0.00148
	Silicon (Si)-Total (mg/L)	8.73	13.4	6.71	5.67	10.6
	Silver (Ag)-Total (mg/L)	0.000028	<0.000020 DLA	<0.000010	<0.000010	0.000049
	Sodium (Na)-Total (mg/L)	62.1	40.1	17.9	15.7	56.2
	Strontium (Sr)-Total (mg/L)	9.90	3.32	0.746	0.794	3.56
	Sulfur (S)-Total (mg/L)	412	146	21.3	20.5	78.3
	Thallium (Tl)-Total (mg/L)	0.000023	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0257	0.00136	0.00189	<0.00030	0.00499
	Uranium (U)-Total (mg/L)	0.0128	0.00659	0.00267	0.00262	0.00453
	Vanadium (V)-Total (mg/L)	0.0022	<0.0010 DLA	<0.00050	<0.00050	0.00419
	Zinc (Zn)-Total (mg/L)	0.0198	0.0265	0.0037	<0.0030	0.212
	Zirconium (Zr)-Total (mg/L)	<0.00060 DLA	<0.00060 DLA	<0.00030	<0.00030	0.00111
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0089	0.0040	0.0027	0.0023	0.0061
	Antimony (Sb)-Dissolved (mg/L)	0.00075	<0.00020 DLA	<0.00010	<0.00010	0.00018
	Arsenic (As)-Dissolved (mg/L)	0.00118	0.00044	0.00025	0.00035	0.00063
	Barium (Ba)-Dissolved (mg/L)	0.0346	0.351	0.0811	0.0842	0.204
	Beryllium (Be)-Dissolved (mg/L)	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.677	0.026	0.022	0.030	0.038
	Cadmium (Cd)-Dissolved (mg/L)	0.000379	0.000068	0.0000132	0.0000061	0.000198
	Calcium (Ca)-Dissolved (mg/L)	420	293	56.6	67.1	237
	Chromium (Cr)-Dissolved (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010	0.00072
	Cobalt (Co)-Dissolved (mg/L)	0.00232	0.00147	0.00010	<0.00010	0.00341
	Copper (Cu)-Dissolved (mg/L)	0.0198	0.0378	0.00893	0.00568	0.0311
	Iron (Fe)-Dissolved (mg/L)	<0.020 DLA	0.056	0.048	<0.010	0.443
	Lead (Pb)-Dissolved (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0090	0.0038	0.0032	0.0014	0.0053
	Magnesium (Mg)-Dissolved (mg/L)	52.9	78.0	27.8	21.1	63.3
	Manganese (Mn)-Dissolved (mg/L)	0.164	2.90	0.158	0.0776	8.14

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1891149-1	L1891149-2	L1891149-3	L1891149-4	L1891149-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	13-FEB-17	14-FEB-17	14-FEB-17	14-FEB-17	14-FEB-17
	Sampled Time	09:40	11:45	13:30	13:40	13:55
	Client ID	UG1	W15	W3	W17	W8A
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0199	0.00668	0.00410	0.00553	0.0122
	Nickel (Ni)-Dissolved (mg/L)	0.0056	0.0017	0.00106	0.00081	0.00164
	Phosphorus (P)-Dissolved (mg/L)	0.33	<0.10 DLA	<0.050	<0.050	0.058
	Potassium (K)-Dissolved (mg/L)	12.0	11.3	2.64	4.09	7.92
	Selenium (Se)-Dissolved (mg/L)	0.00087	0.0115	0.000319	0.000344	0.00160
	Silicon (Si)-Dissolved (mg/L)	7.73	12.8	6.57	5.48	10.2
	Silver (Ag)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	0.000011
	Sodium (Na)-Dissolved (mg/L)	67.0	38.3	18.4	16.2	47.3
	Strontium (Sr)-Dissolved (mg/L)	9.75	3.19	0.725	0.781	3.48
	Sulfur (S)-Dissolved (mg/L)	411	140	20.6	20.4	74.7
	Thallium (Tl)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLA	<0.00060 DLA	<0.00030	<0.00030	0.00074
	Uranium (U)-Dissolved (mg/L)	0.0124	0.00635	0.00253	0.00251	0.00430
	Vanadium (V)-Dissolved (mg/L)	<0.0010 DLA	<0.0010 DLA	<0.00050	<0.00050	0.00143
	Zinc (Zn)-Dissolved (mg/L)	0.0118	0.0230	0.0030	<0.0010	0.147
	Zirconium (Zr)-Dissolved (mg/L)	<0.00060 DLA	<0.00060 DLA	<0.00030	<0.00030	0.00112

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1891149-1, -2, -3, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L1891149-1, -2, -3, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L1891149-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Aluminum (Al)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Potassium (K)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1891149-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1891149-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Reference Information

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

Reference Information

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-02-15 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1891149-COFC

COC Number: 2017-02-15 A

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

[redacted] **Date and Time Required for all E&P TATs:**

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

[redacted] **Oil and Gas Required Fields (client use)**

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	UG1	13-Feb-17	9:40	Water	R	R	R	R	R	R	R	R	R					7
	W15	14-Feb-17	11:45	Water	R	R	R	R	R	R	R	R	R					7
	W3	14-Feb-17	13:30	Water	R	R	R	R	R	R	R	R	R					7
	W17	14-Feb-17	13:40	Water	R	R	R	R	R	R	R	R	R					7
	W8A	14-Feb-17	13:55	Water	R	R	R	R	R	R	R	R	R					6

Short Holding Time

○ Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☑	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3,0				4	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date:2017-02-15	Time: 10:00	Received by: EHF	Date: 15 Feb 2017	Time: 15:53	Received by: JC	Date FEB 16 2017	Time: 13:35

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 22-FEB-17
Report Date: 03-MAR-17 16:59 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1893598
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-02-22 B
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1893598-1	L1893598-2	L1893598-3		
	Description	Water	Water	Water		
	Sampled Date	21-FEB-17	21-FEB-17	21-FEB-17		
	Sampled Time	14:00	14:35	14:50		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	544	534	1600		
	Hardness (as CaCO3) (mg/L)	260	259	927		
	pH (pH)	8.16	8.27	7.92		
	Total Suspended Solids (mg/L)	<3.0	<3.0	104		
	Total Dissolved Solids (mg/L)	322	331	1140		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	243	235	817		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	243	235	817		
	Ammonia, Total (as N) (mg/L)	0.0189	<0.0050	0.439		
	Chloride (Cl) (mg/L)	4.84	6.66	18.3		
	Nitrate and Nitrite (as N) (mg/L)	0.256	0.293	0.203		
	Nitrate (as N) (mg/L)	0.256	0.293	0.131		
	Nitrite (as N) (mg/L)	<0.0010^{HTD}	<0.0010	0.0718		
	Sulfate (SO4) (mg/L)	57.7	56.1	204		
	Anion Sum (meq/L)	6.22	6.06	21.1		
	Cation Sum (meq/L)	6.10	6.00	22.0		
	Cation - Anion Balance (%)	-1.0	-0.6	2.0		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.05	8.46			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0105	0.0057	0.0855		
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00011	0.00072		
	Arsenic (As)-Total (mg/L)	0.00023	0.00032	0.00101		
	Barium (Ba)-Total (mg/L)	0.0817	0.0809	0.279		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000040^{DLA}		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.00010^{DLA}		
	Boron (B)-Total (mg/L)	0.023	0.031	0.038		
	Cadmium (Cd)-Total (mg/L)	0.0000140	0.0000067	0.000293		
	Calcium (Ca)-Total (mg/L)	58.1	68.8	247		
	Chromium (Cr)-Total (mg/L)	<0.00020^{DLB}	<0.00020^{DLB}	0.00178		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00527		
	Copper (Cu)-Total (mg/L)	0.00389	0.00671	0.174		
	Iron (Fe)-Total (mg/L)	0.054	<0.010	7.21		
	Lead (Pb)-Total (mg/L)	<0.000050	0.000056	0.00017		
	Lithium (Li)-Total (mg/L)	0.0033	0.0015	0.0051		
	Magnesium (Mg)-Total (mg/L)	28.9	21.7	79.6		
	Manganese (Mn)-Total (mg/L)	0.138	0.0836	11.4		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1893598-1	L1893598-2	L1893598-3		
	Description	Water	Water	Water		
	Sampled Date	21-FEB-17	21-FEB-17	21-FEB-17		
	Sampled Time	14:00	14:35	14:50		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000089		
	Molybdenum (Mo)-Total (mg/L)	0.00440	0.00610	0.0156		
	Nickel (Ni)-Total (mg/L)	0.00085	0.00087	0.0023		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.13		
	Potassium (K)-Total (mg/L)	2.48	3.93	9.31		
	Selenium (Se)-Total (mg/L)	0.000265	0.000371	0.00147		
	Silicon (Si)-Total (mg/L)	6.79	5.77	10.7		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000057		
	Sodium (Na)-Total (mg/L)	19.1	16.8	58.6		
	Strontium (Sr)-Total (mg/L)	0.748	0.795	3.62		
	Sulfur (S)-Total (mg/L)	21.4	21.0	78.4		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	DLA <0.000020		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	DLA <0.00020		
	Titanium (Ti)-Total (mg/L)	0.00039	<0.00030	0.00505		
	Uranium (U)-Total (mg/L)	0.00265	0.00270	0.00451		
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	0.0056		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.339		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00127		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0011	0.0017	0.0103		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	DLA <0.00020		
	Arsenic (As)-Dissolved (mg/L)	0.00022	0.00031	0.00082		
	Barium (Ba)-Dissolved (mg/L)	0.0793	0.0807	0.267		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	DLA <0.000040		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	DLA <0.00010		
	Boron (B)-Dissolved (mg/L)	0.021	0.029	0.036		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000100	0.0000060	0.000157		
	Calcium (Ca)-Dissolved (mg/L)	56.7	67.9	241		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00111		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00510		
	Copper (Cu)-Dissolved (mg/L)	0.00253	0.00574	0.0424		
	Iron (Fe)-Dissolved (mg/L)	0.037	<0.010	4.09		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	DLA <0.00010		
	Lithium (Li)-Dissolved (mg/L)	0.0032	0.0016	0.0050		
	Magnesium (Mg)-Dissolved (mg/L)	28.8	21.6	78.8		
	Manganese (Mn)-Dissolved (mg/L)	0.134	0.0691	11.0		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1893598-1 Water 21-FEB-17 14:00 W3	L1893598-2 Water 21-FEB-17 14:35 W17	L1893598-3 Water 21-FEB-17 14:50 W8A		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00381	0.00562	0.0140		
	Nickel (Ni)-Dissolved (mg/L)	0.00079	0.00080	0.0021		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	DLA <0.10		
	Potassium (K)-Dissolved (mg/L)	2.42	3.89	9.24		
	Selenium (Se)-Dissolved (mg/L)	0.000268	0.000387	0.00172		
	Silicon (Si)-Dissolved (mg/L)	6.68	5.72	10.4		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	DLA <0.000020		
	Sodium (Na)-Dissolved (mg/L)	19.0	16.7	58.1		
	Strontium (Sr)-Dissolved (mg/L)	0.716	0.771	3.46		
	Sulfur (S)-Dissolved (mg/L)	21.0	20.5	74.8		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	DLA <0.000020		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	DLA <0.00020		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00105		
	Uranium (U)-Dissolved (mg/L)	0.00246	0.00252	0.00423		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.0033		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.279		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00127		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Chromium (Cr)-Total	MB-LOR	L1893598-1, -2, -3
Matrix Spike	Aluminum (Al)-Total	MS-B	L1893598-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1893598-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L1893598-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1893598-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L1893598-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1893598-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1893598-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

Reference Information

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-02-22 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1893598-COFC

COC Number: 2017-02-22 B

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224162 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack
Sampler: SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	21-Feb-17	14:00	Water	R	R	R	R	R	R	R	R	R					7
	W17	21-Feb-17	14:35	Water	R	R	R	R	R	R	R	R	R					7
	W8A	21-Feb-17	14:50	Water	R	R	R	R	R	R	R	R						6

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.0°C					

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts
Date: 2017-02-22
Time: 11:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: VD
Date: Feb 22/17
Time: 14:55

FINAL SHIPMENT RECEPTION (lab use only)

Received by:
Date:
Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-MAR-17
Report Date: 10-MAR-17 18:27 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1896303

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-03-01 A
Legal Site Desc:

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

	Sample ID	L1896303-1	L1896303-2	L1896303-3	L1896303-4	
	Description	Water	Water	Water	Water	
	Sampled Date	28-FEB-17	28-FEB-17	28-FEB-17	28-FEB-17	
	Sampled Time	09:40	10:00	10:45		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	541	531	1650	544	
	Hardness (as CaCO3) (mg/L)	258	256	879	261	
	pH (pH)	8.10	8.22	7.60	8.11	
	Total Suspended Solids (mg/L)	3.0	<3.0	90.9	3.1	
	Total Dissolved Solids (mg/L)	335	350	1220	335	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	237	230	841	241	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	237	230	841	241	
	Ammonia, Total (as N) (mg/L)	0.0213	<0.0050	0.450	0.0222	
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.50 DLDS	<0.050	
	Chloride (Cl) (mg/L)	4.84	6.80	18.7	4.85	
	Fluoride (F) (mg/L)	0.540	0.361	0.54	0.539	
	Nitrate and Nitrite (as N) (mg/L)	0.295	0.261	0.263	0.293	
	Nitrate (as N) (mg/L)	0.295	0.261	0.212	0.293	
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.051	<0.0010	
	Sulfate (SO4) (mg/L)	58.2	57.2	197	58.3	
	Anion Sum (meq/L)	6.14	6.02	21.5	6.21	
	Cation Sum (meq/L)	6.03	5.94	20.7	6.07	
	Cation - Anion Balance (%)	-0.9	-0.7	-1.9	-1.1	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.75	8.48		4.75	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0983	0.0070	0.120	0.0799	
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00010	0.00043	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00030	0.00034	0.00107	0.00027	
	Barium (Ba)-Total (mg/L)	0.0791	0.0792	0.298	0.0778	
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000040 DLA	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.000050	
	Boron (B)-Total (mg/L)	0.023	0.030	0.037	0.023	
	Cadmium (Cd)-Total (mg/L)	0.0000129	0.0000091	0.000261	0.0000216	
	Calcium (Ca)-Total (mg/L)	56.7	68.2	230	55.1	
	Chromium (Cr)-Total (mg/L)	0.00023	0.00019	0.00169	0.00024	
	Cobalt (Co)-Total (mg/L)	0.00015	<0.00010	0.00656	0.00014	
	Copper (Cu)-Total (mg/L)	0.00358	0.00588	0.171	0.00371	
	Iron (Fe)-Total (mg/L)	0.179	<0.010	8.43	0.151	
	Lead (Pb)-Total (mg/L)	0.000061	<0.000050	0.00016	0.000055	
	Lithium (Li)-Total (mg/L)	0.0034	0.0019	0.0051	0.0038	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1896303-1	L1896303-2	L1896303-3	L1896303-4	
	Description	Water	Water	Water	Water	
	Sampled Date	28-FEB-17	28-FEB-17	28-FEB-17	28-FEB-17	
	Sampled Time	09:40	10:00	10:45		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Total Metals	Magnesium (Mg)-Total (mg/L)	30.0	22.4	77.9	29.6	
	Manganese (Mn)-Total (mg/L)	0.164	0.0825	12.3	0.161	
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000077	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	0.00477	0.00640	0.0186	0.00481	
	Nickel (Ni)-Total (mg/L)	0.00102	0.00085	0.0022	0.00100	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.12	<0.050	
	Potassium (K)-Total (mg/L)	2.23	3.86	9.04	2.23	
	Selenium (Se)-Total (mg/L)	0.000299	0.000358	0.00140	0.000351	
	Silicon (Si)-Total (mg/L)	6.25	5.36	9.97	6.47	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000059	<0.000010	
	Sodium (Na)-Total (mg/L)	18.7	16.9	57.1	19.2	
	Strontium (Sr)-Total (mg/L)	0.800	0.860	3.95	0.831	
	Sulfur (S)-Total (mg/L)	19.8	19.9	69.2	20.5	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000020 DLA	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00020 DLA	<0.00010	
	Titanium (Ti)-Total (mg/L)	0.00382	<0.00030	0.00604	0.00266	
	Uranium (U)-Total (mg/L)	0.00276	0.00271	0.00423	0.00274	
	Vanadium (V)-Total (mg/L)	0.00071	<0.00050	0.0062	0.00065	
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.255	<0.0030	
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00145	<0.00030	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0019	0.0021	0.0079	0.0023	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00020 DLA	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00031	0.00085	0.00023	
	Barium (Ba)-Dissolved (mg/L)	0.0743	0.0771	0.253	0.0729	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000040 DLA	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.000050	
	Boron (B)-Dissolved (mg/L)	0.021	0.029	0.035	0.023	
	Cadmium (Cd)-Dissolved (mg/L)	0.0000098	0.0000080	0.000148	0.0000109	
	Calcium (Ca)-Dissolved (mg/L)	55.1	66.7	226	56.6	
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00089	<0.00010	
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00620	<0.00010	
	Copper (Cu)-Dissolved (mg/L)	0.00175	0.00541	0.0278	0.00202	
	Iron (Fe)-Dissolved (mg/L)	0.030	<0.010	1.53	0.032	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0029	0.0015	0.0042	0.0031	

	Sample ID	L1896303-1	L1896303-2	L1896303-3	L1896303-4	
	Description	Water	Water	Water	Water	
	Sampled Date	28-FEB-17	28-FEB-17	28-FEB-17	28-FEB-17	
	Sampled Time	09:40	10:00	10:45		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Magnesium (Mg)-Dissolved (mg/L)	29.3	21.8	76.6	29.0	
	Manganese (Mn)-Dissolved (mg/L)	0.138	0.0613	11.7	0.139	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00456	0.00614	0.0172	0.00452	
	Nickel (Ni)-Dissolved (mg/L)	0.00079	0.00076	0.0019	0.00076	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	DLA <0.10	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.18	3.77	8.77	2.16	
	Selenium (Se)-Dissolved (mg/L)	0.000313	0.000379	0.00165	0.000317	
	Silicon (Si)-Dissolved (mg/L)	6.17	5.31	9.61	5.95	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	DLA <0.000020	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	18.5	16.4	53.9	18.3	
	Strontium (Sr)-Dissolved (mg/L)	0.803	0.829	3.73	0.806	
	Sulfur (S)-Dissolved (mg/L)	19.7	19.3	69.0	19.3	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	DLA <0.000020	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	DLA <0.00020	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00096	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00267	0.00255	0.00410	0.00261	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.0022	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.175	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00133	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1896303-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Total	MS-B	L1896303-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-03-01 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1896303-COFC

COC Number: 2017-03-01 A

Page 1 of 1

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Mcdonnell **Sampler:** CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	28-Feb-17	9:40	Water	R	R	R	R	R	R	R	R	R					7
	W17	28-Feb-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
	W8A	28-Feb-17	10:45	Water	R	R	R	R	R	R	R	R						6
	DUP	28-Feb-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
0,0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-03-01 9:00	Time:	Received by: EHF	Date: 1 March 2017	Time: 16:23	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 08-MAR-17
Report Date: 22-MAR-17 16:55 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1898839

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-03-08A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1898839-1	L1898839-2	L1898839-3	L1898839-4	L1898839-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	06-MAR-17	06-MAR-17	06-MAR-17	07-MAR-17	07-MAR-17
	Sampled Time	14:15	16:25	16:30	13:55	14:10
	Client ID	W62	W14	W12	W3	W17
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1060	3100	2270	537	540
	Hardness (as CaCO3) (mg/L)	572	1590	1080	275	278
	pH (pH)	8.28	8.16	7.90	8.14	8.26
	Total Suspended Solids (mg/L)	<3.0		3.5	<3.0	<3.0
	Total Dissolved Solids (mg/L)	779	2810	1910	323	356
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	349	83.8	166	242	237
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	349	83.8	166	242	237
	Ammonia, Total (as N) (mg/L)	0.0092	9.69	6.94	0.0167	<0.0050
	Chloride (Cl) (mg/L)	27.6	39	35	4.78	6.81
	Nitrate and Nitrite (as N) (mg/L)	5.54	47.4	29.0	0.321	0.212
	Nitrate (as N) (mg/L)	5.49	45.4	27.2	0.321	0.212
	Nitrite (as N) (mg/L)	0.0532	2.06	1.84	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	234	1690	1090	58.1	57.7
	Anion Sum (meq/L)	13.0	41.4	29.1	6.21	6.14
	Cation Sum (meq/L)	12.9	42.8	29.1	6.42	6.41
	Cation - Anion Balance (%)	-0.3	1.7	0.1	1.6	2.2
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)				4.04	7.90
Total Metals	Aluminum (Al)-Total (mg/L)	0.0129		0.0584	0.0460	0.0150
	Antimony (Sb)-Total (mg/L)	<0.00010		0.00048	0.00011	0.00014
	Arsenic (As)-Total (mg/L)	0.00035		0.00049	0.00024	0.00034
	Barium (Ba)-Total (mg/L)	0.133		0.107	0.0741	0.0781
	Beryllium (Be)-Total (mg/L)	<0.000020		DLA <0.000040	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050		DLA <0.00010	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.033		0.249	0.028	0.032
	Cadmium (Cd)-Total (mg/L)	0.0000188		DLM <0.00010	0.0000130	0.0000129
	Calcium (Ca)-Total (mg/L)	159		335	53.8	67.9
	Chromium (Cr)-Total (mg/L)	0.00022		DLA <0.00020	0.00016	0.00013
	Cobalt (Co)-Total (mg/L)	<0.00010		0.00072	0.00012	<0.00010
	Copper (Cu)-Total (mg/L)	0.0485		0.0561	0.00290	0.00815
	Iron (Fe)-Total (mg/L)	0.055		0.108	0.101	0.021
	Lead (Pb)-Total (mg/L)	<0.000050		0.00039	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0025		0.0123	0.0034	0.0017
	Magnesium (Mg)-Total (mg/L)	38.4		42.4	30.0	22.1
	Manganese (Mn)-Total (mg/L)	0.0295		0.513	0.151	0.184

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1898839-6	L1898839-7	L1898839-8		
	Description	WATER	WATER	WATER		
	Sampled Date	07-MAR-17	07-MAR-17	07-MAR-17		
	Sampled Time	14:40	14:50	14:40		
	Client ID	W45	W8A	F-BL		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	2910	1650	<2.0		
	Hardness (as CaCO3) (mg/L)	1500	1010	<0.50		
	pH (pH)	7.91	7.80	5.40		
	Total Suspended Solids (mg/L)	20.7	46.7	<3.0		
	Total Dissolved Solids (mg/L)	2340	1290	<10		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	129	864	<1.0		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	129	864	<1.0		
	Ammonia, Total (as N) (mg/L)	9.02	0.461	<0.0050		
	Chloride (Cl) (mg/L)	36	18.2	<0.50		
	Nitrate and Nitrite (as N) (mg/L)	33.9	0.236	<0.0051		
	Nitrate (as N) (mg/L)	33.4	0.194	<0.0050		
	Nitrite (as N) (mg/L)	0.433	0.0419	<0.0010		
	Sulfate (SO4) (mg/L)	1570	186	<0.30		
	Anion Sum (meq/L)	38.6	21.7	<0.10		
	Cation Sum (meq/L)	39.1	24.0	<0.10		
	Cation - Anion Balance (%)	0.6	5.2	0.0		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)	0.248	0.231	0.0031 RRV		
	Antimony (Sb)-Total (mg/L)	0.00065	0.00036	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00056	0.00124	<0.00010		
	Barium (Ba)-Total (mg/L)	0.162	0.315	0.000051		
	Beryllium (Be)-Total (mg/L)	<0.000040 DLA	0.000037	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.00010 DLA	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.316	0.040	<0.010		
	Cadmium (Cd)-Total (mg/L)	<0.00012 DLM	0.000233	<0.0000050		
	Calcium (Ca)-Total (mg/L)	485	248	<0.050		
	Chromium (Cr)-Total (mg/L)	0.00026	0.00181	<0.00010		
	Cobalt (Co)-Total (mg/L)	0.00151	0.00635	<0.00010		
	Copper (Cu)-Total (mg/L)	0.0582	0.215	0.00121 RRV		
	Iron (Fe)-Total (mg/L)	0.480	8.47	<0.010		
	Lead (Pb)-Total (mg/L)	0.00040	0.000217	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0183	0.0047	<0.0010		
	Magnesium (Mg)-Total (mg/L)	45.3	73.6	<0.10		
	Manganese (Mn)-Total (mg/L)	1.35	11.1	0.00012 RRV		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1898839-1	L1898839-2	L1898839-3	L1898839-4	L1898839-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	06-MAR-17	06-MAR-17	06-MAR-17	07-MAR-17	07-MAR-17
	Sampled Time	14:15	16:25	16:30	13:55	14:10
	Client ID	W62	W14	W12	W3	W17
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050		<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00703		0.0860	0.00452	0.00625
	Nickel (Ni)-Total (mg/L)	0.00105		0.0031	0.00093	0.00092
	Phosphorus (P)-Total (mg/L)	<0.050		<0.10 DLA	<0.050	<0.050
	Potassium (K)-Total (mg/L)	6.03		46.4	2.17	3.81
	Selenium (Se)-Total (mg/L)	0.00234		0.0129	0.000288	0.000343
	Silicon (Si)-Total (mg/L)	7.75		2.97	6.22	5.22
	Silver (Ag)-Total (mg/L)	<0.000010		<0.000020 DLA	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	29.8		130	19.1	16.7
	Strontium (Sr)-Total (mg/L)	1.60		7.37	0.827	0.887
	Sulfur (S)-Total (mg/L)	88.2		344	19.4	18.3
	Thallium (Tl)-Total (mg/L)	<0.000010		<0.000020 DLA	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010		<0.00020 DLA	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00062		0.00273	0.00230	0.00038
	Uranium (U)-Total (mg/L)	0.00521		0.00427	0.00261	0.00252
	Vanadium (V)-Total (mg/L)	<0.00050		<0.0010 DLA	0.00057	<0.00050
	Zinc (Zn)-Total (mg/L)	0.153		<0.0060 DLA	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030		<0.00060 DLA	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0025	0.0236	0.0065	0.0020	0.0019
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00046	0.00035	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00035	0.00037	0.00042	0.00027	0.00036
	Barium (Ba)-Dissolved (mg/L)	0.140	0.278	0.117	0.0820	0.0837
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.029	0.256	0.223	0.023	0.030
	Cadmium (Cd)-Dissolved (mg/L)	0.0000164	0.000028	<0.000050 DLM	0.0000100	0.0000104
	Calcium (Ca)-Dissolved (mg/L)	163	555	366	57.7	74.2
	Chromium (Cr)-Dissolved (mg/L)	0.00015	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00077	0.00064	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0459	0.00175	0.0260	0.00182	0.00593
	Iron (Fe)-Dissolved (mg/L)	0.021	<0.020 DLA	0.031	0.026	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	0.00015	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0032	0.0280	0.0124	0.0036	0.0022
	Magnesium (Mg)-Dissolved (mg/L)	40.3	50.4	41.0	31.8	22.5
	Manganese (Mn)-Dissolved (mg/L)	0.0302	1.64	0.472	0.146	0.0783

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1898839-6	L1898839-7	L1898839-8		
	Description	WATER	WATER	WATER		
	Sampled Date	07-MAR-17	07-MAR-17	07-MAR-17		
	Sampled Time	14:40	14:50	14:40		
	Client ID	W45	W8A	F-BL		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000064	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.0934	0.0169	<0.000050		
	Nickel (Ni)-Total (mg/L)	0.0057	0.00224	<0.00050		
	Phosphorus (P)-Total (mg/L)	<0.10 DLA	0.151	<0.050		
	Potassium (K)-Total (mg/L)	54.4	8.98	<0.10		
	Selenium (Se)-Total (mg/L)	0.0168	0.00134	<0.000050		
	Silicon (Si)-Total (mg/L)	2.71	11.3	<0.050		
	Silver (Ag)-Total (mg/L)	0.000021	0.000097	<0.000010		
	Sodium (Na)-Total (mg/L)	155	53.2	<0.050		
	Strontium (Sr)-Total (mg/L)	11.7	3.56	<0.00020		
	Sulfur (S)-Total (mg/L)	504	74.1	<0.50		
	Thallium (Tl)-Total (mg/L)	<0.000020 DLA	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00020 DLA	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.0104	0.0158	0.00042		
	Uranium (U)-Total (mg/L)	0.00470	0.00424	<0.000010		
	Vanadium (V)-Total (mg/L)	<0.0010 DLA	0.00810	<0.00050		
	Zinc (Zn)-Total (mg/L)	<0.0060 DLA	0.196	<0.0030		
	Zirconium (Zr)-Total (mg/L)	<0.00060 DLA	0.00148	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0095	0.0168	<0.0010		
	Antimony (Sb)-Dissolved (mg/L)	0.00039	<0.00020 DLA	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00047	0.00142	<0.00010		
	Barium (Ba)-Dissolved (mg/L)	0.166	0.349	<0.000050		
	Beryllium (Be)-Dissolved (mg/L)	<0.000040 DLA	<0.000040 DLA	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.267	0.038	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	<0.000050 DLM	0.000148	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	528	262	<0.050		
	Chromium (Cr)-Dissolved (mg/L)	<0.00020 DLA	0.00151	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	0.00136	0.00743	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00320	0.0586	<0.00020		
	Iron (Fe)-Dissolved (mg/L)	0.022	6.92	<0.010		
	Lead (Pb)-Dissolved (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0181	0.0051	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	44.2	86.1	<0.10		
	Manganese (Mn)-Dissolved (mg/L)	1.19	12.3	<0.00010		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1898839-1	L1898839-2	L1898839-3	L1898839-4	L1898839-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	06-MAR-17	06-MAR-17	06-MAR-17	07-MAR-17	07-MAR-17
	Sampled Time	14:15	16:25	16:30	13:55	14:10
	Client ID	W62	W14	W12	W3	W17
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00696	0.117	0.0835	0.00438	0.00617
	Nickel (Ni)-Dissolved (mg/L)	0.00093	0.0025	0.0030	0.00083	0.00082
	Phosphorus (P)-Dissolved (mg/L)	<0.050	DLA <0.10	DLA <0.10	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	5.95	66.8	47.7	2.46	4.02
	Selenium (Se)-Dissolved (mg/L)	0.00271	0.0193	0.0138	0.000332	0.000442
	Silicon (Si)-Dissolved (mg/L)	7.68	1.91	3.12	6.39	5.48
	Silver (Ag)-Dissolved (mg/L)	<0.000010	DLA <0.000020	DLM <0.000050	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	31.0	194	133	19.5	17.5
	Strontium (Sr)-Dissolved (mg/L)	1.67	11.9	7.11	0.774	0.856
	Sulfur (S)-Dissolved (mg/L)	81.7	641	383	19.8	20.2
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	DLA <0.000020	DLA <0.000020	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	DLA <0.00020	DLA <0.00020	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	DLA <0.00060	DLA <0.00060	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00467	0.00686	0.00465	0.00271	0.00256
	Vanadium (V)-Dissolved (mg/L)	<0.00050	DLA <0.0010	DLA <0.0010	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.160	DLA <0.0020	0.0022	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	DLA <0.00060	DLA <0.00060	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1898839-6 WATER 07-MAR-17 14:40 W45	L1898839-7 WATER 07-MAR-17 14:50 W8A	L1898839-8 WATER 07-MAR-17 14:40 F-BL		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.0891	0.0171	<0.000050		
	Nickel (Ni)-Dissolved (mg/L)	0.0044	0.0024	<0.00050		
	Phosphorus (P)-Dissolved (mg/L)	<0.10 DLA	<0.10 DLA	<0.050		
	Potassium (K)-Dissolved (mg/L)	55.7	9.80	<0.10		
	Selenium (Se)-Dissolved (mg/L)	0.0166	0.00158	<0.000050		
	Silicon (Si)-Dissolved (mg/L)	2.41	11.6	<0.050		
	Silver (Ag)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	161	63.0	<0.050		
	Strontium (Sr)-Dissolved (mg/L)	11.0	3.85	<0.00020		
	Sulfur (S)-Dissolved (mg/L)	572	73.1	<0.50		
	Thallium (Tl)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLA	0.00149	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00495	0.00428	<0.000010		
	Vanadium (V)-Dissolved (mg/L)	<0.0010 DLA	0.0062	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	<0.0020 DLA	0.131	<0.0010		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00060 DLA	0.00162	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1898839-4, -5
Matrix Spike	Dissolved Organic Carbon	MS-B	L1898839-4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1898839-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Barium (Ba)-Total	MS-B	L1898839-1, -7, -8
Matrix Spike	Calcium (Ca)-Total	MS-B	L1898839-3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L1898839-1, -7, -8
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1898839-3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1898839-1, -7, -8
Matrix Spike	Manganese (Mn)-Total	MS-B	L1898839-1, -7, -8
Matrix Spike	Sodium (Na)-Total	MS-B	L1898839-3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1898839-1, -7, -8
Matrix Spike	Strontium (Sr)-Total	MS-B	L1898839-3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1898839-1, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

Reference Information

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-03-08A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1898839-COFC

COC Number: 2017-03-08A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Form

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

onfirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224162 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Mcdonnell Sampler: CH/EB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W62	6-Mar-17	14:15	Water	R	R	R	R	R	R	R	R						6
2	W14	6-Mar-17	16:25	Water	R		R		R		R	R						4
3	W12	6-Mar-17	16:30	Water	R	R	R	R	R	R	R	R						6
4	W3	7-Mar-17	13:55	Water	R	R	R	R	R	R	R	R	R					7
5	W17	7-Mar-17	14:10	Water	R	R	R	R	R	R	R	R	R					7
6	W45	7-Mar-17	14:40	Water	R	R	R	R	R	R	R	R						6
7	W8A	7-Mar-17	14:50	Water	R	R	R	R	R	R	R	R						6
8	F-BL	7-Mar-17	14:40	Water	R	R	R	R	R	R	R	R						6

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.5℃					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Emilie Bouchard	Date: 8-Mar-2017 8:30	Time:	Received by: VD.	Date: Mar 8/17	Time: 3:15	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY   OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 15-MAR-17
Report Date: 31-MAR-17 10:40 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1901651

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-03-15 A
Legal Site Desc:

Comments: Please note, the ALS Fort Collins Ra226 detailed analysis report can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1901651-1	L1901651-2	L1901651-3	L1901651-4	L1901651-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-MAR-17	14-MAR-17	14-MAR-17	14-MAR-17	14-MAR-17
	Sampled Time	14:55	09:30	14:35	16:15	17:50
	Client ID	W4	W16	W3	W8A	W17
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	276	563	581	1740	561
	Hardness (as CaCO3) (mg/L)	136	265	281	858	249
	pH (pH)	7.98	7.91	8.00	7.80	8.13
	Total Suspended Solids (mg/L)	<3.0	3.2	<3.0	40.4	14.8
	Total Dissolved Solids (mg/L)	176	375	349	1250	360
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	131	204	245	883	236
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	131	204	245	883	236
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0879	0.0491	0.422	0.0061
	Chloride (Cl) (mg/L)	0.70	7.23	5.55	20.2	7.04
	Nitrate and Nitrite (as N) (mg/L)	0.150	3.91	0.153	0.673	0.194
	Nitrate (as N) (mg/L)	0.150	3.89	0.150	0.635	0.194
	Nitrite (as N) (mg/L)	<0.0010	0.0199	0.0023	0.038	<0.0010
	Sulfate (SO4) (mg/L)	14.0	71.5	61.1	201	58.5
	Anion Sum (meq/L)	2.94	6.05	6.33	22.4	6.16
	Cation Sum (meq/L)	2.92	6.17	6.61	20.3	5.76
	Cation - Anion Balance (%)	-0.4	1.0	2.1	-5.1	-3.3
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	1.84	11.4	5.63		8.66
Total Metals	Aluminum (Al)-Total (mg/L)	0.0224	0.0193	0.0202	0.0890	0.0915
	Antimony (Sb)-Total (mg/L)	0.00011	0.00012	0.00013	0.00044	0.00025
	Arsenic (As)-Total (mg/L)	0.00044	0.00040	0.00029	0.00132	0.00039
	Barium (Ba)-Total (mg/L)	0.0913	0.0933	0.0896	0.310	0.0992
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000026	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.037	0.022	0.036	0.031
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000136	0.0000258	0.000227	0.0000428
	Calcium (Ca)-Total (mg/L)	44.1	77.5	66.5	262	75.3
	Chromium (Cr)-Total (mg/L)	0.00019	0.00014	0.00013	0.00173	0.00021
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00020	0.00644	0.00020
	Copper (Cu)-Total (mg/L)	0.00147	0.0181	0.00619	0.177	0.0314
	Iron (Fe)-Total (mg/L)	0.047	0.125	0.084	7.48	0.136
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	0.000147	0.000077
	Lithium (Li)-Total (mg/L)	0.0010	0.0014	0.0031	0.0045	0.0016
	Magnesium (Mg)-Total (mg/L)	9.78	22.4	32.0	78.7	24.1
	Manganese (Mn)-Total (mg/L)	0.00311	0.231	0.398	12.0	0.663

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1901651-1	L1901651-2	L1901651-3	L1901651-4	L1901651-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-MAR-17	14-MAR-17	14-MAR-17	14-MAR-17	14-MAR-17
	Sampled Time	14:55	09:30	14:35	16:15	17:50
	Client ID	W4	W16	W3	W8A	W17
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000067	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.000885	0.00454	0.00392	0.0167	0.00565
	Nickel (Ni)-Total (mg/L)	<0.00050	0.00076	0.00127	0.00220	0.00134
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.149	<0.050
	Potassium (K)-Total (mg/L)	1.11	3.87	2.58	8.60	4.00
	Selenium (Se)-Total (mg/L)	0.000155	0.00118	0.000137	0.00123	0.000363
	Silicon (Si)-Total (mg/L)	5.26	4.80	7.00	10.4	5.64
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000054	<0.000010
	Sodium (Na)-Total (mg/L)	4.41	17.5	20.6	53.4	17.1
	Strontium (Sr)-Total (mg/L)	0.243	0.792	0.784	3.63	0.841
	Sulfur (S)-Total (mg/L)	5.06	25.8	22.0	68.5	20.6
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00094	0.00103	0.00098	0.00542	0.00435
	Uranium (U)-Total (mg/L)	0.000751	0.00183	0.00242	0.00423	0.00275
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	0.00770	0.00106
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0047	0.0104	0.134	0.0059
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00147	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0025	0.0057	0.0039	0.0129	0.0028
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	DLA <0.00020	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00043	0.00037	0.00031	0.00117	0.00034
	Barium (Ba)-Dissolved (mg/L)	0.0888	0.0935	0.0876	0.303	0.0837
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	DLA <0.000040	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	DLA <0.00010	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.036	0.022	0.035	0.029
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000168	0.0000267	0.000134	0.0000148
	Calcium (Ca)-Dissolved (mg/L)	39.1	69.8	60.2	223	65.3
	Chromium (Cr)-Dissolved (mg/L)	0.00012	0.00012	<0.00010	0.00120	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00012	0.00019	0.00623	<0.00010
	Copper (Cu)-Dissolved (mg/L)	DTC 0.00819	0.0173	0.00392	0.0371	0.00699
	Iron (Fe)-Dissolved (mg/L)	0.015	0.088	0.056	4.68	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	DLA <0.00010	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0012	0.0030	0.0046	0.0020
	Magnesium (Mg)-Dissolved (mg/L)	9.24	22.0	31.8	73.2	21.0
	Manganese (Mn)-Dissolved (mg/L)	0.00248	0.226	0.390	11.1	0.0928

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1901651-1	L1901651-2	L1901651-3	L1901651-4	L1901651-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-MAR-17	14-MAR-17	14-MAR-17	14-MAR-17	14-MAR-17
	Sampled Time	14:55	09:30	14:35	16:15	17:50
	Client ID	W4	W16	W3	W8A	W17
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000814	0.00415	0.00364	0.0149	0.00540
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00080	0.00132	0.0021	0.00080
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	DLA <0.10	<0.050
	Potassium (K)-Dissolved (mg/L)	1.10	3.97	2.67	8.27	3.76
	Selenium (Se)-Dissolved (mg/L)	0.000165	0.00135	0.000167	0.00130	0.000415
	Silicon (Si)-Dissolved (mg/L)	5.28	4.80	6.91	9.99	5.25
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	DLA <0.000020	<0.000010
	Sodium (Na)-Dissolved (mg/L)	4.16	17.3	20.7	51.2	15.5
	Strontium (Sr)-Dissolved (mg/L)	0.227	0.758	0.748	3.33	0.784
	Sulfur (S)-Dissolved (mg/L)	4.82	25.5	21.9	66.3	19.1
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	DLA <0.000020	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	DLA <0.00020	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00036	<0.00030	0.00118	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000716	0.00174	0.00230	0.00407	0.00240
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.0046	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0012	0.0045	0.0054	0.0927	0.0037
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	0.00146	<0.00030
Radiological Parameters	Ra-226 (Bq/L)			0.070		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Boron (B)-Total	MS-B	L1901651-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1901651-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1901651-1, -2, -3, -4, -5
Matrix Spike	Silicon (Si)-Total	MS-B	L1901651-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1901651-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1901651-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Reference Information

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

RA226-MMER-FC Water Ra226 by Alpha Scint, MDC=0.01 Bq/L EPA 903.1

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
FC	ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

2017-03-15 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Thursday, March 30, 2017

Selam Worku
ALS Environmental
8081 Lougheed Hwy, Suite 100
Burnaby, BC V5A 1W9

Re: ALS Workorder: 1703321
Project Name:
Project Number: L1901651

Dear Ms. Worku:

One water sample was received from ALS Environmental, on 3/17/2017. The sample was scheduled for the following analysis:

Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
Shiloh J. Summy
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

1703321

Radium-226:

The sample was prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met, with the following exception:

The requested MDC for ^{226}Ra was not met for RE170322-2MB. The activity for the sample is 5 times greater than the achieved MDC of the method blank. Results are submitted without further qualification.

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1703321
Client Name: ALS Environmental
Client Project Name:
Client Project Number: L1901651
Client PO Number: L1901651

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
L1901651-3	1703321-1		WATER	14-Mar-17	

ALS Environmental

L1901651

VANCOUVER

170332~~3~~ 1 SS 3/17/17

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
225 COMMERCE DRIVE
FORT COLLINS,CO 80524

NOTES: Please reference on final report and invoice: PO# *L1901651*
ALS requires QC data to be provided with your final results.

Please see enclosed 1 **sample(s) in** 1 **Container(s)**

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED DUE DATE	Priority Flag
L1901651-3 W3		3/ 14/ 2017	
	Ra226 by Alpha Scint, MDC=0.01 Bq/L (RA226-MMER-FC 1)	3/28/2017	

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact: Ariel McDonnell, B.Sc.
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9
Phone: (604) 253-4188 Email: Ariel.McDonnell@alsglobal.com

Please email confirmation of receipt to: **Ariel.McDonnell@alsglobal.com**

Shipped By: ______ Date Shipped: ______

Received By: Avery Date Received: 3/17/17 @0950

Verified By: ______ Date Verified: ______

Temperature: ______

Sample Integrity Issues: ______

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

/ SS 3/17/17

Client: ALS BURNABY Workorder No: 1703328

Project Manager: VA SJS Initials: VA Date: 3/17/17

1. Does this project require any special handling in addition to standard ALS procedures?		YES	[✓ NO]
2. Are custody seals on shipping containers intact?	[✓ NONE]	YES	NO
3. Are Custody seals on sample containers intact?	[✓ NONE]	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		[✓ YES]	NO
5. Are the COC and bottle labels complete and legible?		[✓ YES]	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		[✓ YES]	NO
7. Were airbills / shipping documents present and/or removable?	DROP OFF	[✓ YES]	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	YES	[✓ NO]
9. Are all aqueous non-preserved samples pH 4-9?	[✓ N/A]	YES	NO
10. Is there sufficient sample for the requested analyses?		[✓ YES]	NO
11. Were all samples placed in the proper containers for the requested analyses?		[✓ YES]	NO
12. Are all samples within holding times for the requested analyses?		[✓ YES]	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		[✓ YES]	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	[✓ N/A]	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____ heavy	N/A	YES	[✓ NO]
16. Were the samples shipped on ice?		[✓ YES]	NO
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	[✓ RAD ONLY]	YES	NO

Cooler #:	1							
Temperature (°C):	5.8							
No. of custody seals on cooler:	0							
External µR/hr reading:	10							
Background µR/hr reading:								

DOT Survey/ Acceptance Information

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? [✓ YES] / NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO / NA Contact: ____________ Date/Time: ____________

Project Manager Signature / Date:

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM (1703321

Client: ALS BURNABY
Workorder No: ~~1703323~~ VA 3/17
Project Manager: SJS
Initials: VA Date: 3/17/17

NOTE:

No pH adjustments shall be made without prior consent of Project Manager. After pH adjustments, hold metals and radchem samples ≥ 16 hrs. before analysis.

Was the pH of any sample adjusted by the laboratory? **YES** (See Table below) / **NO**

pH Excursion:

ALS Sample ID 1703321-1	Client Sample ID	Initial pH	Final pH	Reagent Used	Volume Added (mL)	Lot No. of Reagent	Requested Analysis	Initials / Date / Time
~~1703323~~ VA 3/17	~~L1900972-1~~	6	<2	HNO_3	1.0	137345	RAD	VA / 3-17-17 / 1540
	L1901651							
	SS 3/17/17							

If applicable, was the client contacted? **YES / NO / NA** Contact: ______________________ Date/Time: ____________

Project Manager Signature / Date: ______________________

Form 201r24.xls (06/04/2012)

1703321

~~1703323~~ VA 3/17

DEFINITIONS: On the Air Waybill 'We', 'Our', 'us' and 'FedEx' refer to Federal Express Corporation, its subsidiaries and branches and their respective employees, agents and independent contractors. 'You' and 'your' refer to the shipper, its employees, principals and agents. If your shipment originates outside the United States, your contract of carriage is with the Federal Express subsidiary, branch or independent contractor who originally accepts the shipment from you. 'Package' means any container or envelope that is accepted by us for delivery, including any such items tendered by you utilizing our automated systems, meters, manifests or waybills. 'Shipment' means all packages, which are tendered to and accepted by us on a single Air Waybill.

AGREEMENT TO TERMS. By giving us your shipment, you agree, regardless of whether you sign the front of this Air Waybill, for yourself and as agent for and on behalf of any other person having an interest in this shipment, to all terms on this NON-NEGOTIABLE Air Waybill. In any applicable tariff, and in our current Service Guide or Standard Conditions of Carriage, copies of which are available upon request. If there is a conflict between this Air Waybill and either the tariff, Service Guide or Standard Conditions then in effect, the tariff and the terms of any customer automation agreement between the shipper and Federal Express will control(the Service Guide or Standard Conditions have secondary priority). No one is authorized to alter or modify the terms of our agreement. This Air Waybill shall be binding on us when the shipment is accepted.

YOUR OBLIGATIONS: You warrant that each article in the shipment is properly described on this Air Waybill and is acceptable for transport by us, and that the shipment is properly marked, addressed (including postal codes) and packaged to ensure safe transportation with ordinary care in handling.

NOTE CONCERNING LIMITATIONS OF LIABILITY. Air Carriage Notice. If the carriage of your shipment by air involves an ultimate destination or stop in a country other than the country of departure, the Warsaw Convention, an international treaty relating to international carriage by air, may be applicable, which treaty would then govern and in most cases limit our liability for loss or delay of or damage to your shipment. In the U.S. the Warsaw Convention limits our liability to U.S. $9.07 per pound (U.S. $20.38 per kilogram). Unless you declare a higher value for carriage as described below. The interpretation of the Warsaw Convention liability limits may vary in other countries. There are no stopping places which are agreed at the time of tender of the shipment and we reserve the right to route shipments in any way we deem appropriate.

Road Transport Notice. Shipments transported partly or solely by road be it explicit agreement to do so or not-in, to, from a country which is party to the Convention on the Contract for the International Carriage of Goods by Road (the 'CMR') are subject to the terms and conditions of the CMR, notwithstanding any other provisions of this Agreement to the contrary. For these shipments transported solely by road, if a conflict arises between the provisions of the CMR and this Air Waybill the terms of the CMR shall prevail.

Limitation of Liability, if not governed by the Warsaw Convention or the CMR as described above, our maximum liability for loss, damage or delay is limited by this Air Waybill to U.S. $100 per shipment or U.S. $9.07 per pound (U.S. $20.38 per kilo) (or equivalent local currency), whichever is greater, unless you declare a higher value for carriage as described below. FedEx does not provide cargo liability or all-risk insurance, but you may pay an additional charge to each additional U.S. $100 (or equivalent local currency) of described value for carriage. If a higher value for carriage is declared and the additional charge is paid, FedEx maximum liability will be the lesser of the declared value for carriage or your actual damages.

LIABILITIES NOT ASSUMED. IN ANY EVENT, WE WON'T BE LIABLE FOR ANY DAMAGES WHETHER DIRECT , INCIDENTAL, SPECIAL OR CONSEQUENTIAL , IN EXCESS OF THE DECLARED VALUE FOR CARRIAGE (INCLUDING BUT NOT LIMITED TO LOSS OF INCOME OR PROFITS) WHETHER OR NOT WE HAD ANY KNOWLEDGE THAT SUCH DAMAGES MIGHT BE INCURRED, UNLESS SUCH DAMAGES WERE CAUSED BY OUR OWN WILLFUL MICONDUCT OR GROSS NEGLIGENCE.

We won't be liable for your actions or omissions, including but not limited to incorrect declaration of cargo, improper or insufficient packing, securing, marking or addressing of the shipment, or for the acts or omissions of the recipient or anyone else with an interest in the shipment. Also we won't be liable if you (or) the recipient violate any of the terms of our agreement. We won't be liable for loss of or damage to shipments of cash, currency or other prohibited items. We won't be liable for loss, damages or delay caused by events we cannot control, including but not limited to acts of God, perils of the air, weather conditions mechanical delays, acts of public enemies, war, strikes, civil commotions, or acts or omissions of public authorities (including customs and health officials) with actual or apparent authority.

NO WARRANTIES. We make no warranties, express or implied.

CLAIM FOR LOSS, DAMAGE FOR DELAY. ALL CLAIMS MUST BE NOTIFIED TO US WITHIN 15 DAYS AFTER DELIVERY OF THE SHIPMENT FAILING WHICH NO ACTION FOR DAMAGES MAY BE BROUGHT. All claims for loss, non-delivery or mis-delivery must be received by us within 90 days after the shipment is accepted by us. The right to damages against us shall be extinguished unless an action is brought within two years from the date of delivery of the shipment or from date on which the shipment should have been delivered. Within 30 days after notification to us (of) the claim, it must be documented by sending us all relevant information about it. We are not obligated to act on any claim until all transportation charges have been paid; the claim amount may not be deducted from those charges. If the recipient accepts the shipment without noting any damage on the delivery record, we will assume the shipment was delivered in good condition. In order for us to consider a claim for damages, the content(s), original shipping cartons, and packing must be available to us for inspection.

RIGHT TO INSPECT. Your shipment may, at our option or at the request of governmental authorities, be opened and inspected by us or such authorities or us at any time.

CUSTOMS CLEARANCE. It is your responsibility to provide proper customs documentation and confirmation, where required.

EXPORT CONTROL. You authorize Federal Express to act as forwarding agent for you for export control and customs purposes. You hereby certify that all statements and information contained in this air waybill relating to exportation are true and correct. Furthermore, you understand that civil and criminal penalties, including forfeiture and sale, may be imposed for making false or fraudulent statements or for the violation of any United States laws on exportation, including but not limited to, 13 USC Sec. 305; 22 USC Sec 401; 18 USC Sec. 1001; 50 USC app. 2410.

MANDATORY LAW. Insofar as any provision contained or referred to in this air Waybill may be contrary to any applicable international treaty, law government regulations, orders or requirements such provision shall remain in effect as a part of our agreement to the extent that it is not overridden. The invalidity or unenforceability of any provision shall not affect any other part of this Air Waybill. Unless otherwise indicated the Sender's address indicated on the face of this Waybill is the place of execution and the place of departure, and Recipient's address listed on the face of this Waybill is the place of destination. Unless otherwise indicated Federal Express Corporation, P.O. Box 727, Memphis, TN 38194 USA is the first carrier of this shipment.

After printing this label:

CONSIGNEE COPY - PLEASE PLACE IN FRONT OF POUCH

1. Fold the printed page along the horizontal line.
2. Place label in shipping pouch and affix it to your shipment.

ORIGIN ID:YBYA (604) 253-4188
HARJIT GILL
ALS ENVIRONMENTAL LAB GROUP
LOUGHEED HIGHWAY

BURNABY, BC V5A1W9
CANADA CA

SHIP DATE: 16MAR17
ACTWGT: 10.00 LB MAN
CAD: 0347419/CAFE3011

BILL SENDER

TO **SAMPLE RECEVING**
ALS ENVIRONMANTAL
225 COMMERCE DRIVE

FORT COLLINS CO 80524 (US)
(970) 490-1511 REF: SUBLETS
DEPT: SUBLET

10.0

5.8°

540C3/1ADB/727F

FedEx Express

E

J161216181002uv

TRK# 7012 5069 2779
0430

10:30A
INTL PRIORITY

XH FTCA

80524
CO-US DEN

ALS -- Fort Collins

SAMPLE SUMMARY REPORT

Client: ALS Environmental
Project: L1901651
Sample ID: L1901651-3
Legal Location:
Collection Date: 3/14/2017

Date: *30-Mar-17*
Work Order: 1703321
Lab ID: 1703321-1
Matrix: WATER
Percent Moisture:

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Radium-226 by Radon Emanation - Method 903.1		**PAI 783**		Prep Date: **3/22/2017**		PrepBy: **RLM**
Ra-226	**0.070 (+/- 0.022)**		**0.0096**	**BQ/l**	NA	3/28/2017 13:54
Carr: BARIUM	*97*		*40-110*	*%REC*	DL = NA	3/28/2017 13:54

Client:	ALS Environmental	**Date:**	*30-Mar-17*
Project:	L1901651	**Work Order:**	1703321
Sample ID:	L1901651-3	**Lab ID:**	1703321-1
Legal Location:		**Matrix:**	WATER
Collection Date:	3/14/2017	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.
Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.
Y2 - Chemical Yield outside default limits.
W - DER is greater than Warning Limit of 1.42
* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.
# - Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.
G - Sample density differs by more than 15% of LCS density.
D - DER is greater than Control Limit
M - Requested MDC not met.
LT - Result is less than requested MDC but greater than achieved MDC.
M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.
L - LCS Recovery below lower control limit.
H - LCS Recovery above upper control limit.
P - LCS, Matrix Spike Recovery within control limits.
N - Matrix Spike Recovery outside control limits
NC - Not Calculated for duplicate results less than 5 times MDC
B - Analyte concentration greater than MDC.
B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).
U or ND - Indicates that the compound was analyzed for but not detected.
E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.
M - Duplicate injection precision was not met.
N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.
Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.
* - Duplicate analysis (relative percent difference) not within control limits.
S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.
B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.
E - Analyte concentration exceeds the upper level of the calibration range.
J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).
A - A tentatively identified compound is a suspected aldol-condensation product.
X - The analyte was diluted below an accurate quantitation level.
* - The spike recovery is equal to or outside the control criteria used.
\+ - The relative percent difference (RPD) equals or exceeds the control criteria.
G - A pattern resembling gasoline was detected in this sample.
D - A pattern resembling diesel was detected in this sample.
M - A pattern resembling motor oil was detected in this sample.
C - A pattern resembling crude oil was detected in this sample.
4 - A pattern resembling JP-4 was detected in this sample.
5 - A pattern resembling JP-5 was detected in this sample.
H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.
L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.
Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

ALS -- Fort Collins

Date: *3/30/2017 7:43:*

Client: ALS Environmental
Work Order: 1703321
Project: L1901651

QC BATCH REPORT

Batch ID: **RE170322-2-2** Instrument ID: **Alpha Scin** Method: **Radium-226 by Radon Emanation**

LCS Sample ID: **RE170322-2** Units: **BQ/l** Analysis Date: **3/28/2017 13:54**
Client ID: Run ID: **RE170322-2B** Prep Date: **3/22/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.68 (+/- 0.417)	0.00792	1.703		98.6	67-120					P
Carr: BARIUM	15700		16680		93.9	40-110					

LCSD Sample ID: **RE170322-2** Units: **BQ/l** Analysis Date: **3/28/2017 13:54**
Client ID: Run ID: **RE170322-2B** Prep Date: **3/22/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.88 (+/- 0.468)	0.00879	1.703		111	67-120		1.68	0.3	2.1	P
Carr: BARIUM	15700		16680		94	40-110		15700			

MB Sample ID: **RE170322-2** Units: **BQ/l** Analysis Date: **3/28/2017 13:54**
Client ID: Run ID: **RE170322-2B** Prep Date: **3/22/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	-0.0012 (+/- 0.0052)	0.011									U,M
Carr: BARIUM	16100		16680		96.7	40-110					

The following samples were analyzed in this batch: 1703321-1

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1901651-COFC

COC Number: 2017-03-15 A

Page of

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days)	4 day [P4] ☐	EMERGENCY	1 Business day [E1] ☐
	3 day [P3] ☐		Same Day, Weekend or Statutory holiday [E0] ☐
	2 day [P2] ☐		
Date and Time Required for all E&P TATs:			

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224162 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** SR/EB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)	Ra 226				Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W4	13-Mar-17	14:55	Water	R	R	R	R	R	R	R	R	R					7
2	W16	14-Mar-17	9:30	Water	R	R	R	R	R	R	R	R	R					7
3	W3	14-Mar-17	14:35	Water	R	R	R	R	R	R	R	R	R	R				8
4	W8A	14-Mar-17	16:15	Water	R	R	R	R	R	R	R	R	R					6
5	W17	14-Mar-17	17:50	Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time

○ *Rush Processing*

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1.0			4,4,4	3,3,6	5,7,7

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-03-15	Time: 11:00	Received by: VD -	Date: March 15/17	Time: 14:50	Received by: Rvc JC	Date: MAR 1 6 2017	Time: 14:35

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY   OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 22-MAR-17
Report Date: 31-MAR-17 15:07 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1904255
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-03-22 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1904255-1	L1904255-2	L1904255-3	L1904255-4
	Description	Water	Water	Water	Water
	Sampled Date	21-MAR-17	21-MAR-17	21-MAR-17	21-MAR-17
	Sampled Time	11:00	14:20	15:33	
	Client ID	W3	W17	STP-E	DUP
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	554	571	1260	544
	Hardness (as CaCO3) (mg/L)	245	261	187	254
	pH (pH)	8.30	8.36	8.11	8.28
	Total Suspended Solids (mg/L)	<3.0	<3.0	12.0	<3.0
	Total Dissolved Solids (mg/L)	316	370	719	356
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	226	228	115	231
	Alkalinity, Carbonate (as CaCO3) (mg/L)	2.4	7.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	229	235	115	231
	Ammonia, Total (as N) (mg/L)	0.0551	<0.0050	0.0072	0.0535
	Chloride (Cl) (mg/L)	5.01	6.73	241	5.02
	Nitrate and Nitrite (as N) (mg/L)	0.106	0.158	8.59	0.105
	Nitrate (as N) (mg/L)	0.106	0.158	8.59	0.105
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0050 DLDS	<0.0010
	Sulfate (SO4) (mg/L)	53.9	56.3	62.1	54.0
	Anion Sum (meq/L)	5.84	6.07	11.0	5.88
	Cation Sum (meq/L)	5.70	6.00	10.7	5.88
	Cation - Anion Balance (%)	-1.2	-0.5	-1.5	0.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.94	8.16	5.39	4.78
Total Metals	Aluminum (Al)-Total (mg/L)	0.0181	0.0184	0.803	0.0185
	Antimony (Sb)-Total (mg/L)	0.00011	<0.00010	0.00065	<0.00010
	Arsenic (As)-Total (mg/L)	0.00029	0.00032	0.00022	0.00025
	Barium (Ba)-Total (mg/L)	0.0786	0.0862	0.0164	0.0781
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	0.000200	<0.000050
	Boron (B)-Total (mg/L)	0.021	0.032	0.158	0.024
	Cadmium (Cd)-Total (mg/L)	0.0000191	0.0000117	0.0000624	0.0000200
	Calcium (Ca)-Total (mg/L)	56.8	70.1	54.2	52.7
	Chromium (Cr)-Total (mg/L)	<0.00010	<0.00010	0.00157	0.00010
	Cobalt (Co)-Total (mg/L)	0.00020	<0.00010	0.00053	0.00020
	Copper (Cu)-Total (mg/L)	0.00280	0.00751	0.0573	0.00299
	Iron (Fe)-Total (mg/L)	0.082	0.023	0.397	0.075
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000322	<0.000050
	Lithium (Li)-Total (mg/L)	0.0024	0.0013	0.0021	0.0026
	Magnesium (Mg)-Total (mg/L)	25.5	21.7	11.1	25.8
	Manganese (Mn)-Total (mg/L)	0.412	0.197	0.0438	0.420

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1904255-1	L1904255-2	L1904255-3	L1904255-4
	Description	Water	Water	Water	Water
	Sampled Date	21-MAR-17	21-MAR-17	21-MAR-17	21-MAR-17
	Sampled Time	11:00	14:20	15:33	
	Client ID	W3	W17	STP-E	DUP
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00410	0.00664	0.00301	0.00436
	Nickel (Ni)-Total (mg/L)	0.00122	0.00098	0.00527	0.00135
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	2.52	0.054
	Potassium (K)-Total (mg/L)	2.22	4.04	24.8	2.49
	Selenium (Se)-Total (mg/L)	0.000096	0.000362	0.000240	0.000094
	Silicon (Si)-Total (mg/L)	6.40	5.73	7.47	6.44
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000040	<0.000010
	Sodium (Na)-Total (mg/L)	16.5	15.2	140	18.1
	Strontium (Sr)-Total (mg/L)	0.718	0.842	0.345	0.663
	Sulfur (S)-Total (mg/L)	20.4	21.6	24.9	20.5
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	0.00035	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00066	0.00092	0.00384	0.00038
	Uranium (U)-Total (mg/L)	0.00224	0.00301	0.000215	0.00221
	Vanadium (V)-Total (mg/L)	0.00051	<0.00050	0.00115	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0211	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0029	0.0033	0.0200	0.0069
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00052	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00030	0.00015	0.00024
	Barium (Ba)-Dissolved (mg/L)	0.0720	0.0758	0.00423	0.0730
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.020	0.029	0.153	0.021
	Cadmium (Cd)-Dissolved (mg/L)	0.0000207	0.0000086	0.0000400	0.0000177
	Calcium (Ca)-Dissolved (mg/L)	54.6	67.6	55.5	57.3
	Chromium (Cr)-Dissolved (mg/L)	0.00012	<0.00010	0.00020	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00018	<0.00010	0.00047	0.00019
	Copper (Cu)-Dissolved (mg/L)	0.00274	0.00625	0.0174	0.00219
	Iron (Fe)-Dissolved (mg/L)	0.062	<0.010	0.030	0.068
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0023	0.0015	0.0023	0.0024
	Magnesium (Mg)-Dissolved (mg/L)	26.4	22.3	11.6	26.9
	Manganese (Mn)-Dissolved (mg/L)	0.422	0.0703	0.0369	0.438

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1904255-1	L1904255-2	L1904255-3	L1904255-4	
	Description	Water	Water	Water	Water	
	Sampled Date	21-MAR-17	21-MAR-17	21-MAR-17	21-MAR-17	
	Sampled Time	11:00	14:20	15:33		
	Client ID	W3	W17	STP-E	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00371	0.00594	0.00264	0.00357	
	Nickel (Ni)-Dissolved (mg/L)	0.00126	0.00079	0.00478	0.00117	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	1.85	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.00	3.87	24.1	2.02	
	Selenium (Se)-Dissolved (mg/L)	0.000108	0.000431	0.000139	0.000095	
	Silicon (Si)-Dissolved (mg/L)	6.27	5.60	7.04	6.32	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	16.7	15.9	146	16.8	
	Strontium (Sr)-Dissolved (mg/L)	0.729	0.827	0.333	0.717	
	Sulfur (S)-Dissolved (mg/L)	19.0	20.4	22.6	18.9	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	0.00012	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00203	0.00264	0.000048	0.00202	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00087	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.0082	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Boron (B)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Iron (Fe)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Potassium (K)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1904255-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1904255-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Reference Information

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

2017-03-22 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1904255-COFC

COC Number: 2017-03-22 A

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

.m all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: Ariel Mcdonnell	**Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	21-Mar-17	11:00	Water	R	R	R	R	R	R	R	R	R					7
	W17	21-Mar-17	14:20	Water	R	R	R	R	R	R	R	R	R					7
	STP-E	20-Mar-17	15:33	Water	R	R	R	R	R	R	R	R	R					7
	DUP	21-Mar-17		water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

Some samples Frozen.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 2

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shelby Black	22-Mar-17	Time:	Received by: V.D.	Date: Mar 22/17	Time: 1505	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 29-MAR-17
Report Date: 07-APR-17 16:49 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1906733
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-03-29 A
Legal Site Desc:

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

	Sample ID	L1906733-1	L1906733-2	L1906733-3	L1906733-4
	Description	WATER	WATER	WATER	WATER
	Sampled Date	28-MAR-17	28-MAR-17	28-MAR-17	28-MAR-17
	Sampled Time	10:05	10:05	10:45	11:00
	Client ID	W3	T-BL	W17	W8A
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	540	<2.0	536	1680
	Hardness (as CaCO3) (mg/L)	238	<0.50 HTC	250	911
	pH (pH)	8.09	5.76	8.33	7.83
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	41.5
	Total Dissolved Solids (mg/L)	342	<10	361	1150
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	227	<1.0	229	866
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	5.8	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	227	<1.0	234	866
	Ammonia, Total (as N) (mg/L)	0.0508	<0.0050	<0.0050	0.408
	Chloride (Cl) (mg/L)	5.17	<0.50	6.90	19.6
	Nitrate and Nitrite (as N) (mg/L)	0.131	<0.0051	0.146	0.481
	Nitrate (as N) (mg/L)	0.131	<0.0050	0.146	0.465
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	0.0157
	Sulfate (SO4) (mg/L)	54.7	<0.30	57.6	191
	Anion Sum (meq/L)	5.84	<0.10	6.09	21.9
	Cation Sum (meq/L)	5.61	<0.10	5.80	21.7
	Cation - Anion Balance (%)	-1.9	0.0	-2.4	-0.4
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.75		8.27	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0121	<0.0030	0.0079	0.326
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00010	0.00055
	Arsenic (As)-Total (mg/L)	0.00024	<0.00010	0.00035	0.00149
	Barium (Ba)-Total (mg/L)	0.0781	<0.000050	0.0855	0.340
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000047
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.021	<0.010	0.031	0.039
	Cadmium (Cd)-Total (mg/L)	0.0000191	<0.0000050	0.0000114	0.000217
	Calcium (Ca)-Total (mg/L)	55.4	<0.050	68.6	244
	Chromium (Cr)-Total (mg/L)	<0.00010	<0.00010	0.00010	0.00194
	Cobalt (Co)-Total (mg/L)	0.00017	<0.00010	<0.00010	0.00564
	Copper (Cu)-Total (mg/L)	0.00293	<0.00050	0.00691	0.283
	Iron (Fe)-Total (mg/L)	0.082	<0.010	<0.010	9.54
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	0.000318
	Lithium (Li)-Total (mg/L)	0.0029	<0.0010	0.0017	0.0048
	Magnesium (Mg)-Total (mg/L)	26.8	<0.10	22.6	75.6
	Manganese (Mn)-Total (mg/L)	0.426	<0.00010	0.0818	10.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1906733-1	L1906733-2	L1906733-3	L1906733-4
	Description	WATER	WATER	WATER	WATER
	Sampled Date	28-MAR-17	28-MAR-17	28-MAR-17	28-MAR-17
	Sampled Time	10:05	10:05	10:45	11:00
	Client ID	W3	T-BL	W17	W8A
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000067
	Molybdenum (Mo)-Total (mg/L)	0.00380	<0.000050	0.00646	0.0159
	Nickel (Ni)-Total (mg/L)	0.00127	<0.00050	0.00084	0.00253
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.196
	Potassium (K)-Total (mg/L)	2.08	<0.10	4.02	9.03
	Selenium (Se)-Total (mg/L)	0.000158	<0.000050	0.000398	0.00152
	Silicon (Si)-Total (mg/L)	6.32	<0.050	5.60	11.1
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000104
	Sodium (Na)-Total (mg/L)	17.2	<0.050	16.9	54.0
	Strontium (Sr)-Total (mg/L)	0.695	<0.00020	0.815	3.57
	Sulfur (S)-Total (mg/L)	18.7	<0.50	19.8	71.3
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00044	<0.00030	0.00038	0.0208
	Uranium (U)-Total (mg/L)	0.00220	<0.000010	0.00293	0.00448
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050	0.00936
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.567
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00143
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD		FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD		FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0029		0.0023	0.0180
	Antimony (Sb)-Dissolved (mg/L)	<0.00010		<0.00010	DLA <0.00020
	Arsenic (As)-Dissolved (mg/L)	0.00024		0.00032	0.00145
	Barium (Ba)-Dissolved (mg/L)	0.0727		0.0743	0.286
	Beryllium (Be)-Dissolved (mg/L)	<0.000020		<0.000020	DLA <0.000040
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050		<0.000050	DLA <0.00010
	Boron (B)-Dissolved (mg/L)	0.019		0.028	0.038
	Cadmium (Cd)-Dissolved (mg/L)	0.0000209		0.0000074	0.000110
	Calcium (Ca)-Dissolved (mg/L)	52.6		64.7	234
	Chromium (Cr)-Dissolved (mg/L)	<0.00010		<0.00010	0.00141
	Cobalt (Co)-Dissolved (mg/L)	0.00018		<0.00010	0.00572
	Copper (Cu)-Dissolved (mg/L)	0.00184		0.00620	0.0457
	Iron (Fe)-Dissolved (mg/L)	0.061		<0.010	7.00
	Lead (Pb)-Dissolved (mg/L)	<0.000050		<0.000050	DLA <0.00010
	Lithium (Li)-Dissolved (mg/L)	0.0025		0.0014	0.0043
	Magnesium (Mg)-Dissolved (mg/L)	26.0		21.5	79.3
	Manganese (Mn)-Dissolved (mg/L)	0.400		0.0542	10.8

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1906733-1	L1906733-2	L1906733-3	L1906733-4	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	28-MAR-17	28-MAR-17	28-MAR-17	28-MAR-17	
	Sampled Time	10:05	10:05	10:45	11:00	
	Client ID	W3	T-BL	W17	W8A	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050		<0.0000050	0.0000058	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00338		0.00559	0.0142	
	Nickel (Ni)-Dissolved (mg/L)	0.00122		0.00078	0.0023	
	Phosphorus (P)-Dissolved (mg/L)	<0.050		<0.050	DLA <0.10	
	Potassium (K)-Dissolved (mg/L)	2.11		3.83	9.16	
	Selenium (Se)-Dissolved (mg/L)	<0.000050		0.000344	0.00148	
	Silicon (Si)-Dissolved (mg/L)	6.26		5.34	10.9	
	Silver (Ag)-Dissolved (mg/L)	<0.000010		<0.000010	DLA <0.000020	
	Sodium (Na)-Dissolved (mg/L)	17.9		16.0	56.0	
	Strontium (Sr)-Dissolved (mg/L)	0.688		0.784	3.59	
	Sulfur (S)-Dissolved (mg/L)	18.6		19.1	70.6	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010		<0.000010	DLA <0.000020	
	Tin (Sn)-Dissolved (mg/L)	<0.00010		<0.00010	DLA <0.00020	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030		<0.00030	0.00140	
	Uranium (U)-Dissolved (mg/L)	0.00200		0.00253	0.00430	
	Vanadium (V)-Dissolved (mg/L)	<0.00050		<0.00050	0.0070	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010		<0.0010	0.181	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030		<0.00030	0.00163	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1906733-1, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1906733-1, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1906733-1, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1906733-1, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1906733-1, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1906733-1, -3, -4
Matrix Spike	Cadmium (Cd)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Copper (Cu)-Total	MS-B	L1906733-2
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Sulfur (S)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Zinc (Zn)-Total	MS-B	L1906733-1, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L1906733-1, -2, -3, -4
Matrix Spike	Sulfate (SO4)	MS-B	L1906733-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Reference Information

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

Reference Information

Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-03-29 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1906733-COFC

COC Number: 2017-03-29 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution	
Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	minto_environment@mintomine.com
Email 2	
Email 3	
Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	ap@mintomine.com
Email 2	

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)	4 day [P4]	☐	EMERGENCY	1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: [illegible]

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Mcdonnell

Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	28-Mar-17	10:05	Water	R	R	R	R	R	R	R	R	R					7
	T-BL	28-Mar-17	10:05	Water	R	R	R	R		R		R						5
	W17	28-Mar-17	10:45	Water	R	R	R	R	R	R	R	R	R					7
	W8A	28-Mar-17	11:00	Water	R	R	R	R	R	R	R	R						6

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐		SIF Observations	Yes ☐	No ☐
Ice Packs	☑	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☑				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0			9.10		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-03-29 9:00	Time:	Received by: EHF	Date: 29 Mar 2017	Time: 15:24	Received by: JM	Date: 03/30/17	Time: 16:05

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2016 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 05-APR-17
Report Date: 13-APR-17 19:43 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1909606
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-04-05 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1909606-1	L1909606-2	L1909606-3	L1909606-4	L1909606-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	04-APR-17	04-APR-17	04-APR-17	04-APR-17	04-APR-17
	Sampled Time	09:45	10:00	10:25	04:30	04:30
	Client ID	W3	W17	W8A	T-BL	W12
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	526	558	1730	<2.0	2440
	Hardness (as CaCO3) (mg/L)	247	264	954		1090
	pH (pH)	8.03	8.27	7.53	5.61	8.03
	Total Suspended Solids (mg/L)	<3.0	<3.0	35.4	<3.0	4.7
	Total Dissolved Solids (mg/L)	314	350	1250	<10	1980
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	230	238	907	<1.0	167
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	230	238	907	<1.0	167
	Ammonia, Total (as N) (mg/L)	0.0579	<0.0050	0.477		6.66
	Chloride (Cl) (mg/L)	5.23	6.96	20.1	<0.50	36
	Nitrate and Nitrite (as N) (mg/L)	0.126	0.132	0.917	<0.0051	27.8
	Nitrate (as N) (mg/L)	0.125	0.132	0.852	HTD <0.0050	25.8
	Nitrite (as N) (mg/L)	0.0016	<0.0010	0.066	HTD <0.0010	2.04
	Sulfate (SO4) (mg/L)	56.3	58.7	172	<0.30	1160
	Anion Sum (meq/L)	5.91	6.19	22.3	<0.10	30.5
	Cation Sum (meq/L)	5.79	6.04	22.1	<0.10	28.7
	Cation - Anion Balance (%)	-1.1	-1.2	-0.4	0.0	-3.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.35	8.51			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0084	0.0074	0.311	<0.0030	0.0949
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00047	<0.00010	0.00030
	Arsenic (As)-Total (mg/L)	0.00027	0.00033	0.00158	<0.00010	0.00045
	Barium (Ba)-Total (mg/L)	0.0765	0.0796	0.321	<0.000050	0.111
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000047	<0.000020	DLA <0.000040
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	DLA <0.00010
	Boron (B)-Total (mg/L)	0.021	0.032	0.042	<0.010	0.257
	Cadmium (Cd)-Total (mg/L)	0.0000196	0.0000077	0.000316	<0.0000050	0.000086
	Calcium (Ca)-Total (mg/L)	56.0	69.0	264	<0.050	356
	Chromium (Cr)-Total (mg/L)	0.00044	0.00012	0.00215	<0.00010	DLA <0.00020
	Cobalt (Co)-Total (mg/L)	0.00022	<0.00010	0.00480	<0.00010	0.00097
	Copper (Cu)-Total (mg/L)	0.00192	0.00712	0.331	<0.00050	0.0778
	Iron (Fe)-Total (mg/L)	0.072	<0.010	7.82	<0.010	0.214
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000379	<0.000050	0.00061
	Lithium (Li)-Total (mg/L)	0.0031	0.0019	0.0053	<0.0010	0.0140
	Magnesium (Mg)-Total (mg/L)	28.3	23.6	86.4	<0.10	46.0
	Manganese (Mn)-Total (mg/L)	0.433	0.0782	10.2	<0.00010	0.714

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1909606-6	L1909606-7	L1909606-8		
	Description	WATER	WATER	WATER		
	Sampled Date	04-APR-17	04-APR-17	04-APR-17		
	Sampled Time	04:30	11:25	02:15		
	Client ID	W14	W62	MC1		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	2700	998	567		
	Hardness (as CaCO3) (mg/L)	1060	532	277		
	pH (pH)	8.19	8.22	8.22		
	Total Suspended Solids (mg/L)		<3.0	5.1		
	Total Dissolved Solids (mg/L)	2200	730	409		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	74.2	365	269		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	74.2	365	269		
	Ammonia, Total (as N) (mg/L)	4.25	<0.0050	0.0102		
	Chloride (Cl) (mg/L)	40	28.1	5.16		
	Nitrate and Nitrite (as N) (mg/L)	37.3	4.18	0.0109		
	Nitrate (as N) (mg/L)	35.1	4.17	0.0109		
	Nitrite (as N) (mg/L)	2.18	0.0085	<0.0010		
	Sulfate (SO4) (mg/L)	1310	191	65.3		
	Anion Sum (meq/L)	32.6	12.4	6.87		
	Cation Sum (meq/L)	30.4	11.9	6.63		
	Cation - Anion Balance (%)	-3.5	-1.8	-1.8		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)			20.2		
Total Metals	Aluminum (Al)-Total (mg/L)		0.0054	0.0195		
	Antimony (Sb)-Total (mg/L)		<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)		0.00034	0.00073		
	Barium (Ba)-Total (mg/L)		0.123	0.0909		
	Beryllium (Be)-Total (mg/L)		<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)		<0.000050	<0.000050		
	Boron (B)-Total (mg/L)		0.033	<0.010		
	Cadmium (Cd)-Total (mg/L)		0.0000150	0.0000197		
	Calcium (Ca)-Total (mg/L)		150	64.6		
	Chromium (Cr)-Total (mg/L)		0.00017	0.00040		
	Cobalt (Co)-Total (mg/L)		0.00013	<0.00010		
	Copper (Cu)-Total (mg/L)		0.0479	0.00859		
	Iron (Fe)-Total (mg/L)		0.045	0.037		
	Lead (Pb)-Total (mg/L)		<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)		0.0031	0.0037		
	Magnesium (Mg)-Total (mg/L)		41.3	30.3		
	Manganese (Mn)-Total (mg/L)		0.0433	0.0141		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1909606-1	L1909606-2	L1909606-3	L1909606-4	L1909606-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	04-APR-17	04-APR-17	04-APR-17	04-APR-17	04-APR-17
	Sampled Time	09:45	10:00	10:25	04:30	04:30
	Client ID	W3	W17	W8A	T-BL	W12
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000112	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00385	0.00657	0.0121	<0.000050	0.0819
	Nickel (Ni)-Total (mg/L)	0.00181	0.00083	0.00278	<0.00050	0.0042
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.171	<0.050	<0.10 DLA
	Potassium (K)-Total (mg/L)	2.14	3.95	9.28	<0.10	46.7
	Selenium (Se)-Total (mg/L)	0.000130	0.000415	0.00150	<0.000050	0.0128
	Silicon (Si)-Total (mg/L)	6.55	5.81	11.7	<0.050	3.36
	Silver (Ag)-Total (mg/L)	<0.000010	0.000259	0.000201	<0.000010	0.000041
	Sodium (Na)-Total (mg/L)	18.4	17.4	61.6	<0.050	134
	Strontium (Sr)-Total (mg/L)	0.739	0.864	4.06	<0.00020	7.86
	Sulfur (S)-Total (mg/L)	20.3	21.3	65.3	<0.50	412
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000020 DLA
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020 DLA
	Titanium (Ti)-Total (mg/L)	<0.00060 DLM	0.00035	0.0167	<0.00030	0.00408
	Uranium (U)-Total (mg/L)	0.00210	0.00282	0.00476	<0.000010	0.00527
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	0.00846	<0.00050	<0.0010 DLA
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.437	<0.0030	0.0084
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00162	<0.00030	<0.00060 DLA
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0027	0.0023	0.0127		0.0057
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00018		0.00028
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00033	0.00119		0.00039
	Barium (Ba)-Dissolved (mg/L)	0.0762	0.0763	0.279		0.110
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	0.000022		<0.000040 DLA
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		<0.00010 DLA
	Boron (B)-Dissolved (mg/L)	0.018	0.026	0.034		0.214
	Cadmium (Cd)-Dissolved (mg/L)	0.0000211	0.0000068	0.000168		0.000077
	Calcium (Ca)-Dissolved (mg/L)	52.3	68.0	247		362
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00113		<0.00020 DLA
	Cobalt (Co)-Dissolved (mg/L)	0.00018	<0.00010	0.00408		0.00091
	Copper (Cu)-Dissolved (mg/L)	0.00233	0.00583	0.0396		0.0256
	Iron (Fe)-Dissolved (mg/L)	0.058	<0.010	2.43		0.047
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		0.00021
	Lithium (Li)-Dissolved (mg/L)	0.0023	0.0018	0.0046		0.0124
	Magnesium (Mg)-Dissolved (mg/L)	28.1	22.8	82.0		44.1
	Manganese (Mn)-Dissolved (mg/L)	0.423	0.0438	9.04		0.705

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1909606-6	L1909606-7	L1909606-8		
	Description	WATER	WATER	WATER		
	Sampled Date	04-APR-17	04-APR-17	04-APR-17		
	Sampled Time	04:30	11:25	02:15		
	Client ID	W14	W62	MC1		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)		<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)		0.00801	0.00115		
	Nickel (Ni)-Total (mg/L)		0.00113	0.00092		
	Phosphorus (P)-Total (mg/L)		<0.050	0.121		
	Potassium (K)-Total (mg/L)		6.03	7.64		
	Selenium (Se)-Total (mg/L)		0.00171	0.000694		
	Silicon (Si)-Total (mg/L)		8.10	12.2		
	Silver (Ag)-Total (mg/L)		0.000032	0.000018		
	Sodium (Na)-Total (mg/L)		28.9	23.5		
	Strontium (Sr)-Total (mg/L)		1.73	0.619		
	Sulfur (S)-Total (mg/L)		71.1	23.8		
	Thallium (Tl)-Total (mg/L)		<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)		<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)		<0.00030	DLM <0.00060		
	Uranium (U)-Total (mg/L)		0.00482	0.00258		
	Vanadium (V)-Total (mg/L)		0.00052	<0.00050		
	Zinc (Zn)-Total (mg/L)		0.136	<0.0030		
	Zirconium (Zr)-Total (mg/L)		<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0229	0.0049	0.0127		
	Antimony (Sb)-Dissolved (mg/L)	0.00025	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00033	0.00035	0.00073		
	Barium (Ba)-Dissolved (mg/L)	0.216	0.122	0.0886		
	Beryllium (Be)-Dissolved (mg/L)	DLA <0.000040	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	DLA <0.00010	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.148	0.024	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	DLM <0.000050	0.0000174	0.0000162		
	Calcium (Ca)-Dissolved (mg/L)	363	147	63.8		
	Chromium (Cr)-Dissolved (mg/L)	DLA <0.00020	0.00018	0.00033		
	Cobalt (Co)-Dissolved (mg/L)	0.00086	0.00012	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00468	0.0519	0.00704		
	Iron (Fe)-Dissolved (mg/L)	DLA <0.020	0.031	0.029		
	Lead (Pb)-Dissolved (mg/L)	DLA <0.00010	0.000064	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0226	0.0023	0.0032		
	Magnesium (Mg)-Dissolved (mg/L)	38.0	39.8	28.6		
	Manganese (Mn)-Dissolved (mg/L)	0.603	0.0406	0.0126		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1909606-1	L1909606-2	L1909606-3	L1909606-4	L1909606-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	04-APR-17	04-APR-17	04-APR-17	04-APR-17	04-APR-17
	Sampled Time	09:45	10:00	10:25	04:30	04:30
	Client ID	W3	W17	W8A	T-BL	W12
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000051		<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00340	0.00629	0.0113		0.0801
	Nickel (Ni)-Dissolved (mg/L)	0.00125	0.00075	0.00231		0.0034
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	0.074		DLA <0.10
	Potassium (K)-Dissolved (mg/L)	2.15	3.76	8.63		44.9
	Selenium (Se)-Dissolved (mg/L)	0.000095	0.000478	0.00175		0.0132
	Silicon (Si)-Dissolved (mg/L)	6.29	5.55	11.2		3.15
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000018		DLA <0.000020
	Sodium (Na)-Dissolved (mg/L)	18.1	15.4	54.2		122
	Strontium (Sr)-Dissolved (mg/L)	0.688	0.808	3.79		7.57
	Sulfur (S)-Dissolved (mg/L)	19.6	20.1	61.4		431
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		DLA <0.000020
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		DLA <0.00020
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00108		DLA <0.00060
	Uranium (U)-Dissolved (mg/L)	0.00201	0.00272	0.00452		0.00526
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00365		DLA <0.0010
	Zinc (Zn)-Dissolved (mg/L)	0.0014	<0.0010	0.182		0.0052
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00165		DLA <0.00060

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1909606-6	L1909606-7	L1909606-8		
	Description	WATER	WATER	WATER		
	Sampled Date	04-APR-17	04-APR-17	04-APR-17		
	Sampled Time	04:30	11:25	02:15		
	Client ID	W14	W62	MC1		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.000050 DLM	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.119	0.00747	0.00103		
	Nickel (Ni)-Dissolved (mg/L)	0.0019	0.00124	0.00088		
	Phosphorus (P)-Dissolved (mg/L)	<0.10 DLA	<0.050	0.081		
	Potassium (K)-Dissolved (mg/L)	59.7	5.95	7.30		
	Selenium (Se)-Dissolved (mg/L)	0.0207	0.00209 DTC	0.000715		
	Silicon (Si)-Dissolved (mg/L)	2.23	7.78	12.2		
	Silver (Ag)-Dissolved (mg/L)	<0.000020 DLA	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	169	25.8	20.9		
	Strontium (Sr)-Dissolved (mg/L)	12.2	1.64	0.579		
	Sulfur (S)-Dissolved (mg/L)	495	68.2	22.7		
	Thallium (Tl)-Dissolved (mg/L)	<0.000020 DLA	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00020 DLA	0.00033 DTC	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLA	<0.00030	0.00045		
	Uranium (U)-Dissolved (mg/L)	0.00821	0.00469	0.00245		
	Vanadium (V)-Dissolved (mg/L)	<0.0010 DLA	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	<0.0020 DLA	0.139	0.0014		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00060 DLA	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1909606-1, -2, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1909606-1, -2, -8
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8
Matrix Spike	Ammonia, Total (as N)	MS-B	L1909606-1, -2, -3, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Reference Information

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-04-05 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1909606-COFC

COC Number: 2017-04-05 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To		
	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / D

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Mcdonnell **Sampler:** CH

Short Holding Time
Rush Processing

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W3	4-Apr-17	9:45	Water	R	R	R	R	R	R	R	R	R					7
2	W17	4-Apr-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
3	W8A	4-Apr-17	10:25	Water	R	R	R	R	R	R	R	R						6
4	T-BL	4-Apr-17	16:30	Water	R	R	R		R		R							4
5	W12	4-Apr-17	16:30	Water	R	R	R	R	R	R	R	R						6
6	W14	4-Apr-17	16:30	Water	R		R		R		R	R						4
7	W62	4-Apr-17	11:25	Water	R	R	R	R	R	R	R	R						6
8	MC1	4-Apr-17	14:15	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0					

SHIPMENT RELEASE (client use)

Released by: Chris Harry Date: 2017-04-05 7:15 Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF Date: 5 Apr 2017 Time: 15:30

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 12-APR-17
Report Date: 24-APR-17 17:04 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1912879
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-04-12 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1912879-1	L1912879-2	L1912879-3	L1912879-4	L1912879-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	10-APR-17	10-APR-17	11-APR-17	11-APR-17	11-APR-17
	Sampled Time	15:55	16:25	08:30	08:45	09:00
	Client ID	W10	W15	W2	W3	W8A
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1250	1040	381	537	1600
	Hardness (as CaCO3) (mg/L)	692	503	179	265	913
	pH (pH)	6.95	8.11	8.25	8.25	7.84
	Total Suspended Solids (mg/L)	143	291	<3.0	<3.0	67.3
	Total Dissolved Solids (mg/L)	967	771	273	343	1180
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	809	182	173	240	842
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	809	182	173	240	842
	Ammonia, Total (as N) (mg/L)	3.25	0.0715	0.0074	0.0178	0.356
	Chloride (Cl) (mg/L)	<2.5 DLDS	17.5	3.16	5.32	17.7
	Nitrate and Nitrite (as N) (mg/L)	<0.025	41.6	<0.0051	0.258	1.33
	Nitrate (as N) (mg/L)	<0.025 DLDS	41.4	<0.0050	0.256	1.22
	Nitrite (as N) (mg/L)	0.0170	0.229	<0.0010	0.0019	0.109
	Sulfate (SO4) (mg/L)	<3.9	237	36.3	60.5	182
	Anion Sum (meq/L)	16.2	12.0	4.30	6.23	21.2
	Cation Sum (meq/L)	19.5	11.3	4.22	6.09	21.1
	Cation - Anion Balance (%)	9.2	-3.2	-0.9	-1.1	-0.3
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		16.0	19.6	5.95	
Total Metals	Aluminum (Al)-Total (mg/L)	0.173	11.9	0.0350	0.0261	0.955
	Antimony (Sb)-Total (mg/L)	0.00027	0.00018	<0.00010	<0.00010	0.00115
	Arsenic (As)-Total (mg/L)	0.00252	0.00208	0.00053	0.00026	0.00144
	Barium (Ba)-Total (mg/L)	0.923	0.202	0.0594	0.0739	0.284
	Beryllium (Be)-Total (mg/L)	0.000030	0.000337	<0.000020	<0.000020	0.000058
	Bismuth (Bi)-Total (mg/L)	<0.000050	0.000058	<0.000050	<0.000050	0.000106
	Boron (B)-Total (mg/L)	<0.010	0.027	<0.010	0.027	0.039
	Cadmium (Cd)-Total (mg/L)	0.0000059	0.000101	0.0000164	0.0000169	0.000288
	Calcium (Ca)-Total (mg/L)	222	139	42.6	60.1	245
	Chromium (Cr)-Total (mg/L)	0.00277	0.00373	0.00033	0.00016	0.00352
	Cobalt (Co)-Total (mg/L)	0.00878	0.00367	<0.00010	<0.00010	0.00351
	Copper (Cu)-Total (mg/L)	0.00990	0.516	0.00933	0.00779	0.671
	Iron (Fe)-Total (mg/L)	83.4	12.2	0.057	0.052	7.40
	Lead (Pb)-Total (mg/L)	0.000056	0.00319	<0.000050	<0.000050	0.000718
	Lithium (Li)-Total (mg/L)	<0.0010	0.0081	0.0025	0.0033	0.0055
	Magnesium (Mg)-Total (mg/L)	48.0	50.2	20.9	31.2	82.4
	Manganese (Mn)-Total (mg/L)	4.33	0.359	0.0196	0.136	8.35

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1912879-6	L1912879-7	L1912879-8	L1912879-9	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	11-APR-17	11-APR-17	11-APR-17	11-APR-17	
	Sampled Time	09:20	16:05	10:00		
	Client ID	W35	MC1	W17	DUP	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	452	411	543	416	
	Hardness (as CaCO3) (mg/L)	196	197	270	196	
	pH (pH)	7.78	8.38	8.47	8.38	
	Total Suspended Solids (mg/L)	4.0	<3.0	<3.0	<3.0	
	Total Dissolved Solids (mg/L)	364	282	348	276	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	88.8	187	225	183	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	6.6	14.6	6.2	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	88.8	193	240	190	
	Ammonia, Total (as N) (mg/L)	0.0980	<0.0050	<0.0050	<0.0050	
	Chloride (Cl) (mg/L)	5.00	3.37	7.17	3.38	
	Nitrate and Nitrite (as N) (mg/L)	25.2	<0.0051	0.131	<0.0051	
	Nitrate (as N) (mg/L)	25.1 HTD	<0.0050	0.131	<0.0050	
	Nitrite (as N) (mg/L)	0.0851	<0.0010	<0.0010	<0.0010	
	Sulfate (SO4) (mg/L)	34.7	39.7	59.9	39.5	
	Anion Sum (meq/L)	4.43	4.78	6.25	4.70	
	Cation Sum (meq/L)	4.42	4.62	6.14	4.59	
	Cation - Anion Balance (%)	-0.2	-1.8	-0.9	-1.2	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	24.2	19.0	8.75	18.9	
Total Metals	Aluminum (Al)-Total (mg/L)	0.472	0.0251	0.0174	0.0282	
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00077	0.00050	0.00035	0.00051	
	Barium (Ba)-Total (mg/L)	0.102	0.0649	0.0793	0.0660	
	Beryllium (Be)-Total (mg/L)	0.000025	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.030	<0.010	
	Cadmium (Cd)-Total (mg/L)	0.0000482	0.0000237	0.0000080	0.0000269	
	Calcium (Ca)-Total (mg/L)	49.4	45.1	71.4	45.3	
	Chromium (Cr)-Total (mg/L)	0.00045	0.00023	0.00013	0.00024	
	Cobalt (Co)-Total (mg/L)	0.00048	<0.00010	<0.00010	<0.00010	
	Copper (Cu)-Total (mg/L)	0.0886	0.0146	0.00889	0.0114	
	Iron (Fe)-Total (mg/L)	0.630	0.052	0.026	0.051	
	Lead (Pb)-Total (mg/L)	0.000234	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Total (mg/L)	0.0011	0.0023	0.0015	0.0020	
	Magnesium (Mg)-Total (mg/L)	19.8	22.2	22.7	22.3	
	Manganese (Mn)-Total (mg/L)	0.202	0.0162	0.126	0.0163	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1912879-1	L1912879-2	L1912879-3	L1912879-4	L1912879-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	10-APR-17	10-APR-17	11-APR-17	11-APR-17	11-APR-17
	Sampled Time	15:55	16:25	08:30	08:45	09:00
	Client ID	W10	W15	W2	W3	W8A
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.000050 DLM	<0.0000050	<0.0000050	0.0000121
	Molybdenum (Mo)-Total (mg/L)	0.000191	0.0138	0.00114	0.00467	0.00658
	Nickel (Ni)-Total (mg/L)	0.00625	0.00260	0.00082	0.00093	0.00367
	Phosphorus (P)-Total (mg/L)	0.377	0.182	0.060	<0.050	0.204
	Potassium (K)-Total (mg/L)	2.62	9.83	3.95	2.53	8.95
	Selenium (Se)-Total (mg/L)	0.000544	0.0129	0.000290	0.000289	0.00137
	Silicon (Si)-Total (mg/L)	18.1	31.4	7.15	6.45	12.7
	Silver (Ag)-Total (mg/L)	0.000013	0.000197	<0.000010	<0.000010	0.000322
	Sodium (Na)-Total (mg/L)	26.6	25.8	13.3	17.8	53.8
	Strontium (Sr)-Total (mg/L)	1.40	2.33	0.425	0.806	3.67
	Sulfur (S)-Total (mg/L)	1.17	76.1	12.1	20.4	61.7
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000069	<0.000010	<0.000010	0.000017
	Tin (Sn)-Total (mg/L)	<0.00010	0.00047	<0.00010	<0.00010	0.00041
	Titanium (Ti)-Total (mg/L)	0.0128	0.842	0.00096	<0.0012 DLM	0.0582
	Uranium (U)-Total (mg/L)	0.000164	0.00442	0.00154	0.00290	0.00464
	Vanadium (V)-Total (mg/L)	0.00312	0.0343	<0.00050	<0.00050	0.00943
	Zinc (Zn)-Total (mg/L)	0.0035	0.0432	<0.0030	<0.0030	0.529
	Zirconium (Zr)-Total (mg/L)	0.00204	0.00268	<0.00030	<0.00030	0.00135
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.107	0.0106	0.0108	0.0078	0.0133
	Antimony (Sb)-Dissolved (mg/L)	0.00021	<0.00010	<0.00010	<0.00010	0.00014
	Arsenic (As)-Dissolved (mg/L)	0.00268	0.00036	0.00052	0.00023	0.00096
	Barium (Ba)-Dissolved (mg/L)	0.879	0.0781	0.0578	0.0711	0.233
	Beryllium (Be)-Dissolved (mg/L)	0.000024	<0.000020	<0.000020	<0.000020	0.000022
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.023	<0.010	0.024	0.036
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000239	0.0000172	0.0000085	0.000175
	Calcium (Ca)-Dissolved (mg/L)	203	128	39.7	56.3	236
	Chromium (Cr)-Dissolved (mg/L)	0.00241	<0.00010	0.00017	<0.00010	0.00104
	Cobalt (Co)-Dissolved (mg/L)	0.00809	0.00016	<0.00010	<0.00010	0.00279
	Copper (Cu)-Dissolved (mg/L)	0.00080	0.0368	0.00806	0.00450	0.0546
	Iron (Fe)-Dissolved (mg/L)	76.5	0.010	0.028	0.024	0.725
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0042	0.0021	0.0031	0.0049
	Magnesium (Mg)-Dissolved (mg/L)	45.0	44.9	19.5	30.2	78.8
	Manganese (Mn)-Dissolved (mg/L)	4.15	0.0840	0.0178	0.122	7.96

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1912879-6	L1912879-7	L1912879-8	L1912879-9
	Description	WATER	WATER	WATER	WATER
	Sampled Date	11-APR-17	11-APR-17	11-APR-17	11-APR-17
	Sampled Time	09:20	16:05	10:00	
	Client ID	W35	MC1	W17	DUP
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000081	0.0000059	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00203	0.00127	0.00647	0.00132
	Nickel (Ni)-Total (mg/L)	0.00129	0.00074	0.00092	0.00074
	Phosphorus (P)-Total (mg/L)	0.086	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	7.46	3.89	3.71	3.91
	Selenium (Se)-Total (mg/L)	0.000522	0.000334	0.000397	0.000346
	Silicon (Si)-Total (mg/L)	4.47	7.63	5.39	7.56
	Silver (Ag)-Total (mg/L)	0.000035	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	7.28	13.6	15.1	13.6
	Strontium (Sr)-Total (mg/L)	0.657	0.477	0.842	0.482
	Sulfur (S)-Total (mg/L)	11.5	13.0	19.5	12.8
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0255	DLM <0.00090	DLM <0.00090	DLM <0.0015
	Uranium (U)-Total (mg/L)	0.000421	0.00168	0.00283	0.00164
	Vanadium (V)-Total (mg/L)	0.00185	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	0.0044	<0.0030	<0.0030	0.0034
	Zirconium (Zr)-Total (mg/L)	0.00031	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0291	0.0103	0.0030	0.0099
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00056	0.00050	0.00034	0.00049
	Barium (Ba)-Dissolved (mg/L)	0.0970	0.0641	0.0750	0.0649
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.029	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000288	0.0000221	<0.0000050	0.0000204
	Calcium (Ca)-Dissolved (mg/L)	47.3	43.0	71.5	43.4
	Chromium (Cr)-Dissolved (mg/L)	0.00018	0.00018	<0.00010	0.00018
	Cobalt (Co)-Dissolved (mg/L)	0.00029	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0570	0.00910	0.00654	0.00900
	Iron (Fe)-Dissolved (mg/L)	0.073	0.027	<0.010	0.027
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0019	0.0013	0.0019
	Magnesium (Mg)-Dissolved (mg/L)	18.8	21.8	22.2	21.2
	Manganese (Mn)-Dissolved (mg/L)	0.182	0.0148	0.0379	0.0149

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1912879-1	L1912879-2	L1912879-3	L1912879-4	L1912879-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	10-APR-17	10-APR-17	11-APR-17	11-APR-17	11-APR-17
	Sampled Time	15:55	16:25	08:30	08:45	09:00
	Client ID	W10	W15	W2	W3	W8A
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000062
	Molybdenum (Mo)-Dissolved (mg/L)	0.000131	0.0126	0.00105	0.00434	0.00593
	Nickel (Ni)-Dissolved (mg/L)	0.00573	<0.00050	0.00070	0.00080	0.00240
	Phosphorus (P)-Dissolved (mg/L)	0.330	<0.050	<0.050	<0.050	0.060
	Potassium (K)-Dissolved (mg/L)	2.48	6.87	3.78	2.42	8.34
	Selenium (Se)-Dissolved (mg/L)	DTC 0.000735	0.0128	0.000290	0.000322	0.00166
	Silicon (Si)-Dissolved (mg/L)	17.6	4.84	6.78	6.13	10.3
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000021
	Sodium (Na)-Dissolved (mg/L)	24.5	23.9	12.4	16.8	51.6
	Strontium (Sr)-Dissolved (mg/L)	1.29	2.12	0.411	0.755	3.51
	Sulfur (S)-Dissolved (mg/L)	0.94	73.8	11.5	19.3	59.1
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00835	0.00092	<0.00030	<0.00030	DLM <0.00090
	Uranium (U)-Dissolved (mg/L)	0.000145	0.00405	0.00144	0.00279	0.00443
	Vanadium (V)-Dissolved (mg/L)	0.00266	<0.00050	<0.00050	<0.00050	0.00232
	Zinc (Zn)-Dissolved (mg/L)	0.0020	<0.0010	0.0019	0.0016	0.145
	Zirconium (Zr)-Dissolved (mg/L)	0.00213	<0.00030	<0.00030	<0.00030	0.00133

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1912879-6	L1912879-7	L1912879-8	L1912879-9	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	11-APR-17	11-APR-17	11-APR-17	11-APR-17	
	Sampled Time	09:20	16:05	10:00		
	Client ID	W35	MC1	W17	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00183	0.00119	0.00610	0.00121	
	Nickel (Ni)-Dissolved (mg/L)	0.00097	0.00064	0.00081	0.00080	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	7.08	3.77	3.65	3.83	
	Selenium (Se)-Dissolved (mg/L)	0.000466	0.000343	0.000476	0.000326	
	Silicon (Si)-Dissolved (mg/L)	3.50	7.36	5.23	7.28	
	Silver (Ag)-Dissolved (mg/L)	0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	6.99	13.2	14.8	13.3	
	Strontium (Sr)-Dissolved (mg/L)	0.637	0.472	0.819	0.474	
	Sulfur (S)-Dissolved (mg/L)	10.9	12.2	18.7	12.1	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.0024 DLM	0.00032	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.000376	0.00157	0.00264	0.00155	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	0.0016	0.0016	<0.0010	0.0024	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Total	MS-B	L1912879-1, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Reference Information

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA

Reference Information

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-04-12 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1912879-COFC

COC Number: 2017-04-12 A

Page of

Report To Contact and company name below will appear on the final report
Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659
Company address below will appear on the final report
Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To
Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Report Format
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

ll E&P TATs with your AM - surcharges will apply
Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐
EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐
Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
For tests that can not be performed according to the service level selected, you will be contacted.

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: 224162 (WUL)
LSD:

Oil and Gas Required Fields (client use)
AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** SR/SB

Analysis Request
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preserved	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved)	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)					Number of Containers
1	W10	10-Apr-17	15:55	Water	R	R	R	R	R	R	R	R						6
2	W15	10-Apr-17	16:25	Water	R	R	R	R	R	R	R	R	R					7
3	W2	11-Apr-17	8:30	Water	R	R	R	R	R	R	R	R	R					7
4	W3	11-Apr-17	8:45	Water	R	R	R	R	R	R	R	R	R					7
5	W8A	11-Apr-17	9:00	Water	R	R	R	R	R	R	R	R						6
6	W35	11-Apr-17	9:20	Water	R	R	R	R	R	R	R	R	R					7
7	MC1	11-Apr-17	16:05	Water	R	R	R	R	R	R	R	R	R					7
8	W17	12-Apr-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
9	Dup	11-Apr-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑
INITIAL COOLER TEMPERATURES °C: 4.0
FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)
Released by: Shaun Roberts Date: 2017-04-12 Time: 11:30

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: EHF Date: 12 Apr 2017 Time: 15:32

FINAL SHIPMENT RECEPTION (lab use only)
Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION
WHITE - LABORATORY COPY YELLOW - CLIENT COPY
OCTOBER 2016 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Jh Apr. 15, 22, 2, 3, 3, 3, 5.4
17:00

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	19-APR-17
Report Date:	28-APR-17 20:02 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #:	L1914885
Project P.O. #:	224162 (WUL)
Job Reference:	
C of C Numbers:	2017-04-19A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914885-1	L1914885-2	L1914885-3	L1914885-4	L1914885-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-APR-17	18-APR-17	18-APR-17	18-APR-17	18-APR-17
	Sampled Time	08:10	08:30	08:40	08:50	09:00
	Client ID	W3	W8A	W35	W15	RO
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	539	1500	187	1120	134
	Hardness (as CaCO3) (mg/L)	281	850	95.9	577	27.5
	pH (pH)	8.24	7.70	7.68	8.25	7.23
	Total Suspended Solids (mg/L)	<3.0	48.3	<3.0	4.7	<3.0
	Total Dissolved Solids (mg/L)	358	1080	187	833	87
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	253	742	73.8	227	17.6
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	253	742	73.8	227	17.6
	Ammonia, Total (as N) (mg/L)	0.0155	0.312	0.0321	0.0362	0.423
	Chloride (Cl) (mg/L)	5.08	17.1	2.87	6.9	1.96
	Nitrate and Nitrite (as N) (mg/L)	0.286	0.682	1.19	39.2	2.81
	Nitrate (as N) (mg/L)	0.285	0.587	1.18	38.7	2.60
	Nitrite (as N) (mg/L)	0.0011	0.094	0.0095	0.438	0.208
	Sulfate (SO4) (mg/L)	59.0	216	12.9	241	29.1
	Anion Sum (meq/L)	6.47	19.9	1.91	12.5	1.22
	Cation Sum (meq/L)	6.49	19.8	2.17	12.6	1.21
	Cation - Anion Balance (%)	0.1	-0.3	6.2	0.4	-0.1
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.53		39.0	16.3	3.79
Total Metals	Aluminum (Al)-Total (mg/L)	0.0139	0.137	0.0915	0.176	0.0071
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00019	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00024	0.00103	0.00055	0.00043	<0.00010
	Barium (Ba)-Total (mg/L)	0.0733	0.258	0.0652	0.0839	0.00261
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000033	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.030	0.039	<0.010	0.021	0.107
	Cadmium (Cd)-Total (mg/L)	0.0000101	0.000263	0.0000246	0.0000231	<0.0000050
	Calcium (Ca)-Total (mg/L)	58.6	229	28.1	149	8.61
	Chromium (Cr)-Total (mg/L)	0.00012	0.00134	0.00036	0.00016	<0.00010
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00306	0.00024	0.00027	<0.00010
	Copper (Cu)-Total (mg/L)	0.00901	0.160	0.0935	0.0436	0.00253
	Iron (Fe)-Total (mg/L)	0.042	3.75	0.166	0.238	<0.010
	Lead (Pb)-Total (mg/L)	<0.000050	0.000167	<0.000050	0.000082	<0.000050
	Lithium (Li)-Total (mg/L)	0.0033	0.0047	<0.0010	0.0026	<0.0010
	Magnesium (Mg)-Total (mg/L)	30.7	69.2	6.62	46.6	1.50
	Manganese (Mn)-Total (mg/L)	0.127	7.18	0.0854	0.145	0.0190

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1914885-6	L1914885-7	L1914885-8	L1914885-9	L1914885-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-APR-17	18-APR-17	18-APR-17	18-APR-17	18-APR-17
	Sampled Time	09:05	15:10	15:25	16:00	
	Client ID	WTPI	W2	MC1	W17	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	2150	337	391	538	539
	Hardness (as CaCO3) (mg/L)	1020	173	204	276	274
	pH (pH)	7.95	8.28	8.28	8.27	8.24
	Total Suspended Solids (mg/L)	5.1	<3.0	<3.0	<3.0	<3.0
	Total Dissolved Solids (mg/L)	1800	256	282	340	317
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	174	169	190	241	238
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	174	169	190	241	238
	Ammonia, Total (as N) (mg/L)	5.84	0.0082	0.0084	<0.0050	<0.0050
	Chloride (Cl) (mg/L)	34	2.45	2.90	7.08	7.09
	Nitrate and Nitrite (as N) (mg/L)	25.5	<0.0051	<0.0051	0.123	0.123
	Nitrate (as N) (mg/L)	23.5	<0.0050	<0.0050	0.123	0.123
	Nitrite (as N) (mg/L)	2.01	<0.0010	<0.0010	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	1040	21.6	28.0	58.2	58.4
	Anion Sum (meq/L)	28.1	3.91	4.48	6.25	6.19
	Cation Sum (meq/L)	27.0	3.99	4.71	6.35	6.29
	Cation - Anion Balance (%)	-2.0	1.0	2.6	0.8	0.8
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	41.4	24.6	25.7	8.27	8.21
Total Metals	Aluminum (Al)-Total (mg/L)	0.0890	0.0626	0.0221	0.0138	0.0076
	Antimony (Sb)-Total (mg/L)	0.00028	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00044	0.00060	0.00063	0.00036	0.00036
	Barium (Ba)-Total (mg/L)	0.0963	0.0613	0.0694	0.0794	0.0771
	Beryllium (Be)-Total (mg/L)	DLA <0.000040	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	DLA <0.00010	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.222	0.011	0.010	0.031	0.031
	Cadmium (Cd)-Total (mg/L)	0.000092	0.0000182	0.0000241	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	329	42.2	46.8	71.6	71.7
	Chromium (Cr)-Total (mg/L)	DLA <0.00020	0.00038	0.00045	0.00011	0.00011
	Cobalt (Co)-Total (mg/L)	0.00090	0.00015	0.00011	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.0718	0.0108	0.0115	0.00696	0.00902
	Iron (Fe)-Total (mg/L)	0.137	0.124	0.088	0.021	0.010
	Lead (Pb)-Total (mg/L)	0.00030	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0117	0.0018	0.0019	0.0013	0.0014
	Magnesium (Mg)-Total (mg/L)	41.8	16.3	19.0	22.6	22.7
	Manganese (Mn)-Total (mg/L)	0.630	0.0356	0.0226	0.0502	0.0361

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1914885-1	L1914885-2	L1914885-3	L1914885-4	L1914885-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-APR-17	18-APR-17	18-APR-17	18-APR-17	18-APR-17
	Sampled Time	08:10	08:30	08:40	08:50	09:00
	Client ID	W3	W8A	W35	W15	RO
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000086	0.0000064	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00499	0.00680	0.000758	0.00858	0.00258
	Nickel (Ni)-Total (mg/L)	0.00092	0.00221	0.00142	0.00052	<0.00050
	Phosphorus (P)-Total (mg/L)	<0.050	0.119	0.067	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.51	8.43	3.78	7.96	2.59
	Selenium (Se)-Total (mg/L)	0.000317	0.00125	0.000181	0.0131	0.000541
	Silicon (Si)-Total (mg/L)	6.38	10.2	4.77	7.19	0.15
	Silver (Ag)-Total (mg/L)	<0.000010	0.000063	0.000028	0.000015	<0.000010
	Sodium (Na)-Total (mg/L)	20.0	54.3	3.55	22.0	13.7
	Strontium (Sr)-Total (mg/L)	0.791	3.23	0.171	2.27	0.178
	Sulfur (S)-Total (mg/L)	21.3	78.3	5.03	90.5	10.3
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	0.00026	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00090 DLM	<0.0060 DLM	<0.0060 DLM	<0.0090 DLM	<0.00030
	Uranium (U)-Total (mg/L)	0.00323	0.00424	0.000109	0.00460	0.000152
	Vanadium (V)-Total (mg/L)	<0.00050	0.00463	0.00067	0.00099	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	0.181	<0.0030	0.0032	0.0040
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00097	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0031	0.143	0.0347	0.0112	0.0038
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00013	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00083	0.00051	0.00037	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0736	0.241	0.0604	0.0830	0.00261
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	0.000028	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.023	0.028	<0.010	0.014	0.099
	Cadmium (Cd)-Dissolved (mg/L)	0.0000086	0.000245	0.0000210	0.0000214	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	59.3	220	28.0	149	8.57
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00089	0.00030	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00289	0.00020	0.00021	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00290	0.106	0.0836	0.0321	0.00069
	Iron (Fe)-Dissolved (mg/L)	0.022	0.389	0.104	0.029	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.00102 DTC	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0036	0.0047	<0.0010	0.0027	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	32.2	72.9	6.33	49.8	1.49
	Manganese (Mn)-Dissolved (mg/L)	0.118	6.98	0.0698	0.134	0.0181

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1914885-6	L1914885-7	L1914885-8	L1914885-9	L1914885-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-APR-17	18-APR-17	18-APR-17	18-APR-17	18-APR-17
	Sampled Time	09:05	15:10	15:25	16:00	
	Client ID	WTPI	W2	MC1	W17	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.0732	0.00114	0.00135	0.00665	0.00643
	Nickel (Ni)-Total (mg/L)	0.0027	0.00119	0.00120	0.00078	0.00076
	Phosphorus (P)-Total (mg/L)	<0.10 DLA	<0.050	0.056	<0.050	<0.050
	Potassium (K)-Total (mg/L)	40.5	3.68	3.87	4.05	3.99
	Selenium (Se)-Total (mg/L)	0.0112	0.000207	0.000249	0.000370	0.000363
	Silicon (Si)-Total (mg/L)	3.26	7.74	8.48	5.51	5.44
	Silver (Ag)-Total (mg/L)	<0.000020 DLA	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	118	10.6	12.9	17.1	16.6
	Strontium (Sr)-Total (mg/L)	6.73	0.389	0.483	0.848	0.828
	Sulfur (S)-Total (mg/L)	366	8.07	10.2	21.4	21.3
	Thallium (Tl)-Total (mg/L)	<0.000020 DLA	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00020 DLA	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00366	0.00201	<0.00060 DLM	0.00152	<0.00030
	Uranium (U)-Total (mg/L)	0.00537	0.00139	0.00179	0.00296	0.00291
	Vanadium (V)-Total (mg/L)	<0.0010 DLA	0.00066	0.00052	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0060 DLA	<0.0030	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0054	0.0156	0.0159	0.0027	0.0040
	Antimony (Sb)-Dissolved (mg/L)	0.00026	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00039	0.00054	0.00057	0.00032	0.00034
	Barium (Ba)-Dissolved (mg/L)	0.0979	0.0610	0.0714	0.0803	0.0782
	Beryllium (Be)-Dissolved (mg/L)	<0.000040	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.192	<0.010	<0.010	0.026	0.026
	Cadmium (Cd)-Dissolved (mg/L)	0.000091	0.0000161	0.0000213	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	335	41.2	47.7	70.6	71.5
	Chromium (Cr)-Dissolved (mg/L)	<0.00020	0.00027	0.00031	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00083	0.00012	0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0315	0.00933	0.0106	0.00653	0.00696
	Iron (Fe)-Dissolved (mg/L)	<0.020	0.057	0.059	<0.010	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.00010	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0121	0.0021	0.0022	0.0017	0.0016
	Magnesium (Mg)-Dissolved (mg/L)	45.5	17.0	20.5	24.3	23.2
	Manganese (Mn)-Dissolved (mg/L)	0.617	0.0314	0.0209	0.0197	0.0201

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914885-1	L1914885-2	L1914885-3	L1914885-4	L1914885-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-APR-17	18-APR-17	18-APR-17	18-APR-17	18-APR-17
	Sampled Time	08:10	08:30	08:40	08:50	09:00
	Client ID	W3	W8A	W35	W15	RO
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000079	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00458	0.00603	0.000731	0.00780	0.00238
	Nickel (Ni)-Dissolved (mg/L)	0.00077	0.00212	0.00113	<0.00050	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	0.099	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.34	8.08	3.50	7.92	2.43
	Selenium (Se)-Dissolved (mg/L)	0.000315	0.00102	0.000144	0.0132	0.000611
	Silicon (Si)-Dissolved (mg/L)	6.61	10.5	4.60	7.19	0.124
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000012	0.000017	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	18.8	52.0	3.33	21.1	13.1
	Strontium (Sr)-Dissolved (mg/L)	0.789	3.11	0.178	2.27	0.181
	Sulfur (S)-Dissolved (mg/L)	21.6	79.6	4.48	91.8	10.7
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	DLM <0.0018	0.00174	0.00085	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00318	0.00421	0.000104	0.00452	0.000144
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00183	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.140	0.0019	0.0021	0.0031
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00098	0.00034	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914885-6	L1914885-7	L1914885-8	L1914885-9	L1914885-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	18-APR-17	18-APR-17	18-APR-17	18-APR-17	18-APR-17
	Sampled Time	09:05	15:10	15:25	16:00	
	Client ID	WTPI	W2	MC1	W17	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	0.0000053	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0732	0.00104	0.00121	0.00583	0.00594
	Nickel (Ni)-Dissolved (mg/L)	0.0026	0.00104	0.00108	0.00072	0.00071
	Phosphorus (P)-Dissolved (mg/L)	<0.10	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	39.4	3.43	3.72	3.96	3.93
	Selenium (Se)-Dissolved (mg/L)	0.0120	0.000254	0.000283	0.000436	0.000404
	Silicon (Si)-Dissolved (mg/L)	3.33	8.09	9.06	5.68	5.44
	Silver (Ag)-Dissolved (mg/L)	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	117	10.1	12.4	16.6	16.5
	Strontium (Sr)-Dissolved (mg/L)	7.19	0.386	0.474	0.798	0.829
	Sulfur (S)-Dissolved (mg/L)	384	8.33	10.5	21.5	21.0
	Thallium (Tl)-Dissolved (mg/L)	<0.000020	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00020	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00060	0.00035	DLM <0.00060	<0.00030	0.00035
	Uranium (U)-Dissolved (mg/L)	0.00558	0.00128	0.00171	0.00281	0.00258
	Vanadium (V)-Dissolved (mg/L)	<0.0010	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0025	0.0017	0.0019	<0.0010	0.0013
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1914885-10, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1914885-1, -4, -5, -7, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1914885-1, -4, -5, -7, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1914885-1, -4, -5, -7, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1914885-3, -6
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Nickel (Ni)-Total	MS-B	L1914885-10, -7, -8, -9
Matrix Spike	Silicon (Si)-Total	MS-B	L1914885-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1914885-1, -2, -3, -4, -5, -6
Matrix Spike	Nitrate (as N)	MS-B	L1914885-1, -10, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Reference Information

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

Reference Information

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-04-19A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1914885-COFC

COC Number: 2017-04-19 A

Page of

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224162 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** SR/SB

.firm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐

EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W3	18-Apr-17	8:10	Water	R	R	R	R	R	R	R	R	R					7
2	W8A	18-Apr-17	8:30	Water	R	R	R	R	R	R	R	R						6
3	W35	18-Apr-17	8:40	Water	R	R	R	R	R	R	R	R	R					7
4	W15	18-Apr-17	8:50	Water	R	R	R	R	R	R	R	R	R					7
5	RO	18-Apr-17	9:00	Water	R	R	R	R	R	R	R	R	R					7
6	WTPI	18-Apr-17	9:05	Water	R	R	R	R	R	R	R	R	R					7
7	W2	18-Apr-17	15:10	Water	R	R	R	R	R	R	R	R	R					7
8	MC1	18-Apr-17	15:25	Water	R	R	R	R	R	R	R	R	R					7
9	W17	18-Apr-17	16:00	Water	R	R	R	R	R	R	R	R	R					7
10	Dup	18-Apr-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐	No ☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated ☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1.6°C					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-04-19	Time: 13:00	Received by: VD.	Date: 04/19/2017	Time: 15:42	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 26-APR-17
Report Date: 05-MAY-17 16:35 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1917913

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-04-26 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1917913-1	L1917913-2	L1917913-3	L1917913-4	L1917913-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	25-APR-17	25-APR-17	25-APR-17	25-APR-17	25-APR-17
	Sampled Time	07:35	07:45	08:25	11:45	14:30
	Client ID	W15	W35	W16	W8A	W2
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	731	177	76.0	1570	267
	Hardness (as CaCO3) (mg/L)	343	84.6	23.9	800	130
	pH (pH)	8.17	7.86	7.55	7.90	8.17
	Total Suspended Solids (mg/L)	6.4	<3.0	<3.0	32.8	22.2
	Total Dissolved Solids (mg/L)	490	168	47	1030	195
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	151	71.5	22.6	734	129
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	151	71.5	22.6	734	129
	Ammonia, Total (as N) (mg/L)	0.0911	0.0207	0.130	0.363	0.0060
	Chloride (Cl) (mg/L)	4.1	2.55	1.07	19.4	1.60
	Nitrate and Nitrite (as N) (mg/L)	22.0	1.36	0.851	0.648	<0.0051
	Nitrate (as N) (mg/L)	21.4	1.35	0.807	0.518	<0.0050
	Nitrite (as N) (mg/L)	0.548	0.0165	0.0438	0.130	<0.0010
	Sulfate (SO4) (mg/L)	147	8.32	9.03	199	14.1
	Anion Sum (meq/L)	7.77	1.77	0.73	19.4	2.93
	Cation Sum (meq/L)	7.56	1.95	0.70	18.8	3.07
	Cation - Anion Balance (%)	-1.4	4.8	-2.0	-1.6	2.5
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.8	32.4	1.91		18.5
Total Metals	Aluminum (Al)-Total (mg/L)	0.153	0.106	0.0684	1.02	0.524
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00026	<0.00010
	Arsenic (As)-Total (mg/L)	0.00030	0.00049	0.00010	0.00133	0.00069
	Barium (Ba)-Total (mg/L)	0.0637	0.0568	0.0139	0.286	0.0554
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000060	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	0.000067	<0.000050
	Boron (B)-Total (mg/L)	0.011	<0.010	0.029	0.035	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000161	0.0000196	0.0000147	0.000243	0.0000209
	Calcium (Ca)-Total (mg/L)	91.3	24.6	7.44	221	29.7
	Chromium (Cr)-Total (mg/L)	0.00015	0.00033	<0.00010	0.00218	0.00115
	Cobalt (Co)-Total (mg/L)	0.00041	0.00019	<0.00010	0.00371	0.00043
	Copper (Cu)-Total (mg/L)	0.0406	0.0653	0.0146	0.443	0.0154
	Iron (Fe)-Total (mg/L)	0.396	0.202	0.078	6.40	0.725
	Lead (Pb)-Total (mg/L)	0.000079	0.000062	<0.000050	0.000640	0.000198
	Lithium (Li)-Total (mg/L)	0.0017	<0.0010	<0.0010	0.0055	0.0016
	Magnesium (Mg)-Total (mg/L)	29.4	6.29	1.51	71.9	13.0
	Manganese (Mn)-Total (mg/L)	0.191	0.0389	0.0381	7.21	0.0645

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1917913-6	L1917913-7	L1917913-8	L1917913-9	
	Description	WATER	WATER	WATER	WATER	
	Sampled Date	25-APR-17	25-APR-17	25-APR-17	25-APR-17	
	Sampled Time	15:20	16:00	16:15		
	Client ID	MC1	W3	W17	DUP	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	242	519	539	266	
	Hardness (as CaCO3) (mg/L)	114	231	266	119	
	pH (pH)	8.19	8.30	8.32	8.19	
	Total Suspended Solids (mg/L)	3.2	<3.0	<3.0	20.4	
	Total Dissolved Solids (mg/L)	168	292	316	161	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	118	233	226	129	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	3.2	5.4	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	118	236	231	129	
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0118	<0.0050	<0.0050	
	Chloride (Cl) (mg/L)	1.45	4.66	6.82	1.60	
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	0.216	0.283	<0.0051	
	Nitrate (as N) (mg/L)	<0.0050	0.214	0.283	<0.0050	
	Nitrite (as N) (mg/L)	<0.0010	0.0013	<0.0010	<0.0010	
	Sulfate (SO4) (mg/L)	12.8	53.4	56.8	14.1	
	Anion Sum (meq/L)	2.66	5.98	6.01	2.91	
	Cation Sum (meq/L)	2.68	5.35	6.21	2.81	
	Cation - Anion Balance (%)	0.5	-5.6	1.6	-1.7	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	17.9	4.86	8.06	18.0	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0619	0.0139	0.0096	0.543	
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00046	0.00022	0.00035	0.00068	
	Barium (Ba)-Total (mg/L)	0.0449	0.0703	0.0749	0.0566	
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	<0.010	0.022	0.029	<0.010	
	Cadmium (Cd)-Total (mg/L)	0.0000152	0.0000078	<0.0000050	0.0000220	
	Calcium (Ca)-Total (mg/L)	26.3	52.8	66.3	29.3	
	Chromium (Cr)-Total (mg/L)	0.00031	<0.00010	0.00012	0.00110	
	Cobalt (Co)-Total (mg/L)	0.00012	<0.00010	<0.00010	0.00044	
	Copper (Cu)-Total (mg/L)	0.0101	0.00428	0.00774	0.0154	
	Iron (Fe)-Total (mg/L)	0.129	0.028	0.011	0.740	
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	0.000197	
	Lithium (Li)-Total (mg/L)	<0.0010	0.0031	0.0016	0.0015	
	Magnesium (Mg)-Total (mg/L)	11.4	27.3	21.9	12.7	
	Manganese (Mn)-Total (mg/L)	0.0299	0.102	0.0514	0.0630	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1917913-1	L1917913-2	L1917913-3	L1917913-4	L1917913-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	25-APR-17	25-APR-17	25-APR-17	25-APR-17	25-APR-17
	Sampled Time	07:35	07:45	08:25	11:45	14:30
	Client ID	W15	W35	W16	W8A	W2
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000081	<0.0000050	0.0000115	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00373	0.000741	0.000676	0.00602	0.000936
	Nickel (Ni)-Total (mg/L)	0.00055	0.00149	<0.00050	0.00245	0.00164
	Phosphorus (P)-Total (mg/L)	<0.050	0.062	<0.050	0.231	0.070
	Potassium (K)-Total (mg/L)	5.36	3.74	0.91	9.43	3.29
	Selenium (Se)-Total (mg/L)	0.00724	0.000158	0.000195	0.00136	0.000190
	Silicon (Si)-Total (mg/L)	4.63	4.41	0.53	12.5	6.78
	Silver (Ag)-Total (mg/L)	0.000012	0.000018	<0.000010	0.000173	<0.000010
	Sodium (Na)-Total (mg/L)	13.3	3.69	4.66	54.5	8.54
	Strontium (Sr)-Total (mg/L)	1.23	0.145	0.0861	3.06	0.292
	Sulfur (S)-Total (mg/L)	52.4	3.26	3.02	77.5	5.07
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000013	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00015	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00699	0.00509	0.00258	0.0536	0.0197
	Uranium (U)-Total (mg/L)	0.00259	0.000083	0.000116	0.00416	0.000971
	Vanadium (V)-Total (mg/L)	0.00075	0.00071	<0.00050	0.00816	0.00189
	Zinc (Zn)-Total (mg/L)	0.0031	0.0040	<0.0030	0.538	0.0037
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00095	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0085	0.0326	0.0185	0.0151	0.0147
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00026	0.00044	<0.00010	0.00062	0.00044
	Barium (Ba)-Dissolved (mg/L)	0.0602	0.0566	0.0141	0.241	0.0507
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.025	0.029	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000161	0.0000188	0.0000105	0.000140	0.0000116
	Calcium (Ca)-Dissolved (mg/L)	88.8	23.4	7.06	206	29.7
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00029	<0.00010	0.00078	0.00023
	Cobalt (Co)-Dissolved (mg/L)	0.00032	0.00015	<0.00010	0.00281	0.00015
	Copper (Cu)-Dissolved (mg/L)	0.0255	0.0557	0.0109	0.0343	0.00777
	Iron (Fe)-Dissolved (mg/L)	0.073	0.143	0.018	0.531	0.071
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	0.000123
	Lithium (Li)-Dissolved (mg/L)	0.0018	<0.0010	<0.0010	0.0048	0.0019
	Magnesium (Mg)-Dissolved (mg/L)	29.5	6.39	1.52	69.5	13.6
	Manganese (Mn)-Dissolved (mg/L)	0.176	0.0348	0.0338	6.82	0.0299

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1917913-6	L1917913-7	L1917913-8	L1917913-9
	Description	WATER	WATER	WATER	WATER
	Sampled Date	25-APR-17	25-APR-17	25-APR-17	25-APR-17
	Sampled Time	15:20	16:00	16:15	
	Client ID	MC1	W3	W17	DUP
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000072
	Molybdenum (Mo)-Total (mg/L)	0.000809	0.00437	0.00597	0.000903
	Nickel (Ni)-Total (mg/L)	0.00099	0.00086	0.00076	0.00165
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.060
	Potassium (K)-Total (mg/L)	2.86	2.34	3.97	3.24
	Selenium (Se)-Total (mg/L)	0.000140	0.000295	0.000383	0.000183
	Silicon (Si)-Total (mg/L)	5.57	6.01	5.42	6.81
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	7.63	17.7	16.6	8.09
	Strontium (Sr)-Total (mg/L)	0.267	0.719	0.780	0.291
	Sulfur (S)-Total (mg/L)	4.45	19.3	20.5	5.10
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00217	0.00073	0.00037	0.0214
	Uranium (U)-Total (mg/L)	0.000811	0.00283	0.00289	0.000958
	Vanadium (V)-Total (mg/L)	0.00051	<0.00050	<0.00050	0.00188
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0040
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0139	0.0027	0.0024	0.0153
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00039	0.00021	0.00036	0.00041
	Barium (Ba)-Dissolved (mg/L)	0.0438	0.0649	0.0867	0.0472
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.019	0.025	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000098	0.0000072	<0.0000050	0.0000097
	Calcium (Ca)-Dissolved (mg/L)	26.4	51.7	65.5	26.5
	Chromium (Cr)-Dissolved (mg/L)	0.00026	<0.00010	0.00012	0.00024
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00875	0.00319	0.00772	0.00920
	Iron (Fe)-Dissolved (mg/L)	0.063	0.013	<0.010	0.065
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0016	0.0033	0.0020	0.0017
	Magnesium (Mg)-Dissolved (mg/L)	11.6	24.8	24.9	12.7
	Manganese (Mn)-Dissolved (mg/L)	0.0283	0.0879	0.0247	0.0313

	Sample ID	L1917913-1	L1917913-2	L1917913-3	L1917913-4	L1917913-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	25-APR-17	25-APR-17	25-APR-17	25-APR-17	25-APR-17
	Sampled Time	07:35	07:45	08:25	11:45	14:30
	Client ID	W15	W35	W16	W8A	W2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	0.0000064	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00356	0.000707	0.000653	0.00531	0.000955
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00144	<0.00050	0.00182	0.00087
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	5.05	3.50	0.90	8.27	3.06
	Selenium (Se)-Dissolved (mg/L)	0.00717	0.000154	0.000145	0.00101	0.000182
	Silicon (Si)-Dissolved (mg/L)	3.97	4.05	0.446	9.81	5.46
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000010	<0.000010	0.000015	<0.000010
	Sodium (Na)-Dissolved (mg/L)	12.8	3.56	4.31	53.0	8.84
	Strontium (Sr)-Dissolved (mg/L)	1.21	0.144	0.0843	2.82	0.295
	Sulfur (S)-Dissolved (mg/L)	50.3	3.24	2.95	74.5	5.55
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00047	0.00160	0.00035	DLM <0.00090	0.00044
	Uranium (U)-Dissolved (mg/L)	0.00232	0.000096	0.000109	0.00353	0.000883
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00161	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0028	0.0026	0.0011	0.121	0.0034
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	0.00084	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1917913-6 WATER 25-APR-17 15:20 MC1	L1917913-7 WATER 25-APR-17 16:00 W3	L1917913-8 WATER 25-APR-17 16:15 W17	L1917913-9 WATER 25-APR-17 DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.000807	0.00416	0.00540	0.000861	
	Nickel (Ni)-Dissolved (mg/L)	0.00080	0.00066	0.00074	0.00093	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.74	1.98	4.22	3.03	
	Selenium (Se)-Dissolved (mg/L)	0.000153	0.000266	0.000405	0.000151	
	Silicon (Si)-Dissolved (mg/L)	5.15	5.58	4.99	5.48	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	7.52	15.5	18.0	8.19	
	Strontium (Sr)-Dissolved (mg/L)	0.263	0.690	0.749	0.257	
	Sulfur (S)-Dissolved (mg/L)	4.41	18.2	19.8	5.03	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00011	
	Titanium (Ti)-Dissolved (mg/L)	0.00037	<0.00030	<0.00030	0.00051	
	Uranium (U)-Dissolved (mg/L)	0.000725	0.00263	0.00251	0.000789	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	0.0024	<0.0010	<0.0010	0.0012	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1917913-1, -3, -5, -6, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1917913-2
Matrix Spike	Dissolved Organic Carbon	MS-B	L1917913-2
Matrix Spike	Dissolved Organic Carbon	MS-B	L1917913-2
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Total	MS-B	L1917913-1, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

Reference Information

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-04-26 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1917913-COFC

COC Number: 2017-04-26 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Form

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

.onfirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM) (filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W15	25-Apr-17	7:35	Water	R	R	R	R	R	R	R	R	R					7
2	W35	25-Apr-17	7:45	Water	R	R	R	R	R	R	R	R	R					7
3	W16	25-Apr-17	8:25	Water	R	R	R	R	R	R	R	R	R					7
4	W8A	25-Apr-17	11:45	Water	R	R	R	R	R	R	R	R						6
5	W2	25-Apr-17	14:30	Water	R	R	R	R	R	R	R	R	R					7
6	MC1	25-Apr-17	15:20	Water	R	R	R	R	R	R	R	R	R					7
7	W3	25-Apr-17	16:00	Water	R	R	R	R	R	R	R	R	R					7
8	W17	25-Apr-17	16:15	Water	R	R	R	R	R	R	R	R	R					7
9	DUP	25-Apr-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-04-26 9:45	Time:	Received by: VD	Date: Apr/26/17	Time: 10:30	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 04-MAY-17
Report Date: 16-MAY-17 17:42 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1921497
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-05-03 B
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1921497-1	L1921497-2	L1921497-3	L1921497-4	L1921497-5
	Sample ID	L1921497-1	L1921497-2	L1921497-3	L1921497-4	L1921497-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17
	Sampled Time	07:45	08:30	08:00	08:10	08:20
	Client ID	MC1	W2	W3	W50	W16A
WATER						
Physical Tests	Conductivity (uS/cm)	167	161	375	334	319
	Hardness (as CaCO3) (mg/L)	84.3	80.6	164	143	136
	pH (pH)	7.84	7.87	8.04	8.03	7.87
	Total Suspended Solids (mg/L)	<3.0	<3.0	10.1	<3.0	<3.0
	Total Dissolved Solids (mg/L)	146	143	225	204	185
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	74.9	73.6	138	117	111
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	74.9	73.6	138	117	111
	Ammonia, Total (as N) (mg/L)	0.0099	0.0092	0.143	0.156	0.146
	Chloride (Cl) (mg/L)	1.66	1.58	4.86	5.10	4.91
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	<0.0051	1.63	2.15	2.11
	Nitrate (as N) (mg/L)	<0.0050	<0.0050	1.58	2.08	2.04
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.0511	0.0717	0.0751
	Sulfate (SO4) (mg/L)	8.89	7.89	43.7	43.1	41.4
	Anion Sum (meq/L)	1.73	1.68	3.91	3.53	3.37
	Cation Sum (meq/L)	1.95	1.86	3.94	3.47	3.34
	Cation - Anion Balance (%)	6.0	5.0	0.3	-0.9	-0.5
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	34.0	32.7	11.4	8.48	8.39
Total Metals	Aluminum (Al)-Total (mg/L)	0.0435	0.0797	0.179	0.232	0.122
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00013	0.00020	<0.00010
	Arsenic (As)-Total (mg/L)	0.00046	0.00052	0.00039	0.00033	0.00027
	Barium (Ba)-Total (mg/L)	0.0363	0.0385	0.0591	0.0567	0.0529
	Beryllium (Be)-Total (mg/L)	0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.035	0.046	0.047
	Cadmium (Cd)-Total (mg/L)	0.0000150	0.0000164	0.0000242	0.0000443	0.0000254
	Calcium (Ca)-Total (mg/L)	22.0	22.3	41.2	39.7	37.7
	Chromium (Cr)-Total (mg/L)	0.00042	0.00046	0.00034	0.00018	0.00017
	Cobalt (Co)-Total (mg/L)	0.00011	0.00019	0.00023	0.00019	0.00015
	Copper (Cu)-Total (mg/L)	0.0104	0.0109	0.0304	0.112	0.0420
	Iron (Fe)-Total (mg/L)	0.151	0.221	0.343	0.485	0.271
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000183	0.000535	0.000246
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	0.0016	0.0012	0.0010
	Magnesium (Mg)-Total (mg/L)	7.26	7.25	16.1	12.0	11.2
	Manganese (Mn)-Total (mg/L)	0.00947	0.0326	0.413	0.322	0.262

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1921497-6	L1921497-7	L1921497-8	L1921497-9	L1921497-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17
	Sampled Time	08:25	08:45	08:50		
	Client ID	W17	W35	W15	DUP1	DUP2
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	508	129	478	166	162
	Hardness (as CaCO3) (mg/L)	247	69.9	245	84.5	80.5
	pH (pH)	8.19	7.56	7.94	7.85	7.86
	Total Suspended Solids (mg/L)	<3.0	<3.0	4.7	<3.0	<3.0
	Total Dissolved Solids (mg/L)	303	152	381	164	158
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	216	50.7	113	74.4	73.4
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	216	50.7	113	74.4	73.4
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0150	0.108	0.0099	0.0100
	Chloride (Cl) (mg/L)	6.57	1.17	2.53	1.67	1.59
	Nitrate and Nitrite (as N) (mg/L)	0.514	1.24	10.8	<0.0051	<0.0051
	Nitrate (as N) (mg/L)	0.514	1.23	10.4	<0.0050	<0.0050
	Nitrite (as N) (mg/L)	<0.0010	0.0050	0.390	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	54.6	5.69	90.3	8.93	7.94
	Anion Sum (meq/L)	5.68	1.25	4.97	1.72	1.68
	Cation Sum (meq/L)	5.68	1.57	5.44	1.95	1.86
	Cation - Anion Balance (%)	0.0	11.4	4.4	6.3	5.1
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	7.80	44.5	32.2	33.4	33.1
Total Metals	Aluminum (Al)-Total (mg/L)	0.0868	0.0518	0.167	0.0457	0.0757
	Antimony (Sb)-Total (mg/L)	0.00017	<0.00010	<0.00010	<0.00010	0.00012
	Arsenic (As)-Total (mg/L)	0.00034	0.00037	0.00037	0.00047	0.00049
	Barium (Ba)-Total (mg/L)	0.0725	0.0453	0.0555	0.0374	0.0390
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.030	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000105	0.0000102	0.0000255	0.0000127	0.0000164
	Calcium (Ca)-Total (mg/L)	64.5	20.6	64.6	21.7	21.9
	Chromium (Cr)-Total (mg/L)	0.00016	0.00037	0.00029	0.00046	0.00045
	Cobalt (Co)-Total (mg/L)	0.00011	0.00011	0.00042	0.00012	0.00019
	Copper (Cu)-Total (mg/L)	0.0520	0.0446	0.0435	0.0106	0.00992
	Iron (Fe)-Total (mg/L)	0.167	0.149	0.335	0.158	0.219
	Lead (Pb)-Total (mg/L)	0.000062	<0.000050	0.000064	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0017	<0.0010	0.0014	<0.0010	<0.0010
	Magnesium (Mg)-Total (mg/L)	21.5	5.18	18.1	7.74	7.15
	Manganese (Mn)-Total (mg/L)	0.0669	0.0109	0.203	0.00984	0.0321

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1921497-11				
	Description	WATER				
	Sampled Date	03-MAY-17				
	Sampled Time	08:15				
	Client ID	RO				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	216				
	Hardness (as CaCO3) (mg/L)	4.84				
	pH (pH)	7.97				
	Total Suspended Solids (mg/L)	<3.0				
	Total Dissolved Solids (mg/L)	138				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	104				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	104				
	Ammonia, Total (as N) (mg/L)	0.281				
	Chloride (Cl) (mg/L)	1.10				
	Nitrate and Nitrite (as N) (mg/L)	2.51				
	Nitrate (as N) (mg/L)	2.31				
	Nitrite (as N) (mg/L)	0.199				
	Sulfate (SO4) (mg/L)	4.81				
	Anion Sum (meq/L)	2.39				
	Cation Sum (meq/L)	2.12				
	Cation - Anion Balance (%)	-6.0				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	3.19				
Total Metals	Aluminum (Al)-Total (mg/L)	0.0158				
	Antimony (Sb)-Total (mg/L)	<0.00010				
	Arsenic (As)-Total (mg/L)	<0.00010				
	Barium (Ba)-Total (mg/L)	0.00133				
	Beryllium (Be)-Total (mg/L)	<0.000020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	0.111				
	Cadmium (Cd)-Total (mg/L)	<0.0000050				
	Calcium (Ca)-Total (mg/L)	1.61				
	Chromium (Cr)-Total (mg/L)	<0.00010				
	Cobalt (Co)-Total (mg/L)	<0.00010				
	Copper (Cu)-Total (mg/L)	0.00442				
	Iron (Fe)-Total (mg/L)	0.022				
	Lead (Pb)-Total (mg/L)	<0.000050				
	Lithium (Li)-Total (mg/L)	<0.0010				
	Magnesium (Mg)-Total (mg/L)	0.23				
	Manganese (Mn)-Total (mg/L)	0.00396				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1921497-1	L1921497-2	L1921497-3	L1921497-4	L1921497-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17
	Sampled Time	07:45	08:30	08:00	08:10	08:20
	Client ID	MC1	W2	W3	W50	W16A
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000064	0.0000070	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.000665	0.000591	0.00569	0.00352	0.00260
	Nickel (Ni)-Total (mg/L)	0.00148	0.00161	0.00146	0.00070	0.00056
	Phosphorus (P)-Total (mg/L)	0.066	0.059	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	1.70	1.91	2.57	2.70	2.53
	Selenium (Se)-Total (mg/L)	0.000100	0.000100	0.000461	0.000623	0.000584
	Silicon (Si)-Total (mg/L)	4.30	4.58	3.98	3.24	2.91
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000018	0.000039	<0.000010
	Sodium (Na)-Total (mg/L)	4.64	4.44	13.2	12.8	12.5
	Strontium (Sr)-Total (mg/L)	0.183	0.175	0.486	0.422	0.404
	Sulfur (S)-Total (mg/L)	3.79	2.97	15.2	15.1	14.6
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00117	0.00234	0.00894	0.0131	DLM <0.0045
	Uranium (U)-Total (mg/L)	0.000412	0.000369	0.00157	0.00107	0.000887
	Vanadium (V)-Total (mg/L)	0.00063	0.00066	0.00091	0.00100	0.00057
	Zinc (Zn)-Total (mg/L)	0.0034	<0.0030	<0.0030	0.0067	0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0412	0.0367	0.0081	0.0060	0.0118
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00044	0.00047	0.00031	0.00026	0.00024
	Barium (Ba)-Dissolved (mg/L)	0.0394	0.0390	0.0613	0.0537	0.0526
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.034	0.040	0.042
	Cadmium (Cd)-Dissolved (mg/L)	0.0000131	0.0000120	0.0000174	0.0000239	0.0000251
	Calcium (Ca)-Dissolved (mg/L)	21.6	21.3	40.4	39.1	36.8
	Chromium (Cr)-Dissolved (mg/L)	0.00038	0.00033	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00010	0.00015	0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0102	0.00863	0.0139	0.0185	0.0249
	Iron (Fe)-Dissolved (mg/L)	0.136	0.137	0.045	0.054	0.078
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	0.000052	0.000203	0.000110
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	0.0014	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	7.35	6.66	15.3	10.9	10.6
	Manganese (Mn)-Dissolved (mg/L)	0.00770	0.0254	0.346	0.284	0.253

	Sample ID	L1921497-6	L1921497-7	L1921497-8	L1921497-9	L1921497-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17
	Sampled Time	08:25	08:45	08:50		
	Client ID	W17	W35	W15	DUP1	DUP2
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000090	0.0000060	0.0000067	0.0000073
	Molybdenum (Mo)-Total (mg/L)	0.00606	0.000495	0.00211	0.000648	0.000604
	Nickel (Ni)-Total (mg/L)	0.00079	0.00157	0.00080	0.00148	0.00163
	Phosphorus (P)-Total (mg/L)	<0.050	0.060	0.071	0.063	<0.050
	Potassium (K)-Total (mg/L)	3.79	1.72	3.97	1.77	1.88
	Selenium (Se)-Total (mg/L)	0.000392	0.000121	0.00373	0.000120	0.000107
	Silicon (Si)-Total (mg/L)	5.50	3.93	4.03	4.57	4.47
	Silver (Ag)-Total (mg/L)	0.000026	0.000012	0.000016	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	15.4	2.88	7.79	4.74	4.34
	Strontium (Sr)-Total (mg/L)	0.752	0.113	0.843	0.185	0.171
	Sulfur (S)-Total (mg/L)	19.6	2.47	31.6	3.41	3.01
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00502	0.00115	<0.0060 DLM	0.00107	0.00225
	Uranium (U)-Total (mg/L)	0.00251	0.000054	0.00144	0.000406	0.000370
	Vanadium (V)-Total (mg/L)	0.00066	<0.00050	0.00074	0.00052	0.00073
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0050	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00032
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0111	0.0411	0.0601	0.0387	0.0343
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00034	0.00036	0.00036	0.00044	0.00050
	Barium (Ba)-Dissolved (mg/L)	0.0741	0.0461	0.0630	0.0387	0.0391
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.026	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000069	0.0000282	0.0000140	0.0000127
	Calcium (Ca)-Dissolved (mg/L)	65.6	20.0	65.3	21.6	21.3
	Chromium (Cr)-Dissolved (mg/L)	0.00011	0.00033	0.00022	0.00039	0.00037
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00010	0.00043	0.00012	0.00016
	Copper (Cu)-Dissolved (mg/L)	0.00997	0.0431	0.0401	0.0103	0.00887
	Iron (Fe)-Dissolved (mg/L)	0.024	0.129	0.160	0.139	0.139
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0015	<0.0010	0.0012	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	20.1	4.86	20.0	7.43	6.65
	Manganese (Mn)-Dissolved (mg/L)	0.0229	0.00634	0.231	0.00793	0.0258

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1921497-11 WATER 03-MAY-17 08:15 RO				
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050				
	Molybdenum (Mo)-Total (mg/L)	0.000419				
	Nickel (Ni)-Total (mg/L)	<0.00050				
	Phosphorus (P)-Total (mg/L)	<0.050				
	Potassium (K)-Total (mg/L)	1.40				
	Selenium (Se)-Total (mg/L)	0.000209				
	Silicon (Si)-Total (mg/L)	0.12				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	47.8				
	Strontium (Sr)-Total (mg/L)	0.0330				
	Sulfur (S)-Total (mg/L)	1.83				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	DLM <0.00060				
	Uranium (U)-Total (mg/L)	0.000037				
	Vanadium (V)-Total (mg/L)	<0.00050				
	Zinc (Zn)-Total (mg/L)	0.0050				
	Zirconium (Zr)-Total (mg/L)	<0.00030				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0013				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	<0.00010				
	Barium (Ba)-Dissolved (mg/L)	0.00105				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.108				
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050				
	Calcium (Ca)-Dissolved (mg/L)	1.56				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	0.00027				
	Iron (Fe)-Dissolved (mg/L)	<0.010				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	<0.0010				
	Magnesium (Mg)-Dissolved (mg/L)	0.23				
	Manganese (Mn)-Dissolved (mg/L)	0.00323				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1921497-1	L1921497-2	L1921497-3	L1921497-4	L1921497-5
	Sample ID	L1921497-1	L1921497-2	L1921497-3	L1921497-4	L1921497-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17
	Sampled Time	07:45	08:30	08:00	08:10	08:20
	Client ID	MC1	W2	W3	W50	W16A
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	0.0000067	0.0000062	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000684	0.000530	0.00529	0.00336	0.00243
	Nickel (Ni)-Dissolved (mg/L)	0.00146	0.00147	0.00085	0.00061	0.00050
	Phosphorus (P)-Dissolved (mg/L)	0.053	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.81	1.90	2.62	2.57	2.54
	Selenium (Se)-Dissolved (mg/L)	0.000139	0.000114	0.000561	0.000652	0.000568
	Silicon (Si)-Dissolved (mg/L)	4.39	4.24	3.57	2.71	2.59
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	4.69	4.25	13.0	12.2	12.3
	Strontium (Sr)-Dissolved (mg/L)	0.182	0.169	0.475	0.419	0.391
	Sulfur (S)-Dissolved (mg/L)	3.08	2.77	14.9	14.5	13.7
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00077	0.00077	0.00033	<0.00030	0.00050
	Uranium (U)-Dissolved (mg/L)	0.000358	0.000331	0.00141	0.000953	0.000812
	Vanadium (V)-Dissolved (mg/L)	0.00050	0.00053	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0032	0.0013	0.0012	0.0018	0.0018
	Zirconium (Zr)-Dissolved (mg/L)	0.00038	0.00034	<0.00030	<0.00030	<0.00030

	Sample ID	L1921497-6	L1921497-7	L1921497-8	L1921497-9	L1921497-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17	02-MAY-17
	Sampled Time	08:25	08:45	08:50		
	Client ID	W17	W35	W15	DUP1	DUP2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	0.0000083	<0.0000050	0.0000069	0.0000073
	Molybdenum (Mo)-Dissolved (mg/L)	0.00545	0.000485	0.00203	0.000615	0.000551
	Nickel (Ni)-Dissolved (mg/L)	0.00062	0.00156	0.00082	0.00147	0.00164
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.64	1.74	4.52	1.82	1.90
	Selenium (Se)-Dissolved (mg/L)	0.000402	0.000113	0.00394	0.000118	0.000093
	Silicon (Si)-Dissolved (mg/L)	5.03	3.78	3.69	4.37	4.34
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	15.1	2.75	8.91	4.73	4.25
	Strontium (Sr)-Dissolved (mg/L)	0.736	0.113	0.832	0.181	0.169
	Sulfur (S)-Dissolved (mg/L)	17.9	2.20	30.2	3.20	2.82
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.00090	DLM <0.00090	0.00144	0.00081	0.00082
	Uranium (U)-Dissolved (mg/L)	0.00228	0.000048	0.00132	0.000372	0.000332
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00050	0.00050	0.00052
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0012	0.0034	0.0018	0.0015
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00034	<0.00030	0.00035	0.00037

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1921497-11				
	Description	WATER				
	Sampled Date	03-MAY-17				
	Sampled Time	08:15				
	Client ID	RO				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.000373				
	Nickel (Ni)-Dissolved (mg/L)	<0.00050				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	1.45				
	Selenium (Se)-Dissolved (mg/L)	0.000237				
	Silicon (Si)-Dissolved (mg/L)	0.065				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	45.2				
	Strontium (Sr)-Dissolved (mg/L)	0.0316				
	Sulfur (S)-Dissolved (mg/L)	1.68				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.000028				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0014				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1921497-11, -3, -4, -5, -6
Matrix Spike	Dissolved Organic Carbon	MS-B	L1921497-11, -3, -4, -5, -6
Matrix Spike	Dissolved Organic Carbon	MS-B	L1921497-1, -10, -2, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1921497-1, -10, -2, -7, -8, -9
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1921497-1, -10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1921497-1
Matrix Spike	Barium (Ba)-Total	MS-B	L1921497-10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1921497-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L1921497-10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1921497-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1921497-10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1921497-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L1921497-10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L1921497-1
Matrix Spike	Potassium (K)-Total	MS-B	L1921497-1
Matrix Spike	Sodium (Na)-Total	MS-B	L1921497-1
Matrix Spike	Sodium (Na)-Total	MS-B	L1921497-10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1921497-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L1921497-10, -11, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Total	MS-B	L1921497-1
Matrix Spike	Uranium (U)-Total	MS-B	L1921497-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

Reference Information

CL-IC-N-VA Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

Reference Information

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-05-03 B

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1921497-COFC

COC Number: 2017-05-03 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format /

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

n all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224162 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack
Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	MC1	2-May-17	7:45	Water	R	R	R	R	R	R	R	R	R					7
	W2	2-May-17	8:30	Water	R	R	R	R	R	R	R	R	R					7
	W3	2-May-17	8:00	Water	R	R	R	R	R	R	R	R	R					7
	W50	2-May-17	8:10	Water	R	R	R	R	R	R	R	R	R					7
	W16A	2-May-17	8:20	Water	R	R	R	R	R	R	R	R	R					7
	W17	2-May-17	8:25	Water	R	R	R	R	R	R	R	R	R					7
	W35	2-May-17	8:45	Water	R	R	R	R	R	R	R	R	R					7
	W15	2-May-17	8:50	Water	R	R	R	R	R	R	R	R	R					7
	DUP1	2-May-17		Water	R	R	R	R	R	R	R	R	R					7
	DUP2	2-May-17		Water	R	R	R	R	R	R	R	R	R					7
	RO	3-May-17	8:15	Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples [illegible]ent use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☑ Ice Cubes ☐
Cooling Initiated ☑
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-05-03 7:00	Time:	Received by: LHF	Date: 4 May 2017	Time: 09:15	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION
WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	10-MAY-17
Report Date:	19-MAY-17 17:45 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1924462

Project P.O. #:	224162 (WUL)
Job Reference:	
C of C Numbers:	2017-05-10A
Legal Site Desc:	

Shane Stack
Account Manager

	Sample ID	L1924462-1	L1924462-2	L1924462-3	L1924462-4	L1924462-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17
	Sampled Time	07:30	07:35	07:45	07:50	08:20
	Client ID	W3	W50	W16A	W17	W35
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	390	357	362	486	143
	Hardness (as CaCO3) (mg/L)	173	149	154	224	76.2
	pH (pH)	8.08	8.10	8.06	8.24	7.76
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	221	204	203	276	77.5
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	145	126	121	201	61.7
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	145	126	121	201	61.7
	Ammonia, Total (as N) (mg/L)	0.0121	0.0598	0.0798	0.0237	0.0132
	Chloride (Cl) (mg/L)	5.03	5.30	5.28	6.12	0.77
	Nitrate and Nitrite (as N) (mg/L)	1.60	2.12	2.13	0.530	0.711
	Nitrate (as N) (mg/L)	1.58	2.07	2.07	0.530	0.709
	Nitrite (as N) (mg/L)	0.0184	0.0504	0.0560	<0.0010	0.0021
	Sulfate (SO4) (mg/L)	46.8	46.4	46.2	51.4	5.43
	Anion Sum (meq/L)	4.14	3.78	3.68	5.31	1.42
	Cation Sum (meq/L)	4.12	3.62	3.74	5.21	1.70
	Cation - Anion Balance (%)	-0.2	-2.2	0.7	-0.9	9.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	11.0	9.90	10.1	6.98	41.9
Total Metals	Aluminum (Al)-Total (mg/L)	0.0307	0.0736	0.121	0.0053	0.0568
	Antimony (Sb)-Total (mg/L)	0.00013	<0.00010	<0.00010	0.00011	<0.00010
	Arsenic (As)-Total (mg/L)	0.00037	0.00032	0.00035	0.00037	0.00044
	Barium (Ba)-Total (mg/L)	0.0595	0.0566	0.0623	0.0681	0.0466
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.035	0.041	0.042	0.030	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000122	0.0000215	0.0000064	0.0000066
	Calcium (Ca)-Total (mg/L)	45.7	42.8	42.7	59.5	23.2
	Chromium (Cr)-Total (mg/L)	0.00017	0.00015	0.00020	0.00013	0.00043
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00016	<0.00010	0.00013
	Copper (Cu)-Total (mg/L)	0.0133	0.0280	0.0357	0.00644	0.0476
	Iron (Fe)-Total (mg/L)	0.085	0.187	0.279	<0.010	0.156
	Lead (Pb)-Total (mg/L)	<0.000050	0.000169	0.00139	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0015	<0.0010	0.0010	0.0014	<0.0010
	Magnesium (Mg)-Total (mg/L)	17.0	13.0	13.0	19.7	5.96
	Manganese (Mn)-Total (mg/L)	0.0362	0.119	0.289	0.0388	0.00813

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1924462-6	L1924462-7	L1924462-8	L1924462-9	L1924462-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17
	Sampled Time	08:35	08:55		13:50	08:20
	Client ID	W15	RO	DUP	MC1	W2
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	462	115	488	206	180
	Hardness (as CaCO3) (mg/L)	218	10.8	226	98.1	90.0
	pH (pH)	7.95	7.52	8.27	8.00	7.98
	Total Suspended Solids (mg/L)	11.8	<3.0	<3.0	67.0	4.8
	TDS (Calculated) (mg/L)	279	66.8	277	113	99.3
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	117	30.9	201	92.8	83.5
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	117	30.9	201	92.8	83.5
	Ammonia, Total (as N) (mg/L)	0.120	0.322	<0.0050	0.0108	0.0075
	Chloride (Cl) (mg/L)	1.92	1.43	6.11	1.67	1.36
	Nitrate and Nitrite (as N) (mg/L)	8.85	2.53	0.526	0.110	0.0265
	Nitrate (as N) (mg/L)	8.53	2.30	0.526	0.109	0.0265
	Nitrite (as N) (mg/L)	0.317	0.228	<0.0010	0.0013	<0.0010
	Sulfate (SO4) (mg/L)	80.5	11.8	51.3	13.7	9.97
	Anion Sum (meq/L)	4.69	1.08	5.30	2.20	1.92
	Cation Sum (meq/L)	4.80	1.07	5.25	2.28	2.08
	Cation - Anion Balance (%)	1.1	-0.9	-0.4	1.9	4.1
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	37.6	2.63	6.83	21.6	23.0
Total Metals	Aluminum (Al)-Total (mg/L)	0.214	0.0046	0.0081	0.122	0.0633
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00017	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00046	<0.00010	0.00037	0.00060	0.00060
	Barium (Ba)-Total (mg/L)	0.0676	0.00121	0.0707	0.0469	0.0422
	Beryllium (Be)-Total (mg/L)	0.000021	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.098	0.031	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000233	<0.0000050	0.0000066	0.0000116	0.0000131
	Calcium (Ca)-Total (mg/L)	62.5	3.53	63.3	26.5	24.0
	Chromium (Cr)-Total (mg/L)	0.00037	<0.00010	0.00018	0.00053	0.00042
	Cobalt (Co)-Total (mg/L)	0.00052	<0.00010	<0.00010	0.00021	0.00018
	Copper (Cu)-Total (mg/L)	0.0472	0.00101	0.00896	0.00715	0.00701
	Iron (Fe)-Total (mg/L)	0.535	<0.010	0.018	0.316	0.270
	Lead (Pb)-Total (mg/L)	0.000062	<0.000050	<0.000050	0.000051	<0.000050
	Lithium (Li)-Total (mg/L)	0.0012	<0.0010	0.0016	<0.0010	<0.0010
	Magnesium (Mg)-Total (mg/L)	17.4	0.70	20.4	9.54	8.28
	Manganese (Mn)-Total (mg/L)	0.276	0.00914	0.0493	0.0765	0.0310

	Sample ID	L1924462-1	L1924462-2	L1924462-3	L1924462-4	L1924462-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17
	Sampled Time	07:30	07:35	07:45	07:50	08:20
	Client ID	W3	W50	W16A	W17	W35
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000065
	Molybdenum (Mo)-Total (mg/L)	0.00342	0.00288	0.00283	0.00584	0.000649
	Nickel (Ni)-Total (mg/L)	0.00094	0.00063	0.00074	0.00063	0.00240
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.69	2.80	2.87	3.69	1.19
	Selenium (Se)-Total (mg/L)	0.000519	0.000616	0.000633	0.000342	0.000134
	Silicon (Si)-Total (mg/L)	3.96	3.32	3.42	4.95	3.89
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	14.5	13.2	13.4	15.0	3.26
	Strontium (Sr)-Total (mg/L)	0.491	0.463	0.457	0.692	0.124
	Sulfur (S)-Total (mg/L)	16.2	15.8	16.1	16.9	2.20
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00131	<0.0045 DLM	0.00591	<0.00030	<0.0024
	Uranium (U)-Total (mg/L)	0.00151	0.00104	0.00104	0.00230	0.000063
	Vanadium (V)-Total (mg/L)	0.00083	0.00070	0.00085	0.00058	0.00071
	Zinc (Zn)-Total (mg/L)	0.0030	<0.0030	<0.0030	<0.0030	0.0039
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00042
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0075	0.0125	0.0079	0.0017	0.0324
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00031	0.00025	0.00027	0.00031	0.00038
	Barium (Ba)-Dissolved (mg/L)	0.0574	0.0536	0.0610	0.0670	0.0447
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.035	0.038	0.039	0.028	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000095	0.0000193	<0.0000050	0.0000050
	Calcium (Ca)-Dissolved (mg/L)	42.0	39.1	40.3	57.3	20.8
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00061
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0112	0.0210	0.0256	0.00578	0.0415
	Iron (Fe)-Dissolved (mg/L)	0.047	0.062	0.073	<0.010	0.150
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.000074	0.000281	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0013	<0.0010	<0.0010	0.0013	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	16.5	12.6	13.0	19.7	5.91
	Manganese (Mn)-Dissolved (mg/L)	0.0295	0.0984	0.259	0.0114	0.00320

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1924462-6	L1924462-7	L1924462-8	L1924462-9	L1924462-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17
	Sampled Time	08:35	08:55		13:50	08:20
	Client ID	W15	RO	DUP	MC1	W2
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000061	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00212	0.00101	0.00604	0.00101	0.000794
	Nickel (Ni)-Total (mg/L)	0.00108	<0.00050	0.00068	0.00171	0.00171
	Phosphorus (P)-Total (mg/L)	0.083	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	3.56	1.95	3.86	1.61	1.55
	Selenium (Se)-Total (mg/L)	0.00322	0.000258	0.000378	0.000179	0.000125
	Silicon (Si)-Total (mg/L)	4.18	0.12	4.98	4.87	4.49
	Silver (Ag)-Total (mg/L)	0.000018	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	7.58	18.1	15.3	6.50	5.52
	Strontium (Sr)-Total (mg/L)	0.725	0.0797	0.699	0.233	0.204
	Sulfur (S)-Total (mg/L)	27.9	3.91	17.6	4.93	3.37
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00827	<0.00030	0.00035	0.00453	0.00213
	Uranium (U)-Total (mg/L)	0.00144	0.000076	0.00239	0.000681	0.000500
	Vanadium (V)-Total (mg/L)	0.00128	<0.00050	0.00061	0.00125	0.00100
	Zinc (Zn)-Total (mg/L)	0.0032	0.0038	<0.0030	<0.0030	0.0031
	Zirconium (Zr)-Total (mg/L)	0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0712	0.0023	0.0032	0.0174	0.0216
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00039	<0.00010	0.00031	0.00049	0.00052
	Barium (Ba)-Dissolved (mg/L)	0.0628	0.00108	0.0675	0.0444	0.0406
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.095	0.032	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000149	<0.0000050	<0.0000050	0.0000090	0.0000103
	Calcium (Ca)-Dissolved (mg/L)	58.6	3.20	58.3	24.2	22.4
	Chromium (Cr)-Dissolved (mg/L)	0.00021	<0.00010	<0.00010	0.00030	0.00051
	Cobalt (Co)-Dissolved (mg/L)	0.00045	<0.00010	<0.00010	0.00014	0.00014
	Copper (Cu)-Dissolved (mg/L)	0.0331	0.00061	0.00637	0.00609	0.00615
	Iron (Fe)-Dissolved (mg/L)	0.233	<0.010	<0.010	0.151	0.164
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0010	<0.0010	0.0015	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	17.3	0.67	19.6	9.18	8.25
	Manganese (Mn)-Dissolved (mg/L)	0.250	0.00813	0.0117	0.0568	0.0197

	Sample ID	L1924462-1	L1924462-2	L1924462-3	L1924462-4	L1924462-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17
	Sampled Time	07:30	07:35	07:45	07:50	08:20
	Client ID	W3	W50	W16A	W17	W35
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000053
	Molybdenum (Mo)-Dissolved (mg/L)	0.00347	0.00279	0.00277	0.00597	0.000601
	Nickel (Ni)-Dissolved (mg/L)	0.00074	0.00054	0.00061	0.00053	0.00173
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.54	2.68	2.84	3.48	1.12
	Selenium (Se)-Dissolved (mg/L)	0.000481	0.000567	0.000634	0.000356	0.000132
	Silicon (Si)-Dissolved (mg/L)	3.99	3.14	3.20	5.24	3.93
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	13.7	12.7	13.1	14.7	3.10
	Strontium (Sr)-Dissolved (mg/L)	0.512	0.463	0.455	0.712	0.120
	Sulfur (S)-Dissolved (mg/L)	17.0	15.7	16.2	18.8	2.10
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00089
	Uranium (U)-Dissolved (mg/L)	0.00132	0.000918	0.000899	0.00220	0.000057
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0010	0.0014	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00045

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1924462-6	L1924462-7	L1924462-8	L1924462-9	L1924462-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17	09-MAY-17
	Sampled Time	08:35	08:55		13:50	08:20
	Client ID	W15	RO	DUP	MC1	W2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	0.0000063	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00209	0.00100	0.00575	0.000981	0.000761
	Nickel (Ni)-Dissolved (mg/L)	0.00088	<0.00050	0.00054	0.00132	0.00153
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.42	1.91	3.68	1.50	1.49
	Selenium (Se)-Dissolved (mg/L)	0.00313	0.000306	0.000362	0.000155	0.000127
	Silicon (Si)-Dissolved (mg/L)	4.06	0.099	5.19	4.58	4.31
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	7.45	17.9	14.8	6.20	5.32
	Strontium (Sr)-Dissolved (mg/L)	0.743	0.0768	0.713	0.233	0.199
	Sulfur (S)-Dissolved (mg/L)	29.4	4.04	18.5	5.00	3.49
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00143	<0.00030	<0.00030	DLM <0.00060	0.00071
	Uranium (U)-Dissolved (mg/L)	0.00132	0.000071	0.00220	0.000642	0.000470
	Vanadium (V)-Dissolved (mg/L)	0.00063	<0.00050	<0.00050	0.00069	0.00064
	Zinc (Zn)-Dissolved (mg/L)	0.0038	0.0024	0.0014	0.0017	0.0012
	Zirconium (Zr)-Dissolved (mg/L)	0.00038	<0.00030	<0.00030	0.00030	0.00034

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1924462-1, -10, -2, -3, -4, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1924462-1, -10, -2, -3, -4, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1924462-1, -10, -2, -3, -4, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1924462-5, -6
Matrix Spike	Dissolved Organic Carbon	MS-B	L1924462-5, -6
Matrix Spike	Dissolved Organic Carbon	MS-B	L1924462-5, -6
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Total	MS-B	L1924462-1, -10, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-05-10A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1924462-COFC

COC Number: 2017-05-10A

Page of

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

...m all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days)	4 day [P4] ☐	EMERGENCY	1 Business day [E1] ☐
	3 day [P3] ☐		Same Day, Weekend or Statutory holiday [E0] ☐
	2 day [P2] ☐		
Date and Time Required for all E&P TATs:	dd-mmm-yy hh:mm		

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224162 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact: Shane Stack	Sampler: SB/EB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W3	9-May-17	7:30	Water	R	R	R	R	R	R	R	R	R					7
2	W50	9-May-17	7:35		R	R	R	R	R	R	R	R	R					7
3	W16A	9-May-17	7:45		R	R	R	R	R	R	R	R	R					7
4	W17	9-May-17	7:50		R	R	R	R	R	R	R	R	R					7
5	W35	9-May-17	8:20		R	R	R	R	R	R	R	R	R					7
6	W15	9-May-17	8:35		R	R	R	R	R	R	R	R	R					7
7	RO	9-May-17	8:55		R	R	R	R	R	R	R	R	R					7
8	DUP	9-May-17			R	R	R	R	R	R	R	R	R					7
9	MC2	9-May-17	13:50		R	R	R	R	R	R	R	R	R					7
10	W2	9-May-17	8:20		R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)	**Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)**
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	
Are samples for human drinking water use? ☐ YES ☑ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐ No ☐
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated ☐			

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4.2.					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017/05/10	Time: 11:00	Received by: VD	Date: May 10/17	Time: 15:40	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 17-MAY-17
Report Date: 30-MAY-17 16:45 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1928294

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-05-17 C
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1928294-1	L1928294-2	L1928294-3	L1928294-4	L1928294-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	16-MAY-17	16-MAY-17	16-MAY-17	16-MAY-17	16-MAY-17
	Sampled Time	09:10	10:00	08:50	09:15	10:40
	Client ID	W16A	W3	W7	W50	W2
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	323	367	149	324	207
	Hardness (as CaCO3) (mg/L)	145	170	78.4	154	107
	pH (pH)	8.24	8.32	8.00	8.24	8.13
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	<3.0	6.7
	TDS (Calculated) (mg/L)	196	219	83.5	200	120
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	115	140	76.3	115	98.6
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	2.8	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	115	143	76.3	115	98.6
	Ammonia, Total (as N) (mg/L)	0.0445	0.0069	0.0070	0.0349	0.0062
	Chloride (Cl) (mg/L)	4.94	4.88	0.56	4.96	1.69
	Nitrate and Nitrite (as N) (mg/L)	2.17	1.58	<0.0051	2.16	0.0935
	Nitrate (as N) (mg/L)	2.09	1.56	0.0050	2.09	0.0935
	Nitrite (as N) (mg/L)	0.0764	0.0137	<0.0010	0.0628	<0.0010
	Sulfate (SO4) (mg/L)	44.8	46.3	4.32	44.9	13.6
	Anion Sum (meq/L)	3.53	4.07	1.63	3.53	2.31
	Cation Sum (meq/L)	3.56	4.08	1.81	3.76	2.46
	Cation - Anion Balance (%)	0.4	0.2	5.3	3.1	3.2
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.1	30.0	25.6	12.1	20.7
Total Metals	Aluminum (Al)-Total (mg/L)	0.0794	0.0210	0.0412	0.0553	0.157
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00010	<0.00010	0.00011	0.00012
	Arsenic (As)-Total (mg/L)	0.00027	0.00030	0.00049	0.00032	0.00068
	Barium (Ba)-Total (mg/L)	0.0544	0.0586	0.0411	0.0532	0.0494
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.043	0.038	<0.010	0.045	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000175	<0.0000050	0.0000082	0.0000113	0.0000158
	Calcium (Ca)-Total (mg/L)	35.4	42.0	19.1	36.9	26.7
	Chromium (Cr)-Total (mg/L)	0.00033	0.00016	0.00054	0.00023	0.00065
	Cobalt (Co)-Total (mg/L)	0.00013	<0.00010	0.00021	<0.00010	0.00024
	Copper (Cu)-Total (mg/L)	0.0291	0.0138	0.00620	0.0252	0.00705
	Iron (Fe)-Total (mg/L)	0.197	0.069	0.233	0.142	0.438
	Lead (Pb)-Total (mg/L)	0.000191	<0.000050	<0.000050	0.000118	0.000083
	Lithium (Li)-Total (mg/L)	<0.0010	0.0016	<0.0010	0.0012	0.0013
	Magnesium (Mg)-Total (mg/L)	11.2	16.1	7.42	11.5	9.40
	Manganese (Mn)-Total (mg/L)	0.196	0.0279	0.0331	0.111	0.0350

	Sample ID	L1928294-6				
	Description	WATER				
	Sampled Date	16-MAY-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	208				
	Hardness (as CaCO3) (mg/L)	108				
	pH (pH)	8.18				
	Total Suspended Solids (mg/L)	7.3				
	TDS (Calculated) (mg/L)	119				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	97.1				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	97.1				
	Ammonia, Total (as N) (mg/L)	<0.0050				
	Chloride (Cl) (mg/L)	1.68				
	Nitrate and Nitrite (as N) (mg/L)	0.0933				
	Nitrate (as N) (mg/L)	0.0933				
	Nitrite (as N) (mg/L)	<0.0010				
	Sulfate (SO4) (mg/L)	13.6				
	Anion Sum (meq/L)	2.28				
	Cation Sum (meq/L)	2.48				
	Cation - Anion Balance (%)	4.4				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	20.4				
Total Metals	Aluminum (Al)-Total (mg/L)	0.144				
	Antimony (Sb)-Total (mg/L)	0.00011				
	Arsenic (As)-Total (mg/L)	0.00066				
	Barium (Ba)-Total (mg/L)	0.0490				
	Beryllium (Be)-Total (mg/L)	<0.000020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	<0.010				
	Cadmium (Cd)-Total (mg/L)	0.0000113				
	Calcium (Ca)-Total (mg/L)	25.1				
	Chromium (Cr)-Total (mg/L)	0.00060				
	Cobalt (Co)-Total (mg/L)	0.00023				
	Copper (Cu)-Total (mg/L)	0.00593				
	Iron (Fe)-Total (mg/L)	0.432				
	Lead (Pb)-Total (mg/L)	0.000070				
	Lithium (Li)-Total (mg/L)	0.0011				
	Magnesium (Mg)-Total (mg/L)	9.64				
	Manganese (Mn)-Total (mg/L)	0.0379				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1928294-1	L1928294-2	L1928294-3	L1928294-4	L1928294-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	16-MAY-17	16-MAY-17	16-MAY-17	16-MAY-17	16-MAY-17
	Sampled Time	09:10	10:00	08:50	09:15	10:40
	Client ID	W16A	W3	W7	W50	W2
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00255	0.00342	0.000812	0.00285	0.00108
	Nickel (Ni)-Total (mg/L)	0.00074	0.00090	0.00177	0.00064	0.00178
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.64	2.52	0.82	2.64	1.35
	Selenium (Se)-Total (mg/L)	0.000609	0.000537	0.000131	0.000627	0.000178
	Silicon (Si)-Total (mg/L)	2.89	3.77	4.82	2.84	4.77
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	13.7	14.7	4.77	13.6	6.48
	Strontium (Sr)-Total (mg/L)	0.379	0.486	0.166	0.431	0.243
	Sulfur (S)-Total (mg/L)	15.1	16.8	1.76	15.8	4.78
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00348	0.00162	0.00113	0.00187	0.00583
	Uranium (U)-Total (mg/L)	0.000781	0.00130	0.000400	0.000851	0.000667
	Vanadium (V)-Total (mg/L)	<0.00050	0.00057	0.00085	0.00053	0.00131
	Zinc (Zn)-Total (mg/L)	0.0030	<0.0030	<0.0030	<0.0030	0.0056
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00035	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0093	0.0080	0.0279	0.0081	0.0173
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00030	0.00030	0.00049	0.00030	0.00053
	Barium (Ba)-Dissolved (mg/L)	0.0555	0.0620	0.0413	0.0539	0.0463
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.048	0.039	<0.010	0.050	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000273	0.0000051	0.0000084	0.0000115	0.0000104
	Calcium (Ca)-Dissolved (mg/L)	41.0	44.5	19.8	43.8	28.4
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00011	0.00038	<0.00010	0.00033
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00019	<0.00010	0.00012
	Copper (Cu)-Dissolved (mg/L)	0.0237	0.0124	0.00568	0.0227	0.00499
	Iron (Fe)-Dissolved (mg/L)	0.068	0.039	0.170	0.064	0.159
	Lead (Pb)-Dissolved (mg/L)	0.000095	<0.000050	<0.000050	0.000072	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	10.5	14.4	7.00	10.8	8.85
	Manganese (Mn)-Dissolved (mg/L)	0.154	0.0165	0.0314	0.0820	0.0126

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1928294-6				
	Description	WATER				
	Sampled Date	16-MAY-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050				
	Molybdenum (Mo)-Total (mg/L)	0.00103				
	Nickel (Ni)-Total (mg/L)	0.00181				
	Phosphorus (P)-Total (mg/L)	<0.050				
	Potassium (K)-Total (mg/L)	1.36				
	Selenium (Se)-Total (mg/L)	0.000165				
	Silicon (Si)-Total (mg/L)	4.92				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	6.61				
	Strontium (Sr)-Total (mg/L)	0.235				
	Sulfur (S)-Total (mg/L)	4.93				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	0.00514				
	Uranium (U)-Total (mg/L)	0.000638				
	Vanadium (V)-Total (mg/L)	0.00127				
	Zinc (Zn)-Total (mg/L)	<0.0030				
	Zirconium (Zr)-Total (mg/L)	<0.00030				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0204				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00057				
	Barium (Ba)-Dissolved (mg/L)	0.0471				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	<0.010				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000069				
	Calcium (Ca)-Dissolved (mg/L)	28.0				
	Chromium (Cr)-Dissolved (mg/L)	0.00033				
	Cobalt (Co)-Dissolved (mg/L)	0.00014				
	Copper (Cu)-Dissolved (mg/L)	0.00563				
	Iron (Fe)-Dissolved (mg/L)	0.157				
	Lead (Pb)-Dissolved (mg/L)	0.000088				
	Lithium (Li)-Dissolved (mg/L)	<0.0010				
	Magnesium (Mg)-Dissolved (mg/L)	9.16				
	Manganese (Mn)-Dissolved (mg/L)	0.0128				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1928294-1	L1928294-2	L1928294-3	L1928294-4	L1928294-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	16-MAY-17	16-MAY-17	16-MAY-17	16-MAY-17	16-MAY-17
	Sampled Time	09:10	10:00	08:50	09:15	10:40
	Client ID	W16A	W3	W7	W50	W2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00275	0.00331	0.000846	0.00295	0.00106
	Nickel (Ni)-Dissolved (mg/L)	0.00059	0.00081	0.00175	0.00065	0.00156
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.62	2.53	0.87	2.73	1.34
	Selenium (Se)-Dissolved (mg/L)	0.000608	0.000472	0.000141	0.000587	0.000155
	Silicon (Si)-Dissolved (mg/L)	2.63	3.47	4.75	2.73	4.56
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	13.1	14.1	4.88	13.8	6.26
	Strontium (Sr)-Dissolved (mg/L)	0.436	0.481	0.169	0.466	0.240
	Sulfur (S)-Dissolved (mg/L)	14.4	14.1	1.54	14.3	4.40
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00038	<0.00030	0.00060	0.00038	DLM <0.00060
	Uranium (U)-Dissolved (mg/L)	0.000823	0.00124	0.000410	0.000856	0.000635
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00068	<0.00050	0.00068
	Zinc (Zn)-Dissolved (mg/L)	0.0021	0.0019	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00043	<0.00030	0.00031

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1928294-6				
	Description	WATER				
	Sampled Date	16-MAY-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00107				
	Nickel (Ni)-Dissolved (mg/L)	0.00156				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	1.35				
	Selenium (Se)-Dissolved (mg/L)	0.000135				
	Silicon (Si)-Dissolved (mg/L)	4.50				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	6.62				
	Strontium (Sr)-Dissolved (mg/L)	0.238				
	Sulfur (S)-Dissolved (mg/L)	4.43				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	0.00063				
	Uranium (U)-Dissolved (mg/L)	0.000669				
	Vanadium (V)-Dissolved (mg/L)	0.00067				
	Zinc (Zn)-Dissolved (mg/L)	<0.0010				
	Zirconium (Zr)-Dissolved (mg/L)	0.00031				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Dissolved Organic Carbon	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Aluminum (Al)-Total	MS-B	L1928294-1
Matrix Spike	Barium (Ba)-Total	MS-B	L1928294-2
Matrix Spike	Barium (Ba)-Total	MS-B	L1928294-3, -4, -5, -6
Matrix Spike	Barium (Ba)-Total	MS-B	L1928294-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L1928294-2
Matrix Spike	Calcium (Ca)-Total	MS-B	L1928294-3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L1928294-1
Matrix Spike	Copper (Cu)-Total	MS-B	L1928294-1
Matrix Spike	Iron (Fe)-Total	MS-B	L1928294-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1928294-2
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1928294-3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1928294-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L1928294-3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L1928294-1
Matrix Spike	Sodium (Na)-Total	MS-B	L1928294-2
Matrix Spike	Sodium (Na)-Total	MS-B	L1928294-3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1928294-2
Matrix Spike	Strontium (Sr)-Total	MS-B	L1928294-3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1928294-1
Matrix Spike	Sulfur (S)-Total	MS-B	L1928294-2
Matrix Spike	Titanium (Ti)-Total	MS-B	L1928294-1
Matrix Spike	Nitrite (as N)	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Nitrate (as N)	MS-B	L1928294-1, -2, -3, -4, -5, -6
Matrix Spike	Sulfate (SO4)	MS-B	L1928294-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Reference Information

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA Water Dissolved organic carbon by combustion APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-WR Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

Reference Information

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SO4-IC-N-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-05-17 C

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1928294-COFC

COC Number: 2017-05-17 C

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Di

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** SR/SB/DF

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
✓	W16A	16-May-17	9:10	Water	R	R	R	R	R	R	R	R	R					7
✓	W3	16-May-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
✓	W7	16-May-17	8:50	Water	R	R	R	R	R	R	R	R	R					7
✓	W50	16-May-17	9:15	Water	R	R	R	R	R	R	R	R	R					7
✓	W2	16-May-17	10:40	Water	R	R	R	R	R	R	R	R	R					7
✓	DUP	16-May-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
15.5/6.0			10	9	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-05-17 C	Time: 11:30	Received by: EHF	Date: 17 May 2017	Time: 16:00	Received by: JC	Date: MAY 19 2017	Time: 11:30 AM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2016 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	24-MAY-17
Report Date:	01-JUN-17 18:26 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1930879

Project P.O. #:	224162 (WUL)
Job Reference:	
C of C Numbers:	2017-05-24 A
Legal Site Desc:	

Shane Stack
Account Manager

	Sample ID	L1930879-1	L1930879-2	L1930879-3	L1930879-4	L1930879-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	22-MAY-17	23-MAY-17	23-MAY-17	23-MAY-17	23-MAY-17
	Sampled Time	17:00	07:25	08:00	08:40	11:05
	Client ID	W55	W3	W50	W16A	MC1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	140	380	336	336	253
	Hardness (as CaCO3) (mg/L)	87.9	180	150	149	127
	pH (pH)	7.84	8.13	8.18	8.25	8.11
	Total Suspended Solids (mg/L)	4.4	9.4	4.4	<3.0	31.6
	TDS (Calculated) (mg/L)	79.9	225	197	199	146
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	70.1	146	116	118	116
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	70.1	146	116	118	116
	Ammonia, Total (as N) (mg/L)	0.0134	0.0218	0.0164	0.0123	0.0071
	Chloride (Cl) (mg/L)	<2.5 DLDS	4.98	5.00	5.00	2.01
	Nitrate and Nitrite (as N) (mg/L)	<0.025	1.43	1.95	1.93	0.248
	Nitrate (as N) (mg/L)	<0.025 DLDS	1.42	1.90	1.92	0.247
	Nitrite (as N) (mg/L)	<0.0050 DLDS	0.0100	0.0487	0.0111	0.0012
	Sulfate (SO4) (mg/L)	2.4	47.3	45.6	45.7	19.3
	Anion Sum (meq/L)	1.45	4.14	3.55	3.59	2.79
	Cation Sum (meq/L)	1.92	4.33	3.64	3.64	2.95
	Cation - Anion Balance (%)	13.9	2.2	1.4	0.7	2.7
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		12.2	13.3	13.5	15.9
Total Metals	Aluminum (Al)-Total (mg/L)	0.180	0.189	0.0427	0.0486	0.674
	Antimony (Sb)-Total (mg/L)	0.00012	<0.00010	<0.00010	<0.00010	0.00011
	Arsenic (As)-Total (mg/L)	0.00075	0.00038	0.00032	0.00032	0.00093
	Barium (Ba)-Total (mg/L)	0.0558	0.0604	0.0542	0.0547	0.0661
	Beryllium (Be)-Total (mg/L)	0.000048	<0.000020	<0.000020	<0.000020	0.000034
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.037	0.043	0.044	0.010
	Cadmium (Cd)-Total (mg/L)	0.0000207	0.0000122	0.0000109	0.0000153	0.0000170
	Calcium (Ca)-Total (mg/L)	26.0	42.8	40.5	39.7	32.3
	Chromium (Cr)-Total (mg/L)	0.00167	0.00041	0.00016	0.00016	0.00160
	Cobalt (Co)-Total (mg/L)	0.00015	0.00018	0.00012	0.00014	0.00076
	Copper (Cu)-Total (mg/L)	0.108	0.0159	0.0252	0.0277	0.00729
	Iron (Fe)-Total (mg/L)	0.347	0.306	0.140	0.181	1.31
	Lead (Pb)-Total (mg/L)	0.000117	0.000106	0.000091	0.000079	0.000299
	Lithium (Li)-Total (mg/L)	0.0011	0.0018	<0.0010	<0.0010	0.0011
	Magnesium (Mg)-Total (mg/L)	5.52	14.4	10.7	11.1	11.0
	Manganese (Mn)-Total (mg/L)	0.0123	0.256	0.109	0.143	0.124

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1930879-6	L1930879-7			
	Description	WATER	WATER			
	Sampled Date	23-MAY-17	24-MAY-17			
	Sampled Time		10:05			
	Client ID	DUP	W2			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	379	338			
	Hardness (as CaCO3) (mg/L)	177	171			
	pH (pH)	8.13	8.25			
	Total Suspended Solids (mg/L)	10.6	10.0			
	TDS (Calculated) (mg/L)	224	197			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	146	162			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	146	162			
	Ammonia, Total (as N) (mg/L)	0.0207	0.0336			
	Chloride (Cl) (mg/L)	4.98	2.92			
	Nitrate and Nitrite (as N) (mg/L)	1.44	0.137			
	Nitrate (as N) (mg/L)	1.43	0.136			
	Nitrite (as N) (mg/L)	0.0102	0.0013			
	Sulfate (SO4) (mg/L)	47.4	24.4			
	Anion Sum (meq/L)	4.14	3.84			
	Cation Sum (meq/L)	4.25	3.96			
	Cation - Anion Balance (%)	1.2	1.5			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.1	13.7			
Total Metals	Aluminum (Al)-Total (mg/L)	0.189	0.142			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00037	0.00094			
	Barium (Ba)-Total (mg/L)	0.0623	0.0681			
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	0.037	<0.010			
	Cadmium (Cd)-Total (mg/L)	0.0000118	0.0000136			
	Calcium (Ca)-Total (mg/L)	43.3	41.3			
	Chromium (Cr)-Total (mg/L)	0.00036	0.00057			
	Cobalt (Co)-Total (mg/L)	0.00021	0.00026			
	Copper (Cu)-Total (mg/L)	0.0162	0.00393			
	Iron (Fe)-Total (mg/L)	0.322	0.696			
	Lead (Pb)-Total (mg/L)	0.000105	0.000115			
	Lithium (Li)-Total (mg/L)	0.0013	<0.0010			
	Magnesium (Mg)-Total (mg/L)	14.8	14.3			
	Manganese (Mn)-Total (mg/L)	0.256	0.0552			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1930879-1	L1930879-2	L1930879-3	L1930879-4	L1930879-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	22-MAY-17	23-MAY-17	23-MAY-17	23-MAY-17	23-MAY-17
	Sampled Time	17:00	07:25	08:00	08:40	11:05
	Client ID	W55	W3	W50	W16A	MC1
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000107	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00143	0.00391	0.00292	0.00291	0.00152
	Nickel (Ni)-Total (mg/L)	0.00228	0.00125	0.00075	0.00079	0.00287
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	0.072
	Potassium (K)-Total (mg/L)	1.10	2.45	2.46	2.50	1.44
	Selenium (Se)-Total (mg/L)	0.000260	0.000436	0.000540	0.000568	0.000220
	Silicon (Si)-Total (mg/L)	4.48	3.69	2.56	2.57	5.96
	Silver (Ag)-Total (mg/L)	0.000013	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	2.84	14.2	13.6	13.6	8.70
	Strontium (Sr)-Total (mg/L)	0.191	0.504	0.439	0.446	0.312
	Sulfur (S)-Total (mg/L)	1.21	15.4	15.7	15.6	6.80
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00730	0.00825	0.00150	0.00223	0.0346
	Uranium (U)-Total (mg/L)	0.000336	0.00149	0.000776	0.000763	0.00106
	Vanadium (V)-Total (mg/L)	0.00132	0.00092	<0.00050	<0.00050	0.00320
	Zinc (Zn)-Total (mg/L)	0.0033	<0.0030	<0.0030	<0.0030	0.0044
	Zirconium (Zr)-Total (mg/L)	0.00063	<0.00030	<0.00030	<0.00030	0.00036
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0678	0.0050	0.0062	0.0068	0.0100
	Antimony (Sb)-Dissolved (mg/L)	0.00011	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00068	0.00031	0.00028	0.00027	0.00057
	Barium (Ba)-Dissolved (mg/L)	0.0565	0.0621	0.0549	0.0557	0.0549
	Beryllium (Be)-Dissolved (mg/L)	0.000042	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.036	0.042	0.041	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000165	<0.0000050	0.0000076	0.0000092	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	25.6	45.6	41.4	41.1	32.3
	Chromium (Cr)-Dissolved (mg/L)	0.00039	0.00025	0.00011	0.00011	0.00027
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00015
	Copper (Cu)-Dissolved (mg/L)	0.101	0.0130	0.0221	0.0242	0.00384
	Iron (Fe)-Dissolved (mg/L)	0.144	0.048	0.062	0.073	0.145
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	0.000158	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0013	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	5.82	16.1	11.3	11.3	11.3
	Manganese (Mn)-Dissolved (mg/L)	0.00584	0.204	0.0262	0.0353	0.0434

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1930879-6	L1930879-7			
	Description	WATER	WATER			
	Sampled Date	23-MAY-17	24-MAY-17			
	Sampled Time		10:05			
	Client ID	DUP	W2			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00386	0.00167			
	Nickel (Ni)-Total (mg/L)	0.00129	0.00155			
	Phosphorus (P)-Total (mg/L)	<0.050	0.052			
	Potassium (K)-Total (mg/L)	2.41	1.64			
	Selenium (Se)-Total (mg/L)	0.000477	0.000182			
	Silicon (Si)-Total (mg/L)	3.79	5.97			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	14.7	11.0			
	Strontium (Sr)-Total (mg/L)	0.520	0.401			
	Sulfur (S)-Total (mg/L)	16.2	8.88			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00838	0.00634			
	Uranium (U)-Total (mg/L)	0.00128	0.00133			
	Vanadium (V)-Total (mg/L)	0.00100	0.00153			
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030			
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0052	0.0097			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00029	0.00072			
	Barium (Ba)-Dissolved (mg/L)	0.0620	0.0687			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.035	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000052	0.0000073			
	Calcium (Ca)-Dissolved (mg/L)	45.3	43.4			
	Chromium (Cr)-Dissolved (mg/L)	0.00011	0.00025			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00014			
	Copper (Cu)-Dissolved (mg/L)	0.0128	0.00305			
	Iron (Fe)-Dissolved (mg/L)	0.048	0.338			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0012	<0.0010			
	Magnesium (Mg)-Dissolved (mg/L)	15.5	15.2			
	Manganese (Mn)-Dissolved (mg/L)	0.205	0.0336			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1930879-1	L1930879-2	L1930879-3	L1930879-4	L1930879-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	22-MAY-17	23-MAY-17	23-MAY-17	23-MAY-17	23-MAY-17
	Sampled Time	17:00	07:25	08:00	08:40	11:05
	Client ID	W55	W3	W50	W16A	MC1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	0.0000100	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00125	0.00353	0.00271	0.00266	0.00147
	Nickel (Ni)-Dissolved (mg/L)	0.00219	0.00094	0.00070	0.00070	0.00136
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.10	2.64	2.62	2.66	1.42
	Selenium (Se)-Dissolved (mg/L)	0.000318	0.000493	0.000618	0.000633	0.000210
	Silicon (Si)-Dissolved (mg/L)	4.69	3.69	2.53	2.52	5.05
	Silver (Ag)-Dissolved (mg/L)	0.000011	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	2.60	14.9	13.2	13.5	8.41
	Strontium (Sr)-Dissolved (mg/L)	0.181	0.517	0.447	0.442	0.307
	Sulfur (S)-Dissolved (mg/L)	1.16	16.2	15.1	15.3	6.53
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00198	<0.00030	0.00032	<0.00030	0.00047
	Uranium (U)-Dissolved (mg/L)	0.000311	0.00128	0.000798	0.000797	0.00104
	Vanadium (V)-Dissolved (mg/L)	0.00092	<0.00050	<0.00050	<0.00050	0.00080
	Zinc (Zn)-Dissolved (mg/L)	0.0013	<0.0010	0.0011	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	0.00053	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1930879-6	L1930879-7			
	Description	WATER	WATER			
	Sampled Date	23-MAY-17	24-MAY-17			
	Sampled Time		10:05			
	Client ID	DUP	W2			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00361	0.00157			
	Nickel (Ni)-Dissolved (mg/L)	0.00096	0.00130			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.59	1.74			
	Selenium (Se)-Dissolved (mg/L)	0.000494	0.000161			
	Silicon (Si)-Dissolved (mg/L)	3.54	6.03			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	14.4	10.8			
	Strontium (Sr)-Dissolved (mg/L)	0.518	0.417			
	Sulfur (S)-Dissolved (mg/L)	15.7	8.60			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00062			
	Uranium (U)-Dissolved (mg/L)	0.00133	0.00135			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00096			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1930879-2, -3, -4, -5, -6, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1930879-2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1930879-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1930879-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1930879-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1930879-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1930879-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1930879-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Reference Information

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-05-24 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Request Form

Canada Toll Free: 1 800 668 9878

L1930879-COFC

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report For**…	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
Company address below will appear on the final report		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

…se confirm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply			
PRIORITY (Business Days)	4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐	EMERGENCY	1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐	
Date and Time Required for all E&P TATs:	dd-mmm-yy hh:mm			

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224162 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact: Shane Stack	Sampler: CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or C… (This description will appe…	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preserve	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved)	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)					Number of Containers
1	W55	22-May-17	17:00	Water	R	R	R	R	R	R	R	R						6
2	W3	23-May-17	7:25	Water	R	R	R	R	R	R	R	R	R					7
3	W50	23-May-17	8:00	Water	R	R	R	R	R	R	R	R	R					7
4	W16A	23-May-17	8:40	Water	R	R	R	R	R	R	R	R	R					7
5	MC1	23-May-17	11:05	Water	R	R	R	R	R	R	R	R	R					7
6	DUP	23-May-17		Water	R	R	R	R	R	R	R	R	R					7
7	W2	24-May-17	10:05	Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)	**Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)**
Are samples taken from a Regulated DW System? ☐ YES ☑ NO	
Are samples for human drinking water use? ☐ YES ☑ NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐	No ☐	
Ice Packs ☑	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated ☑					
INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0/10.0					

SHIPMENT RELEASE (client use)			**INITIAL SHIPMENT RECEPTION (lab use only)**			**FINAL SHIPMENT RECEPTION (lab use only)**		
Released by: Chris Harry	Date: 2017-05-24 10:00	Time:	Received by: EHF	Date: 24 May 2017	Time: 15:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-JUN-17
Report Date: 13-JUN-17 17:50 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1935320
Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-05-31 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1935320-1	L1935320-2	L1935320-3	L1935320-4	L1935320-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-MAY-17	30-MAY-17	30-MAY-17	30-MAY-17	30-MAY-17
	Sampled Time	08:30	10:55	15:45	16:25	
	Client ID	W3	MC1	W50	W16A	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	408	284	342	342	421
	Hardness (as CaCO3) (mg/L)	180	128	146	145	186
	pH (pH)	8.18	8.22	8.29	8.33	8.29
	Total Suspended Solids (mg/L)	3.4	6.6	<3.0	5.4	<3.0
	TDS (Calculated) (mg/L)	231	155	194	195	237
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	164	121	120	119	170
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	2.4	1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	164	121	120	122	171
	Ammonia, Total (as N) (mg/L)	0.0133	0.0349	0.0182	0.0081	0.0116
	Chloride (Cl) (mg/L)	4.63	2.46	4.83	4.81	4.62
	Nitrate and Nitrite (as N) (mg/L)	0.917	0.446	1.80	1.79	0.905
	Nitrate (as N) (mg/L)	0.912	0.444	1.77	1.75	0.901
	Nitrite (as N) (mg/L)	0.0048	0.0027	0.0356	0.0391	0.0040
	Sulfate (SO4) (mg/L)	46.5	23.1	43.7	43.6	46.5
	Anion Sum (meq/L)	4.44	3.00	3.57	3.60	4.57
	Cation Sum (meq/L)	4.26	3.00	3.53	3.52	4.40
	Cation - Anion Balance (%)	-2.1	0.1	-0.6	-1.1	-1.9
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.3	15.5	14.7	14.5	12.2
Total Metals	Aluminum (Al)-Total (mg/L)	0.201	2.29	0.124	0.0948	0.293
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00020	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00038	0.00199	0.00038	0.00036	0.00049
	Barium (Ba)-Total (mg/L)	0.0640	0.0985	0.0551	0.0582	0.0726
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000076	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.029	0.013	0.033	0.034	0.029
	Cadmium (Cd)-Total (mg/L)	0.0000098	0.0000419	0.0000142	0.0000123	0.0000182
	Calcium (Ca)-Total (mg/L)	42.0	31.1	35.1	34.7	41.4
	Chromium (Cr)-Total (mg/L)	0.00041	0.00456	0.00025	0.00025	0.00051
	Cobalt (Co)-Total (mg/L)	0.00019	0.00167	0.00014	0.00013	0.00061
	Copper (Cu)-Total (mg/L)	0.0153	0.0114	0.0333	0.0325	0.0238
	Iron (Fe)-Total (mg/L)	0.328	3.74	0.263	0.242	0.582
	Lead (Pb)-Total (mg/L)	0.000121	0.00115	0.000530	0.000297	0.000233
	Lithium (Li)-Total (mg/L)	0.0014	0.0022	<0.0010	<0.0010	0.0014
	Magnesium (Mg)-Total (mg/L)	16.4	11.6	10.9	11.1	16.8
	Manganese (Mn)-Total (mg/L)	0.136	0.283	0.148	0.101	0.280

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1935320-6				
	Description	Water				
	Sampled Date	31-MAY-17				
	Sampled Time	07:35				
	Client ID	W2				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	269				
	Hardness (as CaCO3) (mg/L)	123				
	pH (pH)	8.23				
	Total Suspended Solids (mg/L)	3.4				
	TDS (Calculated) (mg/L)	147				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	119				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	119				
	Ammonia, Total (as N) (mg/L)	0.0052				
	Chloride (Cl) (mg/L)	2.08				
	Nitrate and Nitrite (as N) (mg/L)	0.257				
	Nitrate (as N) (mg/L)	0.255				
	Nitrite (as N) (mg/L)	0.0016				
	Sulfate (SO4) (mg/L)	19.8				
	Anion Sum (meq/L)	2.88				
	Cation Sum (meq/L)	2.88				
	Cation - Anion Balance (%)	0.0				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	14.8				
Total Metals	Aluminum (Al)-Total (mg/L)	0.710				
	Antimony (Sb)-Total (mg/L)	0.00015				
	Arsenic (As)-Total (mg/L)	0.00106				
	Barium (Ba)-Total (mg/L)	0.0636				
	Beryllium (Be)-Total (mg/L)	<0.000020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	<0.010				
	Cadmium (Cd)-Total (mg/L)	0.0000181				
	Calcium (Ca)-Total (mg/L)	27.7				
	Chromium (Cr)-Total (mg/L)	0.00156				
	Cobalt (Co)-Total (mg/L)	0.00056				
	Copper (Cu)-Total (mg/L)	0.00592				
	Iron (Fe)-Total (mg/L)	1.30				
	Lead (Pb)-Total (mg/L)	0.000405				
	Lithium (Li)-Total (mg/L)	<0.0010				
	Magnesium (Mg)-Total (mg/L)	10.7				
	Manganese (Mn)-Total (mg/L)	0.0888				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1935320-1	L1935320-2	L1935320-3	L1935320-4	L1935320-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-MAY-17	30-MAY-17	30-MAY-17	30-MAY-17	30-MAY-17
	Sampled Time	08:30	10:55	15:45	16:25	
	Client ID	W3	MC1	W50	W16A	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	DLM <0.000025	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00356	0.00196	0.00254	0.00252	0.00353
	Nickel (Ni)-Total (mg/L)	0.00132	0.00572	0.00090	0.00098	0.00163
	Phosphorus (P)-Total (mg/L)	<0.050	0.105	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.34	1.66	2.44	2.49	2.38
	Selenium (Se)-Total (mg/L)	0.000370	0.000278	0.000594	0.000535	0.000373
	Silicon (Si)-Total (mg/L)	4.33	8.73	2.53	2.54	4.37
	Silver (Ag)-Total (mg/L)	<0.000010	0.000023	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	13.4	8.54	11.9	12.5	14.4
	Strontium (Sr)-Total (mg/L)	0.480	0.297	0.370	0.367	0.491
	Sulfur (S)-Total (mg/L)	15.7	7.49	14.0	14.5	15.1
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000021	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00869	0.0936	0.00573	0.00496	0.00977
	Uranium (U)-Total (mg/L)	0.00155	0.00132	0.000811	0.000815	0.00156
	Vanadium (V)-Total (mg/L)	0.00098	0.00842	0.00073	0.00068	0.00129
	Zinc (Zn)-Total (mg/L)	0.0050	0.0095	<0.0030	0.0040	0.0039
	Zirconium (Zr)-Total (mg/L)	0.00039	0.00055	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0062	0.0126	0.0049	0.0062	0.0102
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00032	0.00071	0.00031	0.00033	0.00031
	Barium (Ba)-Dissolved (mg/L)	0.0601	0.0585	0.0540	0.0553	0.0604
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.030	0.014	0.034	0.035	0.030
	Cadmium (Cd)-Dissolved (mg/L)	0.0000056	0.0000056	0.0000082	0.0000093	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	44.1	31.6	39.1	38.1	45.5
	Chromium (Cr)-Dissolved (mg/L)	0.00013	0.00024	0.00012	0.00013	0.00014
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00021	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0129	0.00471	0.0257	0.0271	0.0131
	Iron (Fe)-Dissolved (mg/L)	0.039	0.240	0.053	0.065	0.046
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	0.000095	0.000076	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0020	0.0015	0.0013	0.0012	0.0019
	Magnesium (Mg)-Dissolved (mg/L)	16.9	11.8	11.7	12.1	17.6
	Manganese (Mn)-Dissolved (mg/L)	0.0487	0.192	0.0159	0.0207	0.0542

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1935320-6				
	Description	Water				
	Sampled Date	31-MAY-17				
	Sampled Time	07:35				
	Client ID	W2				
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050				
	Molybdenum (Mo)-Total (mg/L)	0.00163				
	Nickel (Ni)-Total (mg/L)	0.00259				
	Phosphorus (P)-Total (mg/L)	0.051				
	Potassium (K)-Total (mg/L)	1.39				
	Selenium (Se)-Total (mg/L)	0.000183				
	Silicon (Si)-Total (mg/L)	5.75				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	7.68				
	Strontium (Sr)-Total (mg/L)	0.278				
	Sulfur (S)-Total (mg/L)	6.60				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	0.0305				
	Uranium (U)-Total (mg/L)	0.00117				
	Vanadium (V)-Total (mg/L)	0.00341				
	Zinc (Zn)-Total (mg/L)	0.0059				
	Zirconium (Zr)-Total (mg/L)	0.00046				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0133				
	Antimony (Sb)-Dissolved (mg/L)	0.00011				
	Arsenic (As)-Dissolved (mg/L)	0.00061				
	Barium (Ba)-Dissolved (mg/L)	0.0534				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.011				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000056				
	Calcium (Ca)-Dissolved (mg/L)	30.6				
	Chromium (Cr)-Dissolved (mg/L)	0.00024				
	Cobalt (Co)-Dissolved (mg/L)	0.00014				
	Copper (Cu)-Dissolved (mg/L)	0.00386				
	Iron (Fe)-Dissolved (mg/L)	0.168				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0013				
	Magnesium (Mg)-Dissolved (mg/L)	11.5				
	Manganese (Mn)-Dissolved (mg/L)	0.0492				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1935320-1	L1935320-2	L1935320-3	L1935320-4	L1935320-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	30-MAY-17	30-MAY-17	30-MAY-17	30-MAY-17	30-MAY-17
	Sampled Time	08:30	10:55	15:45	16:25	
	Client ID	W3	MC1	W50	W16A	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00368	0.00198	0.00274	0.00269	0.00370
	Nickel (Ni)-Dissolved (mg/L)	0.00094	0.00144	0.00078	0.00084	0.00097
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.35	1.45	2.44	2.52	2.41
	Selenium (Se)-Dissolved (mg/L)	0.000360	0.000246	0.000628	0.000619	0.000363
	Silicon (Si)-Dissolved (mg/L)	3.71	4.36	2.33	2.33	3.84
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	13.8	9.08	12.5	12.7	14.1
	Strontium (Sr)-Dissolved (mg/L)	0.525	0.313	0.429	0.417	0.523
	Sulfur (S)-Dissolved (mg/L)	15.7	7.91	15.2	15.1	16.0
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	DLM <0.00090	0.00035	DLM <0.00090	DLM <0.00060
	Uranium (U)-Dissolved (mg/L)	0.00137	0.00118	0.000807	0.000810	0.00146
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00136	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0011	<0.0010	<0.0010	0.0011
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1935320-6
	Description	Water
	Sampled Date	31-MAY-17
	Sampled Time	07:35
	Client ID	W2
Grouping	**Analyte**	
WATER		
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00174
	Nickel (Ni)-Dissolved (mg/L)	0.00129
	Phosphorus (P)-Dissolved (mg/L)	<0.050
	Potassium (K)-Dissolved (mg/L)	1.35
	Selenium (Se)-Dissolved (mg/L)	0.000183
	Silicon (Si)-Dissolved (mg/L)	4.48
	Silver (Ag)-Dissolved (mg/L)	<0.000010
	Sodium (Na)-Dissolved (mg/L)	8.35
	Strontium (Sr)-Dissolved (mg/L)	0.309
	Sulfur (S)-Dissolved (mg/L)	6.89
	Thallium (Tl)-Dissolved (mg/L)	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00083
	Uranium (U)-Dissolved (mg/L)	0.00112
	Vanadium (V)-Dissolved (mg/L)	0.00107
	Zinc (Zn)-Dissolved (mg/L)	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1935320-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Aluminum (Al)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Barium (Ba)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Potassium (K)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6
Matrix Spike	Sulfur (S)-Total	MS-B	L1935320-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-05-31 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1935320-COFC

COC Number: 2017-05-31 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224162 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	30-May-17	8:30	Water	R	R	R	R	R	R	R	R	R					7
	MC1	30-May-17	10:55	Water	R	R	R	R	R	R	R	R	R					7
	W50	30-May-17	15:45	Water	R	R	R	R	R	R	R	R	R					7
	W16A	30-May-17	16:25	Water	R	R	R	R	R	R	R	R	R					7
	DUP	30-May-17		Water	R	R	R	R	R	R	R	R	R					7
	W2	31-May-17	7:35	Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time

○ *Rush Processing*

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6.0	9.2	14.5			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-05-31 8:00	Time:	Received by: EHT	Date: 01 June 2017	Time: 16:45	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

MS 02/June 2017 14:30

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 07-JUN-17
Report Date: 29-JUN-17 16:09 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1938367

Project P.O. #: 224162 (WUL)
Job Reference:
C of C Numbers: 2017-06-07 A
Legal Site Desc:

Comments: Please note, the ALS Fort Collins Ra226 detailed analysis report can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1938367-1	L1938367-2	L1938367-3	L1938367-4	L1938367-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	05-JUN-17	05-JUN-17	05-JUN-17	05-JUN-17	05-JUN-17
	Sampled Time	08:10	07:45	08:05	14:40	15:35
	Client ID	W17	W35	W15	W16	W6
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	439	168	371	324	122
	Hardness (as CaCO3) (mg/L)	213	84.7	181	146	62.2
	pH (pH)	8.33	7.94	8.06	8.30	7.82
	Total Suspended Solids (mg/L)	<3.0	<3.0	3.5	7.5	294
	TDS (Calculated) (mg/L)	263	93.1	228	192	66.7
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	187	74.3	117	118	63.7
	Alkalinity, Carbonate (as CaCO3) (mg/L)	3.2	<1.0	<1.0	1.6	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	190	74.3	117	119	63.7
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0105	0.0310	0.0125	0.0311
	Chloride (Cl) (mg/L)	5.81	<0.50	1.68	4.62	1.24
	Nitrate and Nitrite (as N) (mg/L)	0.459	1.48	4.27	1.80	0.0077
	Nitrate (as N) (mg/L)	0.459	1.48	4.24	1.77	0.0077
	Nitrite (as N) (mg/L)	<0.0010	0.0017	0.0337	0.0341	<0.0010
	Sulfate (SO4) (mg/L)	49.6	7.52	63.9	43.5	1.36
	Anion Sum (meq/L)	5.03	1.75	4.02	3.54	1.34
	Cation Sum (meq/L)	4.97	1.89	4.02	3.48	1.41
	Cation - Anion Balance (%)	-0.6	3.9	0.0	-0.9	2.5
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	7.51	29.5	30.6	16.3	24.3
Total Metals	Aluminum (Al)-Total (mg/L)	<0.0030	0.0495	0.257	0.232	4.72
	Antimony (Sb)-Total (mg/L)	0.00011	<0.00010	<0.00010	<0.00010	0.00026
	Arsenic (As)-Total (mg/L)	0.00034	0.00038	0.00058	0.00044	0.00294
	Barium (Ba)-Total (mg/L)	0.0629	0.0489	0.0654	0.0598	0.137
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000023	0.000023	0.000022	0.000204
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.031	<0.010	<0.010	0.032	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	0.0000144	0.0000098	0.0000842
	Calcium (Ca)-Total (mg/L)	56.7	24.9	52.1	41.1	22.4
	Chromium (Cr)-Total (mg/L)	0.00012	0.00051	0.00052	0.00035	0.00943
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00038	0.00020	0.00360
	Copper (Cu)-Total (mg/L)	0.00797	0.0295	0.0417	0.0431	0.0124
	Iron (Fe)-Total (mg/L)	<0.010	0.125	0.480	0.407	7.64
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000110	0.000183	0.00238
	Lithium (Li)-Total (mg/L)	0.0016	<0.0010	0.0011	0.0012	0.0037
	Magnesium (Mg)-Total (mg/L)	17.0	6.72	14.4	11.4	6.64
	Manganese (Mn)-Total (mg/L)	0.00274	0.00656	0.117	0.0679	0.273

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1938367-6	L1938367-7	L1938367-8	L1938367-9	L1938367-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	05-JUN-17	06-JUN-17	06-JUN-17	06-JUN-17	05-JUN-17
	Sampled Time	16:30	08:00	08:50	07:30	
	Client ID	W30	W3	W16A	W2	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	366	338	323	242	326
	Hardness (as CaCO3) (mg/L)	165	152	150	115	146
	pH (pH)	8.32	8.21	8.26	8.12	8.29
	Total Suspended Solids (mg/L)	<3.0	5.7	3.5	144	35.7
	TDS (Calculated) (mg/L)	225	199	194	139	193
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	103	130	118	111	120
	Alkalinity, Carbonate (as CaCO3) (mg/L)	2.2	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	105	130	118	111	120
	Ammonia, Total (as N) (mg/L)	0.0346	0.0120	0.0129	0.0348	0.0167
	Chloride (Cl) (mg/L)	2.20	4.48	4.37	2.16	4.63
	Nitrate and Nitrite (as N) (mg/L)	0.750	1.57	1.94	0.367	1.80
	Nitrate (as N) (mg/L)	0.740	1.55	1.91	0.363	1.77
	Nitrite (as N) (mg/L)	0.0093	0.0147	0.0316	0.0042	0.0337
	Sulfate (SO4) (mg/L)	88.6	43.5	43.8	19.8	43.5
	Anion Sum (meq/L)	4.06	3.74	3.54	2.72	3.57
	Cation Sum (meq/L)	3.81	3.60	3.55	2.69	3.48
	Cation - Anion Balance (%)	-3.1	-2.0	0.1	-0.5	-1.3
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		16.9	20.1	19.7	17.9
Total Metals	Aluminum (Al)-Total (mg/L)	0.0603	0.104	0.182	3.12	0.272
	Antimony (Sb)-Total (mg/L)	0.00012	<0.00010	<0.00010	0.00022	<0.00010
	Arsenic (As)-Total (mg/L)	0.00052	0.00039	0.00043	0.00259	0.00041
	Barium (Ba)-Total (mg/L)	0.0616	0.0563	0.0589	0.116	0.0591
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000123	0.000022
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.030	0.030	0.011	0.032
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000078	0.0000103	0.0000605	0.0000121
	Calcium (Ca)-Total (mg/L)	41.5	42.2	41.2	31.7	40.8
	Chromium (Cr)-Total (mg/L)	<0.00010	0.00032	0.00033	0.00620	0.00035
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00011	0.00018	0.00225	0.00023
	Copper (Cu)-Total (mg/L)	0.0250	0.0274	0.0396	0.0156	0.0464
	Iron (Fe)-Total (mg/L)	0.115	0.179	0.332	5.40	0.473
	Lead (Pb)-Total (mg/L)	<0.000050	0.000078	0.000120	0.00148	0.000125
	Lithium (Li)-Total (mg/L)	0.0014	0.0014	0.0012	0.0031	0.0011
	Magnesium (Mg)-Total (mg/L)	16.2	12.9	11.4	11.3	11.3
	Manganese (Mn)-Total (mg/L)	0.0226	0.0607	0.0609	0.377	0.0656

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1938367-1	L1938367-2	L1938367-3	L1938367-4	L1938367-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	05-JUN-17	05-JUN-17	05-JUN-17	05-JUN-17	05-JUN-17
	Sampled Time	08:10	07:45	08:05	14:40	15:35
	Client ID	W17	W35	W15	W16	W6
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000131
	Molybdenum (Mo)-Total (mg/L)	0.00558	0.000807	0.00234	0.00263	0.000429
	Nickel (Ni)-Total (mg/L)	0.00060	0.00148	0.00127	0.00101	0.0113
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	0.272
	Potassium (K)-Total (mg/L)	3.27	0.57	2.41	2.34	0.94
	Selenium (Se)-Total (mg/L)	0.000330	0.000156	0.00150	0.000597	0.000226
	Silicon (Si)-Total (mg/L)	4.76	4.64	4.77	2.72	14.1
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000039
	Sodium (Na)-Total (mg/L)	14.0	4.23	8.02	11.5	3.53
	Strontium (Sr)-Total (mg/L)	0.638	0.147	0.476	0.426	0.109
	Sulfur (S)-Total (mg/L)	17.0	2.92	22.3	14.7	0.90
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000042
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	0.00228	0.0112	0.0120	0.141
	Uranium (U)-Total (mg/L)	0.00204	0.000063	0.000933	0.000856	0.000522
	Vanadium (V)-Total (mg/L)	<0.00050	0.00056	0.00149	0.00127	0.0157
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	0.0208
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00046	0.00044	<0.00030	0.00077
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0016	0.0293	0.0516	0.0053	0.0194
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00031	0.00032	0.00043	0.00032	0.00051
	Barium (Ba)-Dissolved (mg/L)	0.0650	0.0461	0.0608	0.0564	0.0335
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.027	<0.010	<0.010	0.029	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000097	<0.0000050	0.0000083	0.0000057	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	55.9	23.2	49.0	39.8	17.4
	Chromium (Cr)-Dissolved (mg/L)	0.00010	0.00039	0.00032	0.00014	0.00028
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00028	<0.00010	0.00015
	Copper (Cu)-Dissolved (mg/L)	0.00811	0.0257	0.0280	0.0300	0.00230
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.075	0.175	0.041	0.162
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0015	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	17.9	6.47	14.2	11.4	4.55
	Manganese (Mn)-Dissolved (mg/L)	0.00077	0.00514	0.0974	0.0153	0.0257

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1938367-6	L1938367-7	L1938367-8	L1938367-9	L1938367-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	05-JUN-17	06-JUN-17	06-JUN-17	06-JUN-17	05-JUN-17
	Sampled Time	16:30	08:00	08:50	07:30	
	Client ID	W30	W3	W16A	W2	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000091	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00399	0.00296	0.00257	0.00178	0.00270
	Nickel (Ni)-Total (mg/L)	0.00051	0.00119	0.00113	0.00755	0.00106
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.186	<0.050
	Potassium (K)-Total (mg/L)	3.13	2.26	2.27	1.55	2.29
	Selenium (Se)-Total (mg/L)	0.00281	0.000549	0.000599	0.000349	0.000594
	Silicon (Si)-Total (mg/L)	0.68	3.06	2.77	10.8	2.84
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000029	0.000010
	Sodium (Na)-Total (mg/L)	9.77	11.9	10.9	7.93	11.2
	Strontium (Sr)-Total (mg/L)	0.459	0.452	0.424	0.315	0.427
	Sulfur (S)-Total (mg/L)	31.0	15.1	15.1	7.27	15.0
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000029	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00384	0.00547	0.00967	0.112	0.0161
	Uranium (U)-Total (mg/L)	0.00127	0.000988	0.000842	0.00128	0.000858
	Vanadium (V)-Total (mg/L)	0.00054	0.00075	0.00103	0.0112	0.00129
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0129	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00038	0.00056	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0040	0.0068	0.0045	0.0166	0.0056
	Antimony (Sb)-Dissolved (mg/L)	0.00011	<0.00010	<0.00010	<0.00010	0.00012
	Arsenic (As)-Dissolved (mg/L)	0.00051	0.00030	0.00036	0.00070	0.00035
	Barium (Ba)-Dissolved (mg/L)	0.0605	0.0549	0.0578	0.0537	0.0569
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.027	0.027	<0.010	0.030
	Cadmium (Cd)-Dissolved (mg/L)	0.0000051	0.0000054	0.0000088	<0.0000050	0.0000062
	Calcium (Ca)-Dissolved (mg/L)	39.0	39.6	40.4	29.2	39.3
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00016	0.00016	0.00030	0.00012
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00018	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0213	0.0215	0.0280	0.00463	0.0286
	Iron (Fe)-Dissolved (mg/L)	0.022	0.041	0.053	0.272	0.045
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0013	0.0011	0.0010	<0.0010	0.0014
	Magnesium (Mg)-Dissolved (mg/L)	16.5	12.8	11.9	10.2	11.5
	Manganese (Mn)-Dissolved (mg/L)	0.0135	0.0143	0.0122	0.138	0.0126

	Sample ID	L1938367-1	L1938367-2	L1938367-3	L1938367-4	L1938367-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	05-JUN-17	05-JUN-17	05-JUN-17	05-JUN-17	05-JUN-17
	Sampled Time	08:10	07:45	08:05	14:40	15:35
	Client ID	W17	W35	W15	W16	W6
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00479	0.000684	0.00200	0.00249	0.000364
	Nickel (Ni)-Dissolved (mg/L)	0.00052	0.00136	0.00108	0.00082	0.00184
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.37	0.55	2.26	2.33	0.42
	Selenium (Se)-Dissolved (mg/L)	0.000380	0.000105	0.00144	0.000625	0.000103
	Silicon (Si)-Dissolved (mg/L)	4.52	4.04	3.99	2.04	4.98
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	14.4	4.02	7.67	11.4	3.17
	Strontium (Sr)-Dissolved (mg/L)	0.616	0.135	0.434	0.397	0.0751
	Sulfur (S)-Dissolved (mg/L)	14.5	2.44	19.1	13.2	0.67
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00089	0.00170	0.00062	0.00088
	Uranium (U)-Dissolved (mg/L)	0.00167	0.000058	0.000796	0.000769	0.000075
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00070	<0.00050	0.00098
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00038	0.00044	<0.00030	0.00033
Radiological Parameters	Ra-226 (Bq/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Grouping	Analyte	L1938367-6	L1938367-7	L1938367-8	L1938367-9	L1938367-10
	Sample ID	L1938367-6	L1938367-7	L1938367-8	L1938367-9	L1938367-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	05-JUN-17	06-JUN-17	06-JUN-17	06-JUN-17	05-JUN-17
	Sampled Time	16:30	08:00	08:50	07:30	
	Client ID	W30	W3	W16A	W2	DUP
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00352	0.00265	0.00221	0.00166	0.00267
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00103	0.00094	0.00155	0.00085
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.09	2.23	2.29	1.19	2.44
	Selenium (Se)-Dissolved (mg/L)	0.00256	0.000465	0.000669	0.000178	0.000583
	Silicon (Si)-Dissolved (mg/L)	0.471	2.54	2.26	4.38	2.12
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.77	11.6	11.2	7.83	11.5
	Strontium (Sr)-Dissolved (mg/L)	0.419	0.414	0.397	0.275	0.405
	Sulfur (S)-Dissolved (mg/L)	26.9	13.3	13.5	6.49	14.2
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	DLM <0.00060	0.00062	0.00114	0.00051
	Uranium (U)-Dissolved (mg/L)	0.00108	0.000867	0.000689	0.000929	0.000818
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00128	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Radiological Parameters	Ra-226 (Bq/L)		0.0082			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1938367-10, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1938367-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1938367-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1938367-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1938367-1, -10, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1938367-1, -10, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Reference Information

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

RA226-MMER-FC Water Ra226 by Alpha Scint, MDC=0.01 Bq/L EPA 903.1

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
FC	ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-06-07 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Wednesday, June 28, 2017

Shane Stack
ALS Environmental
8081 Lougheed Hwy, Suite 100
Burnaby, BC V5A 1W9

Re: ALS Workorder: 1706292
Project Name:
Project Number: L1938367

Dear Mr. Stack:

One water sample was received from ALS Environmental, on 6/13/2017. The sample was scheduled for the following analysis:

Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

Shiloh Summy

ALS Environmental
Shiloh J. Summy
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

1706292

Radium-226:
The sample was prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met.

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1706292
Client Name: ALS Environmental
Client Project Name:
Client Project Number: L1938367
Client PO Number: L1938367

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
L1938367-7	1706292-1		WATER	06-Jun-17	

ALS Environmental

L1938367

VANCOUVER

Subcontract Request Form

1706292

Subcontract To:

ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
225 COMMERCE DRIVE
FORT COLLINS,CO 80524

NOTES: Please reference on final report and invoice: PO# L1938367
ALS requires QC data to be provided with your final results.

Please see enclosed 1 **sample(s) in** 1 **Container(s)**

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED DUE DATE	Priority Flag
① L1938367-7 W3		6/ 6/ 2017	
	Ra226 by Alpha Scint, MDC=0.01 Bq/L (RA226-MMER-FC 1)	6/21/2017	

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact: Shane Stack
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9
Phone: (604) 253-4188 Email: Shane.Stack@alsglobal.com

Please email confirmation of receipt to: **Shane.Stack@alsglobal.com**

Shipped By: ______ Date Shipped: ______

Received By: ______ Date Received: 6/13/17

Verified By: ______ Date Verified: ______

Temperature: ______

Sample Integrity Issues: ______

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS CA
Workorder No: 1706292
Project Manager: SS
Initials: JNS
Date: 6/13/17

1. Does this project require any special handling in addition to standard ALS procedures?		YES	[✓ NO]
2. Are custody seals on shipping containers intact?	[✓ NONE]	YES	NO
3. Are Custody seals on sample containers intact?	[✓ NONE]	YES	NO
4. Is there a COC (Chain-of-Custody) present or other representative documents?		[✓ YES]	NO
5. Are the COC and bottle labels complete and legible?		[✓ YES]	NO
6. Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		[✓ YES]	NO
7. Were airbills / shipping documents present and/or removable?	DROP OFF	[✓ YES]	NO
8. Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	[✓ YES]	NO
9. Are all aqueous non-preserved samples pH 4-9?	[✓ N/A]	YES	NO
10. Is there sufficient sample for the requested analyses?		[✓ YES]	NO
11. Were all samples placed in the proper containers for the requested analyses?		[✓ YES]	NO
12. Are all samples within holding times for the requested analyses?		[✓ YES]	NO
13. Were all sample containers received intact? (not broken or leaking, etc.)		[✓ YES]	NO
14. Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	[✓ N/A]	YES	NO
15. Do any water samples contain sediment? Amount Amount of sediment: _/_ dusting ____ moderate ____heavy	N/A	[✓ YES]	NO
16. Were the samples shipped on ice?		YES	[✓ NO]
17. Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	[✓ RAD ONLY]	YES	[✓ NO]

Cooler #:	1							
Temperature (°C):	amb							
No. of custody seals on cooler:	0							
External µR/hr reading:	10							
Background µR/hr reading:	10							

DOT Survey/ Acceptance Information

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? [✓ YES] / NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

If applicable, was the client contacted? YES / NO / [✓ NA] Contact: ______ Date/Time: ______

Project Manager Signature / Date: Shiloh Sunny

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

DEFINITIONS: On the Air Waybill 'We', 'Our', 'us' and 'FedEx' refer to Federal Express Corporation, its subsidiaries and branches and their respective employees, agents and independent contractors. 'You' and 'your' refer to the shipper, its employees, principals and agents. If your shipment originates outside the United States, your contract of carriage is with the Federal Express subsidiary, branch or independent contractor who originally accepts the shipment from you. 'Package' means any container or envelope that is accepted by us for delivery, including any such items tendered by you utilizing our automated systems, meters, manifests or waybills. 'Shipment' means all packages, which are tendered to and accepted by us on a single Air Waybill.

AGREEMENT TO TERMS. By giving us your shipment, you agree, regardless of whether you sign the front of this Air Waybill, for yourself and as agent for and on behalf of any other person having an interest in this shipment, to all terms on this NON-NEGOTIABLE Air Waybill. In any applicable tariff, and in our current Service Guide or Standard Conditions of Carriage, copies of which are available upon request. If there is a conflict between this Air Waybill and either the tariff, Service Guide or Standard Conditions then in effect, the tariff and the terms of any customer automation agreement between the shipper and Federal Express will control (the Service Guide or Standard Conditions have secondary priority). No one is authorized to alter or modify the terms of our agreement. This Air Waybill shall be binding on us when the shipment is accepted.

YOUR OBLIGATIONS: You warrant that each article in the shipment is properly described on this Air Waybill and is acceptable for transport by us, and that the shipment is properly marked, addressed (including postal codes) and packaged to ensure safe transportation with ordinary care in handling.

NOTE CONCERNING LIMITATIONS OF LIABILITY. Air Carriage Notice. If the carriage of your shipment by air involves an ultimate destination or stop in a country other than the country of departure, the Warsaw Convention, an international treaty relating to international carriage by air, may be applicable, which treaty would then govern and in most cases limit our liability for loss or delay of or damage to your shipment. In the U.S. the Warsaw Convention limits our liability to U.S. $9.07 per pound (U.S. $20.38 per kilogram). Unless you declare a higher value for carriage as described below. The interpretation of the Warsaw Convention liability limits may vary in other countries. There are no stopping places which are agreed at the time of tender of the shipment and we reserve the right to route shipments in any way we deem appropriate.

Road Transport Notice. Shipments transported partly or solely by road be it explicit agreement to do so or not-in, to, from a country which is party to the Convention on the Contract for the International Carriage of Goods by Road (the 'CMR') are subject to the terms and conditions of the CMR, notwithstanding any other provisions of this Agreement to the contrary. For these shipments transported solely by road, if a conflict arises between the provisions of the CMR and this Air Waybill the terms of the CMR shall prevail.

Limitation of Liability, If not governed by the Warsaw Convention or the CMR as described above, our maximum liability for loss, damage or delay is limited by this Air Waybill to U.S. $100 per shipment or U.S. $9.07 per pound (U.S. $20.38 per kilo) (or equivalent local currency), whichever is greater, unless you declare a higher value for carriage as described below. FedEx does not provide cargo liability or all-risk insurance, but you may pay an additional charge to each additional U.S. $100 (or equivalent local currency) of described value for carriage. If a higher value for carriage is declared and the additional charge is paid, FedEx maximum liability will be the lesser of the declared value for carriage or your actual damages.

LIABILITIES NOT ASSUMED. IN ANY EVENT, WE WON'T BE LIABLE FOR ANY DAMAGES WHETHER DIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, IN EXCESS OF THE DECLARED VALUE FOR CARRIAGE (INCLUDING BUT NOT LIMITED TO LOSS OF INCOME OR PROFITS) WHETHER OR NOT WE HAD ANY KNOWLEDGE THAT SUCH DAMAGES MIGHT BE INCURRED, UNLESS SUCH DAMAGES WERE CAUSED BY OUR OWN WILLFUL MICONDUCT OR GROSS NEGLIGENCE.

We won't be liable for your actions or omissions, including but not limited to incorrect declaration of cargo, improper or insufficient packing, securing, marking or addressing of the shipment, or for the acts or omissions of the recipient or anyone else with an interest in the shipment. Also we won't be liable if you (or) the recipient violate any of the terms of our agreement. We won't be liable for loss of or damage to shipments of cash, currency or other prohibited items. We won't be liable for loss, damages or delay caused by events we cannot control, including but not limited to acts of God, perils of the air, weather conditions mechanical delays, acts of public enemies, war, strikes, civil commotions, or acts or omissions of public authorities (including customs and health officials) with actual or apparent authority.

NO WARRANTIES. We make no warranties, express or implied.

CLAIM FOR LOSS, DAMAGE FOR DELAY. ALL CLAIMS MUST BE NOTIFIED TO US WITHIN 15 DAYS AFTER DELIVERY OF THE SHIPMENT FAILING WHICH NO ACTION FOR DAMAGES MAY BE BROUGHT. All claims for loss, non-delivery or mis-delivery must be received by us within 90 days after the shipment is accepted by us. The right to damages against us shall be extinguished unless an action is brought within two years from the date of delivery of the shipment or from date on which the shipment should have been delivered. Within 30 days after notification to us (of) the claim, it must be documented by sending us all relevant information about it. We are not obligated to act on any claim until all transportation charges have been paid; the claim amount may not be deducted from those charges. If the recipient accepts the shipment without noting any damage on the delivery record, we will assume the shipment was delivered in good condition. In order for us to consider a claim for damages, the content(s), original shipping cartons, and packing must be available to us for inspection.

RIGHT TO INSPECT. Your shipment may, at our option or at the request of governmental authorities, be opened and inspected by us or such authorities or us at any time.

CUSTOMS CLEARANCE. It is your responsibility to provide proper customs documentation and confirmation, where required.

EXPORT CONTROL. You authorize Federal Express to act as forwarding agent for you for export control and customs purposes. You hereby certify that all statements and information contained in this air waybill relating to exportation are true and correct. Furthermore, you understand that civil and criminal penalties, including forfeiture and sale, may be imposed for making false or fraudulent statements or for the violation of any United States laws on exportation, including but not limited to, 13 USC Sec. 305; 22 USC Sec 401; 18 USC Sec. 1001; 50 USC app. 2410.

MANDATORY LAW. Insofar as any provision contained or referred to in this air Waybill may be contrary to any applicable international treaty, law government regulations, orders or requirements such provision shall remain in effect as a part of our agreement to the extent that it is not overridden. The invalidity or unenforceability of any provision shall not affect any other part of this Air Waybill. Unless otherwise indicated the Sender's address indicated on the face of this Waybill is the place of execution and the place of departure, and Recipient's address listed on the face of this Waybill is the place of destination. Unless otherwise indicated Federal Express Corporation, P.O. Box 727, Memphis, TN 38194 USA is the first carrier of this shipment.

After printing this label:
CONSIGNEE COPY - PLEASE PLACE IN FRONT OF POUCH
1. Fold the printed page along the horizontal line.
2. Place label in shipping pouch and affix it to your shipment.

ORIGIN ID:YBYA (604) 253-4188
HARJIT GILL
ALS ENVIRONMENTAL LAB GROUP
LOUGHEED HIGHWAY

BURNABY, BC V5A1W9
CANADA CA

SHIP DATE: 12JUN17
ACTWGT: 25.00 LB MAN
CAD: 0347419/CAFE3011

BILL SENDER

TO SAMPLE RECEVING
ALS ENVIRONMANTAL
225 COMMERCE DRIVE

FORT COLLINS CO 80524
(970) 490-1511 REF: SUBLETS
DEPT: SUBLET

(US)

1706292

540C1/A502/727F

J161216191002uv

TRK# 7012 5069 3374
0430

10:30A
INTL PRIORITY

XH FTCA

80524
CO-US DEN

Client:	ALS Environmental	**Date:**	*28-Jun-17*
Project:	L1938367	**Work Order:**	1706292
Sample ID:	L1938367-7	**Lab ID:**	1706292-1
Legal Location:		**Matrix:**	WATER
Collection Date:	6/6/2017	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Radium-226 by Radon Emanation - Method 903.1		**PAI 783**		Prep Date: **6/14/2017**		PrepBy: **HCJ**
Ra-226	0.0082 (+/- 0.0060)	LT	0.0079	BQ/l	NA	6/27/2017 12:50
Carr: BARIUM	*90.3*		*40-110*	*%REC*	DL = NA	6/27/2017 12:50

Client:	ALS Environmental	**Date:**	*28-Jun-17*
Project:	L1938367	**Work Order:**	1706292
Sample ID:	L1938367-7	**Lab ID:**	1706292-1
Legal Location:		**Matrix:**	WATER
Collection Date:	6/6/2017	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.

G - Sample density differs by more than 15% of LCS density.

D - DER is greater than Control Limit

M - Requested MDC not met.

LT - Result is less than requested MDC but greater than achieved MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).

U or ND - Indicates that the compound was analyzed for but not detected.

E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.

M - Duplicate injection precision was not met.

N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.

Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.

* - Duplicate analysis (relative percent difference) not within control limits.

S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.

B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.

E - Analyte concentration exceeds the upper level of the calibration range.

J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).

A - A tentatively identified compound is a suspected aldol-condensation product.

X - The analyte was diluted below an accurate quantitation level.

* - The spike recovery is equal to or outside the control criteria used.

+ - The relative percent difference (RPD) equals or exceeds the control criteria.

G - A pattern resembling gasoline was detected in this sample.

D - A pattern resembling diesel was detected in this sample.

M - A pattern resembling motor oil was detected in this sample.

C - A pattern resembling crude oil was detected in this sample.

4 - A pattern resembling JP-4 was detected in this sample.

5 - A pattern resembling JP-5 was detected in this sample.

H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.

L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.

Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

Date: *6/28/2017 3:29:*

Client: ALS Environmental
Work Order: 1706292
Project: L1938367

QC BATCH REPORT

Batch ID: **RE170614-1-1** Instrument ID **Alpha Scin** Method: **Radium-226 by Radon Emanation**

LCS Sample ID: **RE170614-1** Units: **BQ/l** Analysis Date: **6/27/2017 13:33**
Client ID: Run ID: **RE170614-1A** Prep Date: **6/14/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.93 (+/- 0.479)	0.00595	1.703		114	67-120					P
Carr: BARIUM	15500		16190		95.6	40-110					

LCSD Sample ID: **RE170614-1** Units: **BQ/l** Analysis Date: **6/27/2017 13:33**
Client ID: Run ID: **RE170614-1A** Prep Date: **6/14/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.87 (+/- 0.462)	0.00456	1.703		110	67-120		1.93	0.1	2.1	P
Carr: BARIUM	15500		16190		95.9	40-110		15500			

MB Sample ID: **RE170614-1** Units: **BQ/l** Analysis Date: **6/27/2017 13:33**
Client ID: Run ID: **RE170614-1A** Prep Date: **6/14/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	0.0028 (+/- 0.0030)	0.0043									U
Carr: BARIUM	15700		16190		97.1	40-110					

The following samples were analyzed in this batch: 1706292-1

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1938367-COFC

COC Number: 2017-06-07 A

Page of

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224162 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** SR/SB/EB

…onfirm all E&P TATs with your AM - surcharges will apply

Regular [R]	☑ Standard TAT if received by 3 pm - business days - no surcharges apply		
PRIORITY (Business Days)	4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐	EMERGENCY	1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐
Date and Time Required for all E&P TATs:	dd-mmm-yy hh:mm		

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preserve	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved)	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)	RA226				Number of Containers
✓	W17	5-Jun-17	8:10	Water	R	R	R	R	R	R	R	R	R					7
✓	W35	5-Jun-17	7:45	Water	R	R	R	R	R	R	R	R	R					7
✓	W15	5-Jun-17	8:05	Water	R	R	R	R	R	R	R	R	R					7
✓	W16	5-Jun-17	14:40	Water	R	R	R	R	R	R	R	R	R					7
✓	W6	5-Jun-17	15:35	Water	R	R	R	R	R	R	R	R	R					7
✓	W30	5-Jun-17	16:30	Water	R	R	R	R	R	R	R	R						6
✓	W3	6-Jun-17	8:00	Water	R	R	R	R	R	R	R	R	R	R				8
✓	W16A	6-Jun-17	8:50	Water	R	R	R	R	R	R	R	R	R					7
✓	W2	6-Jun-17	7:30	Water	R	R	R	R	R	R	R	R	R					7
✓	DUP	5-Jun-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☐	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
13.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-06-07	Time: 11:30	Received by: EHE	Date: 7 June 2017	Time: 1700	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	14-JUN-17
Report Date:	26-JUN-17 17:28 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #:	L1942313
Project P.O. #:	226337 (WUL)
Job Reference:	
C of C Numbers:	2017-06-14 B
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1942313-1	L1942313-2	L1942313-3	L1942313-4	L1942313-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-JUN-17	13-JUN-17	13-JUN-17	13-JUN-17	13-JUN-17
	Sampled Time	08:00	08:30	09:20	11:15	13:30
	Client ID	W3	W50	W16A	MC1	W4
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	346	340	340	224	110
	Hardness (as CaCO3) (mg/L)	163	160	161	108	54.6
	pH (pH)	8.03	8.07	8.08	7.84	7.52
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	793	211
	TDS (Calculated) (mg/L)	207	205	206	132	61.5
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	129	122	122	105	53.3
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	129	122	122	105	53.3
	Ammonia, Total (as N) (mg/L)	0.0167	0.0251	0.0291	0.0838	0.0148
	Chloride (Cl) (mg/L)	4.25	4.39	4.38	1.96	<0.50
	Nitrate (as N) (mg/L)	1.91	2.23	2.24	0.398	0.0257
	Nitrite (as N) (mg/L)	0.0133	0.0264	0.0304	0.0036	<0.0010
	Sulfate (SO4) (mg/L)	46.7	48.2	48.4	19.1	6.36
	Anion Sum (meq/L)	3.81	3.73	3.73	2.58	1.20
	Cation Sum (meq/L)	3.83	3.76	3.77	2.53	1.27
	Cation - Anion Balance (%)	0.3	0.4	0.5	-1.0	2.8
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	20.5	20.0	19.5	22.9	17.7
Total Metals	Aluminum (Al)-Total (mg/L)	0.0669	0.0869	0.0966	13.5	4.94
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00044	0.00032
	Arsenic (As)-Total (mg/L)	0.00043	0.00043	0.00042	0.00684	0.00517
	Barium (Ba)-Total (mg/L)	0.0604	0.0626	0.0630	0.359	0.129
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000557	0.000243
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	0.000108	0.000132
	Boron (B)-Total (mg/L)	0.027	0.028	0.027	0.012	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000084	0.0000121	0.0000097	0.000247	0.000109
	Calcium (Ca)-Total (mg/L)	45.2	45.4	45.1	41.4	17.2
	Chromium (Cr)-Total (mg/L)	0.00031	0.00026	0.00026	0.0262	0.0100
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00012	0.00012	0.00969	0.00350
	Copper (Cu)-Total (mg/L)	0.0258	0.0323	0.0325	0.0461	0.0159
	Iron (Fe)-Total (mg/L)	0.137	0.169	0.178	20.1	6.52
	Lead (Pb)-Total (mg/L)	0.000074	0.000160	0.000092	0.00583	0.00313
	Lithium (Li)-Total (mg/L)	0.0011	<0.0010	<0.0010	0.0094	0.0035
	Magnesium (Mg)-Total (mg/L)	13.7	13.0	12.9	15.9	7.49
	Manganese (Mn)-Total (mg/L)	0.0432	0.0369	0.0300	0.756	0.216
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	DLM <0.000050	DLM <0.000050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1942313-6	L1942313-7	L1942313-8		
	Description	WATER	WATER	WATER		
	Sampled Date	13-JUN-17	13-JUN-17	13-JUN-17		
	Sampled Time	13:55	15:00			
	Client ID	W2	W5	DUP		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	224	144	222		
	Hardness (as CaCO3) (mg/L)	106	67.3	109		
	pH (pH)	7.90	7.69	7.91		
	Total Suspended Solids (mg/L)	527	153	529		
	TDS (Calculated) (mg/L)	130	79.6	131		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	106	67.8	105		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	106	67.8	105		
	Ammonia, Total (as N) (mg/L)	0.0726	0.0229	0.0719		
	Chloride (Cl) (mg/L)	1.87	0.57	1.87		
	Nitrate (as N) (mg/L)	0.365	0.0921	0.362		
	Nitrite (as N) (mg/L)	0.0036	<0.0010	0.0039		
	Sulfate (SO4) (mg/L)	18.3	9.91	18.3		
	Anion Sum (meq/L)	2.57	1.58	2.56		
	Cation Sum (meq/L)	2.48	1.54	2.54		
	Cation - Anion Balance (%)	-1.8	-1.5	-0.4		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	23.3	16.3	21.3		
Total Metals	Aluminum (Al)-Total (mg/L)	11.3	4.02	11.1		
	Antimony (Sb)-Total (mg/L)	0.00044	0.00030	0.00044		
	Arsenic (As)-Total (mg/L)	0.00622	0.00356	0.00614		
	Barium (Ba)-Total (mg/L)	0.302	0.117	0.296		
	Beryllium (Be)-Total (mg/L)	0.000446	0.000172	0.000450		
	Bismuth (Bi)-Total (mg/L)	0.000098	0.000082	0.000099		
	Boron (B)-Total (mg/L)	0.011	<0.010	0.010		
	Cadmium (Cd)-Total (mg/L)	0.000208	0.0000859	0.000214		
	Calcium (Ca)-Total (mg/L)	39.6	21.2	39.2		
	Chromium (Cr)-Total (mg/L)	0.0228	0.00800	0.0223		
	Cobalt (Co)-Total (mg/L)	0.00785	0.00280	0.00775		
	Copper (Cu)-Total (mg/L)	0.0413	0.0124	0.0404		
	Iron (Fe)-Total (mg/L)	17.3	5.68	17.0		
	Lead (Pb)-Total (mg/L)	0.00505	0.00235	0.00509		
	Lithium (Li)-Total (mg/L)	0.0078	0.0032	0.0079		
	Magnesium (Mg)-Total (mg/L)	14.9	7.77	14.4		
	Manganese (Mn)-Total (mg/L)	0.634	0.190	0.599		
	Mercury (Hg)-Total (mg/L)	DLM <0.000050	DLM <0.000050	DLM <0.000050		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Grouping	Analyte					
	Sample ID	L1942313-1	L1942313-2	L1942313-3	L1942313-4	L1942313-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	13-JUN-17	13-JUN-17	13-JUN-17	13-JUN-17	13-JUN-17
	Sampled Time	08:00	08:30	09:20	11:15	13:30
	Client ID	W3	W50	W16A	MC1	W4
WATER						
Total Metals	Molybdenum (Mo)-Total (mg/L)	0.00305	0.00271	0.00263	0.00161	0.000911
	Nickel (Ni)-Total (mg/L)	0.00138	0.00113	0.00117	0.0279	0.0129
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.666	0.251
	Potassium (K)-Total (mg/L)	2.19	2.36	2.33	2.21	1.45
	Selenium (Se)-Total (mg/L)	0.000702	0.000717	0.000683	0.000656	0.000156
	Silicon (Si)-Total (mg/L)	3.20	2.69	2.74	28.5	13.7
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000096	0.000046
	Sodium (Na)-Total (mg/L)	11.2	11.2	11.1	8.36	3.68
	Strontium (Sr)-Total (mg/L)	0.462	0.440	0.437	0.396	0.146
	Sulfur (S)-Total (mg/L)	17.3	17.5	17.5	7.44	2.49
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000090	0.000052
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00014	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00330	0.00533	0.00533	0.380	0.144
	Uranium (U)-Total (mg/L)	0.000905	0.000807	0.000825	0.00202	0.00139
	Vanadium (V)-Total (mg/L)	0.00068	0.00077	0.00078	0.0425	0.0154
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0512	0.0198
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00144	0.00070
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0098	0.0061	0.0056	0.0254	0.0880
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00013	0.00012
	Arsenic (As)-Dissolved (mg/L)	0.00035	0.00039	0.00038	0.00076	0.00086
	Barium (Ba)-Dissolved (mg/L)	0.0618	0.0644	0.0645	0.0564	0.0375
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	0.000026
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.023	0.024	0.024	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000052	0.0000076	0.0000065	<0.0000050	0.0000133
	Calcium (Ca)-Dissolved (mg/L)	43.0	43.2	43.3	28.2	14.1
	Chromium (Cr)-Dissolved (mg/L)	0.00019	0.00016	0.00017	0.00036	0.00034
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00022	0.00015
	Copper (Cu)-Dissolved (mg/L)	0.0220	0.0271	0.0279	0.00492	0.00300
	Iron (Fe)-Dissolved (mg/L)	0.055	0.062	0.067	0.322	0.219
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	0.000081
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	13.6	12.7	12.8	9.15	4.72
	Manganese (Mn)-Dissolved (mg/L)	0.00897	0.0122	0.0170	0.0847	0.0213
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1942313-6	L1942313-7	L1942313-8		
	Description	WATER	WATER	WATER		
	Sampled Date	13-JUN-17	13-JUN-17	13-JUN-17		
	Sampled Time	13:55	15:00			
	Client ID	W2	W5	DUP		
Grouping	**Analyte**					
WATER						
Total Metals	Molybdenum (Mo)-Total (mg/L)	0.00170	0.00106	0.00171		
	Nickel (Ni)-Total (mg/L)	0.0231	0.00964	0.0230		
	Phosphorus (P)-Total (mg/L)	0.552	0.182	0.534		
	Potassium (K)-Total (mg/L)	2.07	1.33	2.02		
	Selenium (Se)-Total (mg/L)	0.000590	0.000240	0.000620		
	Silicon (Si)-Total (mg/L)	25.1	12.0	25.2		
	Silver (Ag)-Total (mg/L)	0.000088	0.000038	0.000087		
	Sodium (Na)-Total (mg/L)	8.30	4.15	8.03		
	Strontium (Sr)-Total (mg/L)	0.370	0.172	0.367		
	Sulfur (S)-Total (mg/L)	7.24	3.49	7.08		
	Thallium (Tl)-Total (mg/L)	0.000078	0.000046	0.000081		
	Tin (Sn)-Total (mg/L)	0.00013	<0.00010	0.00013		
	Titanium (Ti)-Total (mg/L)	0.335	0.129	0.325		
	Uranium (U)-Total (mg/L)	0.00200	0.00119	0.00204		
	Vanadium (V)-Total (mg/L)	0.0376	0.0131	0.0368		
	Zinc (Zn)-Total (mg/L)	0.0424	0.0158	0.0410		
	Zirconium (Zr)-Total (mg/L)	0.00138	0.00054	0.00142		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0274	0.0637	0.0267		
	Antimony (Sb)-Dissolved (mg/L)	0.00013	0.00013	0.00013		
	Arsenic (As)-Dissolved (mg/L)	0.00077	0.00072	0.00077		
	Barium (Ba)-Dissolved (mg/L)	0.0526	0.0386	0.0543		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000133	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	27.8	17.9	28.2		
	Chromium (Cr)-Dissolved (mg/L)	0.00035	0.00031	0.00033		
	Cobalt (Co)-Dissolved (mg/L)	0.00017	0.00013	0.00017		
	Copper (Cu)-Dissolved (mg/L)	0.00445	0.00426	0.00426		
	Iron (Fe)-Dissolved (mg/L)	0.302	0.203	0.298		
	Lead (Pb)-Dissolved (mg/L)	0.000055	0.000083	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	8.91	5.49	9.33		
	Manganese (Mn)-Dissolved (mg/L)	0.0408	0.0237	0.0419		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1942313-1 WATER 13-JUN-17 08:00 W3	L1942313-2 WATER 13-JUN-17 08:30 W50	L1942313-3 WATER 13-JUN-17 09:20 W16A	L1942313-4 WATER 13-JUN-17 11:15 MC1	L1942313-5 WATER 13-JUN-17 13:30 W4
Grouping	**Analyte**					
WATER						
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00257	0.00235	0.00241	0.00151	0.000684
	Nickel (Ni)-Dissolved (mg/L)	0.00119	0.00097	0.00102	0.00173	0.00173
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.39	2.50	2.51	0.95	0.70
	Selenium (Se)-Dissolved (mg/L)	0.000679	0.000724	0.000664	0.000215	0.000113
	Silicon (Si)-Dissolved (mg/L)	2.82	2.35	2.37	4.68	4.94
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	11.5	11.1	11.2	7.18	3.17
	Strontium (Sr)-Dissolved (mg/L)	0.421	0.411	0.411	0.254	0.111
	Sulfur (S)-Dissolved (mg/L)	14.8	15.4	15.3	6.30	2.63
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00057	0.00067	0.00064	0.00130	0.00307
	Uranium (U)-Dissolved (mg/L)	0.000832	0.000759	0.000785	0.000854	0.000670
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00167	0.00143
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	0.00038	0.00051

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1942313-6	L1942313-7	L1942313-8		
	Description	WATER	WATER	WATER		
	Sampled Date	13-JUN-17	13-JUN-17	13-JUN-17		
	Sampled Time	13:55	15:00			
	Client ID	W2	W5	DUP		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00140	0.000868	0.00137		
	Nickel (Ni)-Dissolved (mg/L)	0.00170	0.00174	0.00167		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	0.95	0.74	0.99		
	Selenium (Se)-Dissolved (mg/L)	0.000239	0.000132	0.000196		
	Silicon (Si)-Dissolved (mg/L)	4.61	3.98	4.61		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	7.02	3.54	7.27		
	Strontium (Sr)-Dissolved (mg/L)	0.245	0.134	0.249		
	Sulfur (S)-Dissolved (mg/L)	6.11	3.14	5.80		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	0.00140	0.00287	0.00118		
	Uranium (U)-Dissolved (mg/L)	0.000861	0.000739	0.000847		
	Vanadium (V)-Dissolved (mg/L)	0.00181	0.00136	0.00175		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0017	<0.0010		
	Zirconium (Zr)-Dissolved (mg/L)	0.00037	0.00039	0.00039		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Manganese (Mn)-Total	MB-LOR	L1942313-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1942313-8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1942313-8
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7, -8
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1942313-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions)

Reference Information

should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-06-14 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1942313-COFC

COC Number: 2017-06-14 B

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226337 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Report Format / Dis

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact: Shane Stack **Sampler:** SR/SB

all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the rep	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	13-Jun-17	8:00	Water	R	R	R	R	R	R	R	R	R					7
	W50	13-Jun-17	8:30	Water	R	R	R	R	R	R	R	R	R					7
	W16A	13-Jun-17	9:20	Water	R	R	R	R	R	R	R	R	R					7
	MC1	13-Jun-17	11:15	Water	R	R	R	R	R	R	R	R	R					7
	W4	13-Jun-17	13:30	Water	R	R	R	R	R	R	R	R	R					7
	W2	13-Jun-17	13:55	Water	R	R	R	R	R	R	R	R	R					7
	W5	13-Jun-17	15:00	Water	R	R	R	R	R	R	R	R	R					7
	DUP	13-Jun-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☑	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-06-14	Time: 12:00	Received by: EHF	Date: 14 June 2017	Time: 15.45	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 22-JUN-17
Report Date: 04-JUL-17 13:47 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1947077
Project P.O. #: 226337 (WUL)
Job Reference:
C of C Numbers: 2017-06-21 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1947077-1	L1947077-2	L1947077-3	L1947077-4	L1947077-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	20-JUN-17	20-JUN-17	20-JUN-17	20-JUN-17	20-JUN-17
	Sampled Time	07:45	08:20	08:55	14:10	14:35
	Client ID	W3	W50	W16A	W2	MC1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	391	343	335	288	282
	Hardness (as CaCO3) (mg/L)	187	161	159	139	140
	pH (pH)	8.19	8.13	8.14	8.22	8.20
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	21.7	55.1
	TDS (Calculated) (mg/L)	230	203	202	163	160
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	151	120	118	132	128
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	151	120	118	132	128
	Ammonia, Total (as N) (mg/L)	0.0127	0.0457	0.0586	0.0100	0.0206
	Chloride (Cl) (mg/L)	4.21	3.97	3.94	1.89	1.81
	Nitrate and Nitrite (as N) (mg/L)	1.58	2.41	2.45	0.311	0.317
	Nitrate (as N) (mg/L)	1.57	2.35	2.37	0.310	0.316
	Nitrite (as N) (mg/L)	0.0075	0.0601	0.0808	0.0011	0.0011
	Sulfate (SO4) (mg/L)	48.1	46.4	46.5	21.6	20.9
	Anion Sum (meq/L)	4.25	3.65	3.61	3.17	3.07
	Cation Sum (meq/L)	4.38	3.79	3.75	3.21	3.24
	Cation - Anion Balance (%)	1.5	1.9	2.0	0.6	2.7
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	14.6	18.5	18.8	14.9	15.5
Total Metals	Aluminum (Al)-Total (mg/L)	0.0143	0.0316	0.0509	0.496	1.05
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00011	0.00014
	Arsenic (As)-Total (mg/L)	0.00040	0.00045	0.00045	0.00090	0.00118
	Barium (Ba)-Total (mg/L)	0.0624	0.0601	0.0621	0.0705	0.0836
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	0.000036
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.028	0.029	0.029	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	0.0000076	0.0000084	0.0000164
	Calcium (Ca)-Total (mg/L)	47.8	43.6	43.3	37.2	36.9
	Chromium (Cr)-Total (mg/L)	0.00020	0.00024	0.00024	0.00119	0.00223
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00011	0.00038	0.00075
	Copper (Cu)-Total (mg/L)	0.0163	0.0302	0.0331	0.00513	0.00688
	Iron (Fe)-Total (mg/L)	0.047	0.111	0.151	0.890	1.72
	Lead (Pb)-Total (mg/L)	<0.000050	0.000133	0.000132	0.000245	0.000480
	Lithium (Li)-Total (mg/L)	0.0014	<0.0010	<0.0010	0.0012	0.0015
	Magnesium (Mg)-Total (mg/L)	16.6	12.4	12.6	12.3	12.4
	Manganese (Mn)-Total (mg/L)	0.0160	0.0320	0.0396	0.0442	0.0834

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1947077-6				
	Description	WATER				
	Sampled Date	20-JUN-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	394				
	Hardness (as CaCO3) (mg/L)	181				
	pH (pH)	8.20				
	Total Suspended Solids (mg/L)	<3.0				
	TDS (Calculated) (mg/L)	228				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	152				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	152				
	Ammonia, Total (as N) (mg/L)	0.0134				
	Chloride (Cl) (mg/L)	4.20				
	Nitrate and Nitrite (as N) (mg/L)	1.57				
	Nitrate (as N) (mg/L)	1.56				
	Nitrite (as N) (mg/L)	0.0079				
	Sulfate (SO4) (mg/L)	48.0				
	Anion Sum (meq/L)	4.26				
	Cation Sum (meq/L)	4.25				
	Cation - Anion Balance (%)	-0.1				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	14.7				
Total Metals	Aluminum (Al)-Total (mg/L)	0.0132				
	Antimony (Sb)-Total (mg/L)	<0.00010				
	Arsenic (As)-Total (mg/L)	0.00036				
	Barium (Ba)-Total (mg/L)	0.0648				
	Beryllium (Be)-Total (mg/L)	<0.000020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	0.028				
	Cadmium (Cd)-Total (mg/L)	<0.0000050				
	Calcium (Ca)-Total (mg/L)	47.3				
	Chromium (Cr)-Total (mg/L)	0.00020				
	Cobalt (Co)-Total (mg/L)	<0.00010				
	Copper (Cu)-Total (mg/L)	0.0165				
	Iron (Fe)-Total (mg/L)	0.047				
	Lead (Pb)-Total (mg/L)	<0.000050				
	Lithium (Li)-Total (mg/L)	0.0013				
	Magnesium (Mg)-Total (mg/L)	16.9				
	Manganese (Mn)-Total (mg/L)	0.0159				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1947077-1	L1947077-2	L1947077-3	L1947077-4	L1947077-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	20-JUN-17	20-JUN-17	20-JUN-17	20-JUN-17	20-JUN-17
	Sampled Time	07:45	08:20	08:55	14:10	14:35
	Client ID	W3	W50	W16A	W2	MC1
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000056
	Molybdenum (Mo)-Total (mg/L)	0.00334	0.00251	0.00245	0.00171	0.00186
	Nickel (Ni)-Total (mg/L)	0.00117	0.00106	0.00109	0.00230	0.00338
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	0.075
	Potassium (K)-Total (mg/L)	2.20	2.25	2.30	1.28	1.28
	Selenium (Se)-Total (mg/L)	0.000511	0.000602	0.000687	0.000213	0.000239
	Silicon (Si)-Total (mg/L)	3.55	2.59	2.62	5.93	6.96
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000011
	Sodium (Na)-Total (mg/L)	12.9	10.9	11.1	8.68	8.66
	Strontium (Sr)-Total (mg/L)	0.522	0.425	0.419	0.369	0.370
	Sulfur (S)-Total (mg/L)	15.5	14.9	15.2	7.05	6.98
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000012
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	DLM <0.00090	DLM <0.0018	0.00302	0.0204	0.0439
	Uranium (U)-Total (mg/L)	0.00126	0.000780	0.000808	0.00126	0.00131
	Vanadium (V)-Total (mg/L)	0.00061	0.00070	0.00081	0.00282	0.00442
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.0033	<0.0030	0.0066
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00035	0.00047
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0062	0.0111	0.0127	0.0178	0.0189
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00033	0.00039	0.00040	0.00058	0.00061
	Barium (Ba)-Dissolved (mg/L)	0.0651	0.0617	0.0634	0.0621	0.0658
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.026	0.028	0.028	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000079	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	48.1	44.1	44.1	36.3	36.3
	Chromium (Cr)-Dissolved (mg/L)	0.00017	0.00018	0.00020	0.00027	0.00031
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0157	0.0263	0.0277	0.00347	0.00356
	Iron (Fe)-Dissolved (mg/L)	0.037	0.079	0.094	0.097	0.135
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.000077	0.000092	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0014	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	16.2	12.3	12.0	11.8	12.0
	Manganese (Mn)-Dissolved (mg/L)	0.0112	0.0224	0.0343	0.00536	0.0174

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1947077-6				
	Description	WATER				
	Sampled Date	20-JUN-17				
	Sampled Time					
	Client ID	DUP				
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050				
	Molybdenum (Mo)-Total (mg/L)	0.00332				
	Nickel (Ni)-Total (mg/L)	0.00120				
	Phosphorus (P)-Total (mg/L)	<0.050				
	Potassium (K)-Total (mg/L)	2.23				
	Selenium (Se)-Total (mg/L)	0.000499				
	Silicon (Si)-Total (mg/L)	3.58				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	13.2				
	Strontium (Sr)-Total (mg/L)	0.520				
	Sulfur (S)-Total (mg/L)	15.3				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	0.00071				
	Uranium (U)-Total (mg/L)	0.00125				
	Vanadium (V)-Total (mg/L)	0.00057				
	Zinc (Zn)-Total (mg/L)	<0.0030				
	Zirconium (Zr)-Total (mg/L)	<0.00030				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0062				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00034				
	Barium (Ba)-Dissolved (mg/L)	0.0631				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.027				
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050				
	Calcium (Ca)-Dissolved (mg/L)	46.7				
	Chromium (Cr)-Dissolved (mg/L)	0.00015				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	0.0157				
	Iron (Fe)-Dissolved (mg/L)	0.034				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0012				
	Magnesium (Mg)-Dissolved (mg/L)	15.7				
	Manganese (Mn)-Dissolved (mg/L)	0.0107				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1947077-1	L1947077-2	L1947077-3	L1947077-4	L1947077-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	20-JUN-17	20-JUN-17	20-JUN-17	20-JUN-17	20-JUN-17
	Sampled Time	07:45	08:20	08:55	14:10	14:35
	Client ID	W3	W50	W16A	W2	MC1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00298	0.00220	0.00221	0.00160	0.00161
	Nickel (Ni)-Dissolved (mg/L)	0.00126	0.00110	0.00111	0.00137	0.00154
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.34	2.43	2.39	1.28	1.25
	Selenium (Se)-Dissolved (mg/L)	0.000572	0.000703	0.000728	0.000177	0.000180
	Silicon (Si)-Dissolved (mg/L)	3.87	2.81	2.70	5.40	5.42
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	13.4	11.5	11.3	8.88	9.06
	Strontium (Sr)-Dissolved (mg/L)	0.501	0.409	0.407	0.341	0.343
	Sulfur (S)-Dissolved (mg/L)	14.9	14.7	14.4	6.90	6.59
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00035	0.00075	0.00082	0.00094	0.00074
	Uranium (U)-Dissolved (mg/L)	0.00108	0.000689	0.000709	0.00113	0.00108
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00115	0.00108
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.0010	<0.0010	0.0013
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1947077-6 WATER 20-JUN-17 DUP				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00302				
	Nickel (Ni)-Dissolved (mg/L)	0.00110				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	2.24				
	Selenium (Se)-Dissolved (mg/L)	0.000594				
	Silicon (Si)-Dissolved (mg/L)	3.78				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	13.1				
	Strontium (Sr)-Dissolved (mg/L)	0.486				
	Sulfur (S)-Dissolved (mg/L)	15.3				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	0.00037				
	Uranium (U)-Dissolved (mg/L)	0.00117				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0022				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1947077-3	W16A	WSMT	Water sample(s) for total mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Barium (Ba)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Calcium (Ca)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Manganese (Mn)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Potassium (K)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Sodium (Na)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Strontium (Sr)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Sulfur (S)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6
Matrix Spike	Uranium (U)-Total	MS-B	L1947077-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Reference Information

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-06-21 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1947077-COFC

COC Number: 2017-06-21 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

nfirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226337 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact: Shane Stack

Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear [illegible]port)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	20-Jun-17	7:45	Water	R	R	R	R	R	R	R	R	R					7
	W50	20-Jun-17	8:20	Water	R	R	R	R	R	R	R	R	R					7
	W16A	20-Jun-17	8:55	Water	R	R	R	R	R	R	R	R	R					7
	W2	20-Jun-17	14:10	Water	R	R	R	R	R	R	R	R	R					7
	MC1	20-Jun-17	14:35	Water	R	R	R	R	R	R	R	R	R					7
	DUP	20-Jun-17		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples [illegible] use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐		SIF Observations	Yes ☐	No ☐	
Ice Packs ☐	Ice Cubes ☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated ☐					

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.6					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-06-21 7:15	Time:	Received by: VD	Date: June 22/17	Time: 8:40	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	28-JUN-17
Report Date:	10-JUL-17 17:56 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1950514

Project P.O. #:	226337 (WUL)
Job Reference:	
C of C Numbers:	2017-06-28 A
Legal Site Desc:	

Shane Stack
Account Manager

	Sample ID	L1950514-1	L1950514-2	L1950514-3	L1950514-4	L1950514-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	27-JUN-17	27-JUN-17	27-JUN-17	27-JUN-17	27-JUN-17
	Sampled Time	07:45	09:30	10:00	11:30	07:45
	Client ID	W2	W7	W3	MC1	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	319	228	490	310	319
	Hardness (as CaCO3) (mg/L)	156	111	234	151	154
	pH (pH)	8.15	8.05	8.19	8.21	8.14
	Total Suspended Solids (mg/L)	7.4	22.0	3.4	17.8	5.8
	TDS (Calculated) (mg/L)	183	126	286	178	181
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	150	118	214	150	147
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	150	118	214	150	147
	Ammonia, Total (as N) (mg/L)	0.0133	0.0114	0.0078	0.0183	0.0134
	Chloride (Cl) (mg/L)	2.10	<0.50	4.70	1.82	2.10
	Nitrate and Nitrite (as N) (mg/L)	0.308	0.144	0.232	0.248	0.309
	Nitrate (as N) (mg/L)	0.307	0.144	0.232	0.247	0.308
	Nitrite (as N) (mg/L)	0.0012	<0.0010	<0.0010	0.0015	0.0014
	Sulfate (SO4) (mg/L)	24.8	8.70	54.2	21.8	24.8
	Anion Sum (meq/L)	3.59	2.54	5.56	3.53	3.54
	Cation Sum (meq/L)	3.57	2.55	5.46	3.48	3.53
	Cation - Anion Balance (%)	-0.3	0.1	-0.8	-0.6	-0.2
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.4	13.1	8.26	12.6	12.2
Total Metals	Aluminum (Al)-Total (mg/L)	0.135	0.368	0.0109	0.376	0.124
	Antimony (Sb)-Total (mg/L)	0.00010	0.00011	<0.00010	0.00014	0.00012
	Arsenic (As)-Total (mg/L)	0.00061	0.00059	0.00027	0.00069	0.00056
	Barium (Ba)-Total (mg/L)	0.0702	0.0732	0.0601	0.0612	0.0589
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000020	<0.000020	0.000021	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.024	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000104	<0.0000050	0.0000115	0.0000061
	Calcium (Ca)-Total (mg/L)	42.6	29.8	57.8	40.6	42.1
	Chromium (Cr)-Total (mg/L)	0.00045	0.00098	0.00011	0.00094	0.00043
	Cobalt (Co)-Total (mg/L)	0.00013	0.00037	<0.00010	0.00033	0.00013
	Copper (Cu)-Total (mg/L)	0.00322	0.00288	0.00533	0.00372	0.00317
	Iron (Fe)-Total (mg/L)	0.279	0.659	0.026	0.672	0.238
	Lead (Pb)-Total (mg/L)	0.000077	0.000192	<0.000050	0.000186	0.000089
	Lithium (Li)-Total (mg/L)	0.0015	<0.0010	0.0025	0.0015	0.0014
	Magnesium (Mg)-Total (mg/L)	13.6	10.6	24.8	14.1	13.8
	Manganese (Mn)-Total (mg/L)	0.0225	0.0464	0.0414	0.0416	0.0213

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1950514-1	L1950514-2	L1950514-3	L1950514-4	L1950514-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	27-JUN-17	27-JUN-17	27-JUN-17	27-JUN-17	27-JUN-17
	Sampled Time	07:45	09:30	10:00	11:30	07:45
	Client ID	W2	W7	W3	MC1	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00186	0.00155	0.00468	0.00196	0.00183
	Nickel (Ni)-Total (mg/L)	0.00138	0.00196	0.00107	0.00186	0.00128
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	1.27	0.75	1.99	1.21	1.24
	Selenium (Se)-Total (mg/L)	0.000169	0.000164	0.000283	0.000168	0.000173
	Silicon (Si)-Total (mg/L)	5.81	6.20	5.30	6.05	5.38
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	8.92	6.49	16.2	9.06	8.98
	Strontium (Sr)-Total (mg/L)	0.473	0.338	0.754	0.455	0.458
	Sulfur (S)-Total (mg/L)	8.74	2.79	18.2	7.13	7.91
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00534	0.0160	0.00040	0.0148	0.00578
	Uranium (U)-Total (mg/L)	0.00164	0.00110	0.00261	0.00168	0.00162
	Vanadium (V)-Total (mg/L)	0.00131	0.00216	<0.00050	0.00224	0.00131
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00031	0.00035	<0.00030	0.00033	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0079	0.0101	0.0045	0.0325	0.0088
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00049	0.00039	0.00025	0.00058	0.00048
	Barium (Ba)-Dissolved (mg/L)	0.0662	0.0599	0.0642	0.0632	0.0648
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.022	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000051	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	40.8	27.9	54.8	38.9	40.3
	Chromium (Cr)-Dissolved (mg/L)	0.00017	0.00029	0.00010	0.00027	0.00017
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00276	0.00147	0.00501	0.00271	0.00275
	Iron (Fe)-Dissolved (mg/L)	0.055	0.084	0.013	0.143	0.052
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0014	<0.0010	0.0024	0.0013	0.0014
	Magnesium (Mg)-Dissolved (mg/L)	13.1	10.1	23.5	13.1	13.0
	Manganese (Mn)-Dissolved (mg/L)	0.00924	0.0203	0.0346	0.0158	0.00915

	Sample ID	L1950514-1	L1950514-2	L1950514-3	L1950514-4	L1950514-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	27-JUN-17	27-JUN-17	27-JUN-17	27-JUN-17	27-JUN-17
	Sampled Time	07:45	09:30	10:00	11:30	07:45
	Client ID	W2	W7	W3	MC1	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00163	0.00140	0.00401	0.00175	0.00160
	Nickel (Ni)-Dissolved (mg/L)	0.00107	0.00125	0.00099	0.00124	0.00111
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.43	0.84	2.27	1.35	1.43
	Selenium (Se)-Dissolved (mg/L)	0.000205	0.000174	0.000360	0.000175	0.000199
	Silicon (Si)-Dissolved (mg/L)	5.63	5.86	5.60	5.81	5.74
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.38	6.84	16.9	9.58	9.36
	Strontium (Sr)-Dissolved (mg/L)	0.380	0.279	0.628	0.373	0.380
	Sulfur (S)-Dissolved (mg/L)	8.67	3.00	18.7	7.58	8.48
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00035	DLM <0.00060	0.00044	DLM <0.0020	0.00048
	Uranium (U)-Dissolved (mg/L)	0.00142	0.000948	0.00230	0.00146	0.00140
	Vanadium (V)-Dissolved (mg/L)	0.00087	0.00088	<0.00050	0.00110	0.00083
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Boron (B)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1950514-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1950514-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in $CaCO_3$ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

Reference Information

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

2017-06-28 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1950514-COFC

COC Number: 2017-06-28 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	226337 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** CH/EB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preser	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W2	27-Jun-17	7:45	Water	R	R	R	R	R	R	R	R	R					7
	W7	27-Jun-17	9:30	Water	R	R	R	R	R	R	R	R	R					7
	W3	27-Jun-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
	MC1	27-Jun-17	11:30	Water	R	R	R	R	R	R	R	R	R					7
	DUP	27-Jun-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES ºC			FINAL COOLER TEMPERATURES ºC		
2.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-06-28 8:00	Time:	Received by: PH	Date: June 26/17	Time: 14 45	Received by: PAUL	Date: JUN 29	Time: 16:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2016 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 05-JUL-17
Report Date: 18-JUL-17 18:08 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1953755
Project P.O. #: 226337 (WUL)
Job Reference:
C of C Numbers: 2017-07-05-B
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1953755-1	L1953755-2	L1953755-3	L1953755-4	L1953755-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-JUL-17	03-JUL-17	03-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time	13:45	14:25	14:25	07:40	08:40
	Client ID	W10	W12	W14	W2	MC1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	248	2560	3420	345	336
	Hardness (as CaCO3) (mg/L)	130	1240	1700	164	161
	pH (pH)	7.76	7.99	8.05	8.25	8.29
	Total Suspended Solids (mg/L)	<3.0	9.1	58.1	4.1	10.9
	TDS (Calculated) (mg/L)	145	2300	3290	193	189
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	125	157	76.2	163	163
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	1.8
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	125	157	76.2	163	165
	Ammonia, Total (as N) (mg/L)	0.0288	3.68	3.76	0.0141	<0.0050
	Chloride (Cl) (mg/L)	<0.50	36	39	2.13	1.66
	Nitrate and Nitrite (as N) (mg/L)	2.65	20.8	27.2	0.185	0.151
	Nitrate (as N) (mg/L)	2.62	15.1	21.4	0.184	0.150
	Nitrite (as N) (mg/L)	0.0246	5.77	5.77	0.0013	0.0011
	Sulfate (SO4) (mg/L)	3.45	1430	2150	24.1	20.8
	Anion Sum (meq/L)	2.76	35.5	49.4	3.84	3.78
	Cation Sum (meq/L)	2.98	32.5	45.7	3.75	3.70
	Cation - Anion Balance (%)	3.8	-4.5	-3.9	-1.2	-1.1
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)				9.51	9.79
Total Metals	Aluminum (Al)-Total (mg/L)	0.0775	0.0654	1.31	0.0680	0.247
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00022	0.00029	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00053	0.00040	0.00077	0.00053	0.00068
	Barium (Ba)-Total (mg/L)	0.169	0.110	0.180	0.0718	0.0690
	Beryllium (Be)-Total (mg/L)	<0.000020	DLA <0.000040	0.000042	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	DLA <0.00010	0.00098	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.203	0.247	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000058	0.000148	0.000648	<0.0000050	0.0000071
	Calcium (Ca)-Total (mg/L)	38.3	373	502	42.8	41.5
	Chromium (Cr)-Total (mg/L)	0.00035	DLA <0.00020	0.00454	0.00029	0.00065
	Cobalt (Co)-Total (mg/L)	0.00044	0.00174	0.00282	0.00010	0.00022
	Copper (Cu)-Total (mg/L)	0.0272	0.0498	9.72	0.00237	0.00299
	Iron (Fe)-Total (mg/L)	1.68	0.137	6.11	0.128	0.468
	Lead (Pb)-Total (mg/L)	<0.000050	0.00019	0.00286	<0.000050	0.000126
	Lithium (Li)-Total (mg/L)	<0.0010	0.0173	0.0314	0.0015	0.0013
	Magnesium (Mg)-Total (mg/L)	8.31	50.3	73.3	13.7	14.6
	Manganese (Mn)-Total (mg/L)	0.264	1.43	1.60	0.0237	0.0264

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1953755-6	L1953755-7	L1953755-8	L1953755-9
	Description	Water	Water	Water	Water
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time	09:30	10:20		
	Client ID	W3	W33	F-BL	DUP
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	520	190	<2.0	321
	Hardness (as CaCO3) (mg/L)	249	100	<0.50	162
	pH (pH)	8.31	7.79	5.26	8.10
	Total Suspended Solids (mg/L)	<3.0	3.5	<3.0	8.7
	TDS (Calculated) (mg/L)	301	104	<1.0	187
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	227	100	<1.0	161
	Alkalinity, Carbonate (as CaCO3) (mg/L)	3.6	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	231	100	<1.0	161
	Ammonia, Total (as N) (mg/L)	0.0087	0.0103	<0.0050	0.0146
	Chloride (Cl) (mg/L)	4.60	<0.50	<0.50	1.65
	Nitrate and Nitrite (as N) (mg/L)	0.197	0.442	<0.0051	0.151
	Nitrate (as N) (mg/L)	0.197	0.442	<0.0050	0.150
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	0.0012
	Sulfate (SO4) (mg/L)	54.9	1.71	<0.30	20.8
	Anion Sum (meq/L)	5.90	2.07	<0.10	3.71
	Cation Sum (meq/L)	5.82	2.21	<0.10	3.72
	Cation - Anion Balance (%)	-0.6	3.5	0.0	0.2
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.90		<0.50	9.69
Total Metals	Aluminum (Al)-Total (mg/L)	0.0061	0.0423	<0.0030	0.226
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00012
	Arsenic (As)-Total (mg/L)	0.00025	0.00044	<0.00010	0.00074
	Barium (Ba)-Total (mg/L)	0.0668	0.0529	<0.000050	0.0689
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.026	<0.010	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000126
	Calcium (Ca)-Total (mg/L)	59.0	28.2	<0.050	41.6
	Chromium (Cr)-Total (mg/L)	0.00012	0.00059	<0.00010	0.00063
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00016	<0.00010	0.00020
	Copper (Cu)-Total (mg/L)	0.00353	0.0140	<0.00050	0.00268
	Iron (Fe)-Total (mg/L)	0.014	0.246	<0.010	0.448
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	0.000116
	Lithium (Li)-Total (mg/L)	0.0030	<0.0010	<0.0010	0.0013
	Magnesium (Mg)-Total (mg/L)	27.1	7.66	<0.10	14.6
	Manganese (Mn)-Total (mg/L)	0.0384	0.0289	<0.00010	0.0262

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1953755-1	L1953755-2	L1953755-3	L1953755-4	L1953755-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-JUL-17	03-JUL-17	03-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time	13:45	14:25	14:25	07:40	08:40
	Client ID	W10	W12	W14	W2	MC1
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.000025 DLM	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.000463	0.0741	0.147	0.00146	0.00183
	Nickel (Ni)-Total (mg/L)	0.00126	0.0043	0.0045	0.00110	0.00154
	Phosphorus (P)-Total (mg/L)	<0.050	<0.10 DLA	0.13	<0.050	<0.050
	Potassium (K)-Total (mg/L)	0.70	47.0	96.2	1.50	1.35
	Selenium (Se)-Total (mg/L)	0.000114	0.0110	0.0170	0.000148	0.000157
	Silicon (Si)-Total (mg/L)	1.79	3.32	4.93	5.85	6.31
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000020 DLA	0.00233	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	5.66	122	180	9.43	9.84
	Strontium (Sr)-Total (mg/L)	0.253	6.85	7.16	0.431	0.428
	Sulfur (S)-Total (mg/L)	1.70	427	659	8.50	7.49
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000020 DLA	0.000031	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00183	<0.0033 DLM	0.0769	0.00274	0.00914
	Uranium (U)-Total (mg/L)	0.000071	0.00617	0.0149	0.00179	0.00189
	Vanadium (V)-Total (mg/L)	0.00066	<0.0010 DLA	0.0066	0.00089	0.00166
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0076	0.0228	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00039	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0536	0.0036	0.0356	0.0065	0.0068
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00028	0.00033	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00051	0.00041	0.00031	0.00046	0.00053
	Barium (Ba)-Dissolved (mg/L)	0.178	0.122	0.211	0.0709	0.0642
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.231	0.286	0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000061	<0.00018 DLM	<0.00015 DLM	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	37.0	406	547	42.4	40.2
	Chromium (Cr)-Dissolved (mg/L)	0.00032	<0.00020 DLA	<0.00020 DLA	0.00012	0.00016
	Cobalt (Co)-Dissolved (mg/L)	0.00043	0.00193	0.00133	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0259	0.0397	0.0140	0.00212	0.00171
	Iron (Fe)-Dissolved (mg/L)	1.07	<0.020 DLA	<0.020 DLA	0.031	0.081
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0185	0.0328	0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	9.26	56.4	81.9	14.1	14.7
	Manganese (Mn)-Dissolved (mg/L)	0.282	1.62	1.60	0.0170	0.00921

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1953755-6	L1953755-7	L1953755-8	L1953755-9	
	Description	Water	Water	Water	Water	
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17	
	Sampled Time	09:30	10:20			
	Client ID	W3	W33	F-BL	DUP	
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	0.00489	0.000737	<0.000050	0.00188	
	Nickel (Ni)-Total (mg/L)	0.00093	0.00161	<0.00050	0.00152	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Total (mg/L)	2.19	<0.10	<0.10	1.37	
	Selenium (Se)-Total (mg/L)	0.000312	0.000149	<0.000050	0.000137	
	Silicon (Si)-Total (mg/L)	5.80	5.29	<0.10	6.21	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Total (mg/L)	18.0	4.26	<0.050	9.90	
	Strontium (Sr)-Total (mg/L)	0.761	0.162	<0.00020	0.424	
	Sulfur (S)-Total (mg/L)	19.1	0.77	<0.50	7.02	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	<0.00030	0.00119	<0.00030	0.00820	
	Uranium (U)-Total (mg/L)	0.00286	0.000030	<0.000010	0.00191	
	Vanadium (V)-Total (mg/L)	<0.00050	0.00053	<0.00050	0.00161	
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00049	<0.00030	<0.00030	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0022	0.0337	<0.0010	0.0072	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00041	<0.00010	0.00056	
	Barium (Ba)-Dissolved (mg/L)	0.0663	0.0537	<0.000050	0.0645	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Dissolved (mg/L)	0.024	<0.010	<0.010	<0.010	
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000050	<0.0000050	<0.0000050	
	Calcium (Ca)-Dissolved (mg/L)	54.7	27.3	<0.050	41.1	
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00042	<0.00010	0.00017	
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00016	<0.00010	<0.00010	
	Copper (Cu)-Dissolved (mg/L)	0.00340	0.0129	<0.00020	0.00191	
	Iron (Fe)-Dissolved (mg/L)	0.011	0.205	<0.010	0.085	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0025	<0.0010	<0.0010	0.0011	
	Magnesium (Mg)-Dissolved (mg/L)	27.4	7.85	<0.10	14.5	
	Manganese (Mn)-Dissolved (mg/L)	0.0372	0.0261	<0.00010	0.00922	

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1953755-1	L1953755-2	L1953755-3	L1953755-4	L1953755-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-JUL-17	03-JUL-17	03-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time	13:45	14:25	14:25	07:40	08:40
	Client ID	W10	W12	W14	W2	MC1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000359	0.0787	0.170	0.00138	0.00176
	Nickel (Ni)-Dissolved (mg/L)	0.00126	0.0046	0.0029	0.00100	0.00106
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.10 DLA	<0.10 DLA	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	0.77	50.1	102	1.60	1.40
	Selenium (Se)-Dissolved (mg/L)	0.000153	0.0126	0.0184	0.000196	0.000190
	Silicon (Si)-Dissolved (mg/L)	1.73	3.64	3.01	5.77	6.03
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	6.29	137	200	9.78	10.3
	Strontium (Sr)-Dissolved (mg/L)	0.246	7.51	7.76	0.416	0.407
	Sulfur (S)-Dissolved (mg/L)	1.47	501	743	8.21	6.97
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00090 DLM	<0.00060 DLA	<0.00060 DLA	<0.00030	0.00041
	Uranium (U)-Dissolved (mg/L)	0.000076	0.00708	0.0167	0.00171	0.00187
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.0010 DLA	<0.0010 DLA	0.00069	0.00087
	Zinc (Zn)-Dissolved (mg/L)	0.0015	0.0070	<0.0020 DLA	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	0.00045	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1953755-6	L1953755-7	L1953755-8	L1953755-9	
	Description	Water	Water	Water	Water	
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17	
	Sampled Time	09:30	10:20			
	Client ID	W3	W33	F-BL	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00448	0.000676	<0.000050	0.00174	
	Nickel (Ni)-Dissolved (mg/L)	0.00088	0.00151	<0.00050	0.00104	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.26	0.11	<0.10	1.38	
	Selenium (Se)-Dissolved (mg/L)	0.000350	0.000145	<0.000050	0.000215	
	Silicon (Si)-Dissolved (mg/L)	5.93	5.59	<0.050	6.24	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	18.0	4.35	<0.050	9.99	
	Strontium (Sr)-Dissolved (mg/L)	0.716	0.156	<0.00020	0.405	
	Sulfur (S)-Dissolved (mg/L)	18.6	0.94	<0.50	7.33	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00074	<0.00030	0.00035	
	Uranium (U)-Dissolved (mg/L)	0.00275	0.000030	<0.000010	0.00184	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00086	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00050	<0.00030	<0.00030	

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1953755-4, -5, -6, -8, -9
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1953755-1, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-07-05-B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1953755-COFC

COC Number: 2017-07-05 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 226337 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** EB/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W10	3-Jul-17	13:45	Water	R	R	R	R	R	R	R	R						6
	W12	3-Jul-17	14:25	Water	R	R	R	R	R	R	R	R						6
	W14	3-Jul-17	14:25	Water	R	R	R	R	R	R	R	R						6
	W2	4-Jul-17	7:40	Water	R	R	R	R	R	R	R	R	R					7
	MC1	4-Jul-17	8:40	Water	R	R	R	R	R	R	R	R	R					7
	W3	4-Jul-17	9:30	Water	R	R	R	R	R	R	R	R	R					7
	W33	4-Jul-17	10:20	Water	R	R	R	R	R	R	R	R						6
	F-BL	4-Jul-17		Water	R	R	R	R	R	R	R	R	R					7
	DUP	4-Jul-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
10					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Colin Prentice	Date: 2017-07-05	Time:	Received by: EHF	Date: 5 July 2017	Time: 14:50	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 12-JUL-17
Report Date: 24-JUL-17 17:46 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1957575
Project P.O. #: PO226337 (WUL)
Job Reference:
C of C Numbers: 2017-07-12 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1957575-1	L1957575-2	L1957575-3	L1957575-4	L1957575-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	11-JUL-17	11-JUL-17	11-JUL-17	11-JUL-17	11-JUL-17
	Sampled Time	08:10	09:15	10:45	13:40	14:20
	Client ID	W2	MC1	W8A	W3	W16A
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	353	339	1100	543	400
	Hardness (as CaCO3) (mg/L)	161	162	546	252	181
	pH (pH)	8.31	8.35	8.18	8.33	8.24
	Total Suspended Solids (mg/L)	61.3	320	34.5	<3.0	<3.0
	TDS (Calculated) (mg/L)	192	184	697	304	231
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	165	156	452	230	137
	Alkalinity, Carbonate (as CaCO3) (mg/L)	3.4	5.2	<1.0	6.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	169	161	452	236	137
	Ammonia, Total (as N) (mg/L)	0.0097	0.0218	0.110	0.0066	0.0461
	Chloride (Cl) (mg/L)	1.73	1.36	7.3	4.52	4.31
	Nitrate and Nitrite (as N) (mg/L)	0.146	0.112	3.35	0.175	2.84
	Nitrate (as N) (mg/L)	0.146	0.112	3.28	0.175	2.77
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.0720	<0.0010	0.0710
	Sulfate (SO4) (mg/L)	21.8	19.3	171	53.5	54.4
	Anion Sum (meq/L)	3.89	3.67	13.0	5.97	4.20
	Cation Sum (meq/L)	3.69	3.70	12.8	5.89	4.22
	Cation - Anion Balance (%)	-2.5	0.3	-1.1	-0.6	0.2
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	10.0	10.8		6.06	18.8
Total Metals	Aluminum (Al)-Total (mg/L)	0.774	5.04	1.16	0.0049	0.0234
	Antimony (Sb)-Total (mg/L)	0.00017	0.00029	0.00067	0.00010	0.00018
	Arsenic (As)-Total (mg/L)	0.00108	0.00318	0.00134	0.00029	0.00048
	Barium (Ba)-Total (mg/L)	0.0795	0.156	0.169	0.0674	0.0652
	Beryllium (Be)-Total (mg/L)	0.000028	0.000180	0.000055	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	0.000066	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.025	0.025	0.028
	Cadmium (Cd)-Total (mg/L)	0.0000192	0.0000763	0.000166	<0.0000050	0.0000102
	Calcium (Ca)-Total (mg/L)	44.2	45.0	151	57.5	49.9
	Chromium (Cr)-Total (mg/L)	0.00159	0.00906	0.00146	<0.00010	0.00022
	Cobalt (Co)-Total (mg/L)	0.00055	0.00346	0.00179	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.00515	0.0167	0.415	0.00356	0.0309
	Iron (Fe)-Total (mg/L)	1.31	7.76	5.44	0.015	0.187
	Lead (Pb)-Total (mg/L)	0.000371	0.00207	0.000616	<0.000050	0.00163
	Lithium (Li)-Total (mg/L)	0.0024	0.0050	0.0045	0.0033	0.0014
	Magnesium (Mg)-Total (mg/L)	14.9	16.6	44.4	27.0	14.6
	Manganese (Mn)-Total (mg/L)	0.0747	0.288	2.63	0.0410	0.0748

	Sample ID	L1957575-6	L1957575-7			
	Description	WATER	WATER			
	Sampled Date	11-JUL-17	11-JUL-17			
	Sampled Time	14:50				
	Client ID	W50	DUP			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	399	341			
	Hardness (as CaCO3) (mg/L)	178	162			
	pH (pH)	8.20	8.32			
	Total Suspended Solids (mg/L)	<3.0	181			
	TDS (Calculated) (mg/L)	231	187			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	133	162			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	3.4			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	133	165			
	Ammonia, Total (as N) (mg/L)	0.0318	0.0185			
	Chloride (Cl) (mg/L)	4.44	1.39			
	Nitrate and Nitrite (as N) (mg/L)	3.31	0.112			
	Nitrate (as N) (mg/L)	3.27	0.111			
	Nitrite (as N) (mg/L)	0.0352	0.0014			
	Sulfate (SO4) (mg/L)	55.4	19.5			
	Anion Sum (meq/L)	4.17	3.76			
	Cation Sum (meq/L)	4.17	3.71			
	Cation - Anion Balance (%)	0.0	-0.6			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	19.2	11.8			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0182	3.99			
	Antimony (Sb)-Total (mg/L)	0.00014	0.00027			
	Arsenic (As)-Total (mg/L)	0.00058	0.00269			
	Barium (Ba)-Total (mg/L)	0.0627	0.134			
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000131			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	0.029	<0.010			
	Cadmium (Cd)-Total (mg/L)	0.0000090	0.0000598			
	Calcium (Ca)-Total (mg/L)	49.1	44.1			
	Chromium (Cr)-Total (mg/L)	0.00022	0.00731			
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00262			
	Copper (Cu)-Total (mg/L)	0.0287	0.0138			
	Iron (Fe)-Total (mg/L)	0.127	6.10			
	Lead (Pb)-Total (mg/L)	0.000747	0.00163			
	Lithium (Li)-Total (mg/L)	0.0015	0.0042			
	Magnesium (Mg)-Total (mg/L)	14.2	15.9			
	Manganese (Mn)-Total (mg/L)	0.0218	0.221			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1957575-1 WATER 11-JUL-17 08:10 W2	L1957575-2 WATER 11-JUL-17 09:15 MC1	L1957575-3 WATER 11-JUL-17 10:45 W8A	L1957575-4 WATER 11-JUL-17 13:40 W3	L1957575-5 WATER 11-JUL-17 14:20 W16A
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.000010 DLM	0.000014	0.000011	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00168	0.00180	0.00604	0.00499	0.00271
	Nickel (Ni)-Total (mg/L)	0.00246	0.0112	0.00253	0.00098	0.00106
	Phosphorus (P)-Total (mg/L)	0.054	0.273	0.162	<0.050	<0.050
	Potassium (K)-Total (mg/L)	1.52	1.81	6.27	2.17	2.39
	Selenium (Se)-Total (mg/L)	0.000204	0.000301	0.00477	0.000290	0.000815
	Silicon (Si)-Total (mg/L)	7.59	16.4	11.0	6.14	2.87
	Silver (Ag)-Total (mg/L)	<0.000010	0.000037	0.000163	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	9.91	9.87	33.4	18.0	11.9
	Strontium (Sr)-Total (mg/L)	0.435	0.455	2.02	0.737	0.464
	Sulfur (S)-Total (mg/L)	8.02	7.07	65.0	19.5	19.8
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000042	0.000014	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	0.00013	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0279	0.165	0.0504	<0.00030	0.00088
	Uranium (U)-Total (mg/L)	0.00213	0.00222	0.00286	0.00253	0.00101
	Vanadium (V)-Total (mg/L)	0.00324	0.0153	0.00587	<0.00050	0.00056
	Zinc (Zn)-Total (mg/L)	0.0042	0.0200	0.912	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00033	0.00067	0.00052	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0105	0.0084	0.0103	0.0027	0.0135
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00011	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00051	0.00052	0.00058	0.00025	0.00045
	Barium (Ba)-Dissolved (mg/L)	0.0659	0.0634	0.150	0.0687	0.0672
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.022	0.022	0.025
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000970	<0.0000050	0.0000120
	Calcium (Ca)-Dissolved (mg/L)	39.3	40.7	141	54.9	48.2
	Chromium (Cr)-Dissolved (mg/L)	0.00017	0.00018	0.00049	<0.00010	0.00017
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00134	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00245	0.00184	0.0714	0.00341	0.0296
	Iron (Fe)-Dissolved (mg/L)	0.050	0.065	0.729	0.013	0.139
	Lead (Pb)-Dissolved (mg/L)	0.000230	<0.000050	0.000149	0.000135	0.00173
	Lithium (Li)-Dissolved (mg/L)	0.0013	<0.0010	0.0035	0.0027	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	15.2	14.7	47.1	28.0	14.7
	Manganese (Mn)-Dissolved (mg/L)	0.0220	0.0168	2.93	0.0376	0.0737

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1957575-6	L1957575-7			
	Description	WATER	WATER			
	Sampled Date	11-JUL-17	11-JUL-17			
	Sampled Time	14:50				
	Client ID	W50	DUP			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.000015			
	Molybdenum (Mo)-Total (mg/L)	0.00263	0.00183			
	Nickel (Ni)-Total (mg/L)	0.00083	0.00909			
	Phosphorus (P)-Total (mg/L)	<0.050	0.212			
	Potassium (K)-Total (mg/L)	2.44	1.67			
	Selenium (Se)-Total (mg/L)	0.000858	0.000300			
	Silicon (Si)-Total (mg/L)	3.26	14.2			
	Silver (Ag)-Total (mg/L)	<0.000010	0.000029			
	Sodium (Na)-Total (mg/L)	12.0	9.66			
	Strontium (Sr)-Total (mg/L)	0.471	0.440			
	Sulfur (S)-Total (mg/L)	19.9	7.00			
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000035			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	DLM <0.00090	0.144			
	Uranium (U)-Total (mg/L)	0.000949	0.00220			
	Vanadium (V)-Total (mg/L)	0.00055	0.0125			
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0164			
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00059			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0085	0.0079			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00050	0.00058			
	Barium (Ba)-Dissolved (mg/L)	0.0642	0.0643			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.025	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000052	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	46.8	40.6			
	Chromium (Cr)-Dissolved (mg/L)	0.00018	0.00021			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.0263	0.00186			
	Iron (Fe)-Dissolved (mg/L)	0.095	0.066			
	Lead (Pb)-Dissolved (mg/L)	0.000593	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0011			
	Magnesium (Mg)-Dissolved (mg/L)	14.9	14.9			
	Manganese (Mn)-Dissolved (mg/L)	0.0117	0.0158			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1957575-1	L1957575-2	L1957575-3	L1957575-4	L1957575-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	11-JUL-17	11-JUL-17	11-JUL-17	11-JUL-17	11-JUL-17
	Sampled Time	08:10	09:15	10:45	13:40	14:20
	Client ID	W2	MC1	W8A	W3	W16A
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00153	0.00165	0.00549	0.00469	0.00248
	Nickel (Ni)-Dissolved (mg/L)	0.00103	0.00117	0.00177	0.00097	0.00108
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.50	1.23	6.27	2.20	2.42
	Selenium (Se)-Dissolved (mg/L)	0.000158	0.000159	0.00436	0.000314	0.000777
	Silicon (Si)-Dissolved (mg/L)	5.70	5.95	8.32	5.81	2.70
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000018	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	10.2	9.70	34.8	18.3	12.0
	Strontium (Sr)-Dissolved (mg/L)	0.394	0.388	1.93	0.723	0.455
	Sulfur (S)-Dissolved (mg/L)	7.33	6.35	58.5	17.7	17.9
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00055	0.00033	0.00055	<0.00030	0.00051
	Uranium (U)-Dissolved (mg/L)	0.00179	0.00179	0.00271	0.00271	0.000962
	Vanadium (V)-Dissolved (mg/L)	0.00084	0.00092	0.00114	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0026	<0.0010	0.377	<0.0010	0.0023
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00049	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1957575-6 WATER 11-JUL-17 14:50 W50	L1957575-7 WATER 11-JUL-17 DUP			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00237	0.00167			
	Nickel (Ni)-Dissolved (mg/L)	0.00082	0.00120			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.53	1.25			
	Selenium (Se)-Dissolved (mg/L)	0.000905	0.000161			
	Silicon (Si)-Dissolved (mg/L)	3.16	5.85			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	12.4	9.84			
	Strontium (Sr)-Dissolved (mg/L)	0.442	0.397			
	Sulfur (S)-Dissolved (mg/L)	17.9	6.65			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	0.00042	0.00034			
	Uranium (U)-Dissolved (mg/L)	0.000821	0.00179			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00096			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1957575-6, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1957575-6, -7
Matrix Spike	Aluminum (Al)-Total	MS-B	L1957575-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Total	MS-B	L1957575-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Total	MS-B	L1957575-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in $CaCO_3$ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Reference Information

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-07-12 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1957575-COFC

COC Number: 2017-07-12 A

Page of

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To

Same as Report To ☐ YES ☑ NO

Copy of Invoice with Report ☐ YES ☑ NO

Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226337 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack

Sampler: SR/EB/MM

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W2	11-Jul-17	8:10	Water	R	R	R	R	R	R	R	R	R					7
	MC1	11-Jul-17	9:15	Water	R	R	R	R	R	R	R	R	R					7
	W8A	11-Jul-17	10:45	Water	R	R	R	R	R	R	R	R	[illegible]					[illegible] 6
	W3	11-Jul-17	13:40	Water	R	R	R	R	R	R	R	R	R					7
	W16A	11-Jul-17	14:20	Water	R	R	R	R	R	R	R	R	R					7
	W50	11-Jul-17	14:50	Water	R	R	R	R	R	R	R	R	R					7
	DUP	11-Jul-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 7.7

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts | Date: 2017-07-12 | Time: 10:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: PH | Date: 7/12/17 | Time: 15:29

FINAL SHIPMENT RECEPTION (lab use only)

Received by: | Date: | Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 19-JUL-17
Report Date: 27-JUL-17 18:40 (MT)
Version: FINAL REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1961156
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 2017-07-18 A
Legal Site Desc:

Comments: 27-JUL-2017 Please note, this report has been revised to update the sample ID of L1961156-3 and to remove the incorrect job number.

Shane Stack
Account Manager

	Sample ID	L1961156-1	L1961156-2	L1961156-3	L1961156-4	L1961156-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	17-JUL-17	17-JUL-17	17-JUL-17	18-JUL-17	18-JUL-17
	Sampled Time	08:30	17:10	11:50	08:40	09:35
	Client ID	W16	W17	W8A	MC1	W2
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	401	456	1050	347	354
	Hardness (as CaCO3) (mg/L)	185	212	544	174	172
	pH (pH)	8.21	8.10	7.55	8.23	8.14
	Total Suspended Solids (mg/L)	4.4	<3.0	19.6	19.6	5.2
	TDS (Calculated) (mg/L)	237	264	684	198	209
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	140	189	435	173	167
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	140	189	435	173	167
	Ammonia, Total (as N) (mg/L)	0.0432	<0.0050	0.164	0.0118	0.0085
	Chloride (Cl) (mg/L)	4.76	5.26	7.20	1.69	2.79
	Nitrate and Nitrite (as N) (mg/L)	2.90	0.482	3.19	0.138	0.176
	Nitrate (as N) (mg/L)	2.84	0.482	3.15	0.137	0.171
	Nitrite (as N) (mg/L)	0.0592	<0.0010	0.0370	0.0012	0.0047
	Sulfate (SO4) (mg/L)	56.3	51.6	170	20.9	34.8
	Anion Sum (meq/L)	4.32	5.04	12.7	3.96	4.15
	Cation Sum (meq/L)	4.32	4.96	12.7	3.98	3.90
	Cation - Anion Balance (%)	0.0	-0.8	0.1	0.3	-3.1
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	19.1	10.1		9.45	9.44
Total Metals	Aluminum (Al)-Total (mg/L)	0.0274	0.0033	0.247	0.159	0.0558
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00012	0.00017	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00046	0.00041	0.00085	0.00068	0.00046
	Barium (Ba)-Total (mg/L)	0.0683	0.0702	0.162	0.0684	0.0745
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000037	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.027	0.032	0.025	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000086	<0.0000050	0.000149	0.0000052	<0.0000050
	Calcium (Ca)-Total (mg/L)	48.5	56.8	144	43.2	44.9
	Chromium (Cr)-Total (mg/L)	0.00022	0.00015	0.00104	0.00050	0.00026
	Cobalt (Co)-Total (mg/L)	0.00010	<0.00010	0.00160	0.00018	<0.00010
	Copper (Cu)-Total (mg/L)	0.0296	0.00752	0.199	0.00254	0.00282
	Iron (Fe)-Total (mg/L)	0.148	<0.010	4.10	0.335	0.113
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000202	0.000093	<0.000050
	Lithium (Li)-Total (mg/L)	<0.0010	0.0012	0.0040	0.0013	0.0016
	Magnesium (Mg)-Total (mg/L)	15.3	17.5	46.9	16.0	15.0
	Manganese (Mn)-Total (mg/L)	0.0678	0.00395	2.85	0.0223	0.0264

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1961156-6	L1961156-7			
	Description	Water	Water			
	Sampled Date	18-JUL-17	18-JUL-17			
	Sampled Time	10:45	12:00			
	Client ID	W3	DUP			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	533	359			
	Hardness (as CaCO3) (mg/L)	256	175			
	pH (pH)	8.19	8.17			
	Total Suspended Solids (mg/L)	5.4	26.6			
	TDS (Calculated) (mg/L)	309	202			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	240	169			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	240	169			
	Ammonia, Total (as N) (mg/L)	0.0073	0.0098			
	Chloride (Cl) (mg/L)	4.72	2.49			
	Nitrate and Nitrite (as N) (mg/L)	0.190	0.147			
	Nitrate (as N) (mg/L)	0.190	0.146			
	Nitrite (as N) (mg/L)	<0.0010	0.0013			
	Sulfate (SO4) (mg/L)	54.9	25.7			
	Anion Sum (meq/L)	6.07	4.00			
	Cation Sum (meq/L)	5.96	3.97			
	Cation - Anion Balance (%)	-1.0	-0.4			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	6.34	9.14			
Total Metals	Aluminum (Al)-Total (mg/L)	0.154	0.0829			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00035	0.00049			
	Barium (Ba)-Total (mg/L)	0.0716	0.0753			
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	0.023	<0.010			
	Cadmium (Cd)-Total (mg/L)	0.0000096	0.0000056			
	Calcium (Ca)-Total (mg/L)	56.9	46.1			
	Chromium (Cr)-Total (mg/L)	0.00032	0.00039			
	Cobalt (Co)-Total (mg/L)	0.00019	0.00012			
	Copper (Cu)-Total (mg/L)	0.00896	0.00309			
	Iron (Fe)-Total (mg/L)	0.264	0.160			
	Lead (Pb)-Total (mg/L)	0.000092	<0.000050			
	Lithium (Li)-Total (mg/L)	0.0027	0.0017			
	Magnesium (Mg)-Total (mg/L)	28.3	15.0			
	Manganese (Mn)-Total (mg/L)	0.112	0.0310			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Grouping	Analyte	L1961156-1	L1961156-2	L1961156-3	L1961156-4	L1961156-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	17-JUL-17	17-JUL-17	17-JUL-17	18-JUL-17	18-JUL-17
	Sampled Time	08:30	17:10	11:50	08:40	09:35
	Client ID	W16	W17	W8A	MC1	W2
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000077	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00258	0.00514	0.00616	0.00183	0.00133
	Nickel (Ni)-Total (mg/L)	0.00108	0.00064	0.00213	0.00157	0.00122
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.110	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.46	3.41	6.06	1.38	1.56
	Selenium (Se)-Total (mg/L)	0.000792	0.000348	0.00439	0.000145	0.000128
	Silicon (Si)-Total (mg/L)	2.66	4.89	8.77	6.25	5.90
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000068	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	12.1	14.4	34.6	10.3	10.0
	Strontium (Sr)-Total (mg/L)	0.452	0.581	1.88	0.431	0.451
	Sulfur (S)-Total (mg/L)	18.5	18.1	63.6	7.49	9.25
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00162	<0.00030	0.0119	0.00621	DLM <0.0018
	Uranium (U)-Total (mg/L)	0.000902	0.00162	0.00271	0.00185	0.00175
	Vanadium (V)-Total (mg/L)	0.00065	<0.00050	0.00293	0.00150	0.00087
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.410	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00042	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0132	0.0024	0.0131	0.0156	0.0086
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00043	0.00035	0.00063	0.00053	0.00039
	Barium (Ba)-Dissolved (mg/L)	0.0694	0.0710	0.150	0.0687	0.0741
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	0.000026	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.026	0.030	0.024	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000075	<0.0000050	0.000108	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	48.7	56.4	141	42.5	44.6
	Chromium (Cr)-Dissolved (mg/L)	0.00017	0.00012	0.00049	0.00021	0.00015
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00135	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0283	0.00726	0.0804	0.00191	0.00230
	Iron (Fe)-Dissolved (mg/L)	0.110	<0.010	0.433	0.083	0.036
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0012	0.0037	0.0012	0.0016
	Magnesium (Mg)-Dissolved (mg/L)	15.5	17.4	46.7	16.5	14.7
	Manganese (Mn)-Dissolved (mg/L)	0.0635	0.00092	2.73	0.00954	0.0214

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1961156-6	L1961156-7			
	Description	Water	Water			
	Sampled Date	18-JUL-17	18-JUL-17			
	Sampled Time	10:45	12:00			
	Client ID	W3	DUP			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	DLM <0.000010			
	Molybdenum (Mo)-Total (mg/L)	0.00444	0.00126			
	Nickel (Ni)-Total (mg/L)	0.00137	0.00129			
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050			
	Potassium (K)-Total (mg/L)	2.18	1.55			
	Selenium (Se)-Total (mg/L)	0.000338	0.000119			
	Silicon (Si)-Total (mg/L)	6.03	5.90			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	17.8	9.87			
	Strontium (Sr)-Total (mg/L)	0.711	0.455			
	Sulfur (S)-Total (mg/L)	19.0	8.94			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00859	0.00372			
	Uranium (U)-Total (mg/L)	0.00256	0.00177			
	Vanadium (V)-Total (mg/L)	0.00097	0.00094			
	Zinc (Zn)-Total (mg/L)	0.0037	<0.0030			
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0238	0.0062			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00042			
	Barium (Ba)-Dissolved (mg/L)	0.0691	0.0749			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.023	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	56.6	45.1			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00017			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00356	0.00228			
	Iron (Fe)-Dissolved (mg/L)	0.042	0.035			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0027	0.0015			
	Magnesium (Mg)-Dissolved (mg/L)	28.0	15.1			
	Manganese (Mn)-Dissolved (mg/L)	0.0797	0.0216			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1961156-1	L1961156-2	L1961156-3	L1961156-4	L1961156-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	17-JUL-17	17-JUL-17	17-JUL-17	18-JUL-17	18-JUL-17
	Sampled Time	08:30	17:10	11:50	08:40	09:35
	Client ID	W16	W17	W8A	MC1	W2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000051	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00240	0.00476	0.00573	0.00172	0.00119
	Nickel (Ni)-Dissolved (mg/L)	0.00100	0.00057	0.00180	0.00112	0.00103
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.55	3.49	6.05	1.40	1.55
	Selenium (Se)-Dissolved (mg/L)	0.000762	0.000427	0.00479	0.000157	0.000138
	Silicon (Si)-Dissolved (mg/L)	2.71	4.73	7.89	5.96	5.70
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000020	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	12.3	14.4	34.6	10.6	9.78
	Strontium (Sr)-Dissolved (mg/L)	0.445	0.573	1.82	0.421	0.443
	Sulfur (S)-Dissolved (mg/L)	19.1	17.6	60.6	6.95	8.57
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	0.00072	<0.00030	DLM <0.00060	DLM <0.00060	DLM <0.00060
	Uranium (U)-Dissolved (mg/L)	0.000843	0.00154	0.00252	0.00170	0.00165
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00117	0.00092	0.00058
	Zinc (Zn)-Dissolved (mg/L)	0.0013	0.0011	0.153	<0.0010	0.0014
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00043	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1961156-6	L1961156-7			
	Description	Water	Water			
	Sampled Date	18-JUL-17	18-JUL-17			
	Sampled Time	10:45	12:00			
	Client ID	W3	DUP			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00426	0.00120			
	Nickel (Ni)-Dissolved (mg/L)	0.00090	0.00107			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.22	1.58			
	Selenium (Se)-Dissolved (mg/L)	0.000274	0.000144			
	Silicon (Si)-Dissolved (mg/L)	5.67	5.71			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	17.7	9.97			
	Strontium (Sr)-Dissolved (mg/L)	0.694	0.441			
	Sulfur (S)-Dissolved (mg/L)	18.3	8.66			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.0012	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00242	0.00164			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00062			
	Zinc (Zn)-Dissolved (mg/L)	0.0038	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Aluminum (Al)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Nickel (Ni)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Potassium (K)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Silicon (Si)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Uranium (U)-Total	MS-B	L1961156-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Reference Information

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-07-18 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1961156-COFC

COC Number: 2017-07-18 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226337 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Contact: Shane Stack

Sampler: CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preser	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W16	17-Jul-17	8:30	Water	R	R	R	R	R	R	R	R	R					7
	W17	17-Jul-17	17:10	Water	R	R	R	R	R	R	R	R	R					7
	W8A	17-Jul-17	11:50	Water	R	R	R	R	R	R	R	R						6
	MC1	18-Jul-17	8:40	Water	R	R	R	R	R	R	R	R	R					7
	W2	18-Jul-17	9:35	Water	R	R	R	R	R	R	R	R	R					7
	W3	18-Jul-17	10:45	Water	R	R	R	R	R	R	R	R	R					7
	DUP	18-Jul-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.9	1.9				7.6

SHIPMENT RELEASE (client use)

Released by: Chris Harry

Date: 2017-07-18 11:45

Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by:

Date: July 19, 2017

Time: 11:15

FINAL SHIPMENT RECEPTION (lab use only)

Received by: TP

Date: July 20

Time: 16:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 26-JUL-17
Report Date: 10-AUG-17 12:49 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1964854

Project P.O. #: 226337 (WUL)
Job Reference:
C of C Numbers: 2017-07-25 C
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1964854-1	L1964854-2	L1964854-3	L1964854-4	L1964854-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-JUL-17	24-JUL-17	25-JUL-17	25-JUL-17	25-JUL-17
	Sampled Time	07:34	08:20	09:00	09:25	
	Client ID	W8A	W16	W3	W17	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1110	415	536	458	528
	Hardness (as CaCO3) (mg/L)	568	193	258	219	258
	pH (pH)	7.46	8.17	8.11	8.04	8.11
	Total Suspended Solids (mg/L)	14.0	3.2	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	733	239	306	264	306
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	404	139	230	182	231
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	404	139	230	182	231
	Ammonia, Total (as N) (mg/L)	0.136	0.0490	0.0053	<0.0050	<0.0050
	Chloride (Cl) (mg/L)	8.3	4.84	4.61	5.15	4.61
	Nitrate and Nitrite (as N) (mg/L)	4.36	2.65	0.179	0.396	0.181
	Nitrate (as N) (mg/L)	4.33	2.60	0.179	0.396	0.181
	Nitrite (as N) (mg/L)	0.0290	0.0486	<0.0010	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	218	56.6	54.8	52.3	54.7
	Anion Sum (meq/L)	13.2	4.27	5.89	4.89	5.89
	Cation Sum (meq/L)	13.2	4.47	6.05	5.11	6.05
	Cation - Anion Balance (%)	0.3	2.2	1.3	2.2	1.3
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		18.2	5.80	10.2	6.13
Total Metals	Aluminum (Al)-Total (mg/L)	0.0590	0.0403	0.0087	0.0034	0.0061
	Antimony (Sb)-Total (mg/L)	0.00013	<0.00010	<0.00010	0.00012	<0.00010
	Arsenic (As)-Total (mg/L)	0.00087	0.00056	0.00034	0.00048	0.00034
	Barium (Ba)-Total (mg/L)	0.157	0.0703	0.0682	0.0704	0.0683
	Beryllium (Be)-Total (mg/L)	0.000028	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.030	0.031	0.027	0.035	0.027
	Cadmium (Cd)-Total (mg/L)	0.000125	0.0000124	0.0000076	0.0000059	0.0000099
	Calcium (Ca)-Total (mg/L)	160	53.8	59.8	60.9	60.0
	Chromium (Cr)-Total (mg/L)	0.00068	0.00027	0.00013	0.00016	0.00016
	Cobalt (Co)-Total (mg/L)	0.00137	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.132	0.0329	0.00487	0.00795	0.00391
	Iron (Fe)-Total (mg/L)	2.91	0.176	0.025	<0.010	0.019
	Lead (Pb)-Total (mg/L)	0.000097	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0042	0.0013	0.0032	0.0014	0.0032
	Magnesium (Mg)-Total (mg/L)	45.5	14.8	26.9	16.4	26.7
	Manganese (Mn)-Total (mg/L)	2.63	0.0743	0.0388	0.00067	0.0385

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1964854-1	L1964854-2	L1964854-3	L1964854-4	L1964854-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-JUL-17	24-JUL-17	25-JUL-17	25-JUL-17	25-JUL-17
	Sampled Time	07:34	08:20	09:00	09:25	
	Client ID	W8A	W16	W3	W17	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00803	0.00290	0.00491	0.00564	0.00495
	Nickel (Ni)-Total (mg/L)	0.00197	0.00123	0.00123	0.00091	0.00136
	Phosphorus (P)-Total (mg/L)	0.081	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	6.33	2.65	2.32	3.66	2.36
	Selenium (Se)-Total (mg/L)	0.00495	0.000807	0.000380	0.000404	0.000262
	Silicon (Si)-Total (mg/L)	8.44	3.05	6.15	5.06	6.12
	Silver (Ag)-Total (mg/L)	0.000049	<0.000010	<0.000010	<0.000010	0.000012
	Sodium (Na)-Total (mg/L)	37.2	12.4	18.5	14.6	18.8
	Strontium (Sr)-Total (mg/L)	2.10	0.504	0.761	0.632	0.769
	Sulfur (S)-Total (mg/L)	70.0	19.2	19.3	17.5	18.1
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.0030 DLM	<0.0021 DLM	<0.00060 DLM	<0.00030	<0.00060 DLM
	Uranium (U)-Total (mg/L)	0.00316	0.00106	0.00285	0.00188	0.00256
	Vanadium (V)-Total (mg/L)	0.00245	0.00109	0.00081	0.00096	0.00086
	Zinc (Zn)-Total (mg/L)	0.239	<0.0030	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00045	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0092	0.0109	0.0018	0.0038	0.0044
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00063	0.00045	0.00024	0.00039	0.00023
	Barium (Ba)-Dissolved (mg/L)	0.141	0.0705	0.0689	0.0713	0.0693
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.027	0.029	0.026	0.034	0.025
	Cadmium (Cd)-Dissolved (mg/L)	0.0000936	0.0000110	0.0000082	0.0000059	0.0000100
	Calcium (Ca)-Dissolved (mg/L)	155	53.0	58.8	61.1	60.0
	Chromium (Cr)-Dissolved (mg/L)	0.00059	0.00018	<0.00010	0.00011	0.00011
	Cobalt (Co)-Dissolved (mg/L)	0.00105	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0747	0.0294	0.00290	0.00816	0.00339
	Iron (Fe)-Dissolved (mg/L)	0.638	0.113	0.010	<0.010	0.015
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0041	0.0011	0.0030	0.0014	0.0034
	Magnesium (Mg)-Dissolved (mg/L)	43.9	14.7	27.1	16.3	26.4
	Manganese (Mn)-Dissolved (mg/L)	2.16	0.0689	0.0366	0.0114 DTC	0.0363

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1964854-1	L1964854-2	L1964854-3	L1964854-4	L1964854-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-JUL-17	24-JUL-17	25-JUL-17	25-JUL-17	25-JUL-17
	Sampled Time	07:34	08:20	09:00	09:25	
	Client ID	W8A	W16	W3	W17	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00751	0.00267	0.00430	0.00535	0.00460
	Nickel (Ni)-Dissolved (mg/L)	0.00178	0.00120	0.00125	0.00087	0.00117
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	6.25	2.64	2.39	3.65	2.40
	Selenium (Se)-Dissolved (mg/L)	0.00516	0.000861	0.000265	0.000354	0.000258
	Silicon (Si)-Dissolved (mg/L)	8.05	2.83	6.04	5.02	6.17
	Silver (Ag)-Dissolved (mg/L)	0.000019	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	36.5	12.3	18.8	14.4	18.9
	Strontium (Sr)-Dissolved (mg/L)	1.98	0.491	0.742	0.624	0.745
	Sulfur (S)-Dissolved (mg/L)	70.9	18.7	18.0	17.3	18.2
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.00060	DLM <0.00060	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00292	0.000990	0.00226	0.00172	0.00262
	Vanadium (V)-Dissolved (mg/L)	0.00099	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	DTC 0.320	<0.0010	<0.0010	0.0012	0.0015
	Zirconium (Zr)-Dissolved (mg/L)	0.00038	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Chromium (Cr)-Total	MB-LOR	L1964854-1, -2, -3, -4, -5
Matrix Spike	Dissolved Organic Carbon	MS-B	L1964854-2, -3, -4, -5
Matrix Spike	Dissolved Organic Carbon	MS-B	L1964854-2, -3, -4, -5
Matrix Spike	Dissolved Organic Carbon	MS-B	L1964854-2, -3, -4, -5
Matrix Spike	Boron (B)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Cadmium (Cd)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1964854-1, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Nitrate (as N)	MS-B	L1964854-1, -2, -3, -4, -5
Matrix Spike	Sulfate (SO4)	MS-B	L1964854-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-07-25 C

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1964854-COFC

COC Number: 2017-07-25 C

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

[redacted] Date and Time Required for all E&P TATs: [redacted] [illegible]

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226337 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

[redacted] **Oil and Gas Required Fields (client use)**

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact: Shane Stack **Sampler:** CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preser	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)					Number of Containers
	W8A	24-Jul-17	7:34	Water	R	R	R	R	R	R	R	R						6
	W16	24-Jul-17	8:20	Water	R	R	R	R	R	R	R	R	R					7
	W3	25-Jul-17	9:00	Water	R	R	R	R	R	R	R	R	R					7
	W17	25-Jul-17	9:25	Water	R	R	R	R	R	R	R	R	R					7
	DUP	25-Jul-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples¹ (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☑	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-07-25 10:00	Time:	Received by: EHF	Date: 26 July 2017	Time: 11:30	Received by: Alex	Date: 27/07/2017	Time: 12:20

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

49/5.7/6.)

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 02-AUG-17
Report Date: 24-AUG-17 18:57 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1969064

Project P.O. #: 226337 (WUL)
Job Reference:
C of C Numbers: 2017-08-02 A
Legal Site Desc:

Comments: Please note, the ALS Fort Collins Ra226 detailed analysis report can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1969064-1	L1969064-2	L1969064-3	L1969064-4	L1969064-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17
	Sampled Time	07:40	08:05	08:35	09:15	09:50
	Client ID	W3	W50	W16A	MC1	W2
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	451	431	429	351	350
	Hardness (as CaCO3) (mg/L)	223	198	199	172	173
	pH (pH)	8.05	8.20	8.26	8.27	8.28
	Total Suspended Solids (mg/L)	3.0	6.6	<3.0	56.2	34.8
	TDS (Calculated) (mg/L)	271	248	249	193	197
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	185	151	148	163	168
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	185	151	148	163	168
	Ammonia, Total (as N) (mg/L)	0.0069	0.0280	0.0540	0.0161	0.0061
	Chloride (Cl) (mg/L)	5.06	5.23	5.21	1.69	1.79
	Nitrate and Nitrite (as N) (mg/L)	1.32	2.39	2.50	0.192	0.198
	Nitrate (as N) (mg/L)	1.32	2.36	2.46	0.189	0.196
	Nitrite (as N) (mg/L)	0.0021	0.0230	0.0427	0.0024	0.0012
	Sulfate (SO4) (mg/L)	55.6	57.3	57.6	21.8	22.1
	Anion Sum (meq/L)	5.10	4.53	4.50	3.78	3.90
	Cation Sum (meq/L)	5.18	4.62	4.64	3.93	3.97
	Cation - Anion Balance (%)	0.8	1.0	1.6	1.9	0.9
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.2	16.5	17.1	11.9	11.5
Total Metals	Aluminum (Al)-Total (mg/L)	0.0125	0.0411	0.0330	1.50	0.823
	Antimony (Sb)-Total (mg/L)	0.00011	0.00011	0.00014	0.00018	0.00015
	Arsenic (As)-Total (mg/L)	0.00044	0.00056	0.00050	0.00143	0.00114
	Barium (Ba)-Total (mg/L)	0.0731	0.0785	0.0750	0.0964	0.0872
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	0.000050	0.000031
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.027	0.028	0.028	0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000096	0.0000097	0.0000251	0.0000150
	Calcium (Ca)-Total (mg/L)	53.7	52.5	51.8	43.1	42.9
	Chromium (Cr)-Total (mg/L)	0.00017	0.00027	0.00026	0.00292	0.00173
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00097	0.00055
	Copper (Cu)-Total (mg/L)	0.0142	0.0317	0.0345	0.00776	0.00618
	Iron (Fe)-Total (mg/L)	0.053	0.146	0.243	2.21	1.18
	Lead (Pb)-Total (mg/L)	<0.000050	0.000236	0.000381	0.000585	0.000317
	Lithium (Li)-Total (mg/L)	0.0020	0.0012	0.0013	0.0024	0.0022
	Magnesium (Mg)-Total (mg/L)	21.2	16.7	15.9	15.7	16.6
	Manganese (Mn)-Total (mg/L)	0.0296	0.0783	0.0892	0.0818	0.0556

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1969064-6	L1969064-7	L1969064-8	L1969064-9	
	Description	Water	Water	Water	Water	
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17	
	Sampled Time	11:20	16:00	17:15		
	Client ID	W7	W35	W62	F-BL	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	253	423	1020	<2.0	
	Hardness (as CaCO3) (mg/L)	125	202	516	<0.50	
	pH (pH)	8.08	8.14	8.21	5.44	
	Total Suspended Solids (mg/L)	21.4	6.6	5.0	<3.0	
	TDS (Calculated) (mg/L)	136	254	652	<1.0	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	127	139	339	<1.0	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	127	139	339	<1.0	
	Ammonia, Total (as N) (mg/L)	0.0140	0.0133	0.0132	<0.0050	
	Chloride (Cl) (mg/L)	0.28	0.66	30.0	<0.10	
	Nitrate and Nitrite (as N) (mg/L)	0.116	13.0	7.40	<0.0051	
	Nitrate (as N) (mg/L)	0.115	13.0	7.35	<0.0050	
	Nitrite (as N) (mg/L)	0.0010	0.0220	0.0485	<0.0010	
	Sulfate (SO4) (mg/L)	7.3	31.4	176	<5.0	
	Anion Sum (meq/L)	2.73	4.38	11.8	<0.10	
	Cation Sum (meq/L)	2.86	4.46	11.5	<0.10	
	Cation - Anion Balance (%)	2.3	0.9	-1.6	0.0	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	12.4	24.6		<0.50	
Total Metals	Aluminum (Al)-Total (mg/L)	0.541	0.216	0.126	<0.0030	
	Antimony (Sb)-Total (mg/L)	0.00013	<0.00010	0.00017	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00071	0.00043	0.00055	<0.00010	
	Barium (Ba)-Total (mg/L)	0.0814	0.121	0.113	<0.000050	
	Beryllium (Be)-Total (mg/L)	0.000023	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	<0.010	0.014	0.022	<0.010	
	Cadmium (Cd)-Total (mg/L)	0.0000107	0.0000120	0.0000248	<0.0000050	
	Calcium (Ca)-Total (mg/L)	30.2	53.9	142	<0.050	
	Chromium (Cr)-Total (mg/L)	0.00147	0.00048	0.00044	<0.00010	
	Cobalt (Co)-Total (mg/L)	0.00038	0.00015	0.00023	<0.00010	
	Copper (Cu)-Total (mg/L)	0.00280	0.0621	0.0800	<0.00050	
	Iron (Fe)-Total (mg/L)	0.847	0.339	0.245	<0.010	
	Lead (Pb)-Total (mg/L)	0.000210	0.000067	0.000091	<0.000050	
	Lithium (Li)-Total (mg/L)	0.0013	0.0011	0.0032	<0.0010	
	Magnesium (Mg)-Total (mg/L)	11.8	15.5	41.5	<0.10	
	Manganese (Mn)-Total (mg/L)	0.0418	0.0165	0.0599	<0.00010	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1969064-1	L1969064-2	L1969064-3	L1969064-4	L1969064-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17
	Sampled Time	07:40	08:05	08:35	09:15	09:50
	Client ID	W3	W50	W16A	MC1	W2
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00411	0.00301	0.00289	0.00200	0.00181
	Nickel (Ni)-Total (mg/L)	0.00123	0.00100	0.00100	0.00423	0.00282
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	0.074	0.057
	Potassium (K)-Total (mg/L)	2.63	2.82	2.76	1.51	1.61
	Selenium (Se)-Total (mg/L)	0.000435	0.000692	0.000764	0.000212	0.000164
	Silicon (Si)-Total (mg/L)	4.36	3.15	3.01	9.10	7.54
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000013	<0.000010
	Sodium (Na)-Total (mg/L)	15.5	13.3	12.8	10.3	11.0
	Strontium (Sr)-Total (mg/L)	0.586	0.509	0.500	0.440	0.441
	Sulfur (S)-Total (mg/L)	19.0	19.9	20.2	7.52	7.52
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	0.000014	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00079	DLM <0.0024	DLM <0.0012	0.0518	0.0289
	Uranium (U)-Total (mg/L)	0.00160	0.00110	0.00109	0.00172	0.00175
	Vanadium (V)-Total (mg/L)	0.00053	0.00068	0.00065	0.00553	0.00365
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0062	0.0042
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00062	0.00041
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0026	0.0094	0.0099	0.0097	0.0096
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00035	0.00048	0.00049	0.00064	0.00062
	Barium (Ba)-Dissolved (mg/L)	0.0733	0.0755	0.0773	0.0718	0.0733
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.026	0.027	0.028	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000066	0.0000141	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	54.3	52.0	52.8	42.9	42.8
	Chromium (Cr)-Dissolved (mg/L)	0.00014	0.00015	0.00017	0.00024	0.00043
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0128	0.0276	0.0322	0.00284	0.00269
	Iron (Fe)-Dissolved (mg/L)	0.031	0.085	0.119	0.089	0.060
	Lead (Pb)-Dissolved (mg/L)	<0.000050	0.000141	0.000179	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0019	0.0011	0.0013	0.0017	0.0017
	Magnesium (Mg)-Dissolved (mg/L)	21.2	16.6	16.4	15.7	16.0
	Manganese (Mn)-Dissolved (mg/L)	0.0200	0.0389	0.0871	0.0155	0.00643

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1969064-6	L1969064-7	L1969064-8	L1969064-9
	Description	Water	Water	Water	Water
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17
	Sampled Time	11:20	16:00	17:15	
	Client ID	W7	W35	W62	F-BL
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00141	0.00136	0.00645	<0.000050
	Nickel (Ni)-Total (mg/L)	0.00214	0.00138	0.00143	<0.00050
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	0.90	1.63	5.65	<0.10
	Selenium (Se)-Total (mg/L)	0.000152	0.000257	0.00290	<0.000050
	Silicon (Si)-Total (mg/L)	7.21	5.34	7.77	<0.10
	Silver (Ag)-Total (mg/L)	<0.000010	0.000011	0.000015	<0.000010
	Sodium (Na)-Total (mg/L)	7.58	9.05	24.6	<0.050
	Strontium (Sr)-Total (mg/L)	0.319	0.393	1.57	<0.00020
	Sulfur (S)-Total (mg/L)	2.52	10.5	58.3	<0.50
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0166	0.0108	<0.0063 DLM	<0.00030
	Uranium (U)-Total (mg/L)	0.00104	0.000364	0.00419	<0.000010
	Vanadium (V)-Total (mg/L)	0.00289	0.00115	0.00105	<0.00050
	Zinc (Zn)-Total (mg/L)	0.0032	<0.0030	0.289	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00033	0.00032	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0171	0.0114	0.0060	<0.0010
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00013	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00046	0.00040	0.00042	<0.00010
	Barium (Ba)-Dissolved (mg/L)	0.0760	0.122	0.109	<0.000050
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.013	0.021	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000082	0.0000312	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	30.6	55.1	142	<0.050
	Chromium (Cr)-Dissolved (mg/L)	0.00033	0.00039	0.00020	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00011	<0.00010	0.00013	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00239	0.0416	0.0633	<0.00020
	Iron (Fe)-Dissolved (mg/L)	0.140	0.025	0.037	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0011	0.0012	0.0030	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	11.8	15.5	39.5	<0.10
	Manganese (Mn)-Dissolved (mg/L)	0.0272	0.00734	0.0505	<0.00010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1969064-1 Water 01-AUG-17 07:40 W3	L1969064-2 Water 01-AUG-17 08:05 W50	L1969064-3 Water 01-AUG-17 08:35 W16A	L1969064-4 Water 01-AUG-17 09:15 MC1	L1969064-5 Water 01-AUG-17 09:50 W2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00387	0.00274	0.00263	0.00182	0.00175
	Nickel (Ni)-Dissolved (mg/L)	0.00107	0.00088	0.00096	0.00135	0.00131
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.65	2.87	2.87	1.35	1.51
	Selenium (Se)-Dissolved (mg/L)	0.000481	0.000654	0.000737	0.000147	0.000197
	Silicon (Si)-Dissolved (mg/L)	4.37	3.01	2.84	5.88	5.98
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	15.3	13.3	13.2	10.5	10.8
	Strontium (Sr)-Dissolved (mg/L)	0.593	0.501	0.499	0.429	0.435
	Sulfur (S)-Dissolved (mg/L)	19.1	19.4	19.2	7.01	7.18
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00056	0.00046	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00153	0.00100	0.00100	0.00154	0.00162
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00053	0.00109	0.00103
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.0013	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Radiological Parameters	Ra-226 (Bq/L)	<0.0096				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1969064-6	L1969064-7	L1969064-8	L1969064-9	
	Description	Water	Water	Water	Water	
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17	
	Sampled Time	11:20	16:00	17:15		
	Client ID	W7	W35	W62	F-BL	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00131	0.00127	0.00627	<0.000050	
	Nickel (Ni)-Dissolved (mg/L)	0.00138	0.00128	0.00116	<0.00050	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	0.85	1.52	5.39	<0.10	
	Selenium (Se)-Dissolved (mg/L)	0.000119	0.000270	0.00307	<0.000050	
	Silicon (Si)-Dissolved (mg/L)	6.22	5.02	7.59	<0.050	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	7.59	8.92	23.3	<0.050	
	Strontium (Sr)-Dissolved (mg/L)	0.317	0.394	1.55	<0.00020	
	Sulfur (S)-Dissolved (mg/L)	2.28	10.4	58.6	<0.50	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.00060	DLM <0.00060	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.000917	0.000345	0.00395	<0.000010	
	Vanadium (V)-Dissolved (mg/L)	0.00119	<0.00050	0.00051	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	0.0012	<0.0010	0.193	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
Radiological Parameters	Ra-226 (Bq/L)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1969064-2, -3, -4, -5, -6, -7, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1969064-1
Matrix Spike	Dissolved Organic Carbon	MS-B	L1969064-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1969064-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Aluminum (Al)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Aluminum (Al)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1969064-1
Matrix Spike	Copper (Cu)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Iron (Fe)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1969064-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L1969064-1
Matrix Spike	Potassium (K)-Total	MS-B	L1969064-1
Matrix Spike	Sodium (Na)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1969064-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L1969064-2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1969064-6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1969064-1
Matrix Spike	Sulfur (S)-Total	MS-B	L1969064-1
Matrix Spike	Titanium (Ti)-Total	MS-B	L1969064-2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

BE-T-L-CCMS-VA Water Total Be (Low) in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA Water Dissolved organic carbon by combustion APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-L-IC-N-WR Water Chloride in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

RA226-MMER-FC	Water	Ra226 by Alpha Scint, MDC=0.01 Bq/L	EPA 903.1
SO4-IC-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
FC	ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-02 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Ft. Collins, Colorado

LIMS Version: 6.845

Wednesday, August 23, 2017

Shane Stack
ALS Environmental
8081 Lougheed Hwy, Suite 100
Burnaby, BC V5A 1W9

Re: ALS Workorder: 1708173
Project Name:
Project Number: L1969064

Dear Mr. Stack:

One water sample was received from ALS Environmental, on 8/9/2017. The sample was scheduled for the following analysis:

Radium-226

The results for these analyses are contained in the enclosed reports.

The data contained in the following report have been reviewed and approved by the personnel listed below. In addition, ALS certifies that the analyses reported herein are true, complete and correct within the limits of the methods employed.

Thank you for your confidence in ALS Environmental. Should you have any questions, please call.

Sincerely,

ALS Environmental
For Shiloh J. Summy
Project Manager

ALS Environmental – Fort Collins is accredited by the following accreditation bodies for various testing scopes in accordance with requirements of each accreditation body. All testing is performed under the laboratory management system, which is maintained to meet these requirement and regulations. Please contact the laboratory or accreditation body for the current scope testing parameters.

ALS Environmental – Fort Collins	
Accreditation Body	License or Certification Number
AIHA	214884
Alaska (AK)	UST-086
Alaska (AK)	CO01099
Arizona (AZ)	AZ0742
California (CA)	06251CA
Colorado (CO)	CO01099
Connecticut (CT)	PH-0232
Florida (FL)	E87914
Idaho (ID)	CO01099
Kansas (KS)	E-10381
Kentucky (KY)	90137
L-A-B (DoD ELAP/ISO 170250)	L2257
Louisiana (LA)	05057
Maryland (MD)	285
Missouri (MO)	175
Nebraska(NE)	NE-OS-24-13
Nevada (NV)	CO000782008A
New York (NY)	12036
North Dakota (ND)	R-057
Oklahoma (OK)	1301
Pennsylvania (PA)	68-03116
Tennessee (TN)	2976
Texas (TX)	T104704241
Utah (UT)	CO01099
Washington (WA)	C1280

1708173

Radium-226:
The sample was prepared and analyzed according to the current revision of SOP 783.

All acceptance criteria were met.

ALS -- Fort Collins

Sample Number(s) Cross-Reference Table

OrderNum: 1708173
Client Name: ALS Environmental
Client Project Name:
Client Project Number: L1969064
Client PO Number: L1969064

Client Sample Number	Lab Sample Number	COC Number	Matrix	Date Collected	Time Collected
L1969064-1	1708173-1		WATER	01-Aug-17	

(708173

L1969064

VANCOUVER

ALS Environmental

Subcontract Request Form

Subcontract To:

ALS ENVIRONMENTAL - FORT COLLINS, COLORADO, USA
225 COMMERCE DRIVE
FORT COLLINS,CO 80524

NOTES: Please reference on final report and invoice: PO# *L1969064*
ALS requires QC data to be provided with your final results.

Please see enclosed 1 sample(s) in 1 Container(s)

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED DUE DATE	Priority Flag
① **L1969064-1 W3**		**8/1/2017**	
	Ra226 by Alpha Scint, MDC=0.01 Bq/L (RA226-MMER-FC 1)	8/16/2017	

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact:
Shane Stack
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9
Phone: (604) 253-4188 Email:Shane.Stack@alsglobal.com

Please email confirmation of receipt to: Shane.Stack@alsglobal.com

Shipped By: ______ Date Shipped: ______

Received By: ______ Date Received: 8/9/17 @1000

Verified By: ______ Date Verified: ______

Temperature: ______

Sample Integrity Issues: ______

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS BURNABY

Workorder No: 1708173

Project Manager: SJS

Initials: VA

Date: 8/9/17

1.	Does this project require any special handling in addition to standard ALS procedures?		YES	[✓ NO]
2.	Are custody seals on shipping containers intact?	[✓ NONE]	YES	NO
3.	Are Custody seals on sample containers intact?	[✓ NONE]	YES	NO
4.	Is there a COC (Chain-of-Custody) present or other representative documents?		[✓ YES]	NO
5.	Are the COC and bottle labels complete and legible?		[✓ YES]	NO
6.	Is the COC in agreement with samples received? (IDs, dates, times, no. of samples, no. of containers, matrix, requested analyses, etc.)		[✓ YES]	NO
7.	Were airbills / shipping documents present and/or removable?	DROP OFF	[✓ YES]	NO
8.	Are all aqueous samples requiring preservation preserved correctly? (excluding volatiles)	N/A	YES	[✓ NO]
9.	Are all aqueous non-preserved samples pH 4-9?	[✓ N/A]	YES	NO
10.	Is there sufficient sample for the requested analyses?		[✓ YES]	NO
11.	Were all samples placed in the proper containers for the requested analyses?		[✓ YES]	NO
12.	Are all samples within holding times for the requested analyses?		[✓ YES]	NO
13.	Were all sample containers received intact? (not broken or leaking, etc.)		[✓ YES]	NO
14.	Are all samples requiring no headspace (VOC, GRO, RSK/MEE, Rx CN/S, radon) headspace free? Size of bubble: ____ < green pea ____ > green pea	[✓ N/A]	YES	NO
15.	Do any water samples contain sediment? Amount Amount of sediment: ____ dusting ____ moderate ____ heavy	N/A	YES	[✓ NO]
16.	Were the samples shipped on ice?		[✓ YES]	NO
17.	Were cooler temperatures measured at 0.1-6.0°C? IR gun used*: #2 #4	RAD ONLY	YES	[✓ NO]

Cooler #:	1							
Temperature (°C):	12.9							
No. of custody seals on cooler:	0							
External µR/hr reading:	10							
Background µR/hr reading:	10							

DOT Survey/ Acceptance Information

Were external µR/hr readings ≤ two times background and within DOT acceptance criteria? [✓ YES] / NO / NA (If no, see Form 008.)

Additional Information: PROVIDE DETAILS BELOW FOR A NO RESPONSE TO ANY QUESTION ABOVE, EXCEPT #1 AND #16.

- SAMPLE HAD A PH OF 6. ACID ADDED.

If applicable, was the client contacted? YES / NO / NA Contact: ____________ Date/Time: ____________

Project Manager Signature / Date:

*IR Gun #2: Oakton, SN 29922500201-0066
*IR Gun #4: Oakton, SN 2372220101-0002

Form 201r24.xls (06/04/2012)

Page 1 of ___

ALS Environmental - Fort Collins
CONDITION OF SAMPLE UPON RECEIPT FORM

Client: ALS BURNABY
Workorder No: 1708173
Project Manager: SJS
Initials: VA Date: 8/9/17

NOTE:

No pH adjustments shall be made without prior consent of Project Manager. After pH adjustments, hold metals and radchem samples ≥ 16 hrs. before analysis.

Was the pH of any sample adjusted by the laboratory? **YES** (See Table below) / **NO**

pH Excursion:

ALS Sample ID	Client Sample ID	Initial pH	Final pH	Reagent Used	Volume Added (mL)	Lot No. of Reagent	Requested Analysis	Initials / Date / Time
1708173 -1	L1969064-1	6	<2	HNO_3	1.5	152495	RAD	JA/8.9/1625

If applicable, was the client contacted? **YES / NO / [✓ NA]** Contact: ____________ Date/Time: ____________

Project Manager Signature / Date: ____________

Form 201r24.xls (06/04/2012)

Page ___ of ___

1708173

DEFINITIONS: On the Air Waybill 'We', 'Our', 'us' and 'FedEx' refer to Federal Express Corporation, its subsidiaries and branches and their respective employees, agents and independent contractors. 'You' and 'your' refer to the shipper, its employees, principals and agents. If your shipment originates outside the United States, your contract of carriage is with the Federal Express subsidiary, branch or independent contractor who originally accepts the shipment from you. 'Package' means any container or envelope that is accepted by us for delivery, including any such items tendered by you utilizing our automated systems, meters, manifests or waybills. 'Shipment' means all packages, which are tendered to and accepted by us on a single Air Waybill.

AGREEMENT TO TERMS. By giving us your shipment, you agree, regardless of whether you sign the front of this Air Waybill, for yourself and as agent for and on behalf of any other person having an interest in this shipment, to all terms on this NON-NEGOTIABLE Air Waybill, in any applicable tariff, and in our current Service Guide or Standard Conditions of Carriage, copies of which are available upon request. If there is a conflict between this Air Waybill and either the tariff, Service Guide or Standard Conditions then in effect, the tariff and the terms of any customer automation agreement between the shipper and Federal Express will control(the Service Guide or Standard Conditions have secondary priority). No one is authorized to alter or modify the terms of our agreement. This Air Waybill shall be binding on us when the shipment is accepted.

YOUR OBLIGATIONS: You warrant that each article in the shipment is properly described on this Air Waybill and is acceptable for transport by us, and that the shipment is properly marked, addressed (including postal codes) and packaged to ensure safe transportation with ordinary care in handling.

NOTE CONCERNING LIMITATIONS OF LIABILITY. Air Carriage Notice. If the carriage of your shipment by air involves an ultimate destination or stop in a country other than the country of departure, the Warsaw Convention, an international treaty relating to international carriage by air, may be applicable, which treaty would then govern and in most cases limit our liability for loss or delay of or damage to your shipment. In the U.S. the Warsaw Convention limits our liability to U.S. $9.07 per pound (U.S. $20.38 per kilogram). Unless you declare a higher value for carriage as described below. The interpretation of the Warsaw Convention liability limits may vary in other countries. There are no stopping places which are agreed at the time of tender of the shipment and we reserve the right to route shipments in any way we deem appropriate.

Road Transport Notice. Shipments transported partly or solely by road be it explicit agreement to do so or not-in, to, from a country which is party to the Convention on the Contract for the International Carriage of Goods by Road (the 'CMR') are subject to the terms and conditions of the CMR, notwithstanding any other provisions of this Agreement to the contrary. For these shipments transported solely by road, if a conflict arises between the provisions of the CMR and this Air Waybill the terms of the CMR shall prevail.

Limitation of Liability, if not governed by the Warsaw Convention or the CMR as described above, our maximum liability for loss, damage or delay is limited by this Air Waybill to U.S. $100 per shipment or U.S. $9.07 per pound (U.S. $20.38 per kilo) (or equivalent local currency), whichever is greater, unless you declare a higher value for carriage as described below. FedEx does not provide cargo liability or all-risk insurance, but you may pay an additional charge to each additional U.S. $100 (or equivalent local currency) of described value for carriage. If a higher value for carriage is declared and the additional charge is paid, FedEx maximum liability will be the lesser of the declared value for carriage or your actual damages.

LIABILITIES NOT ASSUMED. IN ANY EVENT, WE WON'T BE LIABLE FOR ANY DAMAGES WHETHER DIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL, IN EXCESS OF THE DECLARED VALUE FOR CARRIAGE (INCLUDING BUT NOT LIMITED TO LOSS OF INCOME OR PROFITS) WHETHER OR NOT WE HAD ANY KNOWLEDGE THAT SUCH DAMAGES MIGHT BE INCURRED, UNLESS SUCH DAMAGES WERE CAUSED BY OUR OWN WILLFUL MICONDUCT OR GROSS NEGLIGENCE.

We won't be liable for your actions or omissions, including but not limited to incorrect declaration of cargo, improper or insufficient packing, securing, marking or addressing of the shipment, or for the acts or omissions of the recipient or anyone else with an interest in the shipment. Also we won't be liable if you (or) the recipient violate any of the terms of our agreement. We won't be liable for loss of or damage to shipments of cash, currency or other prohibited items. We won't be liable for loss, damages or delay caused by events we cannot control, including but not limited to acts of God, perils of the air, weather conditions mechanical delays, acts of public enemies, war, strikes, civil commotions, or acts or omissions of public authorities (including customs and health officials) with actual or apparent authority.

NO WARRANTIES. We make no warranties, express or implied.

CLAIM FOR LOSS, DAMAGE FOR DELAY. ALL CLAIMS MUST BE NOTIFIED TO US WITHIN 15 DAYS AFTER DELIVERY OF THE SHIPMENT FAILING WHICH NO ACTION FOR DAMAGES MAY BE BROUGHT. All claims for loss, non-delivery or mis-delivery must be received by us within 90 days after the shipment is accepted by us. The right to damages against us shall be extinguished unless an action is brought within two years from the date of delivery of the shipment or from date on which the shipment should have been delivered. Within 30 days after notification to us (of) the claim, it must be documented by sending us all relevant information about it. We are not obligated to act on any claim until all transportation charges have been paid; the claim amount may not be deducted from those charges. If the recipient accepts the shipment without noting any damage on the delivery record, we will assume the shipment was delivered in good condition. In order for us to consider a claim for damages, the content(s), original shipping cartons, and packing must be available to us for inspection.

RIGHT TO INSPECT. Your shipment may, at our option or at the request of governmental authorities, be opened and inspected by us or such authorities or us at any time.

CUSTOMS CLEARANCE. It is your responsibility to provide proper customs documentation and confirmation, where required.

EXPORT CONTROL. You authorize Federal Express to act as forwarding agent for you for export control and customs purposes. You hereby certify that all statements and information contained in this air waybill relating to exportation are true and correct. Furthermore, you understand that civil and criminal penalties, including forfeiture and sale, may be imposed for making false or fraudulent statements or for the violation of any United States laws on exportation, including but not limited to, 13 USC Sec. 305; 22 USC Sec 401; 18 USC Sec. 1001; 50 USC app. 2410.

MANDATORY LAW. Insofar as any provision contained or referred to in this air Waybill may be contrary to any applicable international treaty, law government regulations, orders or requirements such provision shall remain in effect as a part of our agreement to the extent that it is not overridden. The invalidity or unenforceability of any provision shall not affect any other part of this Air Waybill. Unless otherwise indicated the Sender's address indicated on the face of this Waybill is the place of execution and the place of departure, and Recipient's address listed on the face of this Waybill is the place of destination. Unless otherwise indicated Federal Express Corporation, P.O. Box 727, Memphis, TN 38194 USA is the first carrier of this shipment.

After printing this label:
CONSIGNEE COPY - PLEASE PLACE IN FRONT OF POUCH
1. Fold the printed page along the horizontal line.
2. Place label in shipping pouch and affix it to your shipment.

ORIGIN ID:YBYA (604) 253-4188
HARJIT GILL
ALS ENVIRONMENTAL LAB GROUP
LOUGHEED HIGHWAY

BURNABY, BC V5A1W9
CANADA CA

SHIP DATE: 08AUG17
ACTWGT: 15.00 LB MAN
CAD: 0347419/CAFE3011

BILL SENDER

TO SAMPLE RECEVING
ALS ENVIRONMANTAL
225 COMMERCE DRIVE

FORT COLLINS CO 80524
(970) 490-1511
REF: SUBLETS
DEPT: SUBLET

10.0
12.9°

(US)

540C1/577E/727F

FedEx.
Express

E

J161216101802uv

10:30A
INTL PRIORITY

TRK# 7012 5069 4006
0430

XH FTCA

80524
CO-US DEN

SAMPLE SUMMARY REPORT

Client:	ALS Environmental	**Date:**	*23-Aug-17*
Project:	L1969064	**Work Order:**	1708173
Sample ID:	L1969064-1	**Lab ID:**	1708173-1
Legal Location:		**Matrix:**	WATER
Collection Date:	8/1/2017	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed
Radium-226 by Radon Emanation - Method 903.1		**PAI 783**		Prep Date: **8/10/2017**		PrepBy: **HCJ**
Ra-226	0.0036 (+/- 0.0057)	U	0.0096	BQ/l	NA	8/22/2017 12:56
Carr: BARIUM	*90*		*40-110*	*%REC*	DL = NA	8/22/2017 12:56

SAMPLE SUMMARY REPORT

Client:	ALS Environmental	**Date:**	*23-Aug-17*
Project:	L1969064	**Work Order:**	1708173
Sample ID:	L1969064-1	**Lab ID:**	1708173-1
Legal Location:		**Matrix:**	WATER
Collection Date:	8/1/2017	**Percent Moisture:**	

Analyses	Result	Qual	Report Limit	Units	Dilution Factor	Date Analyzed

Explanation of Qualifiers

Radiochemistry:

U or ND - Result is less than the sample specific MDC.

Y1 - Chemical Yield is in control at 100-110%. Quantitative yield is assumed.

Y2 - Chemical Yield outside default limits.

W - DER is greater than Warning Limit of 1.42

* - Aliquot Basis is 'As Received' while the Report Basis is 'Dry Weight'.

- Aliquot Basis is 'Dry Weight' while the Report Basis is 'As Received'.

G - Sample density differs by more than 15% of LCS density.

D - DER is greater than Control Limit

M - Requested MDC not met.

LT - Result is less than requested MDC but greater than achieved MDC.

M3 - The requested MDC was not met, but the reported activity is greater than the reported MDC.

L - LCS Recovery below lower control limit.

H - LCS Recovery above upper control limit.

P - LCS, Matrix Spike Recovery within control limits.

N - Matrix Spike Recovery outside control limits

NC - Not Calculated for duplicate results less than 5 times MDC

B - Analyte concentration greater than MDC.

B3 - Analyte concentration greater than MDC but less than Requested MDC.

Inorganics:

B - Result is less than the requested reporting limit but greater than the instrument method detection limit (MDL).

U or ND - Indicates that the compound was analyzed for but not detected.

E - The reported value is estimated because of the presence of interference. An explanatory note may be included in the narrative.

M - Duplicate injection precision was not met.

N - Spiked sample recovery not within control limits. A post spike is analyzed for all ICP analyses when the matrix spike and or spike duplicate fail and the native sample concentration is less than four times the spike added concentration.

Z - Spiked recovery not within control limits. An explanatory note may be included in the narrative.

* - Duplicate analysis (relative percent difference) not within control limits.

S - SAR value is estimated as one or more analytes used in the calculation were not detected above the detection limit.

Organics:

U or ND - Indicates that the compound was analyzed for but not detected.

B - Analyte is detected in the associated method blank as well as in the sample. It indicates probable blank contamination and warns the data user.

E - Analyte concentration exceeds the upper level of the calibration range.

J - Estimated value. The result is less than the reporting limit but greater than the instrument method detection limit (MDL).

A - A tentatively identified compound is a suspected aldol-condensation product.

X - The analyte was diluted below an accurate quantitation level.

* - The spike recovery is equal to or outside the control criteria used.

\+ - The relative percent difference (RPD) equals or exceeds the control criteria.

G - A pattern resembling gasoline was detected in this sample.

D - A pattern resembling diesel was detected in this sample.

M - A pattern resembling motor oil was detected in this sample.

C - A pattern resembling crude oil was detected in this sample.

4 - A pattern resembling JP-4 was detected in this sample.

5 - A pattern resembling JP-5 was detected in this sample.

H - Indicates that the fuel pattern was in the heavier end of the retention time window for the analyte of interest.

L - Indicates that the fuel pattern was in the lighter end of the retention time window for the analyte of interest.

Z - This flag indicates that a significant fraction of the reported result did not resemble the patterns of any of the following petroleum hydrocarbon products:
- gasoline
- JP-8
- diesel
- mineral spirits
- motor oil
- Stoddard solvent
- bunker C

ALS -- Fort Collins

Date: *8/23/2017 10:35*

QC BATCH REPORT

Client: ALS Environmental
Work Order: 1708173
Project: L1969064

Batch ID: **RE170810-1-1** Instrument ID **Alpha Scin** Method: **Radium-226 by Radon Emanation**

LCS Sample ID: **RE170810-1** Units: **BQ/l** Analysis Date: **8/22/2017 12:56**
Client ID: Run ID: **RE170810-1B** Prep Date: **8/10/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.85 (+/- 0.457)	0.0114	1.715		108	67-120					P,M3
Carr: BARIUM	14000		16220		86.4	40-110					

LCSD Sample ID: **RE170810-1** Units: **BQ/l** Analysis Date: **8/22/2017 12:56**
Client ID: Run ID: **RE170810-1B** Prep Date: **8/10/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	1.76 (+/- 0.434)	0.0073	1.715		102	67-120		1.85	0.1	2.1	P
Carr: BARIUM	15700		16220		96.9	40-110		14000			

MB Sample ID: **RE170810-1** Units: **BQ/l** Analysis Date: **8/22/2017 12:56**
Client ID: Run ID: **RE170810-1B** Prep Date: **8/10/2017** DF: **NA**

Analyte	Result	ReportLimit	SPK Val	SPK Ref Value	%REC	Control Limit	Decision Level	DER Ref	DER	DER Limit	Qual
Ra-226	0 (+/- 0.0041)	0.0081									U
Carr: BARIUM	15600		16220		96.3	40-110					

The following samples were analyzed in this batch: 1708173-1

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1969064-COFC

COC Number: 2017-08-02 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226337 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact: **Shane Stack** **Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)	Radium 226 Analysis				Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W3	1-Aug-17	7:40	Water	R	R	R	R	R	R	R	R	R	R				8
2	W50	1-Aug-17	8:05	Water	R	R	R	R	R	R	R	R	R					7
3	W16A	1-Aug-17	8:35	Water	R	R	R	R	R	R	R	R	R					7
4	MC1	1-Aug-17	9:15	Water	R	R	R	R	R	R	R	R	R					7
5	W2	1-Aug-17	9:50	Water	R	R	R	R	R	R	R	R	R					7
6	W7	1-Aug-17	11:20	Water	R	R	R	R	R	R	R	R	R					7
7	W35	1-Aug-17	16:00	Water	R	R	R	R	R	R	R	R	R					7
8	W62	1-Aug-17	17:15	Water	R	R	R	R	R	R	R	R						6
9	F-BL	1-AUG-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
7°C				14.8	15.6

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Corey Roberts	Date:17-08-02	Time:	Received by: JMc	Date: Aug 2, 2017	Time: 15:25	Received by: TP	Date: Aug 3	Time: 15:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 09-AUG-17
Report Date: 18-AUG-17 16:00 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1972393
Project P.O. #: 226337
Job Reference:
C of C Numbers: 2017-08-09 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L1972393-1	L1972393-2	L1972393-3	L1972393-4	L1972393-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17
	Sampled Time	08:20	09:35	10:35	11:30	
	Client ID	W3	W2	MC1	W45	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	507	348	347	3350	521
	Hardness (as CaCO3) (mg/L)	250	168	174	1700	259
	pH (pH)	8.09	8.07	8.20	7.76	8.13
	Total Suspended Solids (mg/L)	<3.0	4.7	6.7	44.7	<3.0
	TDS (Calculated) (mg/L)	300	185	187	3140	306
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	225	144	150	114	232
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	225	144	150	114	232
	Ammonia, Total (as N) (mg/L)	0.0075	0.0070	0.0117	4.55	0.0071
	Chloride (Cl) (mg/L)	4.57	2.39	1.75	34.4	4.57
	Nitrate and Nitrite (as N) (mg/L)	0.196	0.148	0.121	21.2	0.195
	Nitrate (as N) (mg/L)	0.196	0.148	0.120	13.9	0.195
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.0015	7.35	<0.0010
	Sulfate (SO4) (mg/L)	56.2	26.1	22.3	2040	56.2
	Anion Sum (meq/L)	5.81	3.49	3.53	47.3	5.95
	Cation Sum (meq/L)	5.84	3.86	4.00	45.0	6.02
	Cation - Anion Balance (%)	0.2	5.1	6.3	-2.5	0.6
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	6.07	8.37	9.21		6.43
Total Metals	Aluminum (Al)-Total (mg/L)	0.0262	0.0490	0.182	0.498	0.0073
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00011	0.00012	0.00045	<0.00010
	Arsenic (As)-Total (mg/L)	0.00029	0.00053	0.00074	0.00047	0.00027
	Barium (Ba)-Total (mg/L)	0.0717	0.0782	0.0753	0.138	0.0698
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000040 DLA	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.00010 DLA	<0.000050
	Boron (B)-Total (mg/L)	0.027	<0.010	<0.010	0.373	0.026
	Cadmium (Cd)-Total (mg/L)	0.0000053	<0.0000050	0.0000064	<0.00016 DLM	<0.0000050
	Calcium (Ca)-Total (mg/L)	56.5	45.3	43.7	554	55.7
	Chromium (Cr)-Total (mg/L)	0.00016	0.00028	0.00056	0.00029	0.00013
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00018	0.00203	<0.00010
	Copper (Cu)-Total (mg/L)	0.00500	0.00220	0.00251	0.0826	0.00351
	Iron (Fe)-Total (mg/L)	0.051	0.123	0.419	1.32	0.026
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000093	0.00166	<0.000050
	Lithium (Li)-Total (mg/L)	0.0034	0.0020	0.0018	0.0367	0.0033
	Magnesium (Mg)-Total (mg/L)	28.1	15.4	16.3	88.5	28.2
	Manganese (Mn)-Total (mg/L)	0.0519	0.0226	0.0282	1.99	0.0483

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1972393-1	L1972393-2	L1972393-3	L1972393-4	L1972393-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17
	Sampled Time	08:20	09:35	10:35	11:30	
	Client ID	W3	W2	MC1	W45	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00463	0.00148	0.00190	0.117	0.00466
	Nickel (Ni)-Total (mg/L)	0.00106	0.00112	0.00149	0.0192	0.00102
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.10 DLA	<0.050
	Potassium (K)-Total (mg/L)	2.27	1.61	1.48	86.6	2.27
	Selenium (Se)-Total (mg/L)	0.000336	0.000172	0.000181	0.0187	0.000310
	Silicon (Si)-Total (mg/L)	6.04	6.12	6.72	5.16	6.18
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000020 DLA	<0.000010
	Sodium (Na)-Total (mg/L)	18.9	10.6	11.0	186	19.1
	Strontium (Sr)-Total (mg/L)	0.731	0.487	0.464	7.66	0.728
	Sulfur (S)-Total (mg/L)	19.6	9.32	7.93	774	20.0
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000020 DLA	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00030	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00138	0.00245	0.00808	<0.030 DLM	0.00035
	Uranium (U)-Total (mg/L)	0.00279	0.00216	0.00187	0.00880	0.00286
	Vanadium (V)-Total (mg/L)	0.00054	0.00096	0.00167	0.0020	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	0.0091	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0027	0.0071	0.0402	0.0147	0.0035
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00029	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00025	0.00044	0.00055	0.00034	0.00026
	Barium (Ba)-Dissolved (mg/L)	0.0677	0.0739	0.0699	0.130	0.0636
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000040 DLA	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.00010 DLA	<0.000050
	Boron (B)-Dissolved (mg/L)	0.024	<0.010	<0.010	0.350	0.022
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000065	0.000111	0.0000053
	Calcium (Ca)-Dissolved (mg/L)	56.4	42.9	43.7	540	57.0
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00015	0.00019	<0.00020 DLA	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00158	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00342	0.00200		0.00499	0.00324
	Iron (Fe)-Dissolved (mg/L)	0.017	0.044	0.157	0.056	0.015
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	0.000077	<0.00010 DLA	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0033	0.0021	0.0019	0.0356	0.0027
	Magnesium (Mg)-Dissolved (mg/L)	26.4	14.8	15.7	86.0	28.3
	Manganese (Mn)-Dissolved (mg/L)	0.0414	0.0171	0.0150	1.84	0.0404

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1972393-1	L1972393-2	L1972393-3	L1972393-4	L1972393-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17	08-AUG-17
	Sampled Time	08:20	09:35	10:35	11:30	
	Client ID	W3	W2	MC1	W45	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00436	0.00125	0.00173	0.110	0.00451
	Nickel (Ni)-Dissolved (mg/L)	0.00096	0.00097	0.00107	0.0064	0.00094
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.10 DLA	<0.050
	Potassium (K)-Dissolved (mg/L)	2.25	1.63	1.46	88.6	2.21
	Selenium (Se)-Dissolved (mg/L)	0.000351	0.000137	0.000158	0.0179	
	Silicon (Si)-Dissolved (mg/L)	5.83	5.80	6.07	4.12	6.29
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000020 DLA	<0.000010
	Sodium (Na)-Dissolved (mg/L)	18.2	10.6	11.0	191	18.1
	Strontium (Sr)-Dissolved (mg/L)	0.697	0.433	0.442	6.96	0.700
	Sulfur (S)-Dissolved (mg/L)	18.1	8.67	7.19	752	19.7
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000020 DLA	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00020 DLA	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00200	<0.00060 DLA	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00250	0.00175	0.00165	0.00774	0.00265
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00067	0.00101	<0.0010 DLA	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0040 DLB	<0.0020 DLA	0.0013
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00076	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Zinc (Zn)-Dissolved	MB-LOR	L1972393-1, -2, -3, -4, -5
Matrix Spike	Aluminum (Al)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Potassium (K)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1972393-1, -2, -3, -4, -5
Matrix Spike	Sulfur (S)-Total	MS-B	L1972393-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Reference Information

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-09 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1972393-COFC

COC Number: 2017-08-09 A

Page 1 of 1

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To

	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 226337 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	8-Aug-17	8:20	Water	R	R	R	R	R	R	R	R	R					7
	W2	8-Aug-17	9:35	Water	R	R	R	R	R	R	R	R	R					7
	MC1	8-Aug-17	10:35	Water	R	R	R	R	R	R	R	R	R					7
	W45	8-Aug-17	11:30	Water	R	R	R	R	R	R	R	R						6
	DUP	8-Aug-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No	☐
Ice Packs	☐	Ice Cubes	☐	Custody seal intact	Yes ☐	No	☐
Cooling Initiated	☐						

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			12.5	19.1	11.7

SHIPMENT RELEASE (client use)
Released by:Corey Roberts Date:2017-08-09 Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: JMc Date: Aug 9 2017 Time: 15:32

FINAL SHIPMENT RECEPTION (lab use only)
Received by: MS Date: Aug 10/17 Time: 14:55

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	16-AUG-17
Report Date:	25-AUG-17 18:02 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #:	L1976078
Project P.O. #:	226973
Job Reference:	
C of C Numbers:	2017-08-16 A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1976078-1	L1976078-2	L1976078-3	L1976078-4	
	Description	Water	Water	Water	Water	
	Sampled Date	15-AUG-17	15-AUG-17	15-AUG-17	15-AUG-17	
	Sampled Time	08:15	13:45	14:20		
	Client ID	W3	MC1	W2	DUP	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	528	363	349	521	
	Hardness (as CaCO3) (mg/L)	238	170	168	241	
	pH (pH)	8.34	8.43	8.12	8.11	
	Total Suspended Solids (mg/L)	<3.0	10.0	<3.0	<3.0	
	TDS (Calculated) (mg/L)	308	207	195	299	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	238	176	158	230	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	8.6	10.0	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	246	186	158	230	
	Ammonia, Total (as N) (mg/L)	0.0056	0.0073	<0.0050	0.0063	
	Chloride (Cl) (mg/L)	4.48	1.80	2.53	4.49	
	Nitrate and Nitrite (as N) (mg/L)	0.188	0.112	0.111	0.188	
	Nitrate (as N) (mg/L)	0.188	0.111	0.111	0.188	
	Nitrite (as N) (mg/L)	<0.0010	0.0014	<0.0010	<0.0010	
	Sulfate (SO4) (mg/L)	56.1	22.8	27.6	56.1	
	Anion Sum (meq/L)	6.23	4.25	3.82	5.90	
	Cation Sum (meq/L)	5.59	3.90	3.82	5.64	
	Cation - Anion Balance (%)	-5.4	-4.3	0.1	-2.3	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	6.97	9.31	8.64	6.47	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0084	0.256	0.0277	0.0107	
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00011	<0.00010	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00029	0.00074	0.00045	0.00028	
	Barium (Ba)-Total (mg/L)	0.0704	0.0743	0.0733	0.0683	
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	0.027	<0.010	<0.010	0.026	
	Cadmium (Cd)-Total (mg/L)	0.0000052	0.0000081	<0.0000050	0.0000055	
	Calcium (Ca)-Total (mg/L)	55.9	44.8	46.1	54.9	
	Chromium (Cr)-Total (mg/L)	0.00020	0.00064	0.00021	0.00012	
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00023	<0.00010	<0.00010	
	Copper (Cu)-Total (mg/L)	0.00354	0.00288	0.00303	0.00359	
	Iron (Fe)-Total (mg/L)	0.028	0.523	0.091	0.030	
	Lead (Pb)-Total (mg/L)	<0.000050	0.000116	0.000067	<0.000050	
	Lithium (Li)-Total (mg/L)	0.0028	0.0014	0.0018	0.0028	
	Magnesium (Mg)-Total (mg/L)	29.3	17.1	15.5	28.9	
	Manganese (Mn)-Total (mg/L)	0.0496	0.0397	0.0268	0.0498	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1976078-1	L1976078-2	L1976078-3	L1976078-4
	Description	Water	Water	Water	Water
	Sampled Date	15-AUG-17	15-AUG-17	15-AUG-17	15-AUG-17
	Sampled Time	08:15	13:45	14:20	
	Client ID	W3	MC1	W2	DUP
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00492	0.00198	0.00136	0.00487
	Nickel (Ni)-Total (mg/L)	0.00100	0.00149	0.00101	0.00111
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.26	1.47	1.66	2.21
	Selenium (Se)-Total (mg/L)	0.000325	0.000156	0.000136	0.000332
	Silicon (Si)-Total (mg/L)	6.35	6.93	6.09	6.35
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	19.4	11.3	10.9	19.5
	Strontium (Sr)-Total (mg/L)	0.750	0.481	0.488	0.742
	Sulfur (S)-Total (mg/L)	20.2	8.32	9.76	20.3
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	0.0104	0.00119	0.00047
	Uranium (U)-Total (mg/L)	0.00276	0.00174	0.00222	0.00276
	Vanadium (V)-Total (mg/L)	<0.00050	0.00173	0.00071	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0019	0.0064	0.0044	0.0027
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00055	0.00035	0.00020
	Barium (Ba)-Dissolved (mg/L)	0.0655	0.0688	0.0707	0.0650
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.023	<0.010	<0.010	0.023
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	53.1	43.3	44.7	54.2
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00014	0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00277	0.00166	0.00170	0.00306
	Iron (Fe)-Dissolved (mg/L)	0.015	0.115	0.046	0.017
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0031	0.0015	0.0020	0.0032
	Magnesium (Mg)-Dissolved (mg/L)	25.7	15.1	13.7	25.7
	Manganese (Mn)-Dissolved (mg/L)	0.0424	0.0138	0.0224	0.0423

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1976078-1	L1976078-2	L1976078-3	L1976078-4
	Sample ID	L1976078-1	L1976078-2	L1976078-3	L1976078-4
	Description	Water	Water	Water	Water
	Sampled Date	15-AUG-17	15-AUG-17	15-AUG-17	15-AUG-17
	Sampled Time	08:15	13:45	14:20	
	Client ID	W3	MC1	W2	DUP
Grouping	**Analyte**				
WATER					
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00423	0.00175	0.00117	0.00427
	Nickel (Ni)-Dissolved (mg/L)	0.00100	0.00102	0.00092	0.00091
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.19	1.39	1.62	2.19
	Selenium (Se)-Dissolved (mg/L)	0.000321	0.000157	0.000132	0.000301
	Silicon (Si)-Dissolved (mg/L)	5.93	6.06	5.76	5.84
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	17.7	10.4	9.75	17.4
	Strontium (Sr)-Dissolved (mg/L)	0.709	0.455	0.467	0.716
	Sulfur (S)-Dissolved (mg/L)	17.5	7.27	8.72	17.1
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	DTC 0.00129	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00039	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00271	0.00177	0.00216	0.00271
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00074	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0064	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Calcium (Ca)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Copper (Cu)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1976078-1, -2, -3, -4
Matrix Spike	Sulfur (S)-Total	MS-B	L1976078-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Reference Information

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**

Reference Information

WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-16 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1976078-COFC

COC Number: 2017-08-16 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐

EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preser	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
1	W3	15-Aug-17	8:15	Water	R	R	R	R	R	R	R	R	R					7
2	MC1	15-Aug-17	13:45	Water	R	R	R	R	R	R	R	R	R					7
3	W2	15-Aug-17	14:20	Water	R	R	R	R	R	R	R	R	R					7
4	DUP	15-Aug-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C: 5°C.

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-08-16 8:30	Time:	Received by: DW	Date: Aug 16/17	Time: 14:22	Received by: GL	Date: Aug 17/17	Time: 1315

6,7,3°C

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	24-AUG-17
Report Date:	06-SEP-17 17:15 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1980621

Project P.O. #:	226973
Job Reference:	
C of C Numbers:	2017-08-23 C
Legal Site Desc:	

Shane Stack
Account Manager

	Sample ID	L1980621-1	L1980621-2	L1980621-3	L1980621-4	L1980621-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	19-AUG-17	20-AUG-17	21-AUG-17	21-AUG-17	21-AUG-17
	Sampled Time	14:10	12:50	09:00	11:00	14:15
	Client ID	MN-1.5	UG1	W16	W8A	MN-4.5
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	119	2520	440	1130	233
	Hardness (as CaCO3) (mg/L)	56.4	1420	207	576	113
	pH (pH)	7.92	7.95	8.29	7.98	8.17
	Total Suspended Solids (mg/L)	3.8	73.6	<3.0	16.0	<3.0
	TDS (Calculated) (mg/L)	62.3	2350	263	785	127
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	62.7	164	161	349	115
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	2.2	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	62.7	164	163	349	115
	Ammonia, Total (as N) (mg/L)	0.0068	13.8	0.0379	0.112	<0.0050
	Chloride (Cl) (mg/L)	<0.50	<10 DLDS	6.46	10.7	0.58
	Nitrate and Nitrite (as N) (mg/L)	0.0106	36.0	2.02	6.09	0.109
	Nitrate (as N) (mg/L)	0.0106	33.9	1.99	6.06	0.109
	Nitrite (as N) (mg/L)	<0.0010	2.09	0.0228	0.0231	<0.0010
	Sulfate (SO4) (mg/L)	0.94	1450	61.8	287	10.3
	Anion Sum (meq/L)	1.27	36.1	4.88	13.7	2.55
	Cation Sum (meq/L)	1.31	33.0	4.77	13.5	2.53
	Cation - Anion Balance (%)	1.3	-4.5	-1.1	-0.7	-0.4
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	13.7		14.6		8.70
Total Metals	Aluminum (Al)-Total (mg/L)	0.0588	3.03	0.0443	0.744	0.0325
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00086	<0.00010	0.00023	0.00014
	Arsenic (As)-Total (mg/L)	0.00068	0.00115	0.00048	0.00097	0.00037
	Barium (Ba)-Total (mg/L)	0.0411	0.0843	0.0712	0.165	0.0548
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000095	<0.000020	0.000048	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	0.000059	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.783	0.035	0.035	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.000356	0.0000090	0.000236	<0.0000050
	Calcium (Ca)-Total (mg/L)	16.5	526	57.1	170	32.7
	Chromium (Cr)-Total (mg/L)	0.00059	0.00225	0.00018	0.00122	0.00018
	Cobalt (Co)-Total (mg/L)	0.00064	0.00191	<0.00010	0.00153	<0.00010
	Copper (Cu)-Total (mg/L)	0.00358	0.392	0.0304	0.423	0.00158
	Iron (Fe)-Total (mg/L)	1.03	4.55	0.156	7.16	0.051
	Lead (Pb)-Total (mg/L)	<0.000050	0.00533	<0.000050	0.000553	<0.000050
	Lithium (Li)-Total (mg/L)	<0.0010	0.0119	<0.0010	0.0041	0.0013
	Magnesium (Mg)-Total (mg/L)	4.82	50.7	16.1	44.1	9.32
	Manganese (Mn)-Total (mg/L)	0.141	0.233	0.0638	2.33	0.00385

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980621-6	L1980621-7	L1980621-8	L1980621-9	L1980621-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	21-AUG-17	19-AUG-17	22-AUG-17	22-AUG-17	22-AUG-17
	Sampled Time	15:50		09:00	09:30	13:50
	Client ID	MN-2.5	DUP	W3	W17	MC1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	200	119	532	472	354
	Hardness (as CaCO3) (mg/L)	98.6	59.1	252	223	173
	pH (pH)	8.17	7.93	8.38	8.31	8.36
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	108	63.4	305	274	200
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	105	62.9	231	193	173
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	7.2	4.4	5.4
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	105	62.9	238	198	179
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0082	0.0054	<0.0050	0.0104
	Chloride (Cl) (mg/L)	0.51	<0.50	4.24	5.53	1.47
	Nitrate and Nitrite (as N) (mg/L)	0.0293	0.0111	0.181	0.188	0.102
	Nitrate (as N) (mg/L)	0.0293	0.0111	0.181	0.188	0.102
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	4.00	0.93	53.9	52.9	20.1
	Anion Sum (meq/L)	2.22	1.28	6.04	5.24	4.06
	Cation Sum (meq/L)	2.17	1.36	5.86	5.15	3.94
	Cation - Anion Balance (%)	-1.0	3.1	-1.5	-0.9	-1.5
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	8.30	13.8	5.44	9.15	8.11
Total Metals	Aluminum (Al)-Total (mg/L)	0.0338	0.0700	0.0066	0.0035	0.0762
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00030	0.00072	0.00025	0.00038	0.00063
	Barium (Ba)-Total (mg/L)	0.0423	0.0438	0.0671	0.0713	0.0657
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.027	0.034	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000051	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	28.8	16.7	59.7	64.3	46.6
	Chromium (Cr)-Total (mg/L)	0.00024	0.00068	0.00012	0.00013	0.00036
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00071	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.00134	0.00387	0.00290	0.00693	0.00172
	Iron (Fe)-Total (mg/L)	0.086	1.23	0.027	<0.010	0.246
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	0.0028	<0.0010	0.0012
	Magnesium (Mg)-Total (mg/L)	7.46	5.05	27.5	17.4	15.8
	Manganese (Mn)-Total (mg/L)	0.0321	0.143	0.0488	0.00670	0.0263

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1980621-11 WATER 22-AUG-17 14:50 W2	L1980621-12 WATER 19-AUG-17 DUP	L1980621-13 WATER 21-AUG-17 15:15 MN-0.5		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	358	529	237		
	Hardness (as CaCO3) (mg/L)	173	255	112		
	pH (pH)	8.36	8.39	8.18		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	TDS (Calculated) (mg/L)	204	311	130		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	172	232	118		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	5.4	9.6	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	177	241	118		
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050		
	Chloride (Cl) (mg/L)	1.95	4.53	<0.50		
	Nitrate and Nitrite (as N) (mg/L)	0.110	0.187	0.0657		
	Nitrate (as N) (mg/L)	0.110	0.187	0.0657		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	23.4	56.9	12.3		
	Anion Sum (meq/L)	4.11	6.15	2.63		
	Cation Sum (meq/L)	3.92	5.92	2.53		
	Cation - Anion Balance (%)	-2.4	-1.9	-1.9		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	7.45	5.57	8.88		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0303	0.0135	0.0231		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00046	0.00026	0.00036		
	Barium (Ba)-Total (mg/L)	0.0670	0.0669	0.0521		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	0.026	<0.010		
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Calcium (Ca)-Total (mg/L)	48.2	60.0	33.9		
	Chromium (Cr)-Total (mg/L)	0.00021	0.00014	0.00022		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00180	0.00295	0.00108		
	Iron (Fe)-Total (mg/L)	0.094	0.030	0.035		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0014	0.0028	<0.0010		
	Magnesium (Mg)-Total (mg/L)	14.8	27.8	8.22		
	Manganese (Mn)-Total (mg/L)	0.0162	0.0500	0.00344		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980621-1	L1980621-2	L1980621-3	L1980621-4	L1980621-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	19-AUG-17	20-AUG-17	21-AUG-17	21-AUG-17	21-AUG-17
	Sampled Time	14:10	12:50	09:00	11:00	14:15
	Client ID	MN-1.5	UG1	W16	W8A	MN-4.5
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000051	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.000445	0.0221	0.00312	0.0130	0.00104
	Nickel (Ni)-Total (mg/L)	0.00128	0.00290	0.00084	0.00185	0.00081
	Phosphorus (P)-Total (mg/L)	<0.050	0.104	<0.050	0.170	<0.050
	Potassium (K)-Total (mg/L)	0.26	12.7	2.69	6.41	0.98
	Selenium (Se)-Total (mg/L)	0.000058	0.00121	0.000719	0.00641	0.000175
	Silicon (Si)-Total (mg/L)	6.58	13.2	3.02	8.84	6.13
	Silver (Ag)-Total (mg/L)	<0.000010	0.000285	<0.000010	0.000164	<0.000010
	Sodium (Na)-Total (mg/L)	3.29	86.2	13.0	39.5	6.29
	Strontium (Sr)-Total (mg/L)	0.0857	9.59	0.577	2.24	0.222
	Sulfur (S)-Total (mg/L)	<0.50	501	20.4	91.4	3.97
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000039	<0.000010	0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	0.00014	<0.00010	0.00015	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00250	0.216	0.00438	0.0464	<0.0012 DLM
	Uranium (U)-Total (mg/L)	0.000032	0.0119	0.00126	0.00355	0.00104
	Vanadium (V)-Total (mg/L)	0.00083	0.0105	0.00058	0.00498	0.00069
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0291	0.0080	0.585	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00048	<0.00030	<0.00030	0.00046	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0354	0.0074	0.0051	0.0119	0.0054
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00078	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00052	0.00077	0.00041	0.00054	0.00032
	Barium (Ba)-Dissolved (mg/L)	0.0386	0.0271	0.0751	0.134	0.0534
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000040 DLA	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.651	0.028	0.029	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.000225	0.0000071	0.000184	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	15.0	490	55.8	159	32.4
	Chromium (Cr)-Dissolved (mg/L)	0.00047	0.00086	<0.00010	0.00038	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00058	0.00056	<0.00010	0.00102	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00318	0.0218	0.0267	0.100	0.00133
	Iron (Fe)-Dissolved (mg/L)	0.563	<0.020 DLA	0.071	0.197	0.016
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0101	0.0016	0.0043	0.0017
	Magnesium (Mg)-Dissolved (mg/L)	4.57	46.9	16.4	43.5	7.85
	Manganese (Mn)-Dissolved (mg/L)	0.122	0.103	0.0254	1.96	0.00314

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1980621-6	L1980621-7	L1980621-8	L1980621-9	L1980621-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	21-AUG-17	19-AUG-17	22-AUG-17	22-AUG-17	22-AUG-17
	Sampled Time	15:50		09:00	09:30	13:50
	Client ID	MN-2.5	DUP	W3	W17	MC1
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.000922	0.000466	0.00504	0.00565	0.00193
	Nickel (Ni)-Total (mg/L)	0.00094	0.00129	0.00110	0.00064	0.00114
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	0.87	0.27	2.26	3.52	1.39
	Selenium (Se)-Total (mg/L)	0.000061	0.000067	0.000293	0.000386	0.000112
	Silicon (Si)-Total (mg/L)	6.05	6.46	6.12	5.13	6.39
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	4.28	3.33	18.3	14.5	10.6
	Strontium (Sr)-Total (mg/L)	0.144	0.0868	0.783	0.672	0.480
	Sulfur (S)-Total (mg/L)	1.61	0.54	19.3	19.4	7.18
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00190	0.00224	0.00055	<0.00030	0.00360
	Uranium (U)-Total (mg/L)	0.000238	0.000034	0.00289	0.00197	0.00170
	Vanadium (V)-Total (mg/L)	0.00051	0.00092	<0.00050	0.00051	0.00106
	Zinc (Zn)-Total (mg/L)	0.0044	<0.0030	<0.0030	0.0030	0.0069
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00052	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0050	0.0336	0.0022	0.0028	0.0044
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00029	0.00057	0.00023	0.00036	0.00052
	Barium (Ba)-Dissolved (mg/L)	0.0419	0.0403	0.0680	0.0720	0.0650
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.023	0.029	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	27.5	16.0	55.7	61.2	44.2
	Chromium (Cr)-Dissolved (mg/L)	0.00013	0.00042	<0.00010	0.00012	0.00014
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00060	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00117	0.00315	0.00266	0.00649	0.00139
	Iron (Fe)-Dissolved (mg/L)	0.039	0.568	0.017	<0.010	0.119
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0015	<0.0010	0.0036	0.0018	0.0020
	Magnesium (Mg)-Dissolved (mg/L)	7.27	4.63	27.4	17.1	15.3
	Manganese (Mn)-Dissolved (mg/L)	0.0276	0.130	0.0435	0.00108	0.0164

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980621-11	L1980621-12	L1980621-13		
	Description	WATER	WATER	WATER		
	Sampled Date	22-AUG-17	19-AUG-17	21-AUG-17		
	Sampled Time	14:50		15:15		
	Client ID	W2	DUP	MN-0.5		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00152	0.00494	0.00136		
	Nickel (Ni)-Total (mg/L)	0.00092	0.00096	0.00076		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Total (mg/L)	1.52	2.28	0.84		
	Selenium (Se)-Total (mg/L)	0.000123	0.000340	0.000222		
	Silicon (Si)-Total (mg/L)	5.88	6.09	5.62		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	10.2	18.5	6.42		
	Strontium (Sr)-Total (mg/L)	0.494	0.780	0.256		
	Sulfur (S)-Total (mg/L)	8.58	18.9	4.16		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00184	DLM <0.00060	DLM <0.0012		
	Uranium (U)-Total (mg/L)	0.00209	0.00282	0.000740		
	Vanadium (V)-Total (mg/L)	0.00074	<0.00050	0.00069		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0040	0.0063	0.0074		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00039	0.00022	0.00033		
	Barium (Ba)-Dissolved (mg/L)	0.0666	0.0691	0.0520		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	0.023	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	45.7	56.1	31.5		
	Chromium (Cr)-Dissolved (mg/L)	0.00011	<0.00010	0.00013		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00147	0.00334	0.00101		
	Iron (Fe)-Dissolved (mg/L)	0.055	0.026	0.018		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0023	0.0036	0.0015		
	Magnesium (Mg)-Dissolved (mg/L)	14.4	27.8	8.20		
	Manganese (Mn)-Dissolved (mg/L)	0.0126	0.0440	0.00179		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte					
	Sample ID	L1980621-1	L1980621-2	L1980621-3	L1980621-4	L1980621-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	19-AUG-17	20-AUG-17	21-AUG-17	21-AUG-17	21-AUG-17
	Sampled Time	14:10	12:50	09:00	11:00	14:15
	Client ID	MN-1.5	UG1	W16	W8A	MN-4.5
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000405	0.0208	0.00271	0.0116	0.000959
	Nickel (Ni)-Dissolved (mg/L)	0.00114	0.0024	0.00076	0.00142	0.00063
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.10 DLA	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	0.24	11.1	2.72	6.37	0.88
	Selenium (Se)-Dissolved (mg/L)	0.000056	0.00107	0.000726	0.00682	0.000155
	Silicon (Si)-Dissolved (mg/L)	6.07	6.85	3.00	7.12	5.43
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000020 DLA	<0.000010	0.000016	<0.000010
	Sodium (Na)-Dissolved (mg/L)	3.10	78.7	12.9	39.3	5.60
	Strontium (Sr)-Dissolved (mg/L)	0.0788	8.79	0.522	1.96	0.209
	Sulfur (S)-Dissolved (mg/L)	<0.50	492	20.2	89.9	3.28
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00020 DLA	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00090 DLM	<0.00060 DLA	0.00037	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000030	0.0112	0.00111	0.00310	0.000940
	Vanadium (V)-Dissolved (mg/L)	0.00053	<0.0010 DLA	<0.00050	0.00104	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0060	<0.0010	0.157	0.0020
	Zirconium (Zr)-Dissolved (mg/L)	0.00048	<0.00030	<0.00030	0.00035	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980621-6	L1980621-7	L1980621-8	L1980621-9	L1980621-10
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	21-AUG-17	19-AUG-17	22-AUG-17	22-AUG-17	22-AUG-17
	Sampled Time	15:50		09:00	09:30	13:50
	Client ID	MN-2.5	DUP	W3	W17	MC1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000772	0.000404	0.00426	0.00509	0.00169
	Nickel (Ni)-Dissolved (mg/L)	0.00086	0.00112	0.00086	0.00054	0.00089
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	0.82	0.22	2.25	3.52	1.34
	Selenium (Se)-Dissolved (mg/L)	0.000065	0.000051	0.000341	0.000402	0.000123
	Silicon (Si)-Dissolved (mg/L)	5.89	6.18	5.95	4.89	6.06
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	4.08	3.10	17.6	13.7	9.84
	Strontium (Sr)-Dissolved (mg/L)	0.131	0.0784	0.707	0.624	0.439
	Sulfur (S)-Dissolved (mg/L)	1.36	<0.50	18.3	18.4	6.87
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00062	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000205	0.000029	0.00255	0.00173	0.00157
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00054	<0.00050	<0.00050	0.00068
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00047	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1980621-11 WATER 22-AUG-17 14:50 W2	L1980621-12 WATER 19-AUG-17 DUP	L1980621-13 WATER 21-AUG-17 15:15 MN-0.5		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00135	0.00430	0.00118		
	Nickel (Ni)-Dissolved (mg/L)	0.00082	0.00089	0.00070		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	1.46	2.26	0.79		
	Selenium (Se)-Dissolved (mg/L)	0.000130	0.000309	0.000177		
	Silicon (Si)-Dissolved (mg/L)	5.65	6.06	5.61		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	9.49	17.6	6.03		
	Strontium (Sr)-Dissolved (mg/L)	0.452	0.711	0.233		
	Sulfur (S)-Dissolved (mg/L)	7.94	19.0	4.12		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00048	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00192	0.00255	0.000676		
	Vanadium (V)-Dissolved (mg/L)	0.00055	<0.00050	0.00058		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1980621-1, -10, -11, -12, -13, -3, -5, -6, -7, -8, -9
Matrix Spike	Chloride (Cl)	MS-B	L1980621-10, -11, -13, -5, -6, -8, -9
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1980621-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1980621-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1980621-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1980621-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1980621-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1980621-1, -10, -11, -12, -13, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L1980621-5
Matrix Spike	Calcium (Ca)-Total	MS-B	L1980621-5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1980621-5
Matrix Spike	Sodium (Na)-Total	MS-B	L1980621-5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1980621-5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-08-23 C

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1980621-COFC

COC Number: 2017-08-23 C

Page 1 of 2

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack

Sampler: CH/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preser	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	MN-1.5	19-Aug-17	14:10	Water	R	R	R	R	R	R	R	R	R					7
	UG1	20-Aug-17	12:50	Water	R	R	R	R	R	R	R	R						6
	W16	21-Aug-17	9:00	Water	R	R	R	R	R	R	R	R	R					7
	W8A	21-Aug-17	11:00	Water	R	R	R	R	R	R	R	R						6
	MN-4.5	21-Aug-17	14:15	Water	R	R	R	R	R	R	R	R	R					7
	MN-0.5	21-Aug-17	15:15	Water	R	R	R	R	R	R	R	R	R					7
	MN-2.5	21-Aug-17	15:50	Water	R	R	R	R	R	R	R	R	R					7
	DUP	19-Aug-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-08-23 8:00	Time:	Received by: LEHF	Date: 23 Aug 2017	Time: 15:40	Received by: Mirelle 3.5°C	Date: Aug. 24, 2017	Time: 11:45

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

2°C, 12°C, 5.5°C

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1980621-COFC

COC Number: 2017-08-23 C

Page 2 of 2

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To

Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO

Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 226973 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preser	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	22-Aug-17	9:00	Water	R	R	R	R	R	R	R	R	R					7
	W17	22-Aug-17	9:30	Water	R	R	R	R	R	R	R	R	R					7
	MC1	22-Aug-17	13:50	Water	R	R	R	R	R	R	R	R	R					7
	W2	22-Aug-17	14:50	Water	R	R	R	R	R	R	R	R	R					7
	DUP	22-Aug-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☑
Ice Cubes ☐
Cooling Initiated ☑
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4.0					

SHIPMENT RELEASE (client use)

Released by: Chris Harry
Date: 2017-08-23 8:00
Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: GHF
Date: 23 Aug 2017
Time: 15:40

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Michelle 3.5°C
Date: Aug 24, 2017
Time: 11:45

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

2°C, 12°C, 5.8°C

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	30-AUG-17
Report Date:	11-SEP-17 13:28 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #:	L1983900
Project P.O. #:	226973
Job Reference:	
C of C Numbers:	2017-08-30 A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1983900-1	L1983900-2	L1983900-3		
	Description	Water	Water	Water		
	Sampled Date	29-AUG-17	29-AUG-17	29-AUG-17		
	Sampled Time	10:10	10:50	12:10		
	Client ID	MC1	W2	W3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	349	353	516		
	Hardness (as CaCO3) (mg/L)	175	179	260		
	pH (pH)	8.30	8.27	8.25		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	TDS (Calculated) (mg/L)	200	203	307		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	172	172	236		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	3.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	175	172	236		
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	0.0062		
	Chloride (Cl) (mg/L)	1.54	2.08	4.27		
	Nitrate and Nitrite (as N) (mg/L)	0.0717	0.0768	0.173		
	Nitrate (as N) (mg/L)	0.0717	0.0768	0.173		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	20.8	24.4	54.2		
	Anion Sum (meq/L)	3.99	4.00	5.98		
	Cation Sum (meq/L)	3.99	4.07	6.02		
	Cation - Anion Balance (%)	0.1	0.8	0.4		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	8.29	7.72	5.95		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0290	0.0047	0.0069		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00067	0.00039	0.00026		
	Barium (Ba)-Total (mg/L)	0.0679	0.0724	0.0709		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.026		
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Calcium (Ca)-Total (mg/L)	45.5	48.8	59.2		
	Chromium (Cr)-Total (mg/L)	0.00031	0.00018	<0.00010		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00278	0.00174	0.00285		
	Iron (Fe)-Total (mg/L)	0.200	0.061	0.024		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0015	0.0019	0.0032		
	Magnesium (Mg)-Total (mg/L)	16.4	15.5	28.9		
	Manganese (Mn)-Total (mg/L)	0.0218	0.0192	0.0474		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1983900-1 Water 29-AUG-17 10:10 MC1	L1983900-2 Water 29-AUG-17 10:50 W2	L1983900-3 Water 29-AUG-17 12:10 W3		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00186	0.00150	0.00502		
	Nickel (Ni)-Total (mg/L)	0.00098	0.00090	0.00093		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Total (mg/L)	1.41	1.63	2.29		
	Selenium (Se)-Total (mg/L)	0.000136	0.000129	0.000290		
	Silicon (Si)-Total (mg/L)	6.49	6.22	6.38		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	10.5	10.3	18.5		
	Strontium (Sr)-Total (mg/L)	0.469	0.507	0.781		
	Sulfur (S)-Total (mg/L)	6.90	8.11	18.4		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00129	<0.00030	<0.00030		
	Uranium (U)-Total (mg/L)	0.00159	0.00209	0.00279		
	Vanadium (V)-Total (mg/L)	0.00093	0.00064	<0.00050		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0059	0.0073	0.0024		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00059	0.00042	0.00024		
	Barium (Ba)-Dissolved (mg/L)	0.0671	0.0697	0.0694		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.025		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	43.9	46.4	57.6		
	Chromium (Cr)-Dissolved (mg/L)	0.00019	0.00016	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00145	0.00167	0.00267		
	Iron (Fe)-Dissolved (mg/L)	0.142	0.074	0.016		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0016	0.0017	0.0034		
	Magnesium (Mg)-Dissolved (mg/L)	15.8	15.4	28.2		
	Manganese (Mn)-Dissolved (mg/L)	0.0179	0.0203	0.0459		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1983900-1	L1983900-2	L1983900-3		
	Description	Water	Water	Water		
	Sampled Date	29-AUG-17	29-AUG-17	29-AUG-17		
	Sampled Time	10:10	10:50	12:10		
	Client ID	MC1	W2	W3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00170	0.00133	0.00490		
	Nickel (Ni)-Dissolved (mg/L)	0.00091	0.00092	0.00089		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	1.49	1.56	2.19		
	Selenium (Se)-Dissolved (mg/L)	0.000122	0.000133	0.000348		
	Silicon (Si)-Dissolved (mg/L)	6.11	5.91	6.10		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	10.4	10.2	17.8		
	Strontium (Sr)-Dissolved (mg/L)	0.458	0.475	0.771		
	Sulfur (S)-Dissolved (mg/L)	7.11	8.55	18.8		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00151	0.00200	0.00271		
	Vanadium (V)-Dissolved (mg/L)	0.00072	0.00058	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0012	<0.0010	<0.0010		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1983900-1, -2, -3
Matrix Spike	Dissolved Organic Carbon	MS-B	L1983900-1, -2, -3
Matrix Spike	Boron (B)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Cadmium (Cd)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1983900-2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1983900-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L1983900-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1983900-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1983900-1, -2, -3
Matrix Spike	Sulfate (SO4)	MS-B	L1983900-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Reference Information

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-08-30 A

Reference Information

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1983900-COFC

COC Number: 2017-08-30 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days):
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY:
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 226973 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** EB/RH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)	Short Holding Time	Rush Processing			Number of Containers
								P	F/P	P	F/P	P	F/P					
	MC1	29-Aug-17	10:10	Water	R	R	R	R	R	R	R	R	R					7
	W2	29-Aug-17	10:50	Water	R	R	R	R	R	R	R	R	R					7
	W3	29-Aug-17	12:10	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☑ Ice Cubes ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C: 7°C.
FINAL COOLER TEMPERATURES °C: 10

SHIPMENT RELEASE (client use)

Released by: Chris Harry
Date: 2017-08-30 7:45
Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by:
Date: Aug 30/17.
Time: 14:33

FINAL SHIPMENT RECEPTION (lab use only)

Received by:
Date: 9/1/17
Time: 18:30

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

OCTOBER 2015 FRONT

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 06-SEP-17
Report Date: 15-SEP-17 17:56 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1986966
Project P.O. #: 226973
Job Reference:
C of C Numbers: 2017-09-06 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1986966-1	L1986966-2	L1986966-3	L1986966-4	L1986966-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17
	Sampled Time	08:35	09:15	09:30	10:15	10:55
	Client ID	W35	W14	W12	W10	W33
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	388	2840	2660	495	677
	Hardness (as CaCO3) (mg/L)	190	1120	1270	228	312
	pH (pH)	7.95	8.08	7.98	7.76	7.69
	Total Suspended Solids (mg/L)	8.0	155	10.0	9.3	3.3
	TDS (Calculated) (mg/L)	227	2480	2330	288	423
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	150	85.2	171	191	127
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	150	85.2	171	191	127
	Ammonia, Total (as N) (mg/L)	0.0789	2.90	3.98	0.0067	0.0114
	Chloride (Cl) (mg/L)	0.88	37.7	34.3	0.62	1.81
	Nitrate and Nitrite (as N) (mg/L)	6.68	25.9	18.9	15.7	40.8
	Nitrate (as N) (mg/L)	6.67	19.9	13.1	15.6	40.7
	Nitrite (as N) (mg/L)	0.0121	6.08	5.80	0.0121	0.0544
	Sulfate (SO4) (mg/L)	30.5	1580	1450	10.0	46.1
	Anion Sum (meq/L)	4.14	37.4	35.8	5.17	6.45
	Cation Sum (meq/L)	4.27	34.3	33.4	4.99	6.76
	Cation - Anion Balance (%)	1.5	-4.4	-3.5	-1.8	2.4
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	19.2				
Total Metals	Aluminum (Al)-Total (mg/L)	0.507	0.363	0.149	0.0383	0.0238
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00035	0.00039	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00050	0.00055	0.00052	0.00014	0.00041
	Barium (Ba)-Total (mg/L)	0.108	0.176	0.112	0.222	0.152
	Beryllium (Be)-Total (mg/L)	0.000031	DLA <0.000040	DLA <0.000040	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	DLA <0.00010	DLA <0.00010	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	0.217	0.257	0.018	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000266	DLM <0.00015	DLM <0.00020	<0.0000050	0.0000092
	Calcium (Ca)-Total (mg/L)	48.2	326	402	71.5	77.0
	Chromium (Cr)-Total (mg/L)	0.00066	0.00083	0.00025	<0.00010	0.00045
	Cobalt (Co)-Total (mg/L)	0.00050	0.00186	0.00141	0.00012	0.00027
	Copper (Cu)-Total (mg/L)	0.0697	1.03	0.131	0.00781	0.0121
	Iron (Fe)-Total (mg/L)	0.982	0.839	0.347	0.210	0.199
	Lead (Pb)-Total (mg/L)	0.000187	0.00033	0.00035	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0011	0.0385	0.0233	0.0011	<0.0010
	Magnesium (Mg)-Total (mg/L)	17.5	88.0	70.0	15.3	29.5
	Manganese (Mn)-Total (mg/L)	0.167	1.34	1.40	0.0528	0.0837

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1986966-6	L1986966-7	L1986966-8	L1986966-9	L1986966-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17	04-SEP-17
	Sampled Time	11:20	11:40	12:00		08:45
	Client ID	W30	W15	W45	DUP	W62
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	422	834	3170	3200	1010
	Hardness (as CaCO3) (mg/L)	194	428	1420	1400	479
	pH (pH)	8.27	8.34	7.93	7.93	8.32
	Total Suspended Solids (mg/L)	<3.0	9.3	139	98.7	11.3
	TDS (Calculated) (mg/L)	251	544	2560	2930	610
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	126	258	121	121	327
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	7.6	<1.0	<1.0	7.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	126	265	121	121	334
	Ammonia, Total (as N) (mg/L)	0.0317	0.0263	5.52	6.56	0.0091
	Chloride (Cl) (mg/L)	2.32	4.24	30.1	36.5	22.9
	Nitrate and Nitrite (as N) (mg/L)	0.181	9.75	22.1	26.8	5.94
	Nitrate (as N) (mg/L)	0.178	9.73	17.7	21.5	5.89
	Nitrite (as N) (mg/L)	0.0027	0.0180	4.37	5.31	0.0467
	Sulfate (SO4) (mg/L)	92.1	168	1560	1910	164
	Anion Sum (meq/L)	4.51	9.61	37.2	45.1	11.2
	Cation Sum (meq/L)	4.55	9.38	39.8	39.6	10.7
	Cation - Anion Balance (%)	0.4	-1.2	3.3	-6.5	-2.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		15.7			12.8
Total Metals	Aluminum (Al)-Total (mg/L)	0.0531	0.471	1.12	1.30	0.0318
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00021	0.00038	0.00039	0.00012
	Arsenic (As)-Total (mg/L)	0.00075	0.00056	0.00061	0.00064	0.00043
	Barium (Ba)-Total (mg/L)	0.0700	0.109	0.150	0.157	0.109
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000028	<0.000040 DLA	0.000041	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.341	0.345	0.023
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000160	<0.00020 DLM	<0.00020 DLM	0.0000201
	Calcium (Ca)-Total (mg/L)	42.6	120	434	439	136
	Chromium (Cr)-Total (mg/L)	<0.00010	0.00040	0.00047	0.00188	0.00022
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00034	0.00334	0.00364	0.00016
	Copper (Cu)-Total (mg/L)	0.0187	0.0493	0.247	0.274	0.0508
	Iron (Fe)-Total (mg/L)	0.141	0.842	2.45	3.00	0.079
	Lead (Pb)-Total (mg/L)	<0.000050	0.000188	0.00261	0.00255	<0.000050
	Lithium (Li)-Total (mg/L)	0.0018	0.0013	0.0366	0.0379	0.0026
	Magnesium (Mg)-Total (mg/L)	21.9	34.8	93.8	97.0	41.4
	Manganese (Mn)-Total (mg/L)	0.0616	0.0766	2.27	2.24	0.0602

	Sample ID	L1986966-11	L1986966-12	L1986966-13	L1986966-14	L1986966-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	04-SEP-17	04-SEP-17	04-SEP-17	04-SEP-17	04-SEP-17
	Sampled Time	09:10	09:30	09:50	10:20	13:00
	Client ID	AMP-1B	W17	W16	W8A	W51
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	489	488	455	1250	1030
	Hardness (as CaCO3) (mg/L)	224	225	213	615	447
	pH (pH)	8.28	8.30	8.28	8.00	8.12
	Total Suspended Solids (mg/L)	84.7	<3.0	4.0	46.7	70.7
	TDS (Calculated) (mg/L)	276	280	268	851	644
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	214	201	171	393	310
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	3.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	214	204	171	393	310
	Ammonia, Total (as N) (mg/L)	0.0164	<0.0050	0.0334	0.0744	1.94
	Chloride (Cl) (mg/L)	5.63	6.06	6.55	10.9	DLDS <2.5
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	0.180	1.82	6.40	12.4
	Nitrate (as N) (mg/L)	<0.0050	0.180	1.80	6.33	11.8
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.0174	0.0686	0.555
	Sulfate (SO4) (mg/L)	46.8	54.6	60.3	310	224
	Anion Sum (meq/L)	5.40	5.39	4.98	15.1	11.8
	Cation Sum (meq/L)	5.17	5.17	4.94	14.3	10.6
	Cation - Anion Balance (%)	-2.2	-2.1	-0.5	-2.7	-5.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	10.2	10.1	14.8	19.1	1.84
Total Metals	Aluminum (Al)-Total (mg/L)	2.95	0.0129	0.0445	0.565	5.24
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00014	0.00011	0.00032	0.00049
	Arsenic (As)-Total (mg/L)	0.00131	0.00042	0.00047	0.00086	0.00176
	Barium (Ba)-Total (mg/L)	0.155	0.0778	0.0757	0.146	0.131
	Beryllium (Be)-Total (mg/L)	0.000129	<0.000020	<0.000020	0.000050	0.000196
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	0.00111
	Boron (B)-Total (mg/L)	0.032	0.030	0.029	0.029	0.101
	Cadmium (Cd)-Total (mg/L)	0.0000621	0.0000333	0.0000438	0.000136	0.000261
	Calcium (Ca)-Total (mg/L)	66.4	62.8	59.2	179	82.3
	Chromium (Cr)-Total (mg/L)	0.00213	0.00018	0.00017	0.00111	0.00187
	Cobalt (Co)-Total (mg/L)	0.00260	<0.00010	<0.00010	0.00104	0.00366
	Copper (Cu)-Total (mg/L)	0.0831	0.00899	0.0301	0.220	5.17
	Iron (Fe)-Total (mg/L)	4.56	0.018	0.136	2.44	15.6
	Lead (Pb)-Total (mg/L)	0.000897	<0.000050	<0.000050	0.000376	0.00342
	Lithium (Li)-Total (mg/L)	0.0035	0.0012	0.0013	0.0041	0.0144
	Magnesium (Mg)-Total (mg/L)	21.2	19.3	18.1	48.9	67.8
	Manganese (Mn)-Total (mg/L)	0.928	0.00771	0.0514	1.62	0.503

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1986966-16	L1986966-17	L1986966-18	L1986966-19	
	Description	Water	Water	Water	Water	
	Sampled Date	04-SEP-17	05-SEP-17	05-SEP-17	05-SEP-17	
	Sampled Time		07:40	08:35	09:10	
	Client ID	DUP	W3	MC1	W2	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1220	549	374	375	
	Hardness (as CaCO3) (mg/L)	615	261	179	179	
	pH (pH)	8.05	8.35	8.37	8.34	
	Total Suspended Solids (mg/L)	31.3	<3.0	4.7	8.7	
	TDS (Calculated) (mg/L)	847	316	206	210	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	384	239	179	178	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	7.4	6.2	4.8	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	384	247	185	183	
	Ammonia, Total (as N) (mg/L)	0.0984	<0.0050	<0.0050	0.0091	
	Chloride (Cl) (mg/L)	11.0	4.46	1.60	2.14	
	Nitrate and Nitrite (as N) (mg/L)	6.46	0.326	0.0246	0.0286	
	Nitrate (as N) (mg/L)	6.39	0.326	0.0246	0.0286	
	Nitrite (as N) (mg/L)	0.0715	<0.0010	<0.0010	<0.0010	
	Sulfate (SO4) (mg/L)	312	55.3	20.9	24.4	
	Anion Sum (meq/L)	14.9	6.23	4.17	4.22	
	Cation Sum (meq/L)	14.3	6.09	4.07	4.08	
	Cation - Anion Balance (%)	-2.4	-1.2	-1.3	-1.7	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	19.8	6.38	9.10	8.16	
Total Metals	Aluminum (Al)-Total (mg/L)	0.900	0.0057	0.0187	0.120	
	Antimony (Sb)-Total (mg/L)	0.00035	<0.00010	<0.00010	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00108	0.00027	0.00057	0.00048	
	Barium (Ba)-Total (mg/L)	0.159	0.0700	0.0684	0.0736	
	Beryllium (Be)-Total (mg/L)	0.000059	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	0.030	0.026	<0.010	<0.010	
	Cadmium (Cd)-Total (mg/L)	0.000157	<0.0000050	<0.0000050	0.0000059	
	Calcium (Ca)-Total (mg/L)	181	57.6	46.5	47.7	
	Chromium (Cr)-Total (mg/L)	0.00125	0.00012	0.00024	0.00039	
	Cobalt (Co)-Total (mg/L)	0.00126	<0.00010	<0.00010	0.00012	
	Copper (Cu)-Total (mg/L)	0.353	0.00301	0.00174	0.00279	
	Iron (Fe)-Total (mg/L)	4.62	0.025	0.152	0.532	
	Lead (Pb)-Total (mg/L)	0.000603	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Total (mg/L)	0.0042	0.0031	0.0015	0.0018	
	Magnesium (Mg)-Total (mg/L)	50.2	29.7	17.4	16.7	
	Manganese (Mn)-Total (mg/L)	1.68	0.0491	0.0152	0.0253	

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1986966-1	L1986966-2	L1986966-3	L1986966-4	L1986966-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17
	Sampled Time	08:35	09:15	09:30	10:15	10:55
	Client ID	W35	W14	W12	W10	W33
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000298	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00114	0.146	0.0871	0.000776	0.000751
	Nickel (Ni)-Total (mg/L)	0.00170	0.0023	0.0044	<0.00050	0.00154
	Phosphorus (P)-Total (mg/L)	<0.050	<0.10 DLA	<0.10 DLA	<0.050	<0.050
	Potassium (K)-Total (mg/L)	1.04	83.6	57.1	1.87	0.85
	Selenium (Se)-Total (mg/L)	0.000153	0.0185	0.0136	0.000171	0.000383
	Silicon (Si)-Total (mg/L)	6.49	3.91	4.03	3.35	6.48
	Silver (Ag)-Total (mg/L)	0.000015	0.000057	0.000044	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	10.1	226	147	9.61	11.1
	Strontium (Sr)-Total (mg/L)	0.349	5.45	7.14	0.452	0.559
	Sulfur (S)-Total (mg/L)	10.7	576	511	3.91	17.0
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0241	0.0157	0.00681	0.00183	<0.0012 DLM
	Uranium (U)-Total (mg/L)	0.000260	0.00943	0.00761	0.000330	0.000094
	Vanadium (V)-Total (mg/L)	0.00237	0.0016	<0.0010 DLA	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	0.0069	0.0063	0.0159	0.0036	0.0058
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00039
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0134	0.0329	0.0077	0.0027	0.0194
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00026	0.00027	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00034	0.00043	0.00048	<0.00010	0.00040
	Barium (Ba)-Dissolved (mg/L)	0.105	0.198	0.115	0.210	0.161
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.203	0.244	0.016	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000182	<0.00011 DLM	<0.00018 DLM	<0.0000050	0.0000078
	Calcium (Ca)-Dissolved (mg/L)	47.9	313	397	68.9	77.7
	Chromium (Cr)-Dissolved (mg/L)	0.00032	<0.00020 DLA	<0.00020 DLA	<0.00010	0.00043
	Cobalt (Co)-Dissolved (mg/L)	0.00018	0.00151	0.00128	<0.00010	0.00028
	Copper (Cu)-Dissolved (mg/L)	0.0262	0.0124	0.0389	0.00310	0.00965
	Iron (Fe)-Dissolved (mg/L)	0.062	<0.020 DLA	<0.020 DLA	0.013	0.150
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0011	0.0357	0.0222	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	17.1	82.6	66.7	13.7	28.7
	Manganese (Mn)-Dissolved (mg/L)	0.127	1.37	1.43	0.00934	0.0867

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1986966-6	L1986966-7	L1986966-8	L1986966-9	L1986966-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17	04-SEP-17
	Sampled Time	11:20	11:40	12:00		08:45
	Client ID	W30	W15	W45	DUP	W62
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00177	0.00363	0.111	0.112	0.00667
	Nickel (Ni)-Total (mg/L)	0.00050	0.00113	0.0192	0.0390	0.00101
	Phosphorus (P)-Total (mg/L)	<0.050	0.056	<0.10 DLA	<0.10 DLA	<0.050
	Potassium (K)-Total (mg/L)	3.13	3.96	81.5	82.7	5.03
	Selenium (Se)-Total (mg/L)	0.000853	0.00197	0.0160	0.0164	0.00325
	Silicon (Si)-Total (mg/L)	0.55	5.23	5.79	6.16	7.68
	Silver (Ag)-Total (mg/L)	<0.000010	0.000010	0.000048	0.000058	0.000010
	Sodium (Na)-Total (mg/L)	13.4	17.0	206	205	26.7
	Strontium (Sr)-Total (mg/L)	0.483	1.11	6.61	6.73	1.50
	Sulfur (S)-Total (mg/L)	34.1	62.6	639	669	66.0
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	0.000026	0.000028	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	0.00042	0.00109	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00232	0.0291	0.0677	0.0755	<0.0018 DLM
	Uranium (U)-Total (mg/L)	0.000444	0.00374	0.00819	0.00834	0.00472
	Vanadium (V)-Total (mg/L)	0.00056	0.00201	0.0044	0.0050	0.00077
	Zinc (Zn)-Total (mg/L)	0.0034	0.0050	0.0126	0.0175	0.0612
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0055	0.0068	0.0114	0.0130	0.0022
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00012	0.00029	0.00028	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00077	0.00045	0.00039	0.00039	0.00036
	Barium (Ba)-Dissolved (mg/L)	0.0781	0.108	0.139	0.140	0.105
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000040 DLA	<0.000040 DLA	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.332	0.328	0.021
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000077	<0.00015	<0.00015 DLM	0.0000145
	Calcium (Ca)-Dissolved (mg/L)	41.3	115	421	412	131
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00016	<0.00020 DLA	<0.00020 DLA	0.00016
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00012	0.00272	0.00268	0.00013
	Copper (Cu)-Dissolved (mg/L)	0.0129	0.0211	0.0128	0.0116	0.0422
	Iron (Fe)-Dissolved (mg/L)	0.045	0.079	0.172	0.143	0.023
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.00010 DLA	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0014	0.0010	0.0350	0.0343	0.0026
	Magnesium (Mg)-Dissolved (mg/L)	22.0	33.8	89.1	89.9	36.5
	Manganese (Mn)-Dissolved (mg/L)	0.0220	0.0556	2.25	2.27	0.0574

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1986966-11	L1986966-12	L1986966-13	L1986966-14	L1986966-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	04-SEP-17	04-SEP-17	04-SEP-17	04-SEP-17	04-SEP-17
	Sampled Time	09:10	09:30	09:50	10:20	13:00
	Client ID	AMP-1B	W17	W16	W8A	W51
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	0.0000060	DLM <0.000025
	Molybdenum (Mo)-Total (mg/L)	0.00510	0.00561	0.00318	0.0144	0.0342
	Nickel (Ni)-Total (mg/L)	0.00475	0.00073	0.00087	0.00167	0.00176
	Phosphorus (P)-Total (mg/L)	0.173	<0.050	<0.050	0.133	0.649
	Potassium (K)-Total (mg/L)	3.59	3.80	3.01	6.96	9.19
	Selenium (Se)-Total (mg/L)	0.000181	0.000382	0.000684	0.00981	0.00324
	Silicon (Si)-Total (mg/L)	12.2	5.22	3.36	8.49	16.2
	Silver (Ag)-Total (mg/L)	0.000030	<0.000010	<0.000010	0.000082	0.00226
	Sodium (Na)-Total (mg/L)	16.0	15.1	14.0	44.5	31.7
	Strontium (Sr)-Total (mg/L)	0.578	0.658	0.593	2.21	2.20
	Sulfur (S)-Total (mg/L)	16.9	19.7	22.1	120	76.1
	Thallium (Tl)-Total (mg/L)	0.000022	<0.000010	<0.000010	0.000011	0.000134
	Tin (Sn)-Total (mg/L)	0.00011	<0.00010	<0.00010	<0.00010	0.00030
	Titanium (Ti)-Total (mg/L)	0.125	0.00066	0.00211	0.0260	0.345
	Uranium (U)-Total (mg/L)	0.00221	0.00207	0.00131	0.00362	0.00672
	Vanadium (V)-Total (mg/L)	0.00972	0.00058	0.00068	0.00366	0.0247
	Zinc (Zn)-Total (mg/L)	0.0229	0.0069	0.0035	0.692	0.0566
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	0.00037	0.00074
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0022	0.0013	0.0061	0.0066	0.0045
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00011	0.00045
	Arsenic (As)-Dissolved (mg/L)	0.00031	0.00035	0.00043	0.00048	0.00083
	Barium (Ba)-Dissolved (mg/L)	0.0703	0.0707	0.0759	0.138	0.0238
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.030	0.030	0.028	0.030	0.101
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000114	0.0000485	0.000138	DLM <0.000050
	Calcium (Ca)-Dissolved (mg/L)	61.4	62.3	57.2	172	74.7
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	0.00013	0.00027	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00086	0.00027
	Copper (Cu)-Dissolved (mg/L)	0.00382	0.00634	0.0268	0.0683	0.0354
	Iron (Fe)-Dissolved (mg/L)	<0.010	<0.010	0.047	0.272	<0.010
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0015	0.0014	0.0012	0.0040	0.0120
	Magnesium (Mg)-Dissolved (mg/L)	17.1	16.8	17.1	45.1	63.1
	Manganese (Mn)-Dissolved (mg/L)	0.00356	0.00113	0.0220	1.97	0.107

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID Description Sampled Date Sampled Time Client ID	L1986966-16 Water 04-SEP-17 DUP	L1986966-17 Water 05-SEP-17 07:40 W3	L1986966-18 Water 05-SEP-17 08:35 MC1	L1986966-19 Water 05-SEP-17 09:10 W2
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000067	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.0141	0.00485	0.00188	0.00154
	Nickel (Ni)-Total (mg/L)	0.00175	0.00103	0.00099	0.00114
	Phosphorus (P)-Total (mg/L)	0.213	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	7.10	2.42	1.57	1.86
	Selenium (Se)-Total (mg/L)	0.00968	0.000326	0.000118	0.000134
	Silicon (Si)-Total (mg/L)	9.02	6.11	6.36	6.10
	Silver (Ag)-Total (mg/L)	0.000158	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	44.3	19.1	10.9	10.9
	Strontium (Sr)-Total (mg/L)	2.23	0.788	0.488	0.502
	Sulfur (S)-Total (mg/L)	117	19.8	7.49	8.77
	Thallium (Tl)-Total (mg/L)	0.000016	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	0.00012	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0499	<0.00030	<0.0012 DLM	0.00488
	Uranium (U)-Total (mg/L)	0.00372	0.00286	0.00170	0.00212
	Vanadium (V)-Total (mg/L)	0.00552	0.00050	0.00089	0.00098
	Zinc (Zn)-Total (mg/L)	0.938	<0.0030	<0.0030	0.0108
	Zirconium (Zr)-Total (mg/L)	0.00040	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0062	0.0024	0.0042	0.0034
	Antimony (Sb)-Dissolved (mg/L)	0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00050	0.00025	0.00054	0.00041
	Barium (Ba)-Dissolved (mg/L)	0.139	0.0715	0.0660	0.0750
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.031	0.025	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.000124	<0.0000050	<0.0000050	0.0000051
	Calcium (Ca)-Dissolved (mg/L)	173	56.4	44.6	46.1
	Chromium (Cr)-Dissolved (mg/L)	0.00027	<0.00010	0.00017	0.00015
	Cobalt (Co)-Dissolved (mg/L)	0.00086	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0666	0.00276	0.00148	0.00166
	Iron (Fe)-Dissolved (mg/L)	0.251	0.019	0.108	0.052
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0040	0.0032	0.0016	0.0018
	Magnesium (Mg)-Dissolved (mg/L)	44.4	29.1	16.3	15.6
	Manganese (Mn)-Dissolved (mg/L)	1.95	0.0476	0.0135	0.0167

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1986966-1	L1986966-2	L1986966-3	L1986966-4	L1986966-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17
	Sampled Time	08:35	09:15	09:30	10:15	10:55
	Client ID	W35	W14	W12	W10	W33
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00106	0.139	0.0847	0.000697	0.000673
	Nickel (Ni)-Dissolved (mg/L)	0.00139	0.0021	0.0040	<0.00050	0.00148
	Phosphorus (P)-Dissolved (mg/L)	<0.050	DLA <0.10	DLA <0.10	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	0.93	94.0	65.4	1.76	0.85
	Selenium (Se)-Dissolved (mg/L)	0.000140	0.0178	0.0131	0.000155	0.000429
	Silicon (Si)-Dissolved (mg/L)	5.45	3.04	3.68	3.14	6.38
	Silver (Ag)-Dissolved (mg/L)	<0.000010	DLA <0.000020	DLA <0.000020	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.83	212	140	8.65	11.2
	Strontium (Sr)-Dissolved (mg/L)	0.340	5.15	7.06	0.438	0.566
	Sulfur (S)-Dissolved (mg/L)	10.0	518	477	3.34	15.3
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	DLA <0.000020	DLA <0.000020	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	DLA <0.00020	DLA <0.00020	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.00060	DLA <0.00060	DLA <0.00060	<0.00030	DLM <0.00090
	Uranium (U)-Dissolved (mg/L)	0.000217	0.00862	0.00708	0.000302	0.000084
	Vanadium (V)-Dissolved (mg/L)	0.00058	DLA <0.0010	DLA <0.0010	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0015	DLA <0.0020	0.0073	<0.0010	0.0014
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00040

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Sample ID		L1986966-6	L1986966-7	L1986966-8	L1986966-9	L1986966-10
Description		Water	Water	Water	Water	Water
Sampled Date		03-SEP-17	03-SEP-17	03-SEP-17	03-SEP-17	04-SEP-17
Sampled Time		11:20	11:40	12:00		08:45
Client ID		W30	W15	W45	DUP	W62
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00153	0.00315	0.106	0.105	0.00597
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00091	0.0059	0.0063	0.00088
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.10 DLA	<0.10 DLA	<0.050
	Potassium (K)-Dissolved (mg/L)	3.52	4.09	89.0	90.3	5.05
	Selenium (Se)-Dissolved (mg/L)	0.000903	0.00204	0.0147	0.0152	0.00341
	Silicon (Si)-Dissolved (mg/L)	0.417	4.27	3.61	3.64	7.04
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000020 DLA	<0.000020 DLA	<0.000010
	Sodium (Na)-Dissolved (mg/L)	13.4	16.6	199	201	23.7
	Strontium (Sr)-Dissolved (mg/L)	0.461	1.05	6.47	6.34	1.44
	Sulfur (S)-Dissolved (mg/L)	31.6	58.3	597	604	56.9
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000020 DLA	<0.000020 DLA	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00020 DLA	<0.00020 DLA	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00090 DLM	<0.00060 DLA	<0.00060 DLA	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000366	0.00311	0.00761	0.00741	0.00425
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.0010 DLA	<0.0010 DLA	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0020 DLA	0.0021	0.0484
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1986966-11 Water 04-SEP-17 09:10 AMP-1B	L1986966-12 Water 04-SEP-17 09:30 W17	L1986966-13 Water 04-SEP-17 09:50 W16	L1986966-14 Water 04-SEP-17 10:20 W8A	L1986966-15 Water 04-SEP-17 13:00 W51
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00579	0.00527	0.00283	0.0121	0.0333
	Nickel (Ni)-Dissolved (mg/L)	0.00123	0.00057	0.00076	0.00134	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.99	3.75	3.07	6.97	7.73
	Selenium (Se)-Dissolved (mg/L)	0.000144	0.000394	0.000673	0.00871	0.00319
	Silicon (Si)-Dissolved (mg/L)	6.12	4.88	3.16	7.20	6.73
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	0.000014	<0.000010
	Sodium (Na)-Dissolved (mg/L)	14.3	13.4	13.4	39.6	31.4
	Strontium (Sr)-Dissolved (mg/L)	0.543	0.667	0.571	2.23	2.11
	Sulfur (S)-Dissolved (mg/L)	14.8	17.1	20.1	96.2	70.5
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	0.00043	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00171	0.00184	0.00118	0.00336	0.00601
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00098	0.00066
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.0020	0.125	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	0.00039	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1986966-16	L1986966-17	L1986966-18	L1986966-19	
	Sample ID	L1986966-16	L1986966-17	L1986966-18	L1986966-19	
	Description	Water	Water	Water	Water	
	Sampled Date	04-SEP-17	05-SEP-17	05-SEP-17	05-SEP-17	
	Sampled Time		07:40	08:35	09:10	
	Client ID	DUP	W3	MC1	W2	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.0123	0.00449	0.00167	0.00139	
	Nickel (Ni)-Dissolved (mg/L)	0.00127	0.00092	0.00091	0.00089	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	6.93	2.54	1.54	1.86	
	Selenium (Se)-Dissolved (mg/L)	0.00802	0.000312	0.000129	0.000116	
	Silicon (Si)-Dissolved (mg/L)	6.60	6.28	6.32	5.93	
	Silver (Ag)-Dissolved (mg/L)	0.000013	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	38.9	18.6	10.4	10.3	
	Strontium (Sr)-Dissolved (mg/L)	2.24	0.765	0.468	0.484	
	Sulfur (S)-Dissolved (mg/L)	87.2	19.0	6.96	8.01	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.00060	<0.00030	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00337	0.00255	0.00152	0.00195	
	Vanadium (V)-Dissolved (mg/L)	0.00100	<0.00050	0.00073	0.00059	
	Zinc (Zn)-Dissolved (mg/L)	0.123	<0.0010	<0.0010	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	0.00039	<0.00030	<0.00030	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -7
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1986966-12, -13, -14, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1986966-12, -13, -14, -2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1986966-12, -13, -14, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1986966-12, -13, -14, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1986966-12, -13, -14, -2
Matrix Spike	Barium (Ba)-Total	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L1986966-1, -10, -11, -12, -13, -14, -15, -16, -17, -18, -19, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

Reference Information

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

VA

Chain of Custody Numbers:

2017-09-06 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

(ALS) Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1986966-COFC

COC Number: 2017-09-06 A

Page 1 of 2

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Contact: Shane Stack

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W35	3-Sep-17	8:35	Water	R	R	R	R	R	R	R	R	R					7
	W14	3-Sep-17	9:15		R	R	R	R	R	R	R	R						6
	W12	3-Sep-17	9:30		R	R	R	R	R	R	R	R						6
	W10	3-Sep-17	10:15		R	R	R	R	R	R	R	R						6
	W33	3-Sep-17	10:55		R	R	R	R	R	R	R	R						6
	W30	3-Sep-17	11:20		R	R	R	R	R	R	R	R						6
	W15	3-Sep-17	11:40		R	R	R	R	R	R	R	R	R					7
	W45	3-Sep-17	12:00		R	R	R	R	R	R	R	R						6
	DUP	3-Sep-17			R	R	R	R	R	R	R	R						6

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6 °C			8.4		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Emilie Bouchard	Date: September 6th, 2017	Time:	Received by:	Date: Sept 6/17	Time: 14:31	Received by: Shayon	Date: Sept. 7	Time: 1600

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1986966-COFC

COC Number: 2017-09-06 A

Page 2 of 2

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Contact: Shane Stack

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W62	4-Sep-17	8:45	Water	R	R	R	R	R	R	R	R	R					7
	AMP-1B	4-Sep-17	9:10		R	R	R	R	R	R	R	R	R					7
	W17	4-Sep-17	9:30		R	R	R	R	R	R	R	R	R					7
	W16	4-Sep-17	9:50		R	R	R	R	R	R	R	R	R					7
	W8A	4-Sep-17	10:20		R	R	R	R	R	R	R	R	R					7
	W51	4-Sep-17	13:00		R	R	R	R	R	R	R	R	R					7
	DUP	4-Sep-17			R	R	R	R	R	R	R	R	R					7
	W3	5-Sep-17	7:40		R	R	R	R	R	R	R	R	R					7
	MC1	5-Sep-17	8:35		R	R	R	R	R	R	R	R	R					7
	W2	5-Sep-17	10:10		R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6°C.			8.4		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Emilie Bouchard	Date: September 6, 2017	Time:	Received by:	Date: Sept 6/17.	Time: 14:31	Received by: Shayan	Date: Sept. 7	Time: 1600

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

L1986966-COFC

ALS Burnaby – Login Instruction Sheet

Please login in the analyses listed on the Client Chain-of-Custody with the noted Whitehorse (WR) products where sub-samples were taken and retained for analysis.

L1986966
~~ALS L# 1986967~~

Sample #	Anions-All-IC-WR	TSS-Man (or low)-WR *	_-L-IC-N-WR **	_-L-IC-N-WR **	_-L-IC-N-WR **	SO4-IC-WR		Additional information *Use TSS Man or Low as needed based on Client/Quote information (**Enter single anions; Br, F, Cl, NO3, NO2)
1	X	X						
2	X	X						
3	X	X						
4	X	X						
5	X	X						
6	X	X						
7	X	X						
8	X	X						
9	X	X						
10	X	X						
11	X	X						
12	X	X						
13	X	X						
14	X	X						
15	X	X						
16	X	X						
17	X	X						
18	X	X						
19	X	X						
20								
21								
22								
23								
24								

Please contact ALS Whitehorse at 1-867-668-6689 if you have any questions. Thanks.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	13-SEP-17
Report Date:	07-NOV-17 13:26 (MT)
Version:	FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1990955

Project P.O. #:	224159 (MMER)
Job Reference:	
C of C Numbers:	2017-09-13 B
Legal Site Desc:	

Comments: Please note, the Nautilus report for Ceriodaphnia dubia and 72-h P. subcapitata growth can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

2017-09-13 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Toxicity testing for L1990955-1 W3

Sample collected on Sept 12, 2017

Final Report

November 1, 2017

Submitted to: **ALS Environmental**
Burnaby, BC

TABLE OF CONTENTS

Page

List of Tables

List of Appendices

SIGNATURE PAGE

Sones

Report By:
Jillian Sones, BAS.
Laboratory Biologist

A. Tang

Reviewed By:
Armando Tang, R.P. Bio
Laboratory Manager

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

SUMMARY

Sample Information and Test Type

Sample ID	L1990955-1 W3
Sample collection date	September 12, 2017
Sample receipt date	September 14, 2017
Sample receipt temperature	9.5°C
Test types	*Ceriodaphnia dubia* survival and reproduction 72-h *Pseudokirchneriella subcapitata* growth inhibition

Summary of Results

Endpoint	**% v/v (95% CL)**
Ceriodaphnia. dubia	
Survival LC50	>100
Reproduction IC25	>100
Reproduction IC50	>100
Pseudokirchneriella subcapitata	
Growth IC25	>95.2
Growth IC50	>95.2

LC = Lethal Concentration, IC = Inhibition Concentration, CL = Confidence Limits

1.0 INTRODUCTION

Nautilus Environmental Company Inc. conducted sub-lethal toxicity tests for ALS Environmental. Sample L1990955-1 W3 was collected on September 12, 2017 and delivered to the Nautilus Environmental laboratory in Burnaby, BC on September 14, 2017. Testing was initiated on September 14, 2017 for *C. dubia* and *P. subcapitata*. The sample was transported in eight 1-L plastic containers and was received at a temperature of 9.5°C. The sample was stored in the dark at 4 ± 2°C prior to testing. The following toxicity tests were performed on the sample:

- *Ceriodaphnia dubia* survival and reproduction
- 72-h *Pseudokirchneriella subcapitata* growth inhibition

This report describes the results of these toxicity tests. Copies of raw laboratory data sheets and statistical analyses for each test species are provided in Appendices A and B. The chain-of-custody form is provided in Appendix C.

2.0 METHODS

Methods for the toxicity tests are summarized in Tables 1 and 2. Testing using *C. dubia*, and *P. subcapitata* were conducted according to procedures described by Environment Canada (2007a and 2007b). Statistical analyses for all the tests were performed using CETIS (Tidepool Scientific Software, 2013).

Table 1. Summary of test conditions: *Ceriodaphnia dubia* survival and reproduction test.

Test species	*Ceriodaphnia dubia*
Organism source	In-house culture
Organism age	<24 hour old neonates, produced within a 12 hour window
Test type	Static-renewal
Test duration	7 ± 1 day
Test vessel	20-mL glass test tube
Test volume	15 mL
Test solution depth	10 cm
Test concentrations	Seven concentrations, plus laboratory control
Test replicates	10 per treatment
Number of organisms	1 per replicate
Control/dilution water	20% Perrier water and 80% deionized water + 5 µg/L Se and 2 µg/L vitamin B12
Test solution renewal	Daily (100% renewal)
Test temperature	25 ± 1°C
Feeding	Daily with *Pseudokirchneriella subcapitata* and YCT (3:1 ratio)
Light intensity	100 to 600 lux at water surface
Photoperiod	16 hours light / 8 hours dark
Aeration	None
Test measurements	Temperature, dissolved oxygen, pH and conductivity measured daily; hardness and alkalinity of undiluted sample measured at test initiation; survival and reproduction checked daily
Test protocol	Environment Canada (2007a), EPS 1/RM/21
Statistical software	CETIS Version 1.8.7
Test endpoints	Survival and reproduction
Test acceptability criteria for controls	≥80% survival; ≥15 young per surviving control producing three broods; ≥60% of controls producing three or more broods; no ephippia present
Reference toxicant	Sodium chloride (NaCl)

Table 2. Summary of test conditions: *Pseudokirchneriella subcapitata* growth inhibition test.

Test species	*Lemna minor*, strain CPCC# 490
Organism source	In-house axenic culture, obtained from Canadian Phycological Culture Centre, and originally isolated from Wainfleet, Stinking Barn, Niagara Peninsula, Ontario, Canada
Organism age	7- to 10-day old culture
Test type	Static
Test duration	7 days
Test vessel	250-mL glass container
Test volume	100 mL
Test solution depth	4 cm
Test concentrations	Seven concentrations, plus laboratory control
Test replicates	4 per treatment
Number of organisms	Two 3-frond plants per replicate
Control/dilution water	Modified APHA media (deionized water plus 1% of each APHA stock solution A, B and C)
Test solution renewal	None
Test temperature	25 ± 2°C
Feeding	None
Light intensity	4000 to 5600 lux
Photoperiod	24 hours light
Aeration	None
Test measurements	Test area temperature measured daily; temperature, pH and conductivity measured in all concentrations at test initiation; dissolved oxygen of highest concentration measured at test initiation; temperature and pH measured at test termination
Test protocol	Environment Canada (2007b), EPS 1/RM/37
Statistical software	CETIS Version 1.8.7
Test endpoints	Number of fronds and dry weight
Test acceptability criterion for controls	≥ 8-fold increase in number of fronds
Reference toxicant	Potassium chloride (KCl)

3.0 RESULTS

Results of the toxicity tests are summarized in Tables 3 and 4. There were no adverse effects observed on survival and reproduction of *C. dubia* (Table 3), or cell yield of *P. subcapitata* (Table 4). The LC and IC values were therefore greater than the highest test concentration for each of these endpoints in the toxicity tests. Stimulatory effects were observed for *P. subcapitata* cell yield; percent stimulation ranged from 6.72 to 363.9%.

Table 3. Results: *Ceriodaphnia dubia* survival and reproduction test.

Concentration (% v/v)	Survival (%)	Reproduction (Mean ± SD)
Laboratory Control	100	18.3 ± 11.5
1.56	100	18.1 ± 7.5
3.12	100	23.4 ± 4.1
6.25	100	21.0 ± 8.4
12.5	90	21.8 ± 8.6
25	100	22.0 ± 12.5
50	80	13.2 ± 14.7
100	100	18.4 ± 11.9
Test Endpoint (% v/v)		
LC50	>100	--
IC25	--	>100
IC50	--	>100

SD = Standard Deviation, LC = Lethal Concentration, IC = Inhibition Concentration

Table 4. **Results: *Pseudokirchneriella subcapitata* growth inhibition test.**

Concentration (% v/v)	Cell Yield (x 10^4 cells/mL) (Mean ± SD)	Stimulation (%)
Laboratory Control	29.8 ± 2.4	--
1.5	31.8 ± 3.3	6.72
3.0	31.8 ± 1.3	6.72
6.0	40.2 ± 3.0*	35.29
11.9	81.8 ± 4.5*	174.8
23.8	135.3 ± 5.7*	354.6
47.6	138.0 ± 8.3*	363.9
95.2	127.0 ± 3.2*	326.9
Test Endpoint (% v/v)		
IC25	>95.2	--
IC50	>95.2	--

SD = Standard Deviation, IC = Inhibition Concentration
* = Indicates cell yield that were significantly greater than the control

4.0 QA/QC

The health history of the test organisms used in the exposure was acceptable and met the requirements of the Environment Canada protocol. The tests met all control acceptability criteria and water quality parameters remained within ranges specified in the protocol throughout the tests. There were no deviations from the test methodology. Uncertainty associated with the tests is best described by the standard deviation around the mean and/or the confidence intervals around the point estimates.

Results of the reference toxicant tests conducted during the testing program are summarized in Table 5. These tests were performed under the same conditions as the sample tested. Results for *P. subcapitata* fell within the acceptable range for organism performance of mean and two standard deviation range, based on historical results obtained by the laboratory with these tests. Thus, the sensitivity of the organisms used in this test was appropriate.

Reproduction results fell within the range of mean and two standard deviations in the reference toxicant test with *C. dubia*. However, survival results fell slightly outside of three standard deviations range. A thorough investigation was performed and the results indicated that proper procedures were followed and that no technical errors occurred during testing. Thus, this may indicate that survival in this batch of organisms used in this test may have been more sensitive compared to previous batches of *C. dubia*.

Table 5. Reference toxicant test results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
C. dubia	Survival (LC50): 1.7 g/L NaCl	2.0 (1.9 – 2.2)	5	September 25, 2017
	Reproduction (IC50): 1.4 g/L NaCl	1.5 (1.0 – 2.1)	20	
P. subcapitata	Growth (IC50): 34.9 µg/L Zn	32.8 (26.5 – 40.5)	11	September 22, 2017

SD = Standard Deviation, CV = Coefficient of Variation, LC = Lethal Concentration, IC = Inhibition Concentration

5.0 REFERENCES

Environment Canada. 2007a. Biological test method: test of reproduction and survival using the cladoceran *Ceriodaphnia dubia*. Environmental Protection Series. Report EPS 1/RM/21, Second Edition, February 2007. Environment Canada, Method Development and Application Section, Environmental Science and Technology Centre, Science and Technology Branch, Ottawa, ON. 74 pp.

Environment Canada. 2007b. Biological test method: growth inhibition test using the freshwater alga. Environmental Protection Series, Report EPS 1/RM/25. Second Edition, March 2007. Environment Canada, Method Development and Application Section, Environmental Science and Technology Centre, Science and Technology Branch, Ottawa, ON. 53 pp.

Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 Tidepool Scientific Software, McKinleyville, CA. 275 pp.

APPENDIX A – *Ceriodaphnia dubia* Toxicity Test Data

Ceriodaphnia dubia Summary Sheet

Client: Ais/Minto
Work Order No.: 170989

Start Date/Time: Sept 14/17 @ 1700h
Set up by: JS

Sample Information:

Sample ID: L1990955-1 W3
Sample Date: Sept 12/17
Date Received: Sept ~~13~~ 14/17
Sample Volume: 8 x 1L JS

Test Validity Criteria:
1) Mean survival of first generation controls is ≥80 %
2) At least 60% of controls have produced three broods within 8 days
3) An average of ≥15 live young produced per surviving female in the control solutions during the first three broods.
4) Invalid if ephippia observed in any control solution at any time.

WQ Ranges:
T (°C) = 25 ± 1; DO (mg/L) = 3.3 to 8.4 ; pH = 6.0 to 8.5

Test Organism Information:

Broodstock No.: 090617B
Age of young (Day 0): <24-h (within 12-h)
Avg No. young in first 3 broods of previous 7 d: 21
Mortality (%) in previous 7 d: 0
Individual female # used ≥8 young on test day (21-29, 31-34, ~~40~~ JS 37, 40) JS

NaCl Reference Toxicant Results:

Reference Toxicant ID: Cd ~~167~~ 165 em
Stock Solution ID: 17Na05
Date Initiated: ~~Oct 4/17~~ Sept 25/17 em
7-d LC50 (95% CL): ~~2.1 (1.5 - 3.0)~~ 1.7 (1.3 - 2.1) em g/L NaCL
7-d IC50 (95% CL): ~~1.9 (1.6 - 2.1)~~ 1.4 (0.9 - 1.8) g/L NaCL

7-d LC50 Reference Toxicant Mean and Historical Range: 2.0 (~~1.6-2.5~~ 1.9-2.2 em) g/L NaCL CV (%): ~~12~~ 5 em
7-d IC50 Reference Toxicant Mean and Historical Range: 1.5 (1.0-2.1) g/L NaCL CV (%): 20

Test Results:

	Survival	Reproduction
LC50 % (v/v) (95% CL)	>100	▨
IC25 % (v/v) (95% CL)	▨	>100
IC50 % (v/v) (95% CL)	▨	>100

Reviewed by:

Date reviewed: Oct. 27, 2017

Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: ACS/Minto
Sample ID: ~~05 W3~~ L1990955-1 W3
Work Order #: 170989

Start Date & Time: Sept 14/17 @ 1700h
Stop Date & Time: Sept 21/17 @ 830h
CER #: 4
Test Species: *Ceriodaphnia dubia*

Concentration control	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	25.0	25.0	25.0	25.0	24.0	25.0	24.0	250	240	25.0	24.0	25.0	24.0	250
DO (mg/L)	8.0	7.6	8.0	7.6	8.1	7.5	8.2	7.2	8.2	7.2	8.2	7.4	8.1	7.6
pH	8.0	7.7	8.1	7.7	8.0	7.7	8.1	7.7	8.2	7.8	8.2	7.9	8.0	7.4
Cond. (µS/cm)	205	204		210		207		207		197		209		200
Initials	JS	JS		A		A		EMM		JS		EMM		EMM

(v/v) Concentration 1.56%	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	25.0	24.0	25.0	24.0	250	240	25.0	24.0	25.0	24.0	250
DO (mg/L)	8.2	7.5	8.0	7.5	7.8	7.6	8.1	7.2	8.2	7.1	8.2	7.2	8.2	7.6
pH	8.0	7.8	8.0	7.9	8.1	7.9	8.1	7.7	8.2	7.8	8.2	7.9	8.0	7.9
Cond. (µS/cm)	217	214		212		221		220		214		~~207~~ 203		
Initials	JS	JS		A		A		EMM		JS		EMM		EMM

(v/v) Concentration 12.5%	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	25.0	24.0	25.0	24.0	250	24.0	25.0	24.0	25.0	24.0	250
DO (mg/L)	8.2	7.5	8.1	7.5	7.8	7.6	8.1	7.2	8.2	7.6	8.2	7.2	8.2	7.5
pH	8.0	7.9	8.0	8.0	8.0	8.0	8.1	7.8	8.2	7.9	8.2	8.0	8.0	7.3
Cond. (µS/cm)	248	258		259		261		258		254		250		251
Initials	JS	JS		A		A		EMM		JS		EMM		EMM

(v/v) Concentration 100%	Days													
	0	1		2		3		4		5		6		7
	init.	old	new	old	new	old	new	old	new	old	new	old	new	final
Temperature (°C)	24.0	25.0	24.0	25.0	24.0	25.0	24.0	250	24.0	25.0	24.0	25.0	24.0	250
DO (mg/L)	8.2	7.6	8.1	7.5	7.8	7.6	8.1	7.1	8.2	7.0	8.2	7.2	8.1	7.5
pH	7.8	8.2	7.9	8.3	8.0	8.4	8.0	8.1	7.9	8.1	7.9	8.3	7.9	6.9
Cond. (µS/cm)	556	555		551		547		550		555		551		558
Initials	JS	JS		A		A		EMM		JS		EMM		EMM

Thermometer: 4 DO meter/probe: 1 / 2 pH meter/probe: 1 / 2 Conductivity meter/probe: 1 / 2

	Control	100% (v/v)		
Hardness*	100	92		
Alkalinity*	96	100		

* mg/L as CaCO3

Analysts: EMM, JS, AWB

Reviewed by:

Date reviewed: Oct. 26, 2017

Sample Description: light yellow, clear, odourless, no particulates

Comments: Broodboard Used: 090617B (21-29, 31-34, 37, 40)

Chronic Freshwater Toxicity Test
C. dubia Reproduction Data

Client: ACS/Minto
Sample ID: JS ~~W3~~ L1990955-1 W3
Work Order: 170989

Start Date & Time: Sept 14/17 @ 1700h
Stop Date & Time: Sept 21/17 @ 830h
Set up by: JS

% (v/v)

Concentration: control

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
4	3	✓	3	✓	✓	✓	✓	3	3	4	tmm
5	9	✓	8	4	✓	5	4	9	9	✓	tmm
6	15	✓	✓	5	~~15~~	15	5	12	15	10	JS
7	✓	✓	10	8	✓	11	✓	✓	✓	13	tmm
8											
Total	27	0	21	17	0	31	9	24	27	27	JS

Concentration: 1.56

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
4	3	3	3	3	3	4	4	✓	3	✓	tmm
5	8	9	10	8	✓	✓	✓	4	✓	✓	tmm
6	✓	✓	✓	✓	8	5	5	6	8	✓	JS
7	10	9	12	10	10	13	9	✓	11	✓	tmm
8											
Total	21	21	25	21	21	22	18	10	22	0	JS

Concentration: 3.12

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
4	2	3	3	3	4	3	3	2	3	4	tmm
5	✓	✓	✓	9	✓	✓	9	6	7	8	tmm
6	8	13	13	14	10	8	6	12	✓	✓	JS
7	11	14	13	✓	12	9	✓	✓	13	9	tmm
8											
Total	21	30	29	26	26	20	18	20	23	21	JS

Concentration: 6.25

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
4	3	✓	✓	4	3	✓	✓	4	3	3	tmm
5	6	5	4	✓	✓	✓	5	✓	8	6	tmm
6	✓	13	10	6	7	✓	10	8	13	✓	JS
7	11	14	12	9	10	✓	12	9	✓	12	tmm
8											
Total	20	32	26	19	20	0	27	21	24	21	JS

Concentration: 12.5

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓		A
4	✓	✓	✓	3	4	✓	✓	4	✓		tmm
5	4	6	7	6	6	6	3	✓	5		tmm
6	7	8	8	14	15	10	✓	9	9		JS
7	12	13	10	✓	✓	12	11	14	12		tmm
8											
Total	23	27	25	23	25	28	14	27	26	0 X	JS

Concentration: 25

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
4	4	✓	✓	3	✓	✓	✓	✓	4	✓	tmm
5	✓	✓	5	✓	5	✓	4	4	✓	3	tmm
6	9	✓	11	14	14	✓	10	12	12	15	JS
7	12	✓	14	16	10	✓	12	✓	13	14	tmm
8					29 JS						
Total	25	0	30	33	39	0	26	16	29	32	JS

Concentration: 50

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓		✓	✓	✓	✓	✓	✓	A
4	✓	✓	3		4	4	✓	X	✓	✓	tmm
5	2	4	9		✓	✓	✓		✓	✓	tmm
6	4	13	✓		15	12	✓		✓	✓	JS
7	9	12	12		13	16	✓		✓	✓	tmm
8											
Total	15	29	24	0X	32	32	0	0X	0	0	JS

Concentration: 100

Days	A	B	C	D	E	F	G	H	I	J	Init
1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	JW
2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	A
4	✓	✓	3	3	✓	✓	✓	4	✓	✓	tmm
5	5	✓	✓	✓	5	✓	4	✓	5	4	tmm
6	13	✓	11	13	10	✓	13	12	12	11	JS
7	14	✓	12	14	✓	✓	✓	16	✓	✓	tmm
8											
Total	32	0	26	30	15	0	17	32	17	15	JS

Concentration:

Days	A	B	C	D	E	F	G	H	I	J	Init
1											
2											
3											
4											
5											
6											
7											
8											
Total											

Notes: X = mortality.

Sample Description: See water quality page.

Comments: Total # Young only based on the first 3 Broods. Fourth and subsequent broods not included in total count.

Reviewed by:

Date reviewed: Oct. 26, 2017

Version 2.1 Issued July 29, 2009

Nautilus Environmental

CETIS Analytical Report

Report Date: 12 Oct-17 18:48 (p 1 of 2)
Test Code: 170989 | 09-6785-8480

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	20-7747-5959	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	12 Oct-17 18:46	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes
Batch ID:	03-0188-1705	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Jill Sones
Start Date:	14 Sep-17 17:00	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	20% Perrier Water
Ending Date:	21 Sep-17 08:30	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 15h	**Source:**	In-House Culture	**Age:**	<24h
Sample ID:	13-9188-2167	**Code:**	52F66FB7	**Client:**	ALS
Sample Date:	12 Sep-17 08:40	**Material:**	Water Sample	**Project:**	
Receive Date:	14 Sep-17 15:55	**Source:**	ALS		
Sample Age:	56h (9.5 °C)	**Station:**	L1990955-1 W3		

Linear Regression Options

Model Function	Threshold Option	Threshold	Optimized	Pooled	Het Corr	Weighted
Log-Angle [Asin(P^0.5)=A+B*log(X)]	Control Threshold	0.0000001	No	Yes	No	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Adj R2	F Stat	Critical	P-Value	Decision(α:5%)
20	-11.4	29.2	26.95	0.02053		0.4048				Lack of Fit Not Tested

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	22.5	N/A	N/A	4.444	NA	NA
EC10	83.29	N/A	N/A	1.201	NA	NA
EC15	233.9	N/A	N/A	0.4275	NA	NA
EC20	573.5	N/A	N/A	0.1744	NA	NA
EC25	1296	N/A	N/A	0.07717	NA	NA
EC40	11590	N/A	N/A	0.008629	NA	NA
EC50	45560	N/A	N/A	0.002195	NA	NA

>100%(v/v)
em

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
Slope	0.1693	0.09922	-0.02514	0.3638	1.707	0.1388	Non-Significant Parameter
Intercept	-0.003477	0.1241	-0.2468	0.2399	-0.028	0.9786	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	5.258572	5.258572	1	5.76	0.0533	Non-Significant
Residual	5.477359	0.9128931	6			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Goodness-of-Fit	Pearson Chi-Sq GOF	5.477	12.59	0.4842	Non-Significant Heterogenity
	Likelihood Ratio GOF	6.285	12.59	0.3920	Non-Significant Heterogenity
Distribution	Shapiro-Wilk W Normality	0.9044	0.6805	0.3166	Normal Distribution
	Anderson-Darling A2 Normality	0.4539	2.492	0.2745	Normal Distribution

7d Survival Rate Summary

			Calculated Variate(A/B)								
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Negative Control	10	1	1	1	0	0	0.0%	0.0%	10	10
1.56		10	1	1	1	0	0	0.0%	0.0%	10	10
3.12		10	1	1	1	0	0	0.0%	0.0%	10	10
6.25		10	1	1	1	0	0	0.0%	0.0%	10	10
12.5		10	0.9	0	1	0.1	0.3162	35.14%	10.0%	9	10
25		10	1	1	1	0	0	0.0%	0.0%	10	10
50		10	0.8	0	1	0.1333	0.4216	52.7%	20.0%	8	10
100		10	1	1	1	0	0	0.0%	0.0%	10	10

Analyst: JS QA: Oct. 26/17

CETIS Analytical Report

Report Date: 12 Oct-17 18:48 (p 2 of 2)
Test Code: 170989 | 09-6785-8480

Ceriodaphnia 7-d Survival and Reproduction Test **Nautilus Environmental**

Analysis ID:	20-7747-5959	**Endpoint:**	7d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	12 Oct-17 18:46	**Analysis:**	Linear Regression (MLE)	**Official Results:**	Yes

7d Survival Rate Detail

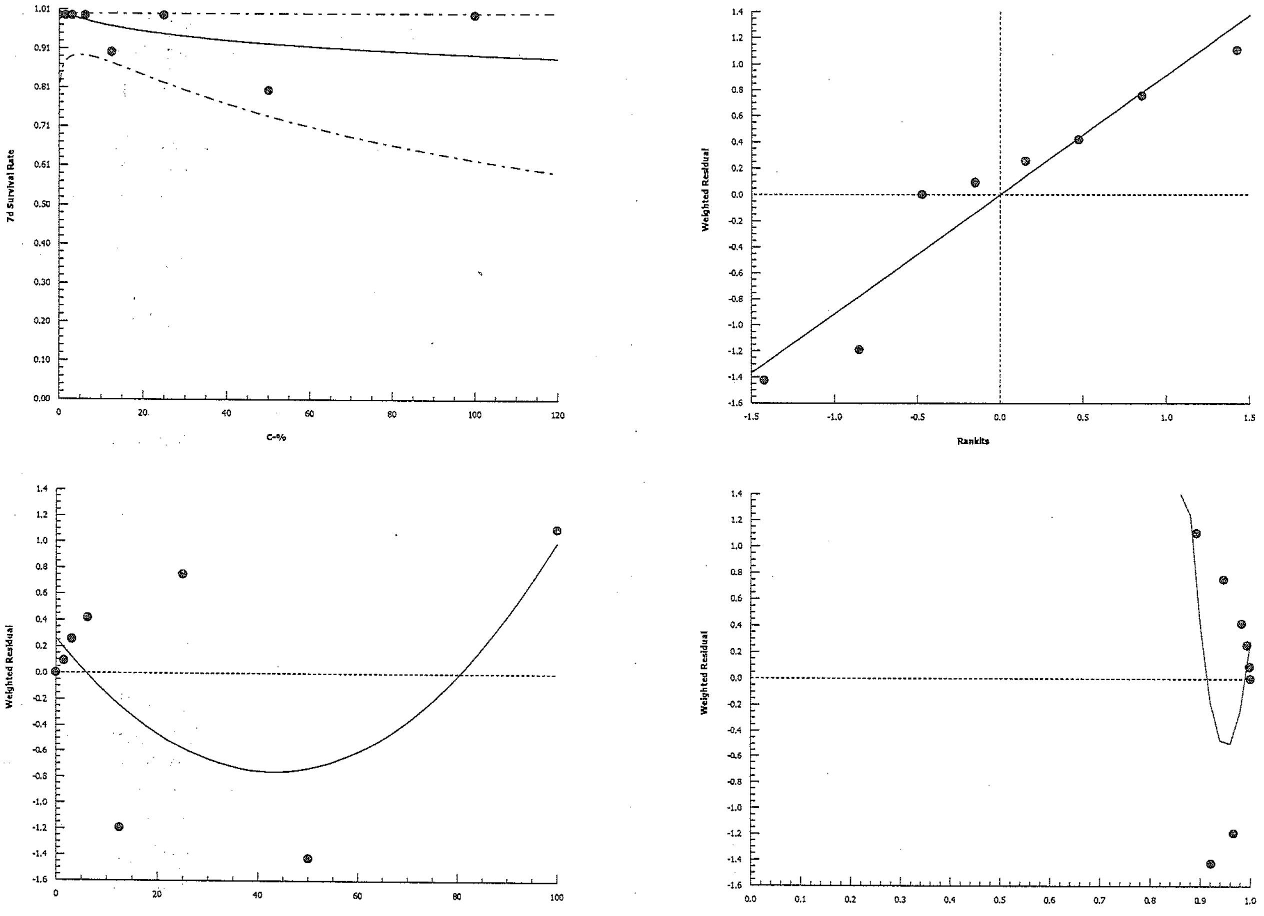
C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1	1	1	1	1	1	1	1	1	1
1.56		1	1	1	1	1	1	1	1	1	1
3.12		1	1	1	1	1	1	1	1	1	1
6.25		1	1	1	1	1	1	1	1	1	1
12.5		1	1	1	1	1	1	1	1	1	0
25		1	1	1	1	1	1	1	1	1	1
50		1	1	1	0	1	1	1	0	1	1
100		1	1	1	1	1	1	1	1	1	1

7d Survival Rate Binomials

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
1.56		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
3.12		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
6.25		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
12.5		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1
25		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
50		1/1	1/1	1/1	0/1	1/1	1/1	1/1	0/1	1/1	1/1
100		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

Graphics

Log-Angle [Asin(P^0.5)=A+B*log(X)]



Oct-26/17

Analyst: JS QA:

CETIS Analytical Report

Report Date: 12 Oct-17 18:48 (p 1 of 2)
Test Code: 170989 | 09-6785-8480

Ceriodaphnia 7-d Survival and Reproduction Test **Nautilus Environmental**

Analysis ID:	00-2122-7028	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	12 Oct-17 18:47	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	03-0188-1705	**Test Type:**	Reproduction-Survival (7d)	**Analyst:**	Jill Sones
Start Date:	14 Sep-17 17:00	**Protocol:**	EC/EPS 1/RM/21	**Diluent:**	20% Perrier Water
Ending Date:	21 Sep-17 08:30	**Species:**	Ceriodaphnia dubia	**Brine:**	
Duration:	6d 15h	**Source:**	In-House Culture	**Age:**	<24h

Sample ID:	13-9188-2167	**Code:**	52F66FB7	**Client:**	ALS
Sample Date:	12 Sep-17 08:40	**Material:**	Water Sample	**Project:**	
Receive Date:	14 Sep-17 15:55	**Source:**	ALS		
Sample Age:	56h (9.5 °C)	**Station:**	L1990955-1 W3		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	526497	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	28.93	0.4314	70.14	3.456	1.426	231.8
IC10	33.46	1.049	N/A	2.989	NA	95.32
IC15	38.67	13.38	N/A	2.586	NA	7.476
IC20	44.67	17.22	N/A	2.239	NA	5.806
IC25	>100	N/A	N/A	<1	NA	NA
IC40	>100	N/A	N/A	<1	NA	NA
IC50	>100	N/A	N/A	<1	NA	NA

Reproduction Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	10	18.3	0	31	3.63	11.48	62.73%	0.0%
1.56		10	18.1	0	25	2.369	7.49	41.38%	1.09%
3.12		10	23.4	18	30	1.301	4.115	17.59%	-27.87%
6.25		10	21	0	32	2.662	8.42	40.09%	-14.75%
12.5		10	21.8	0	28	2.728	8.626	39.57%	-19.13%
25		10	22	0	33	3.961	12.53	56.93%	-20.22%
50		10	13.2	0	32	4.652	14.71	111.4%	27.87%
100		10	18.4	0	32	3.751	11.86	64.47%	-0.55%

Reproduction Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	Negative Control	27	0	21	17	0	31	9	24	27	27
1.56		21	21	25	21	21	22	18	10	22	0
3.12		21	30	29	26	26	20	18	20	23	21
6.25		20	32	26	19	20	0	27	21	24	21
12.5		23	27	25	23	25	28	14	27	26	0
25		25	0	30	33	29	0	26	16	29	32
50		15	29	24	0	32	32	0	0	0	0
100		32	0	26	30	15	0	17	32	17	15

Analyst: JS QA: Oct-26/17

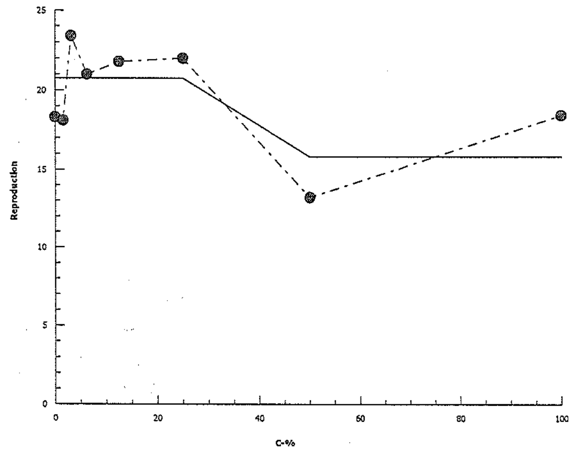
CETIS Analytical Report

Report Date: 12 Oct-17 18:48 (p 2 of 2)
Test Code: 170989 | 09-6785-8480

Ceriodaphnia 7-d Survival and Reproduction Test — **Nautilus Environmental**

Analysis ID:	00-2122-7028	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.8.7
Analyzed:	12 Oct-17 18:47	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Oct-26/17

Analyst: JS QA:

Client: ALS/minto

W.O.#: 170989

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Sample ID	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
20% pemer	sept15/17	sept15/17	5.0	4.9	5.0	96	50	5.0	100	FMM
W3	sept15/17	sept15/17	50	5.1	5.2	100	50	4.6	92	↓

Notes:

Reviewed by:

Date Reviewed: Oct. 26, 2017

APPENDIX B – *Pseudokirchneriella subcapitata* Toxicity Test Data

Pseudokirchneriella subcapitata Summary Sheet

Client: ALS/minto

Work Order No.: 170990

Start Date: Sept 15/17

Set up by: MLI

Sample Information:

Sample ID: L1990955-1 W3

Sample Date: Sept 12/~~15~~ MQ 17

Date Received: Sept 14/17

Sample Volume: 8x1L

Test Organism Information:

Culture Date: Sept 8/17

Age of culture (Day 0): 7d

Zinc Reference Toxicant Results:

Reference Toxicant ID: SC161

Stock Solution ID: 17Zn03

Date Initiated: Sept 22/17

72-h IC50 (95% CL): 34.9 (32.9-37.0) µg/L Zn

72-h IC50 Reference Toxicant Mean and Range: 32.8 (26.5-40.5) µg/L Zn CV (%): 11

Test Results:

	Algal Growth
IC25 %(v/v) (95% CL)	>95.2
IC50 %(v/v) (95% CL)	>95.2

Reviewed by:

Date reviewed: Oct. 5, 2017

72-h Algal Growth Inhibition Toxicity Test
Water Quality Measurements

Client : ALS/Minto
Setup by: MLJ
Sample ID: L1990955-1 W3
Test Date/Time: Sept 15/17 @ 0805h.
Work Order No.: 170990.
CER #: 4.
Test Species: *Pseudokirchneriella subcapitata*
Culture Date: Sept 8/17
Age of Culture: 7d
Culture Health: Good
Culture Count: 1 460 2 445
Average: 452.5
Culture Cell Density (c1): 452.5 x10⁴ cells/mL

v1 = 220,000 cells/ml x 100 ml / (c1) 452.5 x10⁴ cells/ml = 4.86mL.

Time Zero Counts: 1 22 2 23
Average: 22.5 *MLJ
No. of Cells/mL: 22.5x10⁴
Initial Density: # cells/mL ÷ 220 µL x 10 µL = 10227 cells/mL.

Concentration %(v/v)	Water Quality pH	Water Quality Temp (°C)	Incubator Temperature (°C)				Microplates rotated 2X per day?			
	0 h	0 h	0 h	24 h	48 h	72 h	0 h	24 h	48 h	72 h
Control	7.0	23.0	24.5	24.6	24.5	24.0	✓	✓	✓	✓
1.5	7.0	23.0	↓	↓	↓	↓	✓	✓	✓	✓
3.0	7.2	23.0	↓	↓	↓	↓	✓	✓	✓	✓
6.0	7.4	23.0	↓	↓	↓	↓	✓	✓	✓	✓
11.9	7.6	23.0	↓	↓	↓	↓	✓	✓	✓	✓
23.8	7.9	23.0	↓	↓	↓	↓	✓	✓	✓	✓
47.6	8.1	23.0	↓	↓	↓	↓	✓	✓	✓	✓
95.2	8.2	23.0	↓	↓	↓	↓	✓	✓	✓	✓
Initials	MLJ	MLJ	MLJ	[illegible]	[illegible]	MLJ	MLJ	[illegible]	[illegible]	MLJ

Initial control pH: Well 1: 7.0 Well 2: 7.0
Final control pH: Well 1: 6.9 Well 2: 6.9
Light intensity (lux): 3820.
Date measured: Sept 15/17.
Thermometer: 4 **Light meter:** 1 **pH meter/probe:** 1 / 1
Sample Description: light yellow, clear, odourless, no particulates
Comments:
Reviewed:
Date reviewed: Oct 5, 2017

Version 1.3; Issued July 19, 2017

Nautilus Environmental Company Inc.

Pseudokirchneriella subcapitata Algal Counts

Client: ALS/Minto
WO#: 170990
Sample ID: L1990955-1 W3

Start Date/Time: 15-Sep-17 @ 0805h
Termination Date/Time 18-Sep-17 @ 0805h

Initial Cell Density: 10227 cell/mL

225000
0.22
0.01
10227.27

Concentration %(v/v)	Rep	Count 1 (x 10^4)	Count 2 (x 10^4)	Count 3 (x 10^4)	Count 4 (x 10^4)	Mean (x 10^4)	Cell Yield (x 10^4) cell/mL		
Control	A	28				28	27.0	mean	29.7
	B	30				30	29.0	SD	2.37547
	C	31				31	30.0	CV	7.990877
	D	28				28	27.0		
	E	33				33	32.0		
	F	34				34	33.0		
	G	29				29	28.0		
	H	33				33	32.0		
1.5	A	36				36	35.0		
	B	29				29	28.0		
	C	31				31	30.0		
	D	35				35	34.0		
3	A	33				33	32.0		
	B	31				31	30.0		
	C	34				34	33.0		
	D	33				33	32.0		
6	A	42				42	41.0		
	B	40				40	39.0		
	C	38				38	37.0		
	D	45				45	44.0		
11.9	A	83				83	82.0		
	B	79				79	78.0		
	C	80				80	79.0		
	D	89				89	88.0		
23.8	A	140				140	139.0		
	B	142				142	141.0		
	C	133				133	132.0		
	D	130				130	129.0		
47.6	A	133				133	132.0		
	B	131				131	130.0		
	C	148				148	147.0		
	D	144				144	143.0		
95.2	A	131				131	130.0		
	B	130				130	129.0		
	C	127				127	126.0		
	D	124				124	123.0		

Reviewed by: ______________________

Date reviewed: Oct. 5, 2017

Pseudokirchneriella subcapitata Toxicity Test Data Sheet
72-h Algal Cell Counts

Client: ALS/Minto
Work Order #: 170990.
Sample ID: L1990955-1 W3
Start Date/Time: Sept 15/17@0805h
Termination Date: Sept 18/17@0805h.
Test set up by: MLT

Concentration %(v/v)	Rep	Count 1	Count 2	Count 3	Count 4	Comments	Initials
Control	A	28					MLT
	B	30					
	C	31					
	D	28					
	E	33					
	F	34					
	G	29					
	H	33					
1.5	A	36					
	B	29					
	C	31					
	D	35					
3.0	A	33					
	B	31					
	C	34					
	D	33					
6.0	A	42					
	B	40					
	C	38					
	D	45					
11.9	A	83					
	B	79					
	C	80					
	D	89					
23.8	A	140					
	B	142					
	C	133					
	D	130					
47.6	A	133					
	B	131					
	C	148					
	D	144					
95.0	A	131					
	B	130					
	C	127					
	D	124					↓

Comments:

Reviewed by:

Date Reviewed: Oct. 5, 2017

CETIS Analytical Report

Report Date: 27 Sep-17 18:27 (p 1 of 2)
Test Code: 170990 | 10-6566-6095

EC Alga Growth Inhibition Test

Nautilus Environmental

Analysis ID:	08-5835-5179	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 18:27	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	14-9564-1824	**Test Type:**	Cell Growth	**Analyst:**	Mimi Tran
Start Date:	15 Sep-17 08:05	**Protocol:**	EC/EPS 1/RM/25	**Diluent:**	Deionized Water + nutrients
Ending Date:	18 Sep-17 08:05	**Species:**	Pseudokirchneriella subcapitata	**Brine:**	
Duration:	72h	**Source:**	In-House Culture	**Age:**	7d

Sample ID:	13-9188-2167	**Code:**	52F66FB7	**Client:**	ALS
Sample Date:	12 Sep-17 08:40	**Material:**	Water Sample	**Project:**	
Receive Date:	14 Sep-17 15:55	**Source:**	ALS		
Sample Age:	71h (9.5 °C)	**Station:**	L1990955-1 W3		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1155823	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Control Trend	Mann-Kendall Trend			0.2821	Non-significant Trend in Controls

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	>95.2	N/A	N/A	<1.05	NA	NA
IC10	>95.2	N/A	N/A	<1.05	NA	NA
IC15	>95.2	N/A	N/A	<1.05	NA	NA
IC20	>95.2	N/A	N/A	<1.05	NA	NA
IC25	>95.2	N/A	N/A	<1.05	NA	NA
IC40	>95.2	N/A	N/A	<1.05	NA	NA
IC50	>95.2	N/A	N/A	<1.05	NA	NA

Cell Yield Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	8	29.75	27	33	0.8399	2.375	7.99%	0.0%
1.5		4	31.75	28	35	1.652	3.304	10.41%	-6.72%
3		4	31.75	30	33	0.6292	1.258	3.96%	-6.72%
6		4	40.25	37	44	1.493	2.986	7.42%	-35.29%
11.9		4	81.75	78	88	2.25	4.5	5.51%	-174.8%
23.8		4	135.3	129	141	2.839	5.679	4.2%	-354.6%
47.6		4	138	130	147	4.143	8.287	6.01%	-363.9%
95.2		4	127	123	130	1.581	3.162	2.49%	-326.9%

Cell Yield Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	Negative Control	27	29	30	27	32	33	28	32
1.5		35	28	30	34				
3		32	30	33	32				
6		41	39	37	44				
11.9		82	78	79	88				
23.8		139	141	132	129				
47.6		132	130	147	143				
95.2		130	129	126	123				

Oct. 5/17

Analyst: MT QA:

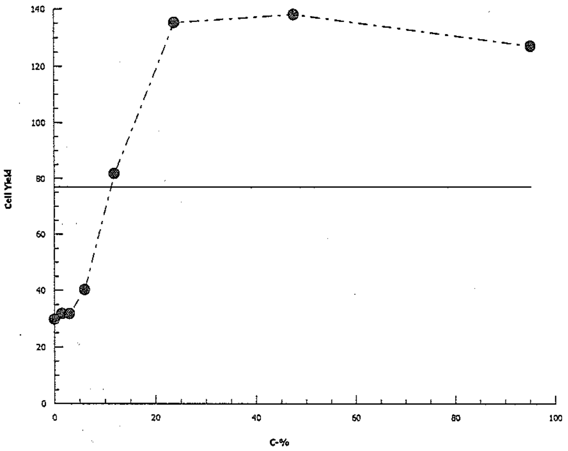
CETIS Analytical Report

Report Date:	27 Sep-17 18:27 (p 2 of 2)
Test Code:	170990 | 10-6566-6095

EC Alga Growth Inhibition Test **Nautilus Environmental**

Analysis ID:	08-5835-5179	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 18:27	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Oct-5/17

Analyst: MLT QA:

CETIS Analytical Report

Report Date: 06 Oct-17 11:44 (p 1 of 2)
Test Code: 170990 | 10-6566-6095

EC Alga Growth Inhibition Test

Nautilus Environmental

Analysis ID:	08-8844-2486	**Endpoint:**	Cell Yield	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 18:26	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	14-9564-1824	**Test Type:**	Cell Growth	**Analyst:**	Mimi Tran
Start Date:	15 Sep-17 08:05	**Protocol:**	EC/EPS 1/RM/25	**Diluent:**	Deionized Water + nutrients
Ending Date:	18 Sep-17 08:05	**Species:**	Pseudokirchneriella subcapitata	**Brine:**	
Duration:	72h	**Source:**	In-House Culture	**Age:**	7d

Sample ID:	13-9188-2167	**Code:**	52F66FB7	**Client:**	ALS
Sample Date:	12 Sep-17 08:40	**Material:**	Water Sample	**Project:**	
Receive Date:	14 Sep-17 15:55	**Source:**	ALS		
Sample Age:	71h (9.5 °C)	**Station:**	L1990955-1 W3		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Untransformed	NA	C < T	NA	NA	21.9%	3	6	4.243	33.33

Dunnett Multiple Comparison Test

Control	vs	C-%	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Negative Control		1.5	0.775	2.526	6.519	10	0.6628	CDF	Non-Significant Effect
		3	0.775	2.526	6.519	10	0.6628	CDF	Non-Significant Effect
		6*	4.069	2.526	6.519	10	0.0012	CDF	Significant Effect
		11.9*	20.15	2.526	6.519	10	<0.0001	CDF	Significant Effect
		23.8*	40.88	2.526	6.519	10	<0.0001	CDF	Significant Effect
		47.6*	41.95	2.526	6.519	10	<0.0001	CDF	Significant Effect
		95.2*	37.68	2.526	6.519	10	<0.0001	CDF	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Control Trend	Mann-Kendall Trend			0.2821	Non-significant Trend in Controls

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	77176.39	11025.2	7	620.8	<0.0001	Significant Effect
Error	497.25	17.75893	28			
Total	77673.64		35			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	12.8	18.48	0.0772	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9901	0.9166	0.9831	Normal Distribution

Cell Yield Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Negative Control	8	29.75	27.76	31.74	29.5	27	33	0.8399	7.99%	0.0%
1.5		4	31.75	26.49	37.01	32	28	35	1.652	10.41%	-6.72%
3		4	31.75	29.75	33.75	32	30	33	0.6292	3.96%	-6.72%
6		4	40.25	35.5	45	40	37	44	1.493	7.42%	-35.29%
11.9		4	81.75	74.59	88.91	80.5	78	88	2.25	5.51%	-174.8%
23.8		4	135.3	126.2	144.3	135.5	129	141	2.839	4.2%	-354.6%
47.6		4	138	124.8	151.2	137.5	130	147	4.143	6.01%	-363.9%
95.2		4	127	122	132	127.5	123	130	1.581	2.49%	-326.9%

Analyst: MT QA: Oct 6/17

CETIS Analytical Report

Report Date: 06 Oct-17 11:44 (p 2 of 2)
Test Code: 170990 | 10-6566-6095

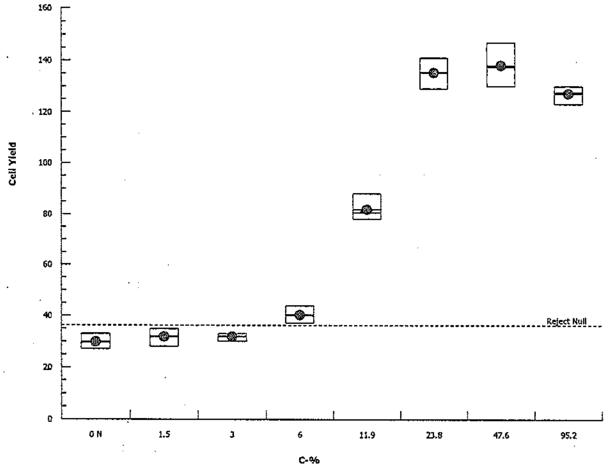
EC Alga Growth Inhibition Test — **Nautilus Environmental**

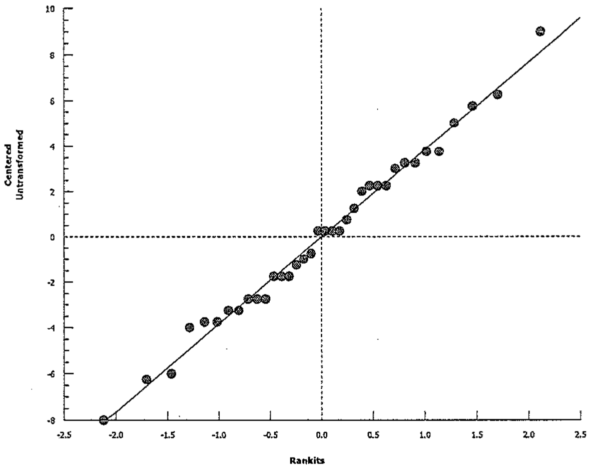
Analysis ID: 08-8844-2486 **Endpoint:** Cell Yield **CETIS Version:** CETISv1.8.7
Analyzed: 27 Sep-17 18:26 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Cell Yield Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	Negative Control	27	29	30	27	32	33	28	32
1.5		35	28	30	34				
3		32	30	33	32				
6		41	39	37	44				
11.9		82	78	79	88				
23.8		139	141	132	129				
47.6		132	130	147	143				
95.2		130	129	126	123				

Graphics





Analyst: MG QA: Oct-6/17

APPENDIX C – Chain-of-Custody Forms

ALS Environmental

L1990955

VANCOUVER

Subcontract Request Form

Subcontract To: Wo#: 170989 Sub lethal 7-day Daphnia
170990 Sub lethal 72hr Algae

NAUTILUS ENVIRONMENTAL
8664 COMMERCE COURT
BURNABY,BC V5A 4N7

NOTES: Please reference on final report and invoice: PO# L1990955
ALS requires QC data to be provided with your final results.

Please see enclosed 1 **sample(s) in** ~~9~~ 8 **Container(s)**

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED DUE DATE	Priority Flag
L1990955-1 W3	Special Request- Nautilus Environmental (SPECIAL REQUEST-NL 14)	9/ 12/ 2017 9/22/2017	

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact: Shane Stack
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9
Phone: (604) 253-4188 Email: Shane.Stack@alsglobal.com

Please email confirmation of receipt to: **Shane.Stack@alsglobal.com**

Shipped By: ______ Date Shipped: ______

Received By: ______ Date Received: Sept 14/17 @ 1555

Verified By: ______ Date Verified: ______

Temperature: 9.5

Sample Integrity Issues: ______

8x1 L (bottle)

sample description: light yellow, clear, odourless, no particulates.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1990955-COFC

COC Number: 2017-09-13 B

Page 1 of 1

Report To	Contact and companyname below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224159 (MMER)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack
Sampler: CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	96hr LC50 RainbowTrout	48hr - LC50 Daphnia	7day - RainbowTroutEmbryoToxicity	7day - Ceriodaphnia	7day - Lemma minor	Alga 72-h Growth Inhibition	7day - Flathead Minnow	Number of Containers
	W3	12-Sep-17	8:40	Water				R		R		8
								WO# 170989		WO# 170910		

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☐ Ice Cubes ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5°C.			9.5		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Colin Prentice	Date: 2017-09-13	Time:	Received by:	Date: Sept 13/17.	Time: 15:01	Received by: Andy Ip	Date: Sept 14/17	Time: 1555h

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

OCTOBER 2015 FRONT

END OF REPORT

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1990955-COFC

COC Number: 2017-09-13 B

Page 1 of 1

Report To	Contact and companyname below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4] ☐		**1 Business day [E1]** ☐	
3 day [P3] ☐		**Same Day, Weekend or Statutory holiday [E0]** ☐	
2 day [P2] ☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224159 (MMER)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	96hr LC50 RainbowTrout	48hr - LC50 Daphnia	7day - RainbowTroutEmbryoToxicity	7day - Ceriodaphnia	7day - Lemma minor	Alga 72-h Growth Inhibition	7day - Flathead Minnow							Number of Containers
	W3	12-Sep-17	8:40	Water				R		R								8

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐

Ice Packs ☐ Ice Cubes ☐

Cooling Initiated ☐

SIF Observations Yes ☐ No ☐

Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5°C.					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Colin Prentice	Date: 2017-09-13	Time:	Received by:	Date: Sept 13/17.	Time: 15:01	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 13-SEP-17
Report Date: 25-SEP-17 14:01 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1990965

Project P.O. #: 226973 (WUL)
Job Reference:
C of C Numbers: 2017-09-13 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1990965-1	L1990965-2	L1990965-3	L1990965-4	L1990965-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-SEP-17	11-SEP-17	11-SEP-17	12-SEP-17	12-SEP-17
	Sampled Time	08:05	08:40	10:15	08:40	14:44
	Client ID	W16	W17	W8A	W3	MC1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	446	470	1050	518	330
	Hardness (as CaCO3) (mg/L)	215	226	529	255	161
	pH (pH)	8.41	8.44	8.36	8.50	8.42
	Total Suspended Solids (mg/L)	<3.0	<3.0	20.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	272	278	727	307	187
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	171	198	324	236	170
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	171	198	324	236	170
	Ammonia, Total (as N) (mg/L)	0.0429	<0.0050	0.0362	0.0051	<0.0050
	Chloride (Cl) (mg/L)	6.69	6.17	7.8	4.43	1.38
	Nitrate and Nitrite (as N) (mg/L)	1.86	0.172	6.20	0.167	0.0327
	Nitrate (as N) (mg/L)	1.85	0.172	6.17	0.167	0.0327
	Nitrite (as N) (mg/L)	0.0141	<0.0010	0.0289	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	62.5	54.6	266	54.9	17.8
	Anion Sum (meq/L)	5.03	5.28	12.7	5.99	3.80
	Cation Sum (meq/L)	4.99	5.27	12.4	5.98	3.67
	Cation - Anion Balance (%)	-0.5	-0.2	-1.1	-0.1	-1.7
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	13.5	8.78	17.0	5.76	9.45
Total Metals	Aluminum (Al)-Total (mg/L)	0.0282	0.0030	0.335	0.0071	0.0588
	Antimony (Sb)-Total (mg/L)	0.00011	0.00013	0.00040	<0.00010	0.00011
	Arsenic (As)-Total (mg/L)	0.00042	0.00037	0.00077	0.00025	0.00058
	Barium (Ba)-Total (mg/L)	0.0752	0.0717	0.118	0.0691	0.0614
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000021	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.028	0.032	0.026	0.026	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000070	<0.0000050	0.000135	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	55.5	58.9	144	53.1	39.4
	Chromium (Cr)-Total (mg/L)	0.00017	0.00011	0.00164	0.00015	0.00036
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	0.00059	<0.00010	0.00010
	Copper (Cu)-Total (mg/L)	0.0268	0.00698	0.150	0.00316	0.00183
	Iron (Fe)-Total (mg/L)	0.087	<0.010	1.04	0.028	0.199
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000265	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0013	0.0013	0.0032	0.0029	0.0014
	Magnesium (Mg)-Total (mg/L)	17.9	18.9	40.0	30.2	16.0
	Manganese (Mn)-Total (mg/L)	0.0420	0.00223	0.802	0.0497	0.0220

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1990965-6	L1990965-7			
	Description	Water	Water			
	Sampled Date	12-SEP-17	12-SEP-17			
	Sampled Time	15:23				
	Client ID	W2	DUP			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	336	330			
	Hardness (as CaCO3) (mg/L)	167	163			
	pH (pH)	8.42	8.43			
	Total Suspended Solids (mg/L)	<3.0	5.3			
	TDS (Calculated) (mg/L)	191	188			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	167	169			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	167	169			
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050			
	Chloride (Cl) (mg/L)	1.63	1.38			
	Nitrate and Nitrite (as N) (mg/L)	0.0249	0.0291			
	Nitrate (as N) (mg/L)	0.0249	0.0291			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Sulfate (SO4) (mg/L)	19.7	17.9			
	Anion Sum (meq/L)	3.80	3.79			
	Cation Sum (meq/L)	3.81	3.73			
	Cation - Anion Balance (%)	0.1	-0.9			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	8.76	9.26			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0187	0.0501			
	Antimony (Sb)-Total (mg/L)	0.00011	0.00013			
	Arsenic (As)-Total (mg/L)	0.00048	0.00057			
	Barium (Ba)-Total (mg/L)	0.0602	0.0624			
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Total (mg/L)	40.2	39.4			
	Chromium (Cr)-Total (mg/L)	0.00023	0.00033			
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00010			
	Copper (Cu)-Total (mg/L)	0.00179	0.00183			
	Iron (Fe)-Total (mg/L)	0.083	0.186			
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Total (mg/L)	0.0015	0.0014			
	Magnesium (Mg)-Total (mg/L)	15.9	16.1			
	Manganese (Mn)-Total (mg/L)	0.00957	0.0217			

	Sample ID	L1990965-1	L1990965-2	L1990965-3	L1990965-4	L1990965-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-SEP-17	11-SEP-17	11-SEP-17	12-SEP-17	12-SEP-17
	Sampled Time	08:05	08:40	10:15	08:40	14:44
	Client ID	W16	W17	W8A	W3	MC1
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000057	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00290	0.00533	0.0137	0.00449	0.00153
	Nickel (Ni)-Total (mg/L)	0.00081	0.00065	0.00129	0.00102	0.00130
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.069	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.83	3.63	6.07	2.39	1.32
	Selenium (Se)-Total (mg/L)	0.000754	0.000384	0.00972	0.000317	0.000118
	Silicon (Si)-Total (mg/L)	3.39	5.18	8.21	6.33	6.39
	Silver (Ag)-Total (mg/L)	0.000092	<0.000010	0.000044	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	13.4	14.5	36.1	18.4	9.56
	Strontium (Sr)-Total (mg/L)	0.544	0.620	1.67	0.700	0.393
	Sulfur (S)-Total (mg/L)	21.2	18.7	97.3	19.2	6.25
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	DLM <0.0012	<0.00030	0.0177	<0.00030	0.00253
	Uranium (U)-Total (mg/L)	0.00127	0.00194	0.00255	0.00268	0.00148
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	0.00226	<0.00050	0.00097
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.460	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0040	0.0074	0.0075	0.0112	0.0062
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00014	<0.00010	0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00042	0.00037	0.00061	0.00023	0.00051
	Barium (Ba)-Dissolved (mg/L)	0.0761	0.0739	0.111	0.0693	0.0599
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.029	0.032	0.025	0.025	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000075	<0.0000050	0.000116	0.0000056	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	58.1	61.3	151	56.4	41.9
	Chromium (Cr)-Dissolved (mg/L)	0.00011	0.00011	0.00065	0.00015	0.00023
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00038	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.0244	0.00736	0.0747	DTC 0.00480	0.00167
	Iron (Fe)-Dissolved (mg/L)	0.040	0.011	0.147	0.037	0.088
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0011	0.0013	0.0034	0.0032	0.0011
	Magnesium (Mg)-Dissolved (mg/L)	17.1	17.8	36.9	27.7	13.7
	Manganese (Mn)-Dissolved (mg/L)	0.0286	DTC 0.00678	0.811	0.0478	0.0135

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1990965-6	L1990965-7			
	Description	Water	Water			
	Sampled Date	12-SEP-17	12-SEP-17			
	Sampled Time	15:23				
	Client ID	W2	DUP			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00143	0.00161			
	Nickel (Ni)-Total (mg/L)	0.00119	0.00122			
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050			
	Potassium (K)-Total (mg/L)	1.46	1.31			
	Selenium (Se)-Total (mg/L)	0.000108	0.000128			
	Silicon (Si)-Total (mg/L)	6.13	6.36			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	9.71	9.60			
	Strontium (Sr)-Total (mg/L)	0.416	0.405			
	Sulfur (S)-Total (mg/L)	6.91	6.81			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00087	0.00254			
	Uranium (U)-Total (mg/L)	0.00176	0.00152			
	Vanadium (V)-Total (mg/L)	0.00074	0.00091			
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0039			
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0049	0.0060			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00048	0.00052			
	Barium (Ba)-Dissolved (mg/L)	0.0607	0.0605			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	43.0	41.3			
	Chromium (Cr)-Dissolved (mg/L)	0.00019	0.00022			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00165	0.00159			
	Iron (Fe)-Dissolved (mg/L)	0.052	0.094			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0016	0.0013			
	Magnesium (Mg)-Dissolved (mg/L)	14.5	14.6			
	Manganese (Mn)-Dissolved (mg/L)	0.00785	0.0146			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1990965-1	L1990965-2	L1990965-3	L1990965-4	L1990965-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	11-SEP-17	11-SEP-17	11-SEP-17	12-SEP-17	12-SEP-17
	Sampled Time	08:05	08:40	10:15	08:40	14:44
	Client ID	W16	W17	W8A	W3	MC1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00290	0.00549	0.0140	0.00464	0.00153
	Nickel (Ni)-Dissolved (mg/L)	0.00075	0.00062	0.00099	0.00097	0.00097
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.92	3.65	6.02	2.40	1.29
	Selenium (Se)-Dissolved (mg/L)	0.000771	0.000458	0.0102	0.000320	0.000095
	Silicon (Si)-Dissolved (mg/L)	3.38	5.07	7.38	6.14	5.87
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000011	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	13.9	14.9	37.0	18.8	9.42
	Strontium (Sr)-Dissolved (mg/L)	0.565	0.656	1.79	0.743	0.431
	Sulfur (S)-Dissolved (mg/L)	22.6	19.1	97.9	19.5	6.08
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00038	DLM <0.00060	DLM <0.00060	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00119	0.00184	0.00242	0.00256	0.00141
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00081	<0.00050	0.00065
	Zinc (Zn)-Dissolved (mg/L)	0.0010	0.0011	0.178	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1990965-6	L1990965-7
	Description	Water	Water
	Sampled Date	12-SEP-17	12-SEP-17
	Sampled Time	15:23	
	Client ID	W2	DUP
Grouping	**Analyte**		
WATER			
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00149	0.00155
	Nickel (Ni)-Dissolved (mg/L)	0.00096	0.00106
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.46	1.32
	Selenium (Se)-Dissolved (mg/L)	0.000144	0.000111
	Silicon (Si)-Dissolved (mg/L)	6.14	6.34
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	9.79	9.77
	Strontium (Sr)-Dissolved (mg/L)	0.440	0.418
	Sulfur (S)-Dissolved (mg/L)	7.08	6.39
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00060 DLM
	Uranium (U)-Dissolved (mg/L)	0.00168	0.00143
	Vanadium (V)-Dissolved (mg/L)	0.00064	0.00069
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Copper (Cu)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Potassium (K)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Uranium (U)-Total	MS-B	L1990965-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Reference Information

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**

Reference Information

WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-09-13 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1990965-COFC

COC Number: 2017-09-13 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack

Sampler: CR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W16	11-Sep-17	8:05	Water	R	R	R	R	R	R	R	R	R					7
	W17	11-Sep-17	8:40	Water	R	R	R	R	R	R	R	R	R					7
	W8A	11-Sep-17	10:15	Water	R	R	R	R	R	R	R	R	R					7
	W3	12-Sep-17	8:40	Water	R	R	R	R	R	R	R	R	R					7
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]					[redacted]
	MC1	12-Sep-17	14:44	Water	R	R	R	R	R	R	R	R	R					7
	W2	12-Sep-17	15:23	Water	R	R	R	R	R	R	R	R	R					7
	DUP	12-Sep-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			7.5 avg		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Colin Prentice	Date: 2017-09-13	Time:	Received by:	Date:	Time:	Received by: Cude	Date: Sep 14	Time: 1330

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 20-SEP-17
Report Date: 02-OCT-17 18:54 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1994568
Project P.O. #: 226973
Job Reference:
C of C Numbers: 2017-09-20 A
Legal Site Desc:

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1994568-1	L1994568-2	L1994568-3		
	Description	Water	Water	Water		
	Sampled Date	19-SEP-17	19-SEP-17	19-SEP-17		
	Sampled Time	14:45	16:40			
	Client ID	W3	MC1	DUP		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	510	344	343		
	Hardness (as CaCO3) (mg/L)	252	169	174		
	pH (pH)	8.30	8.30	8.31		
	Total Suspended Solids (mg/L)	<3.0	<3.0	5.4		
	TDS (Calculated) (mg/L)	310	200	200		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	239	177	174		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	4.0	3.6	4.4		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	243	181	178		
	Ammonia, Total (as N) (mg/L)	0.0057	<0.0050	<0.0050		
	Chloride (Cl) (mg/L)	4.42	1.57	1.58		
	Nitrate and Nitrite (as N) (mg/L)	0.153	0.0288	0.0275		
	Nitrate (as N) (mg/L)	0.153	0.0288	0.0275		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010		
	Sulfate (SO4) (mg/L)	55.2	20.3	20.3		
	Anion Sum (meq/L)	6.15	4.08	4.03		
	Cation Sum (meq/L)	5.90	3.86	3.95		
	Cation - Anion Balance (%)	-2.1	-2.8	-1.1		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.66	8.85	8.62		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0083	0.0144	0.0234		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00027	0.00053	0.00051		
	Barium (Ba)-Total (mg/L)	0.0680	0.0609	0.0600		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.026	<0.010	<0.010		
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Calcium (Ca)-Total (mg/L)	53.2	41.3	40.6		
	Chromium (Cr)-Total (mg/L)	0.00016	0.00027	0.00025		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00294	0.00173	0.00169		
	Iron (Fe)-Total (mg/L)	0.031	0.107	0.118		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0036	0.0017	0.0017		
	Magnesium (Mg)-Total (mg/L)	27.7	15.3	15.2		
	Manganese (Mn)-Total (mg/L)	0.0465	0.0131	0.0141		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1994568-1	L1994568-2	L1994568-3
	Description	Water	Water	Water
	Sampled Date	19-SEP-17	19-SEP-17	19-SEP-17
	Sampled Time	14:45	16:40	
	Client ID	W3	MC1	DUP
Grouping	**Analyte**			
WATER				
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00485	0.00169	0.00169
	Nickel (Ni)-Total (mg/L)	0.00092	0.00100	0.00102
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.26	1.31	1.29
	Selenium (Se)-Total (mg/L)	0.000298	0.000136	0.000099
	Silicon (Si)-Total (mg/L)	6.08	6.08	6.05
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	18.5	10.1	10.0
	Strontium (Sr)-Total (mg/L)	0.757	0.452	0.446
	Sulfur (S)-Total (mg/L)	19.1	6.96	6.87
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00070	DLM <0.0012	0.00100
	Uranium (U)-Total (mg/L)	0.00289	0.00166	0.00161
	Vanadium (V)-Total (mg/L)	<0.00050	0.00077	0.00076
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0030	0.0054	0.0045
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00048	0.00047
	Barium (Ba)-Dissolved (mg/L)	0.0683	0.0636	0.0625
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.025	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	56.6	42.9	44.5
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00018	0.00016
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00337	0.00145	0.00141
	Iron (Fe)-Dissolved (mg/L)	0.024	0.075	0.075
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0034	0.0015	0.0015
	Magnesium (Mg)-Dissolved (mg/L)	26.9	15.1	15.2
	Manganese (Mn)-Dissolved (mg/L)	0.0433	0.0106	0.0103

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1994568-1	L1994568-2	L1994568-3		
	Description	Water	Water	Water		
	Sampled Date	19-SEP-17	19-SEP-17	19-SEP-17		
	Sampled Time	14:45	16:40			
	Client ID	W3	MC1	DUP		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00449	0.00157	0.00158		
	Nickel (Ni)-Dissolved (mg/L)	0.00075	0.00082	0.00081		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	2.27	1.35	1.36		
	Selenium (Se)-Dissolved (mg/L)	0.000383	0.000091	0.000092		
	Silicon (Si)-Dissolved (mg/L)	6.16	6.27	6.15		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	18.3	9.96	9.99		
	Strontium (Sr)-Dissolved (mg/L)	0.750	0.437	0.443		
	Sulfur (S)-Dissolved (mg/L)	19.1	7.07	6.98		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00261	0.00147	0.00150		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00059	0.00060		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0023	<0.0010		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1994568-1, -2, -3
Matrix Spike	Dissolved Organic Carbon	MS-B	L1994568-1, -2, -3
Matrix Spike	Dissolved Organic Carbon	MS-B	L1994568-1, -2, -3
Matrix Spike	Chloride (Cl)	MS-B	L1994568-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1994568-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L1994568-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1994568-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1994568-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1994568-1, -2, -3
Matrix Spike	Nitrate (as N)	MS-B	L1994568-1, -2, -3
Matrix Spike	Sulfate (SO4)	MS-B	L1994568-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions)

Reference Information

should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-09-20 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1994568-COFC

COC Number: 2017-09-20 A

Page of

Report To Contact and company name below will appear on the final report

Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659

Company address below will appear on the final report

Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 226973 (WUL)
LSD:

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Contact: Shane Stack
Sampler: SR/CH

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	19-Sep-17	14:45	Water	R	R	R	R	R	R	R	R	R					7
	MC1	19-Sep-17	16:40	Water	R	R	R	R	R	R	R	R	R					7
	DUP	19-Sep-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 5°C.
FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts
Date: 2017-09-19
Time: 9:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by:
Date: Sept 20/17
Time: 14:07

FINAL SHIPMENT RECEPTION (lab use only)

Received by:
Date:
Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-SEP-17
Report Date: 08-NOV-17 15:43 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1998015

Project P.O. #: 224159 (MMER)
Job Reference:
C of C Numbers: 2017-09-26 C
Legal Site Desc:

Comments: Please note, the Nautilus report for 7-d Lemna minor growth inhibition can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping **Analyte**					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

2017-09-26 C

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Toxicity Testing on L1998015-1 W3

Sample collected on September 26, 2017

Final Report

November 7, 2017

Submitted to: **ALS Environmental**
Burnaby, BC

TABLE OF CONTENTS

List of Tables

List of Appendices

SIGNATURE PAGE

A. Tang

Report By:
Jeslin Wijaya, B.Sc
Laboratory Biologist

Reviewed By:
Armando Tang, R.P.Bio
Laboratory Manager

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

SUMMARY

Sample Information and Test Type

Sample ID	L1998015-1 W3
Sample collection date	September 26, 2017
Sample receipt date	September 28 2017
Sample receipt temperature	11°C
Test types	7-d *Lemna minor* growth inhibition

Summary of Results

Endpoint	**% v/v**
Lemna minor	
Frond count IC25	>97
Frond count IC50	>97
Dry weight IC25	>97
Dry weight IC50	>97

IC = Inhibition Concentration

1.0 INTRODUCTION

Nautilus Environmental Company Inc. conducted a *Lemna minor* growth inhibition toxicity test for Minto Explorations Ltd. as part of their requirements under the Metal Mining Effluent Regulations (MMER) and Environmental Effects Monitoring (EEM) program. Sample L1998015-1 W3 was collected on September 26, 2017 and delivered to the Nautilus Environmental laboratory in Burnaby, BC on September 28, 2017. Testing was initiated on September 28, 2017. The sample was transported in two 1-L plastic containers and was received at a temperature of 11°C. The sample was stored in the dark at 4 ± 2°C prior to testing.

This report describes the results of the *L. minor* toxicity test. Copies of raw laboratory data sheets and statistical analyses are provided in Appendix A. The chain-of-custody form is provided in Appendix B.

2.0 METHODS

Methods for the toxicity tests are summarized in Table 1. Testing was conducted according to procedures described by Environment Canada (2007). Statistical analyses for the test were performed using CETIS (Tidepool Scientific Software, 2013).

Table 1. Summary of test conditions: *Lemna minor* growth inhibition test.

Test species	*Lemna minor*, strain CPCC# 490
Organism source	In-house axenic culture, obtained from Canadian Phycological Culture Centre, and originally isolated from Wainfleet, Stinking Barn, Niagara Peninsula, Ontario, Canada
Organism age	7- to 10-day old culture
Test type	Static
Test duration	7 days
Test vessel	250-mL glass container
Test volume	100 mL
Test solution depth	4 cm
Test concentrations	Seven concentrations, plus laboratory control
Test replicates	4 per treatment
Number of organisms	Two 3-frond plants per replicate
Control/dilution water	Modified APHA media (deionized water plus 1% of each APHA stock solution A, B and C)
Test solution renewal	None
Test temperature	25 ± 2°C
Feeding	None
Light intensity	4000 to 5600 lux
Photoperiod	24 hours light
Aeration	None
Test measurements	Test area temperature measured daily; temperature, pH and conductivity measured in all concentrations at test initiation; dissolved oxygen of highest concentration measured at test initiation; temperature and pH measured at test termination
Test protocol	Environment Canada (2007), EPS 1/RM/37
Statistical software	CETIS Version 1.8.7
Test endpoints	Number of fronds and dry weight
Test acceptability criterion for controls	≥ 8-fold increase in number of fronds
Reference toxicant	Potassium chloride (KCl)

3.0 RESULTS

Results of the toxicity test conducted on sample L1998015-1 W3 are provided in Table 2. There were no adverse effects on frond growth or dry weight, resulting in IC25 and IC50 values of >97% (v/v) for both endpoints. Significant stimulation on dry weight were observed in test concentrations 48.5 and 97% (v/v); percent stimulation ranged between 30.4 and 33.2%.

Table 2. Results: *Lemna minor* growth inhibition test.

Concentration (% v/v)	Frond Growth (No. of Fronds) (Mean ± SD)	Stimulation (%)	Dry Weight (mg) (Mean ± SD)	Stimulation (%)
Laboratory Control	110.3 ± 9.5	--	9.3 ± 0.7	--
1.5	107.3 ± 13.4	--	8.6 ± 1.0	--
3.0	105.3 ± 22.7	--	8.6 ± 1.6	--
6.1	111.5 ± 7.0	1.1	9.2 ± 0.9	--
12.1	118.8 ± 8.2	7.7	9.3 ± 0.6	0.65
24.2	121.5 ± 18.6	10.2	10.8 ± 1.7	17.0
48.5	129.3 ± 3.6	17.2	12.1 ± 0.9*	30.4
97	120.0 ± 17.1	8.8	12.3 ± 1.8*	33.2
Test Endpoint (% v/v)				
IC25	>97		>97	
IC50	>97		>97	

SD = Standard Deviation, IC = Inhibition Concentration
* = Indicates dry weight that were significantly greater than the control

4.0 QA/QC

The health history of the test organisms used in the exposure was acceptable and met the requirements of the Environment Canada protocol. The test met all control acceptability criteria and water quality parameters remained within ranges specified in the protocol throughout the test. There were no deviations from the test methodology. Uncertainty associated with the test is best described by the standard deviation around the mean and/or the confidence intervals around the point estimates.

Results of the reference toxicant test conducted during the testing program are summarized in Table 3. Results for this test fell within the range for organism performance of the mean and two standard deviations, based on historical results obtained by the laboratory with this test. Thus, the sensitivity of the organisms used in this test was appropriate. The reference toxicant test was performed under the same conditions as those used for the sample.

Table 3. Reference toxicant test results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
L. minor	No. Fronds (IC50): 3.8 g/L KCl	3.7 (3.0 – 4.6)	11	September 29, 2017

SD = Standard Deviation, CV = Coefficient of Variation, IC = Inhibition Concentration,

5.0 REFERENCES

Environment Canada. 2007. Biological test method: tests for measuring the inhibition of growth using the freshwater macrophyte, *Lemna minor*. Environmental Protection Series, Report EPS 1/RM/37. Second Edition. January 2007. Environment Canada, Method Development and Application Section, Environmental Technology Centre, Ottawa, ON. 112 pp.

Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 Tidepool Scientific Software, McKinleyville, CA. 275 pp.

APPENDIX A – *Lemna minor* Toxicity Test Data

Lemna minor Summary Sheet

Client: ALS / Minto

Work Order No.: 171055

Start Date: Sept 28 / 17

Set up by: JW

Sample Information:

Sample ID: L 1998015 - 1 W3

Sample Date: Sept 26 / 17

Date Received: Sept 28 / 17

Sample Volume: 2 x 1L

Test Organism Information:

Culture Date: 092117

Age of culture (Day 0): 7 days

>8X growth in APHA?: Y (34 fronds)

KCl Reference Toxicant Results:

Reference Toxicant ID: Lm ~~155~~ 151 JW

Date Initiated: Sept 29 / 17

7-d No. of Fronds IC50 (95% CL): 3.8 (2.8 - 4.6) g/L KCl

7-d No. Fronds IC50 Reference Toxicant Mean (2 SD Range): 3.7 (3.0 - 4.6) g/L KCl CV (%): 11

Test Results:

	Number of Fronds	Dry Weight
IC25 %(v/v) (95% CL)	>97	>97
IC50 %(v/v) (95% CL)	>97	>97

Reviewed by: JOh

Date reviewed: Oct. 20/17

Plant Growth Inhibition Toxicity Test
Water Quality Measurements

Client: ALS / Minto
Setup by: JW
Sample ID: W3 (L1998015-1)
Test Date: Sept 28/17
Work Order No.: 171055
CER #: 4
Culture Source: CPCC # 490
Test Species: *Lemna minor*
Test Culture Age: 7 days
> 8X Growth? (Y/N): Y JW ~~(Sept 28/17)~~ (34 fronds)
Light Intensity Range: 4100 - 5000 lux
Date Measured: Sept 28/17

Day	0	1	2	3	4	5	6	7
Shelf Temp (°C)	24.5	24.5	24.5	24.5	24.5	24.5	24.5	24.5
Initials	JW	JW	JW	Emm	JW	JW	JW	JW

Sample Characteristics:	**Initial Water Quality**			**Adjusted Water Quality**
Temperature (°C)	25.0	**Aeration?:**	20 min	25.0
DO (mg/L)	8.7	**Nutrients added?[1]:**	Y →	8.4
pH	7.8			8.1
Conductivity (µS)	560			1358

[1] 10 mL of each APHA stock (A,B and C) added to 970 mL sample.

Concentration	**Temperature (°C)**		**pH**		**Conductivity (µS)**
% (V/V)	**Day 0**	**Day 7**	**Day 0**	**Day 7**	**0 h**
Control	24.0	24.5	JW 8.~~2~~3	8.3	872
1.5	24.0	24.5	8.2	8.5	886
3	24.0	24.5	8.2	8.7	894
6.1	24.0	24.5	8.2	8.7	910
12.1	24.0	24.5	8.2	8.8	941
24.2	24.0	24.5	8.2	8.8	1001
48.5	24.0	24.5	8.2	9.0	1124
97	25.0	24.5	8.1	9.1	1358
Initials	JW	JW	JW	MLT	JW

Thermometer: 4 **Light meter:** 1 **pH meter/probe:** 1 / 1 **DO meter/probe:** 1 / 1 **Conductivity meter/probe:** 1 / 1

Sample Description: Clear, light yellow, odorless, some particulates.

Comments:

Reviewed:

Date Reviewed: Oct-20/17

Lemna minor Toxicity Test Data Sheet - 7-d Frond Counts

Client: ALS
Sample ID: W3 (L1998015-1)
Work Order #: 171055

Start Date: Sept 28 /17
Termination Date: Oct 5 /17
Test set up by: JW

Concentration JW ~~g~~ % (v/v)	Rep	No. of fronds		Chlorosis	Necrosis	Yellow	Abnormal size	Gibbosity	Single fronds	Root destruction	Loss of buoyancy	Comments	Initials
		Day 0	Day 7										
control	A	6	109										JW
	B	6	130										
	C	6	111										
	D	6	115										
1.5	A	6	122										
	B	6	127										
	C	6	105										
	D	6	99										
3	A	6	80										
	B	6	109										
	C	6	126										
	D	6	130										
6.1	A	6	117										
	B	6	108										
	C	6	121										
	D	6	124										
12.1	A	6	116										
	B	6	134										
	C	6	129										
	D	6	120										
24.2	A	6	152										
	B	6	108										
	C	6	130										
	D	6	120										↓

Comments:

Reviewed by:

Date Reviewed: Oct. 13/17

Lemna minor Toxicity Test Data Sheet - 7-d Frond Counts

Client: ALS
Sample ID: W3 (L1998015 - 1)
Work Order #: 171055

Start Date: Sept 28 /17
Termination Date: Oct 5 /17
Test set up by: JW

Concentration % (v/v)	Rep	No. of fronds		Chlorosis	Necrosis	Yellow	Abnormal size	Gibbosity	Single fronds	Root destruction	Loss of buoyancy	Comments	Initials
		Day 0	Day 7										
48.5	A	6	136										JW
	B	6	133										
	C	6	132										
	D	6	140										
97	A	6	145										
	B	6	105										
	C	6	121										
	D	6	133										↓
	A												
	B												
	C												
	D												
	A												
	B												
	C												
	D												
	A												
	B												
	C												
	D												
	A												
	B												
	C												
	D												

Comments:

Reviewed by: JGh

Date Reviewed: Oct. 13/17

7-d *Lemna minor* Weight Data Sheet

Client: ALS / Minto

Sample ID: W3 (L1998015 -1)

WO #: 171055 JW

Start Date: sept 28 / 17

Termination Date: oct 5 / 17

Balance ID: Bal - 1

W3 ~~Blue~~ Black

Concentration	Rep	Pan No.	Pan weight (mg)	Pan + plant (mg)	Initials
% (v/v) control	A	1	1280.08	1288.91	JW
	B	2	1279.25	1289.51	
	C	3	1280.97	1290.23	
	D	4	1279.49	1288.19	
1.5	A	5	1274.71	1283.57	
	B	6	1280.99	1290.60	
	C	7	1274.16	1282.82	
	D	8	1276.72	1283.96	
3	A	9	1277.35	1283.60	
	B	10	1279.33	1288.07	
	C	11	1275.33	1284.81	
	D	12	1275.52	1285.43	
6.1	A	13	1274.72	1283.63	
	B	14	1280.09	1288.07	
	C	15	1281.78	1291.59	
	D	16	1279.43	1289.49	
12.1	A	17	1276.10	1284.95	
	B	18	1277.56	1287.60	
	C	19	1282.95	1292.51	
	D	20	1282.01	1290.85	
24.2	A	21	1283.99	1297.21	
	B	22	1279.15	1288.29	
	C	23	1282.85	1293.16	
	D	24	1279.11	1289.77	
48.5	A	25	1273.68	1286.11	
	B	26	1272.35	1284.54	
	C	27	1278.33	1289.12	
	D	28	1277.53	1290.43	↓

Comments: 10 % Reweigh = # 1: 1288.75 mg # 27: 1289.02 mg
(mg) # 13: 1283.52 mg # 32: 1290.01 mg

Reviewed by: JGu

Date Reviewed: Oct. 13/17

7-d *Lemna minor* Weight Data Sheet

Client: ALS

Sample ID: W3 (L1998015 - 1)

WO #: 171055 JW

Start Date: Sept 28 / 17

Termination Date: Oct 5 / 17

Balance ID: Bal - 1

W3 ~~Blue~~ · Black

Concentration	Rep	Pan No.	Pan weight (mg)	Pan + plant (mg)	Initials
% (v/v)	A	29	1277 · 26	1290 · 90	JW
	B	30	1271 · 74	1282 . 17	↓
97	C	31	1275 · 41	1286 . 68	
	D	32	1276 . 04	1290 . 06	
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				
	A				
	B				
	C				
	D				

Comments:

Reviewed by:

Date Reviewed: Oct - 13 / 17

CETIS Analytical Report

Report Date: 09 Oct-17 17:50 (p 1 of 2)
Test Code: 171055 | 20-4038-8962

Lemna Growth Inhibition Test

Nautilus Environmental

Analysis ID:	19-1163-4932	**Endpoint:**	Frond Count	**CETIS Version:**	CETISv1.8.7
Analyzed:	09 Oct-17 17:49	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	03-7269-1221	**Test Type:**	Lemna Growth	**Analyst:**	JW ~~Jill Sones~~ Jeslin Wijaya
Start Date:	28 Sep-17	**Protocol:**	EC/EPS 1/RM/37	**Diluent:**	Modified APHA
Ending Date:	05 Oct-17	**Species:**	Lemna minor	**Brine:**	
Duration:	7d 0h	**Source:**	CPCC#490	**Age:**	7d

Sample ID:	13-1359-5064	**Code:**	4E4BDEB8	**Client:**	ALS
Sample Date:	26 Sep-17	**Material:**	Water Sample	**Project:**	
Receive Date:	28 Sep-17 13:30	**Source:**	ALS		
Sample Age:	48h (11 °C)	**Station:**	L1998015-1 W3		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	238844	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	>97	N/A	N/A	<1.031	NA	NA
IC10	>97	N/A	N/A	<1.031	NA	NA
IC15	>97	N/A	N/A	<1.031	NA	NA
IC20	>97	N/A	N/A	<1.031	NA	NA
IC25	>97	N/A	N/A	<1.031	NA	NA
IC40	>97	N/A	N/A	<1.031	NA	NA
IC50	>97	N/A	N/A	<1.031	NA	NA

Frond Count Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	4	110.3	103	124	4.75	9.5	8.62%	0.0%
1.5		4	107.3	93	121	6.688	13.38	12.47%	2.72%
3		4	105.3	74	124	11.37	22.74	21.6%	4.54%
6.1		4	111.5	102	118	3.476	6.952	6.24%	-1.13%
12.1		4	118.8	110	128	4.11	8.221	6.92%	-7.71%
24.2		4	121.5	102	146	9.323	18.65	15.35%	-10.2%
48.5		4	129.3	126	134	1.797	3.594	2.78%	-17.23%
97		4	120	99	139	8.544	17.09	14.24%	-8.84%

Frond Count Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	103	124	105	109
1.5		116	121	99	93
3		74	103	120	124
6.1		111	102	115	118
12.1		110	128	123	114
24.2		146	102	124	114
48.5		130	127	126	134
97		139	99	115	127

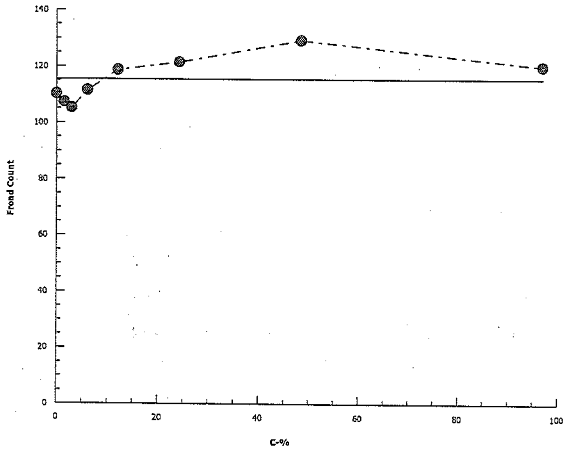
Analyst: JW QA: JOL

Lemna Growth Inhibition Test

Nautilus Environmental

Analysis ID: 19-1163-4932
Analyzed: 09 Oct-17 17:49
Endpoint: Frond Count
Analysis: Linear Interpolation (ICPIN)
CETIS Version: CETISv1.8.7
Official Results: Yes

Graphics



Analyst: JW

QA: JGu Oct 13/17

CETIS Analytical Report

Report Date:	20 Oct-17 10:28 (p 1 of 2)
Test Code:	171055 | 20-4038-8962

Lemna Growth Inhibition Test

Nautilus Environmental

Analysis ID:	04-0616-3837	**Endpoint:**	Frond Count	**CETIS Version:**	CETISv1.8.7
Analyzed:	20 Oct-17 10:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	03-7269-1221	**Test Type:**	Lemna Growth	**Analyst:**	JW ~~Jill Sones~~ Jeslin Wijaya
Start Date:	28 Sep-17	**Protocol:**	EC/EPS 1/RM/37	**Diluent:**	Modified APHA
Ending Date:	05 Oct-17	**Species:**	Lemna minor	**Brine:**	
Duration:	7d 0h	**Source:**	CPCC#490	**Age:**	7d

Sample ID:	13-1359-5064	**Code:**	4E4BDEB8	**Client:**	ALS
Sample Date:	26 Sep-17	**Material:**	Water Sample	**Project:**	
Receive Date:	28 Sep-17 13:30	**Source:**	ALS		
Sample Age:	48h (11 °C)	**Station:**	L1998015-1 W3		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Untransformed	NA	C < T	NA	NA	22.2%	97	>97	NA	1.031

Dunnett Multiple Comparison Test

Control	vs	C-%	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Negative Control		1.5	-0.3044	2.482	24.46	6	0.9354	CDF	Non-Significant Effect
		3	-0.5073	2.482	24.46	6	0.9607	CDF	Non-Significant Effect
		6.1	0.1268	2.482	24.46	6	0.8406	CDF	Non-Significant Effect
		12.1	0.8623	2.482	24.46	6	0.5453	CDF	Non-Significant Effect
		24.2	1.141	2.482	24.46	6	0.4160	CDF	Non-Significant Effect
		48.5	1.928	2.482	24.46	6	0.1395	CDF	Non-Significant Effect
		97	0.9891	2.482	24.46	6	0.4859	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1890.219	270.0313	7	1.39	0.2549	Non-Significant Effect
Error	4663.75	194.3229	24			
Total	6553.969		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	10.78	18.48	0.1487	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.985	0.9081	0.9248	Normal Distribution

Frond Count Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Negative Control	4	110.3	95.13	125.4	107	103	124	4.75	8.62%	0.0%
1.5		4	107.3	85.97	128.5	107.5	93	121	6.688	12.47%	2.72%
3		4	105.3	69.07	141.4	111.5	74	124	11.37	21.6%	4.54%
6.1		4	111.5	100.4	122.6	113	102	118	3.476	6.24%	-1.13%
12.1		4	118.8	105.7	131.8	118.5	110	128	4.11	6.92%	-7.71%
24.2		4	121.5	91.83	151.2	119	102	146	9.323	15.35%	-10.2%
48.5		4	129.3	123.5	135	128.5	126	134	1.797	2.78%	-17.23%
97		4	120	92.81	147.2	121	99	139	8.544	14.24%	-8.84%

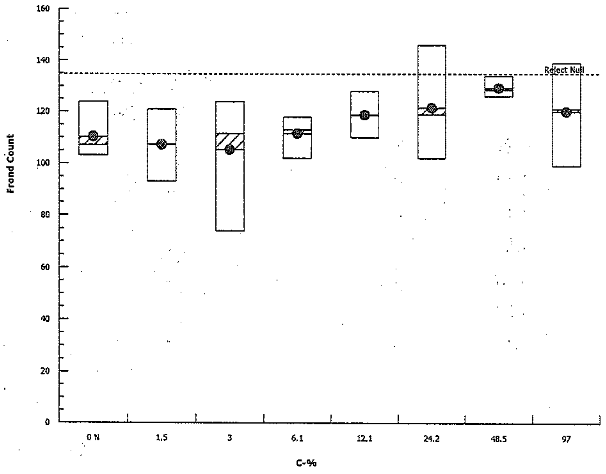
Frond Count Detail

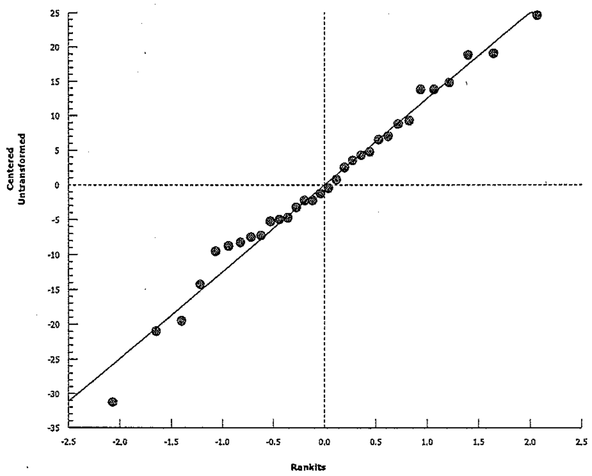
C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	103	124	105	109
1.5		116	121	99	93
3		74	103	120	124
6.1		111	102	115	118
12.1		110	128	123	114
24.2		146	102	124	114
48.5		130	127	126	134
97		139	99	115	127

Analyst: JW QA: JGL

Analysis ID:	04-0616-3837	**Endpoint:**	Frond Count	**CETIS Version:**	CETISv1.8.7
Analyzed:	20 Oct-17 10:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Graphics





CETIS Analytical Report

Report Date: 09 Oct-17 17:50 (p 1 of 2)
Test Code: 171055 | 20-4038-8962

Lemna Growth Inhibition Test

Nautilus Environmental

Analysis ID:	19-5046-2732	**Endpoint:**	Total Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	09 Oct-17 17:50	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	03-7269-1221	**Test Type:**	Lemna Growth	**Analyst:**	JW ~~Jill Sones~~ Jeslin Wijaya
Start Date:	28 Sep-17	**Protocol:**	EC/EPS 1/RM/37	**Diluent:**	Modified APHA
Ending Date:	05 Oct-17	**Species:**	Lemna minor	**Brine:**	
Duration:	7d 0h	**Source:**	CPCC#490	**Age:**	7d

Sample ID:	13-1359-5064	**Code:**	4E4BDEB8	**Client:**	ALS
Sample Date:	26 Sep-17	**Material:**	Water Sample	**Project:**	
Receive Date:	28 Sep-17 13:30	**Source:**	ALS		
Sample Age:	48h (11 °C)	**Station:**	L1998015-1 W3		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	228634	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	>97	N/A	N/A	<1.031	NA	NA
IC10	>97	N/A	N/A	<1.031	NA	NA
IC15	>97	N/A	N/A	<1.031	NA	NA
IC20	>97	N/A	N/A	<1.031	NA	NA
IC25	>97	N/A	N/A	<1.031	NA	NA
IC40	>97	N/A	N/A	<1.031	NA	NA
IC50	>97	N/A	N/A	<1.031	NA	NA

Total Dry Weight-mg Summary

			Calculated Variate						
C-%	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	Negative Control	4	9.263	8.7	10.26	0.3534	0.7067	7.63%	0.0%
1.5		4	8.592	7.24	9.61	0.495	0.9901	11.52%	7.23%
3		4	8.595	6.25	9.91	0.8182	1.636	19.04%	7.21%
6.1		4	9.19	7.98	10.06	0.4729	0.9458	10.29%	0.78%
12.1		4	9.322	8.84	10.04	0.2926	0.5852	6.28%	-0.65%
24.2		4	10.83	9.14	13.22	0.8596	1.719	15.87%	-16.95%
48.5		4	12.08	10.79	12.9	0.4538	0.9076	7.51%	-30.39%
97		4	12.34	10.43	14.02	0.8806	1.761	14.27%	-33.23%

Total Dry Weight-mg Detail

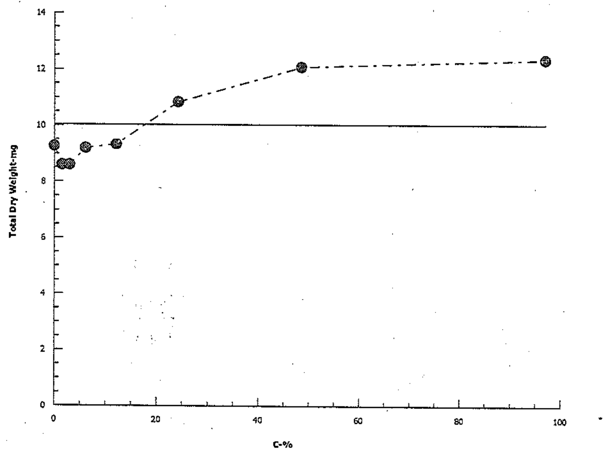
C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	8.83	10.26	9.26	8.7
1.5		8.86	9.61	8.66	7.24
3		6.25	8.74	9.48	9.91
6.1		8.91	7.98	9.81	10.06
12.1		8.85	10.04	9.56	8.84
24.2		13.22	9.14	10.31	10.66
48.5		12.43	12.19	10.79	12.9
97		13.64	10.43	11.27	14.02

Analyst: JW QA: JGL

Lemna Growth Inhibition Test **Nautilus Environmental**

Analysis ID:	19-5046-2732	**Endpoint:**	Total Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	09 Oct-17 17:50	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst: JW QA: JCk Oct. 13/17

CETIS Analytical Report

Report Date: 20 Oct-17 10:29 (p 1 of 2)
Test Code: 171055 | 20-4038-8962

Lemna Growth Inhibition Test

Nautilus Environmental

Analysis ID:	10-4042-7087	**Endpoint:**	Total Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	20 Oct-17 10:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes
Batch ID:	03-7269-1221	**Test Type:**	Lemna Growth	**Analyst:**	JW ~~Jill Sones~~ Jesún Nibaya
Start Date:	28 Sep-17	**Protocol:**	EC/EPS 1/RM/37	**Diluent:**	Modified APHA
Ending Date:	05 Oct-17	**Species:**	Lemna minor	**Brine:**	
Duration:	7d 0h	**Source:**	CPCC#490	**Age:**	7d
Sample ID:	13-1359-5064	**Code:**	4E4BDEB8	**Client:**	ALS
Sample Date:	26 Sep-17	**Material:**	Water Sample	**Project:**	
Receive Date:	28 Sep-17 13:30	**Source:**	ALS		
Sample Age:	48h (11 °C)	**Station:**	L1998015-1 W3		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Untransformed	NA	C < T	NA	NA	23.5%	24.2	48.5	34.26	4.132

Dunnett Multiple Comparison Test

Control	vs	C-%	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Negative Control		1.5	-0.765	2.482	2.174	6	0.9804	CDF	Non-Significant Effect
		3	-0.762	2.482	2.174	6	0.9803	CDF	Non-Significant Effect
		6.1	-0.08282	2.482	2.174	6	0.8944	CDF	Non-Significant Effect
		12.1	0.06846	2.482	2.174	6	0.8571	CDF	Non-Significant Effect
		24.2	1.792	2.482	2.174	6	0.1739	CDF	Non-Significant Effect
		48.5*	3.214	2.482	2.174	6	0.0103	CDF	Significant Effect
		97*	3.514	2.482	2.174	6	0.0051	CDF	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	64.37354	9.19622	7	5.993	0.0004	Significant Effect
Error	36.82623	1.534426	24			
Total	101.1998		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	6.176	18.48	0.5194	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9886	0.9081	0.9776	Normal Distribution

Total Dry Weight-mg Summary

C-%	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	Negative Control	4	9.263	8.138	10.39	9.045	8.7	10.26	0.3534	7.63%	0.0%
1.5		4	8.592	7.017	10.17	8.76	7.24	9.61	0.495	11.52%	7.23%
3		4	8.595	5.991	11.2	9.11	6.25	9.91	0.8182	19.04%	7.21%
6.1		4	9.19	7.685	10.69	9.36	7.98	10.06	0.4729	10.29%	0.78%
12.1		4	9.322	8.391	10.25	9.205	8.84	10.04	0.2926	6.28%	-0.65%
24.2		4	10.83	8.097	13.57	10.49	9.14	13.22	0.8596	15.87%	-16.95%
48.5		4	12.08	10.63	13.52	12.31	10.79	12.9	0.4538	7.51%	-30.39%
97		4	12.34	9.538	15.14	12.46	10.43	14.02	0.8806	14.27%	-33.23%

Total Dry Weight-mg Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	8.83	10.26	9.26	8.7
1.5		8.86	9.61	8.66	7.24
3		6.25	8.74	9.48	9.91
6.1		8.91	7.98	9.81	10.06
12.1		8.85	10.04	9.56	8.84
24.2		13.22	9.14	10.31	10.66
48.5		12.43	12.19	10.79	12.9
97		13.64	10.43	11.27	14.02

Analyst: JW QA: JGu Oct 20/17

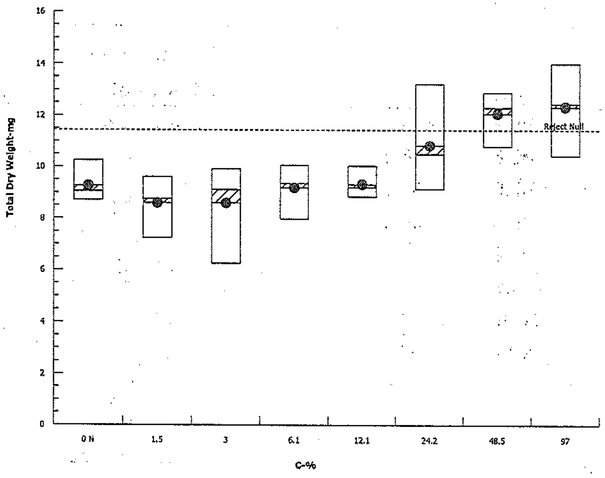
CETIS Analytical Report

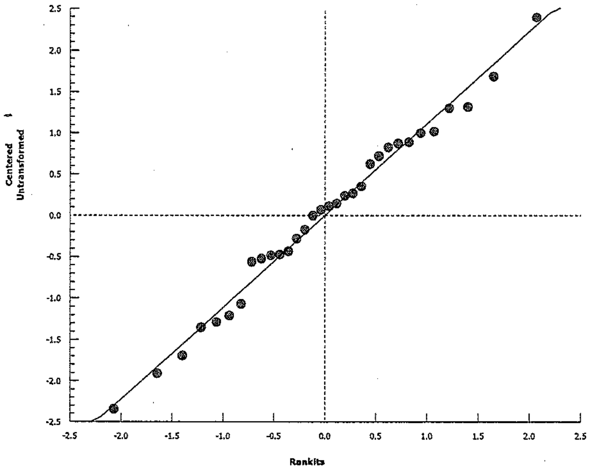
Report Date:	20 Oct-17 10:29 (p 2 of 2)
Test Code:	171055 | 20-4038-8962

Lemna Growth Inhibition Test **Nautilus Environmental**

Analysis ID:	10-4042-7087	**Endpoint:**	Total Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	20 Oct-17 10:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Graphics





Analyst: JW QA: JGu Oct-20/17

APPENDIX B – Chain-of-Custody Form

L1998015

VANCOUVER

ALS Environmental

Subcontract Request Form

Subcontract To:

NAUTILUS ENVIRONMENTAL
8664 COMMERCE COURT
BURNABY,BC V5A 4N7

NOTES: Please reference on final report and invoice: PO# L1998015 w
ALS requires QC data to be provided with your final results.

Please see enclosed 2 **sample(s) in** 2 **Container(s)**

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED DUE DATE	Priority Flag	
L1998015-1 W3 2x1L	Special Request- Nautilus Environmental (SPECIAL REQUEST-NL 14)	**9/26/2017** 10/6/2017	WO # 171055 Lemna	11°C
disposed **L1998015-2 W3** 5x20L See Krysta Testing postponed	Special Request- Nautilus Environmental (SPECIAL REQUEST-NL 14)	**9/26/2017** 10/6/2017		11°C

Subcontract Info Contact: Walter Lin (604) 253-4188
Analysis and reporting info contact: Shane Stack
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9

MINTO

Phone: (604) 253-4188 Email: Shane.Stack@alsglobal.com

Please email confirmation of receipt to: **Shane.Stack@alsglobal.com**

Shipped By: ______ Date Shipped: ______
Received By: Nao Yamamoto - NY Date Received: Sept 28/17 @ 13:30.
Verified By: Nautilus Date Verified: ______
Temperature: ______
Sample Integrity Issues: n/a

sample description : clear, light yellow, odorless, some particulates.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1998015-COFC

COC Number: 2017-09-26 C

Page 1 of 1

Report To	Contact and companyname below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Companyaddress below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): **4 day [P4]** ☐ **3 day [P3]** ☐ **2 day [P2]** ☐

EMERGENCY: **1 Business day [E1]** ☐ **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224159 (MMER)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/EB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	96hr LC50 RainbowTrout	48hr - LC50 Daphnia	7day - RainbowTroutEmbryoToxicity	7day - Ceriodaphnia	7day - Lemma minor	Alga 72-h Growth Inhibition	7day - Flathead Minnow							Number of Containers
	W3	26-Sep-17	8:25	Water					R									2
	W3	26-Sep-17	8:25	Water			R											5

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☐ Ice Cubes ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9°C.	4°C	4°C	4°C	4°C	4°C

SHIPMENT RELEASE (client use)		
Released by:Chris Harry	Date:2017-09-26 8:00	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by:	Date: Sept27/17	Time: 09:05

FINAL SHIPMENT RECEPTION (lab use only)		
Received by: Chrystal	Date: Sept 28/2017	Time: 10:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form maydelay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

[1] If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

END OF REPORT

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1998015-COFC

COC Number: 2017-09-26 C

Page 1 of 1

Report To	Contact and companyname below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)	
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report ☑ YES ☐ NO	
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	224159 (MMER)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:**	**Sampler:** CH/EB

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	96hr LC50 RainbowTrout	48hr - LC50 Daphnia	7day - RainbowTroutEmbryoToxicity	7day - Ceriodaphnia	7day - Lemma minor	Alga 72-h Growth Inhibition	7day - Flathead Minnow							Number of Containers
	W3	26-Sep-17	8:25	Water					R									2
	W3	26-Sep-17	8:25	Water			R											5

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9°C.	4°C	4°C	4°C	4°C	4°C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-09-26 8:00	Time:	Received by:	Date: Sept 27/17	Time: 09:05	Received by: Chrystal	Date: Sept 28/2017	Time: 10:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-SEP-17
Report Date: 16-OCT-17 18:11 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1998026
Project P.O. #: 226973 (WUL)
Job Reference:
C of C Numbers: 2017-09-26 B
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1998026-1	L1998026-2	L1998026-3	L1998026-4	L1998026-5
	Sample ID	L1998026-1	L1998026-2	L1998026-3	L1998026-4	L1998026-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-SEP-17	25-SEP-17	25-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time	10:10	10:25	11:11	08:25	09:45
	Client ID	W17	W16	W8A	W3	W2
WATER						
Physical Tests	Conductivity (uS/cm)	483	471	1100	527	348
	Hardness (as CaCO3) (mg/L)	231	228	569	264	174
	pH (pH)	8.26	8.28	7.97	8.32	8.29
	Total Suspended Solids (mg/L)	<3.0	<3.0	35.8	<3.0	5.0
	TDS (Calculated) (mg/L)	285	285	758	314	200
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	204	176	369	237	173
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	4.8	2.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	204	176	369	242	175
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0424	0.120	0.0058	<0.0050
	Chloride (Cl) (mg/L)	6.36	6.79	9.1	4.43	1.83
	Nitrate and Nitrite (as N) (mg/L)	0.219	1.94	5.76	0.177	0.0120
	Nitrate (as N) (mg/L)	0.219	1.92	5.62	0.177	0.0120
	Nitrite (as N) (mg/L)	<0.0010	0.0117	0.140	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	55.6	66.5	254	55.3	21.6
	Anion Sum (meq/L)	5.43	5.23	13.3	6.11	4.00
	Cation Sum (meq/L)	5.41	5.33	13.4	6.17	4.00
	Cation - Anion Balance (%)	-0.2	0.9	0.2	0.5	0.0
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	8.59	13.3	17.1	6.39	8.53
Total Metals	Aluminum (Al)-Total (mg/L)	0.0040	0.121	0.323	0.0051	0.0119
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00011	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00041	0.00048	0.00079	0.00025	0.00040
	Barium (Ba)-Total (mg/L)	0.0736	0.0849	0.127	0.0727	0.0632
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000031	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.032	0.029	0.029	0.028	<0.010
	Cadmium (Cd)-Total (mg/L)	0.0000053	0.0000105	0.000296	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	64.1	64.0	163	61.0	47.5
	Chromium (Cr)-Total (mg/L)	0.00011	0.00026	0.00073	0.00010	0.00021
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00012	0.00103	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.00725	0.0291	0.219	0.00263	0.00170
	Iron (Fe)-Total (mg/L)	<0.010	0.242	2.91	0.026	0.063
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000162	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0012	0.0011	0.0040	0.0037	0.0020
	Magnesium (Mg)-Total (mg/L)	19.5	19.4	44.6	29.6	14.9
	Manganese (Mn)-Total (mg/L)	0.0135	0.0826	1.99	0.0525	0.0121

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998026-6	L1998026-7			
	Description	Water	Water			
	Sampled Date	26-SEP-17	26-SEP-17			
	Sampled Time		09:45			
	Client ID	DUP	F-BL			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	524	<2.0			
	Hardness (as CaCO3) (mg/L)	261	<0.50			
	pH (pH)	8.34	5.42			
	Total Suspended Solids (mg/L)	<3.0	<3.0			
	TDS (Calculated) (mg/L)	314	<1.0			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	235	<1.0			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	6.6	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	242	<1.0			
	Ammonia, Total (as N) (mg/L)	0.0065	<0.0050			
	Chloride (Cl) (mg/L)	4.43	<0.50			
	Nitrate and Nitrite (as N) (mg/L)	0.174	<0.0051			
	Nitrate (as N) (mg/L)	0.174	<0.0050			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Sulfate (SO4) (mg/L)	55.3	<5.0			
	Anion Sum (meq/L)	6.12	<0.10			
	Cation Sum (meq/L)	6.11	<0.10			
	Cation - Anion Balance (%)	0.0	0.0			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.81	<0.50			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0200	<0.0030			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00025	<0.00010			
	Barium (Ba)-Total (mg/L)	0.0694	<0.000050			
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	0.028	<0.010			
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Total (mg/L)	61.9	<0.050			
	Chromium (Cr)-Total (mg/L)	0.00014	<0.00010			
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Total (mg/L)	0.00492	<0.00050			
	Iron (Fe)-Total (mg/L)	0.052	<0.010			
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Total (mg/L)	0.0038	<0.0010			
	Magnesium (Mg)-Total (mg/L)	27.4	<0.10			
	Manganese (Mn)-Total (mg/L)	0.0500	0.00017			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998026-1	L1998026-2	L1998026-3	L1998026-4	L1998026-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-SEP-17	25-SEP-17	25-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time	10:10	10:25	11:11	08:25	09:45
	Client ID	W17	W16	W8A	W3	W2
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	DLM <0.000025	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00592	0.00308	0.0121	0.00522	0.00154
	Nickel (Ni)-Total (mg/L)	0.00063	0.00083	0.00153	0.00101	0.00095
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.100	<0.050	<0.050
	Potassium (K)-Total (mg/L)	3.79	3.14	6.83	2.54	1.61
	Selenium (Se)-Total (mg/L)	0.000437	0.000688	0.00678	0.000283	0.000081
	Silicon (Si)-Total (mg/L)	5.22	3.78	8.01	6.75	6.37
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000065	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	15.6	14.9	38.7	19.9	10.2
	Strontium (Sr)-Total (mg/L)	0.697	0.635	2.16	0.769	0.463
	Sulfur (S)-Total (mg/L)	20.3	25.2	98.2	20.3	7.74
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	0.00570	0.0177	<0.00030	0.00055
	Uranium (U)-Total (mg/L)	0.00205	0.00145	0.00282	0.00276	0.00182
	Vanadium (V)-Total (mg/L)	<0.00050	0.00083	0.00283	<0.00050	0.00062
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0099	0.261	<0.0030	0.0032
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00039	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0015	0.0327	0.0110	0.0030	0.0040
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00039	0.00043	0.00055	0.00023	0.00041
	Barium (Ba)-Dissolved (mg/L)	0.0812	0.0873	0.129	0.0723	0.0705
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.031	0.028	0.028	0.025	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.000275	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	60.7	59.8	154	58.7	42.6
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00012	0.00038	<0.00010	0.00020
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00087	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00681	0.0272	0.106	0.00300	0.00188
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.093	0.439	0.021	0.050
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0014	0.0011	0.0039	0.0036	0.0016
	Magnesium (Mg)-Dissolved (mg/L)	19.3	19.2	44.9	28.4	16.4
	Manganese (Mn)-Dissolved (mg/L)	0.00275	0.0640	1.86	0.0493	0.0135

	Sample ID	L1998026-6	L1998026-7			
	Description	Water	Water			
	Sampled Date	26-SEP-17	26-SEP-17			
	Sampled Time		09:45			
	Client ID	DUP	F-BL			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00490	<0.000050			
	Nickel (Ni)-Total (mg/L)	0.00095	<0.00050			
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050			
	Potassium (K)-Total (mg/L)	2.35	<0.10			
	Selenium (Se)-Total (mg/L)	0.000276	<0.000050			
	Silicon (Si)-Total (mg/L)	6.69	<0.10			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	18.7	<0.050			
	Strontium (Sr)-Total (mg/L)	0.773	<0.00020			
	Sulfur (S)-Total (mg/L)	20.0	<0.50			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00132	<0.00030			
	Uranium (U)-Total (mg/L)	0.00274	<0.000010			
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030			
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0036	<0.0010			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00021	<0.00010			
	Barium (Ba)-Dissolved (mg/L)	0.0714	<0.000050			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	0.025	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	58.8	<0.050			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00236	0.00022 RRV			
	Iron (Fe)-Dissolved (mg/L)	0.019	<0.010			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0037	<0.0010			
	Magnesium (Mg)-Dissolved (mg/L)	27.8	<0.10			
	Manganese (Mn)-Dissolved (mg/L)	0.0477	<0.00010			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1998026-1	L1998026-2	L1998026-3	L1998026-4	L1998026-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-SEP-17	25-SEP-17	25-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time	10:10	10:25	11:11	08:25	09:45
	Client ID	W17	W16	W8A	W3	W2
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00557	0.00276	0.0111	0.00450	0.00136
	Nickel (Ni)-Dissolved (mg/L)	0.00068	0.00081	0.00164	0.00094	0.00106
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.98	3.22	7.05	2.50	1.78
	Selenium (Se)-Dissolved (mg/L)	0.000511	0.000787	0.00737	0.000282	0.000116
	Silicon (Si)-Dissolved (mg/L)	5.30	3.73	7.50	6.55	6.25
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000015	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	16.1	15.4	39.9	19.3	10.9
	Strontium (Sr)-Dissolved (mg/L)	0.660	0.582	2.02	0.751	0.434
	Sulfur (S)-Dissolved (mg/L)	18.4	22.5	89.5	19.6	7.40
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00151	DLM <0.00060	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00195	0.00129	0.00266	0.00252	0.00176
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00113	<0.00050	0.00051
	Zinc (Zn)-Dissolved (mg/L)	0.0024	0.0043	0.296	<0.0010	0.0052
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00037	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1998026-6 Water 26-SEP-17 DUP	L1998026-7 Water 26-SEP-17 09:45 F-BL			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00452	<0.000050			
	Nickel (Ni)-Dissolved (mg/L)	0.00091	<0.00050			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	2.46	<0.10			
	Selenium (Se)-Dissolved (mg/L)	0.000289	<0.000050			
	Silicon (Si)-Dissolved (mg/L)	6.48	<0.050			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	19.0	<0.050			
	Strontium (Sr)-Dissolved (mg/L)	0.763	<0.00020			
	Sulfur (S)-Dissolved (mg/L)	19.4	<0.50			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00259	<0.000010			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Laboratory Control Sample	Manganese (Mn)-Total	MES	L1998026-1, -2, -3, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1998026-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Dissolved Organic Carbon	MS-B	L1998026-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1998026-1, -2, -3, -5, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1998026-1, -2, -3, -5, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1998026-1, -2, -3, -5, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1998026-1, -2, -3, -5, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1998026-1, -2, -3, -5, -7
Matrix Spike	Barium (Ba)-Total	MS-B	L1998026-1, -2, -3, -7
Matrix Spike	Calcium (Ca)-Total	MS-B	L1998026-1, -2, -3, -7
Matrix Spike	Magnesium (Mg)-Total	MS-B	L1998026-1, -2, -3, -7
Matrix Spike	Sodium (Na)-Total	MS-B	L1998026-1, -2, -3, -7
Matrix Spike	Strontium (Sr)-Total	MS-B	L1998026-1, -2, -3, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

Reference Information

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-09-26 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1998026-COFC

COC Number: 2017-09-26 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)	
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report ☑ YES ☐ NO	
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days):
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY:
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	226973 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** CH/EB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W17	25-Sep-17	10:10	Water	R	R	R	R	R	R	R	R	R					7
	W16	25-Sep-17	10:25	Water	R	R	R	R	R	R	R	R	R					7
	W8A	25-Sep-17	11:11	Water	R	R	R	R	R	R	R	R	R					6
	W3	26-Sep-17	8:25	Water	R	R	R	R	R	R	R	R	R					7
	W2	26-Sep-17	9:45	Water	R	R	R	R	R	R	R	R	R					7
	DUP	26-Sep-17		Water	R	R	R	R	R	R	R	R	R					7
	F-BL	26-Sep-17	9:45	Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time
Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4°C.			2°C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-09-26 8:00	Time:	Received by:	Date: Sept 27/17.	Time: 09:05	Received by:	Date: Sep 28/17	Time: 10:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2016 FRONT

A.M.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 04-OCT-17
Report Date: 19-OCT-17 18:24 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2002445
Project P.O. #: 226973 (WUL)
Job Reference:
C of C Numbers: 2017-10-03 A
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L2002445-1	L2002445-2	L2002445-3	L2002445-4	L2002445-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	03-OCT-17	03-OCT-17	03-OCT-17	03-OCT-17	03-OCT-17
	Sampled Time	08:55	09:35	10:00	10:30	13:15
	Client ID	W3	W35	W15	W30	BC
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	541	312	706	478	220
	Hardness (as CaCO3) (mg/L)	261	149	352	212	101
	pH (pH)	8.29	7.99	8.21	8.27	8.14
	Total Suspended Solids (mg/L)	<3.0	52.6	3.2	13.5	3.3
	TDS (Calculated) (mg/L)	311	178	447	280	123
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	239	125	216	146	106
	Alkalinity, Carbonate (as CaCO3) (mg/L)	2.8	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	242	125	216	146	106
	Ammonia, Total (as N) (mg/L)	0.0053	0.0148	0.0095	0.0239	<0.0050
	Chloride (Cl) (mg/L)	4.36	0.89	2.77	2.78	0.59
	Nitrate and Nitrite (as N) (mg/L)	0.180	6.57	7.99	0.213	0.0517
	Nitrate (as N) (mg/L)	0.180	6.56	7.98	0.210	0.0517
	Nitrite (as N) (mg/L)	<0.0010	0.0098	0.0055	0.0032	<0.0010
	Sulfate (SO4) (mg/L)	54.3	14.8	140	101	16.0
	Anion Sum (meq/L)	6.09	3.29	7.88	5.11	2.46
	Cation Sum (meq/L)	6.10	3.30	7.71	4.91	2.37
	Cation - Anion Balance (%)	0.1	0.1	-1.1	-2.1	-1.8
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.80	20.0	15.1	9.22	8.02
Total Metals	Aluminum (Al)-Total (mg/L)	0.0051	1.60	0.0317	0.357	0.0378
	Antimony (Sb)-Total (mg/L)	0.00017	0.00022	0.00021	0.00021	0.00026
	Arsenic (As)-Total (mg/L)	0.00022	0.00068	0.00036	0.00067	0.00068
	Barium (Ba)-Total (mg/L)	0.0684	0.0920	0.0835	0.0980	0.0662
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000074	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.032	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000279	<0.0000050	0.0000131	0.0000086
	Calcium (Ca)-Total (mg/L)	56.1	39.7	99.2	51.5	24.3
	Chromium (Cr)-Total (mg/L)	0.00012	0.00120	0.00027	0.00031	0.00026
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00098	0.00013	0.00025	<0.00010
	Copper (Cu)-Total (mg/L)	0.00257	0.156	0.00874	0.0445	0.00203
	Iron (Fe)-Total (mg/L)	0.026	2.69	0.234	0.627	0.091
	Lead (Pb)-Total (mg/L)	<0.000050	0.000616	<0.000050	0.000246	<0.000050
	Lithium (Li)-Total (mg/L)	0.0030	0.0013	<0.0010	0.0018	0.0012
	Magnesium (Mg)-Total (mg/L)	29.4	14.4	27.8	23.6	10.2
	Manganese (Mn)-Total (mg/L)	0.0494	0.100	0.0377	0.119	0.0173

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002445-6	L2002445-7			
	Description	WATER	WATER			
	Sampled Date	03-OCT-17	03-OCT-17			
	Sampled Time	13:40	14:30			
	Client ID	W2	W7			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	358	288			
	Hardness (as CaCO3) (mg/L)	174	139			
	pH (pH)	8.15	8.28			
	Total Suspended Solids (mg/L)	23.9	4.9			
	TDS (Calculated) (mg/L)	199	157			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	174	150			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	174	150			
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0148			
	Chloride (Cl) (mg/L)	1.90	<0.50			
	Nitrate and Nitrite (as N) (mg/L)	0.0162	0.118			
	Nitrate (as N) (mg/L)	0.0162	0.118			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Sulfate (SO4) (mg/L)	22.0	10.1			
	Anion Sum (meq/L)	3.98	3.21			
	Cation Sum (meq/L)	3.95	3.16			
	Cation - Anion Balance (%)	-0.4	-0.9			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	8.91	8.44			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0098	0.741			
	Antimony (Sb)-Total (mg/L)	0.00017	0.00018			
	Arsenic (As)-Total (mg/L)	0.00038	0.00075			
	Barium (Ba)-Total (mg/L)	0.0666	0.0931			
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000033			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Total (mg/L)	0.0000068	0.0000139			
	Calcium (Ca)-Total (mg/L)	45.2	35.5			
	Chromium (Cr)-Total (mg/L)	0.00018	0.00161			
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00074			
	Copper (Cu)-Total (mg/L)	0.00171	0.00230			
	Iron (Fe)-Total (mg/L)	0.078	1.36			
	Lead (Pb)-Total (mg/L)	<0.000050	0.000385			
	Lithium (Li)-Total (mg/L)	0.0015	0.0013			
	Magnesium (Mg)-Total (mg/L)	15.8	13.8			
	Manganese (Mn)-Total (mg/L)	0.0197	0.0994			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002445-1	L2002445-2	L2002445-3	L2002445-4	L2002445-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	03-OCT-17	03-OCT-17	03-OCT-17	03-OCT-17	03-OCT-17
	Sampled Time	08:55	09:35	10:00	10:30	13:15
	Client ID	W3	W35	W15	W30	BC
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00471	0.000864	0.00227	0.00145	0.00125
	Nickel (Ni)-Total (mg/L)	0.00097	0.00196	0.00086	0.00068	0.00114
	Phosphorus (P)-Total (mg/L)	<0.050	0.083	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.31	1.02	2.78	3.74	0.82
	Selenium (Se)-Total (mg/L)	0.000369	0.000145	0.00184	0.000707	0.000056
	Silicon (Si)-Total (mg/L)	6.60	8.86	5.47	1.33	6.37
	Silver (Ag)-Total (mg/L)	<0.000010	0.000058	<0.000010	0.000016	<0.000010
	Sodium (Na)-Total (mg/L)	18.7	7.17	13.9	13.9	7.74
	Strontium (Sr)-Total (mg/L)	0.763	0.236	0.793	0.525	0.271
	Sulfur (S)-Total (mg/L)	18.8	5.27	50.9	36.0	5.71
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000017	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	0.0657	0.00161	0.0165	DLM <0.00090
	Uranium (U)-Total (mg/L)	0.00299	0.000181	0.00233	0.000532	0.00321
	Vanadium (V)-Total (mg/L)	<0.00050	0.00573	0.00059	0.00141	0.00087
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0165	0.0050	0.0066	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00041	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0025	0.0157	0.0088	0.0031	0.0135
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00010	<0.00010	0.00014
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00029	0.00031	0.00055	0.00058
	Barium (Ba)-Dissolved (mg/L)	0.0693	0.0724	0.0808	0.0864	0.0649
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.028	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000050	0.0000085	<0.0000050	<0.0000050	0.0000069
	Calcium (Ca)-Dissolved (mg/L)	55.5	38.1	95.4	48.8	23.9
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00034	0.00019	<0.00010	0.00021
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00278	0.0194	0.00719	0.00987	0.00186
	Iron (Fe)-Dissolved (mg/L)	0.021	0.045	0.100	0.026	0.047
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0029	<0.0010	<0.0010	0.0016	0.0011
	Magnesium (Mg)-Dissolved (mg/L)	29.8	13.1	27.6	21.9	10.0
	Manganese (Mn)-Dissolved (mg/L)	0.0472	0.0343	0.0296	0.00672	0.0150

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002445-6	L2002445-7			
	Description	WATER	WATER			
	Sampled Date	03-OCT-17	03-OCT-17			
	Sampled Time	13:40	14:30			
	Client ID	W2	W7			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00141	0.00128			
	Nickel (Ni)-Total (mg/L)	0.00104	0.00278			
	Phosphorus (P)-Total (mg/L)	<0.050	0.108			
	Potassium (K)-Total (mg/L)	1.58	1.16			
	Selenium (Se)-Total (mg/L)	0.000085	0.000108			
	Silicon (Si)-Total (mg/L)	6.46	7.85			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	10.3	8.19			
	Strontium (Sr)-Total (mg/L)	0.475	0.386			
	Sulfur (S)-Total (mg/L)	7.82	3.59			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	0.00045	0.0302			
	Uranium (U)-Total (mg/L)	0.00225	0.00153			
	Vanadium (V)-Total (mg/L)	0.00058	0.00318			
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0055			
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0045	0.0053			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00036	0.00042			
	Barium (Ba)-Dissolved (mg/L)	0.0685	0.0702			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000051	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	43.9	34.5			
	Chromium (Cr)-Dissolved (mg/L)	0.00013	0.00017			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00170	0.00091			
	Iron (Fe)-Dissolved (mg/L)	0.060	0.102			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.0015	<0.0010			
	Magnesium (Mg)-Dissolved (mg/L)	15.5	12.8			
	Manganese (Mn)-Dissolved (mg/L)	0.0184	0.0405			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002445-1	L2002445-2	L2002445-3	L2002445-4	L2002445-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	03-OCT-17	03-OCT-17	03-OCT-17	03-OCT-17	03-OCT-17
	Sampled Time	08:55	09:35	10:00	10:30	13:15
	Client ID	W3	W35	W15	W30	BC
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00456	0.000767	0.00219	0.00137	0.00119
	Nickel (Ni)-Dissolved (mg/L)	0.00095	0.00123	0.00080	<0.00050	0.00107
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.31	0.62	2.68	3.36	0.81
	Selenium (Se)-Dissolved (mg/L)	0.000334	0.000112	0.00194	0.000665	0.000070
	Silicon (Si)-Dissolved (mg/L)	6.56	5.68	5.40	0.560	6.31
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	18.8	6.86	13.7	13.2	7.56
	Strontium (Sr)-Dissolved (mg/L)	0.736	0.225	0.804	0.512	0.264
	Sulfur (S)-Dissolved (mg/L)	19.1	5.05	49.6	33.6	5.37
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00087	0.00050	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00292	0.000136	0.00234	0.000466	0.00305
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	0.00066
	Zinc (Zn)-Dissolved (mg/L)	0.0013	0.0028	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2002445-6 WATER 03-OCT-17 13:40 W2	L2002445-7 WATER 03-OCT-17 14:30 W7			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00130	0.00137			
	Nickel (Ni)-Dissolved (mg/L)	0.00103	0.00083			
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050			
	Potassium (K)-Dissolved (mg/L)	1.56	1.02			
	Selenium (Se)-Dissolved (mg/L)	0.000074	0.000154			
	Silicon (Si)-Dissolved (mg/L)	6.28	6.32			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	10.1	7.95			
	Strontium (Sr)-Dissolved (mg/L)	0.465	0.377			
	Sulfur (S)-Dissolved (mg/L)	7.43	3.36			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030			
	Uranium (U)-Dissolved (mg/L)	0.00212	0.00146			
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00057			
	Zinc (Zn)-Dissolved (mg/L)	0.0016	<0.0010			
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030			

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Barium (Ba)-Total	MS-B	L2002445-3
Matrix Spike	Calcium (Ca)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Calcium (Ca)-Total	MS-B	L2002445-3
Matrix Spike	Copper (Cu)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2002445-3
Matrix Spike	Manganese (Mn)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Manganese (Mn)-Total	MS-B	L2002445-3
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Potassium (K)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sodium (Na)-Total	MS-B	L2002445-3
Matrix Spike	Strontium (Sr)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Strontium (Sr)-Total	MS-B	L2002445-3
Matrix Spike	Sulfur (S)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7
Matrix Spike	Sulfur (S)-Total	MS-B	L2002445-3
Matrix Spike	Uranium (U)-Total	MS-B	L2002445-1, -2, -3, -4, -5, -6, -7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Reference Information

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in $CaCO_3$ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Reference Information

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-10-03 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2002445-COFC

COC Number: 2017-10-03 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: [illegible]

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information	
ALS Account # / Quote #:	
Job #:	
PO / AFE:	226973 (WUL)
LSD:	
ALS Lab Work Order # (lab use only)	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: **Shane Stack**	**Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	3-Oct-17	8:55	Water	R	R	R	R	R	R	R	R	R					7
	W35	3-Oct-17	9:35	Water	R	R	R	R	R	R	R	R	R					7
	W15	3-Oct-17	10:00	Water	R	R	R	R	R	R	R	R	R					7
	W30	3-Oct-17	10:30	Water	R	R	R	R	R	R	R	R	R					7
	BC	3-Oct-17	13:15	Water	R	R	R	R	R	R	R	R	R					7
	W2	3-Oct-17	13:40	Water	R	R	R	R	R	R	R	R	R					7
	W7	3-Oct-17	14:30	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐
Ice Packs	☒	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐					

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6.0			8		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Corey Roberts	Date:2017-10-03	Time:	Received by: GHF	Date: 4 Oct 2017	Time: 14:50	Received by: JC	Date: OCT - 5 2017	Time: 13:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 12-OCT-17
Report Date: 23-OCT-17 19:17 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2006096

Project P.O. #: 226973 (WUL)
Job Reference:
C of C Numbers: 2017-10-11 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2006096-1	L2006096-2	L2006096-3	L2006096-4	L2006096-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	07-OCT-17	07-OCT-17	07-OCT-17	09-OCT-17	09-OCT-17
	Sampled Time	14:45	15:30	15:55	10:10	10:30
	Client ID	C4	W46	W6	W17	W16
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	306	337	224	498	489
	Hardness (as CaCO3) (mg/L)	158	168	113	238	235
	pH (pH)	8.31	8.35	8.21	8.36	8.35
	Total Suspended Solids (mg/L)	<3.0	4.5	<3.0	<3.0	63.5
	TDS (Calculated) (mg/L)	174	197	122	290	299
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	160	171	121	202	184
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	3.2	7.4
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	160	171	121	205	191
	Ammonia, Total (as N) (mg/L)	0.0089	0.0108	<0.0050	<0.0050	0.0726
	Chloride (Cl) (mg/L)	0.88	1.86	0.97	6.56	7.04
	Nitrate and Nitrite (as N) (mg/L)	0.0269	0.113	<0.0051	0.284	1.89
	Nitrate (as N) (mg/L)	0.0269	0.113	<0.0050	0.284	1.88
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	0.0085
	Sulfate (SO4) (mg/L)	13.4	22.5	2.57	57.8	69.6
	Anion Sum (meq/L)	3.51	3.96	2.51	5.52	5.61
	Cation Sum (meq/L)	3.51	3.86	2.49	5.49	5.42
	Cation - Anion Balance (%)	0.0	-1.3	-0.4	-0.3	-1.8
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	11.3	7.65	9.73	8.78	12.7
Total Metals	Aluminum (Al)-Total (mg/L)	0.0103	0.0247	0.0067	0.0041	1.65
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	0.00010
	Arsenic (As)-Total (mg/L)	0.00070	0.00048	0.00048	0.00038	0.00085
	Barium (Ba)-Total (mg/L)	0.0660	0.0701	0.0507	0.0728	0.102
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	0.000080
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	0.030	0.028
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000182
	Calcium (Ca)-Total (mg/L)	40.7	41.3	34.0	64.7	65.9
	Chromium (Cr)-Total (mg/L)	0.00032	0.00024	0.00025	0.00015	0.00139
	Cobalt (Co)-Total (mg/L)	0.00020	0.00011	<0.00010	<0.00010	0.00118
	Copper (Cu)-Total (mg/L)	0.00150	0.00148	0.00095	0.00648	0.0638
	Iron (Fe)-Total (mg/L)	0.444	0.178	0.098	<0.010	2.73
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	0.000563
	Lithium (Li)-Total (mg/L)	0.0015	0.0016	<0.0010	0.0016	0.0027
	Magnesium (Mg)-Total (mg/L)	13.3	16.7	8.52	19.5	19.9
	Manganese (Mn)-Total (mg/L)	0.105	0.0577	0.0362	0.0140	0.305

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2006096-6	L2006096-7	L2006096-8	L2006096-9	L2006096-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	09-OCT-17	09-OCT-17	10-OCT-17	10-OCT-17	10-OCT-17
	Sampled Time	11:00	15:00	08:50	11:10	13:50
	Client ID	W8A	MN	W3	BC	MC1
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	1060	556	533	226	357
	Hardness (as CaCO3) (mg/L)	591	203	267	106	181
	pH (pH)	8.24	8.05	8.42	8.20	8.37
	Total Suspended Solids (mg/L)	36.3	29.7	<3.0	<3.0	3.5
	TDS (Calculated) (mg/L)	758	362	317	127	206
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	362	80.3	237	107	174
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	7.2	<1.0	7.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	362	80.3	244	107	181
	Ammonia, Total (as N) (mg/L)	0.108	0.612	<0.0050	<0.0050	0.0053
	Chloride (Cl) (mg/L)	9.0	1.81	4.45	0.64	1.62
	Nitrate and Nitrite (as N) (mg/L)	6.41	26.0	0.189	0.0764	0.0848
	Nitrate (as N) (mg/L)	6.31	25.9	0.189	0.0764	0.0848
	Nitrite (as N) (mg/L)	0.106	0.105	<0.0010	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	248	89.7	55.8	17.2	21.2
	Anion Sum (meq/L)	13.1	5.47	6.21	2.53	4.14
	Cation Sum (meq/L)	13.8	5.35	6.22	2.49	4.12
	Cation - Anion Balance (%)	2.4	-1.1	0.1	-0.8	-0.3
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)			5.56	7.37	8.36
Total Metals	Aluminum (Al)-Total (mg/L)	0.326	0.529	0.0067	0.0213	0.0665
	Antimony (Sb)-Total (mg/L)	0.00011	0.00035	<0.00010	0.00021	<0.00010
	Arsenic (As)-Total (mg/L)	0.00070	0.00052	0.00025	0.00067	0.00055
	Barium (Ba)-Total (mg/L)	0.123	0.0407	0.0684	0.0698	0.0618
	Beryllium (Be)-Total (mg/L)	0.000029	0.000022	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.029	0.114	0.027	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	0.000356	0.0000891	<0.0000050	0.0000056	<0.0000050
	Calcium (Ca)-Total (mg/L)	167	67.6	59.5	26.3	45.8
	Chromium (Cr)-Total (mg/L)	0.00075	0.00288	0.00012	0.00024	0.00034
	Cobalt (Co)-Total (mg/L)	0.00090	0.00032	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.197	0.0793	0.00241	0.00189	0.00164
	Iron (Fe)-Total (mg/L)	2.37	0.726	0.028	0.064	0.191
	Lead (Pb)-Total (mg/L)	0.000195	0.000338	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0042	0.0057	0.0036	0.0016	0.0017
	Magnesium (Mg)-Total (mg/L)	46.3	9.71	29.6	10.5	16.7
	Manganese (Mn)-Total (mg/L)	2.00	0.0618	0.0517	0.0184	0.0175

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2006096-1	L2006096-2	L2006096-3	L2006096-4	L2006096-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	07-OCT-17	07-OCT-17	07-OCT-17	09-OCT-17	09-OCT-17
	Sampled Time	14:45	15:30	15:55	10:10	10:30
	Client ID	C4	W46	W6	W17	W16
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	DLM <0.000025
	Molybdenum (Mo)-Total (mg/L)	0.000852	0.00206	0.000642	0.00594	0.00304
	Nickel (Ni)-Total (mg/L)	0.00168	0.00111	0.00146	0.00078	0.00200
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	0.130
	Potassium (K)-Total (mg/L)	1.10	1.36	0.49	3.59	3.30
	Selenium (Se)-Total (mg/L)	0.000092	0.000154	<0.000050	0.000420	0.000645
	Silicon (Si)-Total (mg/L)	6.45	6.50	7.79	5.52	7.60
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000020
	Sodium (Na)-Total (mg/L)	7.07	10.9	4.80	15.4	14.5
	Strontium (Sr)-Total (mg/L)	0.277	0.461	0.151	0.688	0.640
	Sulfur (S)-Total (mg/L)	4.94	8.33	1.12	20.8	25.3
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	0.000013
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	DLM <0.00090	0.00168	0.00031	<0.00030	0.0885
	Uranium (U)-Total (mg/L)	0.000787	0.00145	0.000195	0.00198	0.00142
	Vanadium (V)-Total (mg/L)	<0.00050	0.00076	0.00052	<0.00050	0.00640
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	0.0108
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00049
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0048	0.0066	0.0047	0.0037	0.0034
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00070	0.00045	0.00050	0.00036	0.00044
	Barium (Ba)-Dissolved (mg/L)	0.0660	0.0695	0.0505	0.0736	0.0845
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	<0.010	0.029	0.025
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000075
	Calcium (Ca)-Dissolved (mg/L)	41.8	40.7	31.6	64.1	63.0
	Chromium (Cr)-Dissolved (mg/L)	0.00023	0.00011	0.00019	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	0.00021	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00087	0.00140	0.00092	0.00604	0.0217
	Iron (Fe)-Dissolved (mg/L)	0.354	0.132	0.083	<0.010	0.048
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0013	0.0014	<0.0010	0.0014	0.0012
	Magnesium (Mg)-Dissolved (mg/L)	13.0	16.2	8.40	18.9	19.0
	Manganese (Mn)-Dissolved (mg/L)	0.102	0.0546	0.0357	0.00269	0.202

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2006096-6	L2006096-7	L2006096-8	L2006096-9	L2006096-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	09-OCT-17	09-OCT-17	10-OCT-17	10-OCT-17	10-OCT-17
	Sampled Time	11:00	15:00	08:50	11:10	13:50
	Client ID	W8A	MN	W3	BC	MC1
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.0116	0.0253	0.00502	0.00145	0.00178
	Nickel (Ni)-Total (mg/L)	0.00149	<0.00050	0.00105	0.00113	0.00119
	Phosphorus (P)-Total (mg/L)	0.103	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	6.84	3.96	2.36	0.87	1.38
	Selenium (Se)-Total (mg/L)	0.00687	0.0181	0.000282	0.000070	0.000135
	Silicon (Si)-Total (mg/L)	8.37	3.90	6.72	6.17	6.80
	Silver (Ag)-Total (mg/L)	0.000038	0.000027	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	39.1	26.2	19.1	8.08	10.7
	Strontium (Sr)-Total (mg/L)	2.21	1.76	0.778	0.288	0.458
	Sulfur (S)-Total (mg/L)	102	32.9	20.5	6.16	7.89
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	0.00041	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0186	0.0176	0.00045	0.00067	<0.0030 DLM
	Uranium (U)-Total (mg/L)	0.00277	0.000950	0.00269	0.00300	0.00156
	Vanadium (V)-Total (mg/L)	0.00291	0.00208	<0.00050	0.00078	0.00083
	Zinc (Zn)-Total (mg/L)	0.180	0.0082	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	0.00038	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0100	0.0031	0.0019	0.0109	0.0036
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00024	<0.00010	0.00015	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00057	0.00043	0.00023	0.00065	0.00051
	Barium (Ba)-Dissolved (mg/L)	0.115	0.0349	0.0683	0.0675	0.0602
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.026	0.103	0.024	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.000300	0.0000733	0.0000054	0.0000081	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	163	65.7	57.9	25.4	45.7
	Chromium (Cr)-Dissolved (mg/L)	0.00042	0.00047	<0.00010	0.00017	0.00017
	Cobalt (Co)-Dissolved (mg/L)	0.00070	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.104	0.0314	0.00228	0.00178	0.00135
	Iron (Fe)-Dissolved (mg/L)	0.374	<0.010	0.020	0.041	0.070
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	0.000110	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0037	0.0050	0.0034	0.0013	0.0016
	Magnesium (Mg)-Dissolved (mg/L)	44.9	9.56	29.6	10.4	16.3
	Manganese (Mn)-Dissolved (mg/L)	1.78	0.0351	0.0471	0.0166	0.00785

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2006096-1 Water 07-OCT-17 14:45 C4	L2006096-2 Water 07-OCT-17 15:30 W46	L2006096-3 Water 07-OCT-17 15:55 W6	L2006096-4 Water 09-OCT-17 10:10 W17	L2006096-5 Water 09-OCT-17 10:30 W16
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.000729	0.00182	0.000413	0.00532	0.00271
	Nickel (Ni)-Dissolved (mg/L)	0.00151	0.00095	0.00128	0.00062	0.00077
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	1.10	1.34	0.49	3.61	2.96
	Selenium (Se)-Dissolved (mg/L)	0.000088	0.000167	0.000061	0.000473	0.000767
	Silicon (Si)-Dissolved (mg/L)	6.05	6.19	7.53	5.36	3.91
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	6.94	10.5	4.79	14.9	14.3
	Strontium (Sr)-Dissolved (mg/L)	0.287	0.457	0.140	0.687	0.611
	Sulfur (S)-Dissolved (mg/L)	4.63	7.77	0.94	20.3	24.9
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000818	0.00142	0.000171	0.00192	0.00130
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00055	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0012	<0.0010	<0.0010	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

	Sample ID	L2006096-6	L2006096-7	L2006096-8	L2006096-9	L2006096-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	09-OCT-17	09-OCT-17	10-OCT-17	10-OCT-17	10-OCT-17
	Sampled Time	11:00	15:00	08:50	11:10	13:50
	Client ID	W8A	MN	W3	BC	MC1
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0112	0.0228	0.00442	0.00118	0.00154
	Nickel (Ni)-Dissolved (mg/L)	0.00131	<0.00050	0.00092	0.00116	0.00091
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	6.63	3.82	2.36	0.86	1.36
	Selenium (Se)-Dissolved (mg/L)	0.00758	0.0199	0.000352	<0.000050	0.000117
	Silicon (Si)-Dissolved (mg/L)	7.56	2.67	6.56	5.84	6.42
	Silver (Ag)-Dissolved (mg/L)	0.000013	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	38.6	26.3	19.2	7.99	10.5
	Strontium (Sr)-Dissolved (mg/L)	2.12	1.68	0.762	0.274	0.454
	Sulfur (S)-Dissolved (mg/L)	96.8	31.7	20.6	5.85	7.54
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	0.00012	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	DLM <0.00060	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00250	0.000882	0.00255	0.00287	0.00150
	Vanadium (V)-Dissolved (mg/L)	0.00122	<0.00050	<0.00050	0.00064	0.00051
	Zinc (Zn)-Dissolved (mg/L)	0.110	0.0027	<0.0010	0.0034	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	0.00047	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
WSMT	Water sample(s) for total mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L2006096-1, -10, -2, -3, -4, -5, -8, -9
Matrix Spike	Nitrate (as N)	MS-B	L2006096-7
Matrix Spike	Sulfate (SO4)	MS-B	L2006096-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are

Reference Information

included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-10-11 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2006096-COFC

COC Number: 2017-10-11 A

Page of

Report To	Contact and company name below will appear on the final report		
Company:	Minto Explorations Ltd.		
Contact:	Minto Environment - Coordinator		
Phone:	1-604-759-4659		
	Company address below will appear on the final report		
Street:	2100-510 West Georgia St.		
City/Province:	Vancouver, British Columbia		
Postal Code:	V6B 0M3		
Invoice To	Same as Report To	☐ YES	☑ NO
	Copy of Invoice with Report	☐ YES	☑ NO
Company:	Minto Explorations Ltd.		
Contact:	Ruth Cayetano		

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack

Sampler: SR/CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	C4	7-Oct-17	14:45	Water	R	R	R	R	R	R	R	R	R					7
	W46	7-Oct-17	15:30	Water	R	R	R	R	R	R	R	R	R					7
	W6	7-Oct-17	15:55	Water	R	R	R	R	R	R	R	R	R					7
	W17	9-Oct-17	10:10	Water	R	R	R	R	R	R	R	R	R					7
	W16	9-Oct-17	10:30	Water	R	R	R	R	R	R	R	R	R					7
	W8A	9-Oct-17	11:00	Water	R	R	R	R	R	R	R	R						6
	MN	9-Oct-17	15:00	Water	R	R	R	R	R	R	R	R						6
	W3	10-Oct-17	8:50	Water	R	R	R	R	R	R	R	R	R					7
	BC	10-Oct-17	11:10	Water	R	R	R	R	R	R	R	R	R					7
	MC1	10-Oct-17	13:50	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1°C	2°C				

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-10-11	Time: 11:00	Received by:	Date: OCT 12/17	Time: 11:39	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 18-OCT-17
Report Date: 02-NOV-17 19:31 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2009424

Project P.O. #: 226973 (WUL)
Job Reference:
C of C Numbers: 2017-10-18A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2009424-1	L2009424-2	L2009424-3	L2009424-4	L2009424-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	17-OCT-17	17-OCT-17	17-OCT-17	17-OCT-17	17-OCT-17
	Sampled Time	09:35	10:00	14:20	14:45	
	Client ID	W3	W8A	BC	W2	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	524	1290	228	351	532
	Hardness (as CaCO3) (mg/L)	250	633	107	182	257
	pH (pH)	8.41	7.88	8.20	8.35	8.40
	Total Suspended Solids (mg/L)	<3.0	4.0	<3.0	<3.0	<3.0
	TDS (Calculated) (mg/L)	309	884	128	208	316
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	230	413	107	172	235
	Alkalinity, Carbonate (as CaCO3) (mg/L)	11.0	<1.0	<1.0	5.4	11.4
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	241	413	107	178	246
	Ammonia, Total (as N) (mg/L)	0.0054	0.149	<0.0050	<0.0050	0.0057
	Chloride (Cl) (mg/L)	4.42	12.0	0.70	1.99	4.49
	Nitrate and Nitrite (as N) (mg/L)	0.196	6.60	0.0865	0.126	0.200
	Nitrate (as N) (mg/L)	0.196	6.36	0.0865	0.126	0.200
	Nitrite (as N) (mg/L)	<0.0010	0.246	<0.0010	<0.0010	<0.0010
	Sulfate (SO4) (mg/L)	55.6	319	17.6	23.7	56.3
	Anion Sum (meq/L)	6.10	15.7	2.54	4.11	6.24
	Cation Sum (meq/L)	5.88	14.9	2.52	4.14	6.04
	Cation - Anion Balance (%)	-1.9	-2.8	-0.5	0.5	-1.6
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.35		6.97	7.48	5.42
Total Metals	Aluminum (Al)-Total (mg/L)	0.0055	0.0666	0.0151	0.0183	0.0046
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00013	0.00015	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00025	0.00061	0.00062	0.00038	0.00023
	Barium (Ba)-Total (mg/L)	0.0653	0.124	0.0610	0.0606	0.0619
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000024	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.029	0.039	<0.010	<0.010	0.029
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.000436	0.0000079	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	55.9	190	25.4	45.5	56.1
	Chromium (Cr)-Total (mg/L)	0.00013	0.00058	0.00018	0.00015	<0.00010
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00096	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.00266	0.147	0.00235	0.00151	0.00217
	Iron (Fe)-Total (mg/L)	0.025	1.01	0.045	0.063	0.025
	Lead (Pb)-Total (mg/L)	<0.000050	0.000076	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0042	0.0058	0.0018	0.0024	0.0043
	Magnesium (Mg)-Total (mg/L)	29.4	52.1	10.0	15.1	28.6
	Manganese (Mn)-Total (mg/L)	0.0524	2.50	0.0196	0.0123	0.0493

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2009424-1	L2009424-2	L2009424-3	L2009424-4	L2009424-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	17-OCT-17	17-OCT-17	17-OCT-17	17-OCT-17	17-OCT-17
	Sampled Time	09:35	10:00	14:20	14:45	
	Client ID	W3	W8A	BC	W2	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00479	0.0131	0.00135	0.00132	0.00478
	Nickel (Ni)-Total (mg/L)	0.00094	0.00121	0.00096	0.00086	0.00089
	Phosphorus (P)-Total (mg/L)	<0.050	0.055	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.35	7.69	0.90	1.56	2.27
	Selenium (Se)-Total (mg/L)	0.000298	0.00790	0.000054	0.000078	0.000287
	Silicon (Si)-Total (mg/L)	6.26	7.60	5.49	6.24	6.19
	Silver (Ag)-Total (mg/L)	<0.000010	0.000038	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	19.6	45.9	8.08	10.8	19.8
	Strontium (Sr)-Total (mg/L)	0.773	2.56	0.280	0.454	0.769
	Sulfur (S)-Total (mg/L)	19.9	123	5.75	8.30	19.4
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	0.00421	0.00044	0.00087	<0.00030
	Uranium (U)-Total (mg/L)	0.00291	0.00342	0.00323	0.00213	0.00285
	Vanadium (V)-Total (mg/L)	<0.00050	0.00196	0.00064	0.00051	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	0.109	<0.0030	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00045	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0014	0.0087	0.0083	0.0029	0.0016
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00011	0.00013	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00053	0.00061	0.00035	0.00023
	Barium (Ba)-Dissolved (mg/L)	0.0628	0.126	0.0645	0.0600	0.0637
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.027	0.032	<0.010	<0.010	0.027
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.000242	0.0000072	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	54.3	174	25.9	47.6	56.9
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00044	0.00014	0.00012	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00069	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00214	0.0725	0.00166	0.00147	0.00218
	Iron (Fe)-Dissolved (mg/L)	0.019	0.460	0.031	0.036	0.019
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0037	0.0047	0.0018	0.0024	0.0041
	Magnesium (Mg)-Dissolved (mg/L)	27.8	48.1	10.3	15.3	28.0
	Manganese (Mn)-Dissolved (mg/L)	0.0481	2.08	0.0185	0.0105	0.0465

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2009424-1	L2009424-2	L2009424-3	L2009424-4	L2009424-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	17-OCT-17	17-OCT-17	17-OCT-17	17-OCT-17	17-OCT-17
	Sampled Time	09:35	10:00	14:20	14:45	
	Client ID	W3	W8A	BC	W2	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00456	0.0122	0.00120	0.00126	0.00438
	Nickel (Ni)-Dissolved (mg/L)	0.00087	0.00125	0.00094	0.00081	0.00087
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.33	7.25	0.87	1.58	2.33
	Selenium (Se)-Dissolved (mg/L)	0.000293	0.00874	<0.000050	0.000080	0.000303
	Silicon (Si)-Dissolved (mg/L)	6.13	7.54	5.54	6.07	6.20
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000013	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	18.9	43.5	8.14	10.7	19.2
	Strontium (Sr)-Dissolved (mg/L)	0.782	2.59	0.284	0.491	0.767
	Sulfur (S)-Dissolved (mg/L)	18.6	115	5.74	7.89	19.3
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00063	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00269	0.00331	0.00327	0.00208	0.00279
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00120	0.00058	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.202 DTC	<0.0010	0.0012	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00048	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L2009424-1, -3, -4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L2009424-1, -2, -3, -4, -5
Matrix Spike	Sulfate (SO4)	MS-B	L2009424-5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Reference Information

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-10-18A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2009424-COFC

COC Number: 2017-10-18 A

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 226973 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack
Sampler: SR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Dissolved Solids (TDS)	P Total Metals (TM), Hardness	F/P Dissolved Metals (DM)(filtered and preserve	P Total Mercury, Hardness	F/P Dissolved Mercury [1] (Filtered + preserved)	P Total Nutrients (Ammonia)	F/P Dissolved Organic Carbon (DOC)					Number of Containers
	W3	17-Oct-17	9:35	Water	R	R	R	R	R	R	R	R	R					7
	W8A	17-Oct-17	10:00	Water	R	R	R	R	R	R	R	R						6
	BC	17-Oct-17	14:20	Water	R	R	R	R	R	R	R	R	R					7
	W2	17-Oct-17	14:45	Water	R	R	R	R	R	R	R	R	R					7
	DUP	17-Oct-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0			5	6	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-10-18	Time: 9:00	Received by: EHF	Date: 18 Oct 2017	Time: 14:40	Received by: Shayan	Date: Oct. 19	Time: 1425

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 24-OCT-17
Report Date: 22-NOV-17 16:19 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L2011956

Project P.O. #: 224159 (MMER)
Job Reference:
C of C Numbers: 2017.10.22A
Legal Site Desc:

Comments: Please note, this report contains only Nautilus Environmental reports (at the end of the attachment).

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID					
Grouping Analyte					

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location

Chain of Custody Numbers:

2017.10.22A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Toxicity testing on L2011956-1 W3

Sample collected October 22, 2017

Final Report

November 20, 2017

Submitted to: **ALS Environmental**
Burnaby, BC

TABLE OF CONTENTS

Page

List of Tables

List of Appendices

APPENDIX A – *Oncorhynchus mykiss* Toxicity Test Data
APPENDIX B – Chain-of-Custody Forms

SIGNATURE PAGE

A. Tang

Report By:
Kania Lywe, B.Sc.
Laboratory Biologist

Reviewed By:
Armando Tang, R.P.Bio
Senior Reviewer

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

SUMMARY

Sample Information and Test Type

Sample ID	L2011956-1 W3
Samples collection date	October 22, 2017
Samples receipt date	October 24, 2017
Samples receipt temperature	8.0°C
Test type	7-d rainbow trout (*Oncorhynchus mykiss*) embryo viability

Summary of Results

Endpoint	**L2011956-1 W3 (% v/v)**
Oncorhynchus mykiss	
Embryo viability EC25	>100
Embryo viability EC50	>100

EC = Effective Concentration

1.0 INTRODUCTION

Nautilus Environmental Company Inc. conducted an early life stage embryo toxicity test on rainbow trout (*Oncorhynchus mykiss*) for ALS Environmental. Sample L2011956-1 W3 was collected on October 22, 2017 and delivered to the Nautilus Environmental laboratory in Burnaby, BC on October 24, 2017. The sample was transported in five 20-L plastic containers and was received at a temperature of 8.0°C. The sample was stored in the dark at 4 ± 2°C prior to testing.

This report describes the results of these toxicity tests. Copies of raw laboratory data sheets and statistical analysis for each species are provided in Appendix A. The chain-of-custody form is provided in Appendix B.

2.0 METHODS

Methods for the toxicity test using rainbow trout are summarized in Table 1. The rainbow trout embryo viability test followed procedures described by Environment Canada (1998) and modified by Canaria *et al*. (1999). Statistical analyses were performed using CETIS (Tidepool Scientific Software, 2013).

Table 1. **Summary of test conditions: 7-d rainbow trout (*Oncorhynchus mykiss*) embryo viability test.**

Test species	*Oncorhynchus mykiss*
Organism source	Hatchery
Organism age	<30 minutes post fertilization, <24 hour old gametes
Test type	Static-renewal
Test duration	7 days
Test vessel	2-L plastic container
Test volume	2 L
Test solution depth	17 cm
Test concentrations	Five concentrations, plus laboratory control
Test replicates	4 per treatment
Number of organisms	30 per replicate
Control/dilution water	Dechlorinated Metro Vancouver municipal tapwater
Test solution renewal	Daily (80% renewal)
Test temperature	14 ± 1°C
Feeding	None
Light intensity	Dark
Photoperiod	24 hours dark
Aeration	Continuous gentle aeration
Test measurements	Temperature, dissolved oxygen, pH and conductivity measured daily; hardness and alkalinity of undiluted sample measured at test initiation; survival checked daily
Test protocol	Environment Canada (1998), EPS 1/RM/28; Canaria *et al.* (1999)
Statistical software	CETIS Version 1.8.7
Test endpoint	Embryo viability
Test acceptability criterion for controls	Embryo viability ≥70%
Reference toxicant	Sodium dodecyl sulphate (SDS)

3.0 RESULTS

Results of the toxicity test for sample L2011956-1 W3 are summarized in Table 2. Embryo viability in all test treatments was ≥90% and there were no adverse effects observed on embryo viability.

Table 2. Results: 7-d rainbow trout (*Oncorhynchus mykiss*) embryo viability test.

Concentration (% v/v)	**Embryo Viability (%) (Mean ± SD)**
Laboratory Control	93.3 ± 9.0
6.25	94.2 ± 9.6
12.5	94.2 ± 5.7
25	90.8 ± 12.0
50	95.8 ± 3.2
100	94.2 ± 7.4
Test Endpoint (% v/v)	
EC25	>100
EC50	>100

SD = Standard Deviation, EC = Effective Concentration

4.0 QA/QC

The health history of the test organisms used in the exposure was acceptable and met the requirements of the Environment Canada protocol. The test met all control acceptability criteria and water quality parameters remained within ranges specified in the protocol throughout the test. Uncertainty associated with the test is best described by the standard deviation around the mean and/or the confidence intervals around the point estimates.

The eggs were exposed using a blocked design; eggs from each of the four female fish were used in each of replicates A, B, C and D. This approach deviated from the Environment Canada method, which specifies that all the eggs should be pooled for testing. However, this modification was used because the egg quality from each female varied considerably and blocking would minimize the effects of poor quality eggs from any one particular female fish. However, the results were not affected as the control criterion was still met at the end of the test.

Results of the reference toxicant tests conducted during the testing program are summarized in Table 3. Result for this test fell within the acceptable range for organism performance of mean and two standard deviations, based on historical results obtained by the laboratory with this test. Thus, the sensitivity of the organisms used in these tests was appropriate. The reference toxicant was performed under the same conditions as those used for the samples.

Table 3. Reference toxicant test results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
O. mykiss	Viability (EC50): 4.0 mg/L SDS	4.3 (2.0 – 9.0)	45	October 24, 2017

SD = Standard Deviation, CV = Coefficient of Variation, EC = Effective Concentration

5.0 REFERENCES

Canaria, E.C., J.R. Elphick and H.C. Bailey. 1999. A simplified procedure for conducting small-scale short-term embryo toxicity tests with salmonids. *Environ. Toxicol.* 14:301-307.

Environment Canada. 1998. Biological test method: toxicity tests using early life stages of salmonid fish (rainbow trout). Environmental Protection Series EPS 1/RM/28. Second Edition, July 1998. Environment Canada, Method Development and Application Section, Environmental Technology Centre, Ottawa, ON. 102 pp.

Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 Tidepool Scientific Software, McKinleyville, CA. 222 pp.

APPENDIX A – *Oncorhynchus mykiss* Toxicity Test Data

Rainbow Trout Early Life Stage Summary Sheet

Client: ALS

Start Date/Time: Oct24/17 @1610h

Work Order No.: 171215

Test Species: *Oncorhynchus mykiss*

Sample Information:

Sample ID: L2011956-1 W3
Sample Date: Oct22/17
Date Received: Oct24/17
Sample Volume: 5x20L

Dilution Water:

Type: Dechlorinated Tap Water
Hardness (mg/L $CaCO_3$): 12
Alkalinity (mg/L $CaCO_3$): 10

Test Organism Information:

Batch No.: 102417
Source: Vancouver Island Trout Hatchery
Loading Density: 0.90g/L

Number of male broodstock used: 3
Number of female broodstock used: 4
Sperm motility check: Verification of sperm motility using a compound microscope

SDS Reference Toxicant Results:

Reference Toxicant ID: RTE1008
Stock Solution ID: 17S03 (1000mg/L SDS)
Date Initiated: Oct 24/17
7-d EC50 (95% CL): 4.0(3.8–4.2) mg/L SDS

Reference Toxicant Mean and Range: 4.3(2.0–9.0) mg/L SDS
Reference Toxicant CV (%): 45

Test Results:

	Sample ID		
	L2011956-1 W3		
EC25 % (v/v) (95% CL)	>100		
EC50 % (v/v) (95% CL)	>100		

Reviewed by:

Date reviewed: Nov. 14/17

Issued: October 4, 2016; Ver. 1.2

Nautilus Environmental Company Inc.

7-d Chronic Freshwater Toxicity Test
Initial and Final Water Quality Measurements

Client: ALS
Sample ID: L2011956-1 W3
Work Order #: ~~171225~~ 171215

Start Date & Time: Oct 24/17 @ 1610h
Stop Date & Time: Oct 31/17 @ 1100h
CER #: ~~8~~ 9
Test Species: *Oncorhynchus mykiss*

% (v/v) Concentration control	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	final
Temperature (°C)	14.0	14.0	14.0	14.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
DO (mg/L)	9.6	9.9	9.8	10.1	9.8	9.8	9.7	9.8	9.7	9.9	9.8	9.7	9.5	9.8
pH	6.9	7.1	7.1	7.1	7.2	6.8	6.9	7.0	7.1	7.0	7.2	6.6	6.6	6.7
Cond. (µS/cm)	32	34		34		34		34		34		~~34~~ ~~36~~ 36		38
Initials	k	k		k		k		A		A		k		k

Concentration 6.25	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	final
Temperature (°C)	~~14.0~~ 13.5	14.0	14.0	14.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
DO (mg/L)	9.4	9.8	9.8	9.6	9.8	9.8	9.7	9.9	9.8	9.9	9.8	9.5	9.4	9.8
pH	7.2	7.2	7.4	7.5	7.5	7.0	7.4	7.3	7.4	7.4	7.6	7.2	7.2	7.4
Cond. (µS/cm)	69	65		68		64		67		65		67		68
Initials	k	k		k		k		A		A		k		k

Concentration 25	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	final
Temperature (°C)	15.0	14.0	14.0	14.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
DO (mg/L)	9.5	9.8	9.8	9.6	9.8	9.8	9.7	9.9	9.8	10.0	9.9	9.5	9.4	9.8
pH	7.6	7.8	7.8	7.8	7.9	7.6	7.7	7.6	7.7	7.7	7.8	7.7	7.7	7.8
Cond. (µS/cm)	175	176		172		172		174		175		176		176
Initials	YL	k		k		k		A		A		k		k

Concentration 100	Days													
	0	1		2		3		4		5		6		7
	init.	new	old	new	old	new	old	new	old	new	old	new	old	final
Temperature (°C)	15.0	14.0	14.0	14.5	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0	15.0
DO (mg/L)	9.8	9.7	9.8	9.6	9.8	9.8	9.7	9.5	9.8	9.9	9.8	9.5	9.4	9.8
pH	7.9	8.0	8.5	8.1	8.5	8.0	8.4	8.1	8.3	8.0	8.4	8.0	8.5	8.5
Cond. (µS/cm)	551	543		542		541		543		542		545		538
Initials	k	k		k		k		A		A		k		k

Thermometer: CER-9 DO meter/probe: 2/3 / 2/3 pH meter/probe: 3 / 3 Conductivity meter/probe: 2/3 / 2/3

	Control	100%		
Hardness*	12	280		
Alkalinity*	10	272		

* mg/L as CaCO3

Analysts: AW/KL
Reviewed by: JGL
Date reviewed: Nov. 14/17

Sample Description: Clear, slightly yellow, odourless, some particulates.

Comments:

Version 1.2 Issued July 19, 2017

Embryo Toxicity Test
Daily Mortality

Client: ALS
Sample ID: L201956-1 W3
Work Order #: 171215

Start Date & Time: Oct24/17 @ 1610h
Stop Date & Time: Oct31/17 @ 1100h
Test Species: *Oncorhynchus mykiss*

Concentration %(v/v)	Rep	Day of Test - No. of Mortalities							Total Dead Eggs	Total Undeveloped	Total No. Embryo	Total Exposed
		1	2	3	4	5	6	7				
control	1	0	0	0	0	0	0	0	0	0	30	30
	2						1	0	1	0	29	30
	3						1	3	4	2	24	30
	4						0	0	0	1	29	30
6.25	1						0		0	0	30	30
	2						0		0	1	29	30
	3						4		4	2	24	30
	4						0		0	0	30	30
12.5	1						0		0	0	30	30
	2						0		0	2	28	30
	3						3	1	4	0	26	30
	4						0	0	0	1	29	30
25	1						0	0	0	1	29	30
	2						0	0	0	2	28	30
	3						6	1	7	1	22	30
	4						0	0	0	0	30	30
50	1						0	0	0	0	30	30
	2						0		0	1	29	30
	3						2		2	0	28	30
	4						2		2	0	28	30
100	1						0		0	0	30	30
	2						0		0	1	29	30
	3					1	0	2	3	2	25	30
	4					0	1	0	1	0	29	30
	1											
	2											
	3											
	4											
	1											
	2											
	3											
	4											
Tech Initials												

Comments:

Reviewed by:

Date reviewed: Nov. 14/17

CETIS Analytical Report

Report Date: 31 Oct-17 18:54 (p 1 of 2)
Test Code: 171215 | 14-5200-9738

Salmonid Embryo Survival and Development Test

Nautilus Environmental

Analysis ID:	16-7089-6539	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.8.7
Analyzed:	31 Oct-17 18:54	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	13-1860-7194	**Test Type:**	Development	**Analyst:**	Kania Lywe
Start Date:	24 Oct-17 16:10	**Protocol:**	EC/EPS 1/RM/28	**Diluent:**	Dechlorinated Tap Water
Ending Date:	31 Oct-17 11:00	**Species:**	Oncorhynchus mykiss	**Brine:**	
Duration:	6d 19h	**Source:**	Vancouver Island Trout Hatchery	**Age:**	

Sample ID:	11-7501-0747	**Code:**	46093DBB	**Client:**	ALS
Sample Date:	22 Oct-17	**Material:**	Water Sample	**Project:**	
Receive Date:	24 Oct-17 10:45	**Source:**	ALS		
Sample Age:	64h (8 °C)	**Station:**	L2011956-1 W3		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1345287	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	>100	N/A	N/A	<1	NA	NA
EC10	>100	N/A	N/A	<1	NA	NA
EC15	>100	N/A	N/A	<1	NA	NA
EC20	>100	N/A	N/A	<1	NA	NA
EC25	>100	N/A	N/A	<1	NA	NA
EC40	>100	N/A	N/A	<1	NA	NA
EC50	>100	N/A	N/A	<1	NA	NA

Proportion Normal Summary

			Calculated Variate(A/B)								
C-%	**Control Type**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	Negative Control	4	0.9333	0.8	1	0.04513	0.09027	9.67%	0.0%	112	120
6.25		4	0.9417	0.8	1	0.04787	0.09574	10.17%	-0.89%	113	120
12.5		4	0.9417	0.8667	1	0.02846	0.05693	6.05%	-0.89%	113	120
25		4	0.9083	0.7333	1	0.0599	0.1198	13.19%	2.68%	109	120
50		4	0.9583	0.9333	1	0.01596	0.03191	3.33%	-2.68%	115	120
100		4	0.9417	0.8333	1	0.03696	0.07391	7.85%	-0.89%	113	120

Proportion Normal Detail

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	1	0.9667	0.8	0.9667
6.25		1	0.9667	0.8	1
12.5		1	0.9333	0.8667	0.9667
25		0.9667	0.9333	0.7333	1
50		1	0.9667	0.9333	0.9333
100		1	0.9667	0.8333	0.9667

Proportion Normal Binomials

C-%	Control Type	Rep 1	Rep 2	Rep 3	Rep 4
0	Negative Control	30/30	29/30	24/30	29/30
6.25		30/30	29/30	24/30	30/30
12.5		30/30	28/30	26/30	29/30
25		29/30	28/30	22/30	30/30
50		30/30	29/30	28/30	28/30
100		30/30	29/30	25/30	29/30

Analyst:________ QA:________ Nov. 14/17

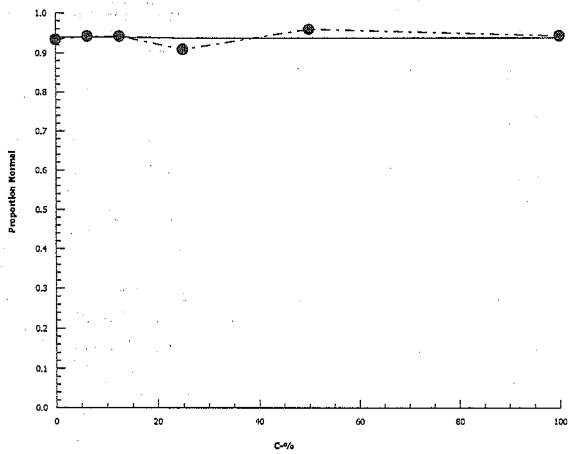
CETIS Analytical Report

Report Date: 31 Oct-17 18:54 (p 2 of 2)
Test Code: 171215 | 14-5200-9738

Salmonid Embryo Survival and Development Test **Nautilus Environmental**

Analysis ID: 16-7089-6539 **Endpoint:** Proportion Normal **CETIS Version:** CETISv1.8.7
Analyzed: 31 Oct-17 18:54 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Graphics



Analyst:________ QA: JGb
Nov.14/17

Client: ALS

W.O.#: 171215

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Sample ID	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
L2011956-1 W3	Oct24/17	Oct24/17	50	13.7	13.8	272	50	14.0	280	K
Dechlor	Oct~~23~~24/17	Oct~~23~~24/17	100	1.1	1.2	10	100	1.2	12	K

Notes:

Reviewed by: Jbh

Date Reviewed: Nov. 14/17

APPENDIX B – Chain-of-Custody Forms

L2011956

VANCOUVER

ALS Environmental

Subcontract Request Form

Subcontract To:

NAUTILUS ENVIRONMENTAL
8664 COMMERCE COURT
BURNABY,BC V5A 4N7

NOTES: Please reference on final report and invoice: PO# L2011956 WO# 171215
ALS requires QC data to be provided with your final results.

7-day Rainbow Trout / Embryo Tox

Please see enclosed 1 **sample(s) in** 5 **Container(s)**

5x20L pails

SAMPLE NUMBER	ANALYTICAL REQUIRED	DATE SAMPLED DUE DATE	Priority Flag
L2011956-1 W3	Special Request- Nautilus Environmental (SPECIAL REQUEST-NL 14)	10/22/2017 11/15/2017	

Subcontract Info Contact: Walter Lin (604) 253-4188

Analysis and reporting info contact:
Shane Stack
8081 LOUGHEED HWY
SUITE 100
BURNABY,BC V5A 1W9
Phone: (604) 253-4188 Email: Shane.Stack@alsglobal.com

Please email confirmation of receipt to: **Shane.Stack@alsglobal.com**

Shipped By: mel
Date Shipped: Oct 24 2017
Received By: Nautilus
Date Received: Oct 24/17 @ 10:45
Verified By: NY - Nair Yamamoto
Date Verified:
Temperature: 8.0°C

Sample Integrity Issues:

Tuesday, October 24, 2017 11:25 AM

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2011956-COFC

COC Number: ~~10/22/2017~~ 2017.10.22A

Page 1 of 1

Report To

Contact and companyname below will appear on the final report

Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659

Company address below will appear on the final report

Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Invoice To

Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 224159 (MMER)
LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Contact:
Sampler: CH/CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	96hr LC50 RainbowTrout	48hr - LC50 Daphnia	7day - RainbowTroutEmbryoToxicity	7day - Ceriodaphnia	7day - Lemma minor	Alga 72-h Growth Inhibition	7day - Flathead Minnow							Number of Containers
	W3	22-Oct-17	8:05	Water			R											5

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐
Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2017-10-22 10:00	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

END OF REPORT

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2011956-COFC

COC Number: ~~10/22/2017~~ 2017.10.22A

Page 1 of 1

Report To	Contact and companyname below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)

- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY

- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 224159 (MMER)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler: CH/CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	96hr LC50 RainbowTrout	48hr - LC50 Daphnia	7day - RainbowTroutEmbryoToxicity	7day - Ceriodaphnia	7day - Lemma minor	Alga 72-h Growth Inhibition	7day - Flathead Minnow							Number of Containers
	W3	22-Oct-17	8:05	Water			R											5

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Chris Harry	Date:2017-10-22 10:00	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form maydelay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the backpage of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	25-OCT-17
Report Date:	06-NOV-17 19:34 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2013198

Project P.O. #:	226973 (WUL)
Job Reference:	
C of C Numbers:	2017-10-25 A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2013198-1	L2013198-2	L2013198-3	L2013198-4	L2013198-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	24-OCT-17	24-OCT-17	24-OCT-17	24-OCT-17	24-OCT-17
	Sampled Time	08:50	09:15	09:40	10:40	
	Client ID	W3	AMP-1B	W2	MC1	DUP
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	522	472	365	367	246
	Hardness (as CaCO3) (mg/L)	289	255	200	201	128
	pH (pH)	8.20	8.09	8.17	8.22	8.18
	Total Suspended Solids (mg/L)	<3.0	256	52.4	<3.0	<3.0
	TDS (Calculated) (mg/L)	327	295	220	219	145
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	243	214	180	186	117
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	243	214	180	186	117
	Ammonia, Total (as N) (mg/L)	0.0053	<0.0050	<0.0050	0.0054	<0.0050
	Bromide (Br) (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Chloride (Cl) (mg/L)	4.56	6.41	2.39	1.81	0.87
	Fluoride (F) (mg/L)	0.544	0.431	0.351	0.439	0.140
	Nitrate (as N) (mg/L)	0.208	0.0321	0.110	0.151	0.108
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	0.0010	<0.0010
	Sulfate (SO4) (mg/L)	57.6	51.9	27.1	23.8	20.0
	Anion Sum (meq/L)	6.23	5.57	4.24	4.29	2.79
	Cation Sum (meq/L)	6.73	5.85	4.52	4.54	2.98
	Cation - Anion Balance (%)	3.8	2.5	3.2	2.8	3.4
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.28	7.91	7.41	6.99	7.10
Total Metals	Aluminum (Al)-Total (mg/L)	0.0280	3.05	1.06	0.0398	0.0178
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00016	<0.00010	0.00010
	Arsenic (As)-Total (mg/L)	0.00026	0.00103	0.00094	0.00046	0.00063
	Barium (Ba)-Total (mg/L)	0.0618	0.0949	0.0849	0.0657	0.0691
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000119	0.000040	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.027	0.027	0.010	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000193	0.0000371	<0.0000050	0.0000076
	Calcium (Ca)-Total (mg/L)	62.1	70.4	54.9	49.4	29.6
	Chromium (Cr)-Total (mg/L)	0.00026	0.00221	0.00231	0.00031	0.00028
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00140	0.00074	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.00365	0.0351	0.0121	0.00173	0.00194
	Iron (Fe)-Total (mg/L)	0.058	4.35	1.65	0.112	0.052
	Lead (Pb)-Total (mg/L)	<0.000050	0.000665	0.000434	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0041	0.0032	0.0025	0.0015	0.0013
	Magnesium (Mg)-Total (mg/L)	32.0	22.6	18.2	19.0	12.2

	Sample ID	L2013198-1	L2013198-2	L2013198-3	L2013198-4	L2013198-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	24-OCT-17	24-OCT-17	24-OCT-17	24-OCT-17	24-OCT-17
	Sampled Time	08:50	09:15	09:40	10:40	
	Client ID	W3	AMP-1B	W2	MC1	DUP
Grouping	**Analyte**					
WATER						
Total Metals	Manganese (Mn)-Total (mg/L)	0.0769	0.239	0.120	0.0256	0.0318
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.000050 DLM	<0.000025 DLM	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00467	0.00498	0.00127	0.00150	0.00127
	Nickel (Ni)-Total (mg/L)	0.00100	0.00302	0.00325	0.00101	0.00115
	Phosphorus (P)-Total (mg/L)	<0.050	0.095	0.065	<0.050	<0.050
	Potassium (K)-Total (mg/L)	2.28	3.31	1.89	1.42	0.90
	Selenium (Se)-Total (mg/L)	0.000378	0.000123	0.000170	0.000192	<0.000050
	Silicon (Si)-Total (mg/L)	6.39	11.9	8.37	6.57	6.32
	Silver (Ag)-Total (mg/L)	<0.000010	0.000051	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	19.6	16.2	11.4	11.7	9.15
	Strontium (Sr)-Total (mg/L)	0.753	0.526	0.485	0.462	0.284
	Sulfur (S)-Total (mg/L)	19.1	17.6	9.15	7.77	6.79
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000019	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00090 DLM	0.133	0.0409	0.00198	<0.00090 DLM
	Uranium (U)-Total (mg/L)	0.00260	0.00193	0.00218	0.00147	0.00292
	Vanadium (V)-Total (mg/L)	<0.00050	0.00855	0.00356	0.00062	0.00071
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0165	0.0146	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0024	0.0040	0.0046	0.0033	0.0080
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00030	0.00035	0.00038	0.00066
	Barium (Ba)-Dissolved (mg/L)	0.0641	0.0627	0.0687	0.0645	0.0724
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.025	0.023	<0.010	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000057	0.0000134	<0.0000050	0.0000056
	Calcium (Ca)-Dissolved (mg/L)	62.0	68.4	51.3	49.7	30.5
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	0.00014	0.00019
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00236	0.00396	0.00263	0.00141	0.00175
	Iron (Fe)-Dissolved (mg/L)	0.019	<0.010	0.033	0.052	0.029
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0036	0.0016	0.0024	0.0017	0.0016
	Magnesium (Mg)-Dissolved (mg/L)	32.5	20.5	17.4	18.8	12.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID		L2013198-1	L2013198-2	L2013198-3	L2013198-4	L2013198-5
Description		WATER	WATER	WATER	WATER	WATER
Sampled Date		24-OCT-17	24-OCT-17	24-OCT-17	24-OCT-17	24-OCT-17
Sampled Time		08:50	09:15	09:40	10:40	
Client ID		W3	AMP-1B	W2	MC1	DUP
Grouping	**Analyte**					
WATER						
Dissolved Metals	Manganese (Mn)-Dissolved (mg/L)	0.0651	0.00280	0.0114	0.0206	0.0319
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00434	0.00436	0.00109	0.00141	0.00120
	Nickel (Ni)-Dissolved (mg/L)	0.00095	0.00108	0.00096	0.00081	0.00105
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	2.32	2.66	1.75	1.41	0.95
	Selenium (Se)-Dissolved (mg/L)	0.000338	0.000106	0.000083	0.000140	0.000068
	Silicon (Si)-Dissolved (mg/L)	6.18	5.71	6.03	6.30	6.00
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	20.6	15.8	11.2	11.0	9.38
	Strontium (Sr)-Dissolved (mg/L)	0.746	0.497	0.481	0.442	0.292
	Sulfur (S)-Dissolved (mg/L)	18.5	16.9	8.49	7.44	6.14
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00242	0.00171	0.00203	0.00135	0.00272
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	0.00062
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.0010	0.0058	0.0011	0.0011
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Dissolved Organic Carbon	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L2013198-1, -2, -3, -4, -5
Matrix Spike	Sulfate (SO4)	MS-B	L2013198-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-VA	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-VA	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

Reference Information

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-10-25 A

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L2013198-COFC

COC Number: 2017-10-25 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: **Shane Stack**

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	24-Oct-17	8:50	Water	R	R	R	R	R	R	R	R	R					7
	AMP-1B	24-Oct-17	9:15	Water	R	R	R	R	R	R	R	R	R					7
	W2	24-Oct-17	9:40	Water	R	R	R	R	R	R	R	R	R					7
	MC1	24-Oct-17	10:40	Water	R	R	R	R	R	R	R	R	R					7
	DUP	24-Oct-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
1°C ~~10~~	3°C		2	3	

SHIPMENT RELEASE (client use)		
Released by:Corey Roberts	Date:2017-10-25	Time:

INITIAL SHIPMENT RECEPTION (lab use only)		
Received by: (A)	Date: OCT 25/17	Time: 14:37

FINAL SHIPMENT RECEPTION (lab use only)		
Received by: (A) JC	Date: OCT 2 6 2017	Time: 12pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-NOV-17
Report Date: 16-NOV-17 11:55 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2016822
Project P.O. #: 226973
Job Reference:
C of C Numbers: 2017-11-01 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2016822-1	L2016822-2	L2016822-3	L2016822-4	
	Description	Water	Water	Water	Water	
	Sampled Date	30-OCT-17	30-OCT-17	31-OCT-17	31-OCT-17	
	Sampled Time	09:15	10:25	09:50	10:20	
	Client ID	W17	W8A	W3	MC1	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	486	1350	525	368	
	Hardness (as CaCO3) (mg/L)	238	706	254	185	
	pH (pH)	8.43	8.12	8.30	8.23	
	Total Suspended Solids (mg/L)	<3.0	36.9	<3.0	5.7	
	TDS (Calculated) (mg/L)	288	957	306	215	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	192	447	233	189	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	9.6	<1.0	3.8	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	202	447	237	189	
	Ammonia, Total (as N) (mg/L)	0.0061	0.225	0.0080	0.0090	
	Chloride (Cl) (mg/L)	6.70	13.4	4.45	1.84	
	Nitrate and Nitrite (as N) (mg/L)	0.281	7.25	0.203	0.187	
	Nitrate (as N) (mg/L)	0.281	7.01	0.203	0.187	
	Nitrite (as N) (mg/L)	<0.0010	0.232	<0.0010	<0.0010	
	Sulfate (SO4) (mg/L)	58.6	337	56.0	24.1	
	Anion Sum (meq/L)	5.46	16.9	6.03	4.34	
	Cation Sum (meq/L)	5.48	16.5	5.87	4.19	
	Cation - Anion Balance (%)	0.2	-1.1	-1.4	-1.7	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	10.1		5.30	7.32	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0039	0.0815	0.0074	0.179	
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00023	<0.00010	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00042	0.00077	0.00025	0.00054	
	Barium (Ba)-Total (mg/L)	0.0689	0.150	0.0652	0.0711	
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000027	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	0.033	0.034	0.028	<0.010	
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.000220	<0.0000050	0.0000067	
	Calcium (Ca)-Total (mg/L)	67.2	211	58.1	49.9	
	Chromium (Cr)-Total (mg/L)	<0.00030 DLB	0.00096	<0.00030 DLB	0.00087	
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00084	<0.00010	0.00017	
	Copper (Cu)-Total (mg/L)	0.00630	0.106	0.00305	0.00271	
	Iron (Fe)-Total (mg/L)	<0.010	3.04	0.027	0.363	
	Lead (Pb)-Total (mg/L)	<0.000050	0.000137	<0.000050	0.000077	
	Lithium (Li)-Total (mg/L)	0.0018	0.0043	0.0035	0.0021	
	Magnesium (Mg)-Total (mg/L)	20.4	57.0	30.7	18.7	
	Manganese (Mn)-Total (mg/L)	0.00971	2.42	0.0468	0.0445	

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2016822-1	L2016822-2	L2016822-3	L2016822-4
	Description	Water	Water	Water	Water
	Sampled Date	30-OCT-17	30-OCT-17	31-OCT-17	31-OCT-17
	Sampled Time	09:15	10:25	09:50	10:20
	Client ID	W17	W8A	W3	MC1
Grouping	**Analyte**				
WATER					
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	DLM <0.000050
	Molybdenum (Mo)-Total (mg/L)	0.00620	0.0134	0.00510	0.00161
	Nickel (Ni)-Total (mg/L)	0.00073	0.00214	0.00102	0.00144
	Phosphorus (P)-Total (mg/L)	<0.050	0.079	<0.050	<0.050
	Potassium (K)-Total (mg/L)	3.67	7.26	2.23	1.45
	Selenium (Se)-Total (mg/L)	0.000358	0.00850	0.000304	0.000133
	Silicon (Si)-Total (mg/L)	5.29	8.10	6.42	7.24
	Silver (Ag)-Total (mg/L)	<0.000010	0.000031	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	15.5	47.5	19.4	11.2
	Strontium (Sr)-Total (mg/L)	0.723	2.61	0.797	0.490
	Sulfur (S)-Total (mg/L)	20.4	119	19.5	8.22
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	<0.005	0.00040	0.00828
	Uranium (U)-Total (mg/L)	0.00217	0.00378	0.00281	0.00167
	Vanadium (V)-Total (mg/L)	<0.00050	0.00271	<0.00050	0.00120
	Zinc (Zn)-Total (mg/L)	<0.0030	0.415	<0.0030	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00047	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0039	0.0068	0.0019	0.0029
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00013	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00035	0.00052	0.00024	0.00038
	Barium (Ba)-Dissolved (mg/L)	0.0700	0.140	0.0618	0.0682
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.028	0.029	0.023	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.000185	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	62.7	193	55.3	45.8
	Chromium (Cr)-Dissolved (mg/L)	0.00010	0.00052	<0.00010	0.00013
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00076	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00575	0.0494	0.00186	0.00127
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.522	0.016	0.049
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0013	0.0036	0.0029	0.0012
	Magnesium (Mg)-Dissolved (mg/L)	19.7	54.3	28.1	17.2
	Manganese (Mn)-Dissolved (mg/L)	0.00493	2.30	0.0432	0.0224

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2016822-1 Water 30-OCT-17 09:15 W17	L2016822-2 Water 30-OCT-17 10:25 W8A	L2016822-3 Water 31-OCT-17 09:50 W3	L2016822-4 Water 31-OCT-17 10:20 MC1	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00550	0.0121	0.00468	0.00144	
	Nickel (Ni)-Dissolved (mg/L)	0.00064	0.00177	0.00083	0.00083	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	3.55	7.38	2.12	1.35	
	Selenium (Se)-Dissolved (mg/L)	DLB <0.00040	0.00927	0.000299	0.000122	
	Silicon (Si)-Dissolved (mg/L)	5.06	7.53	5.89	6.26	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	14.6	47.3	17.0	10.5	
	Strontium (Sr)-Dissolved (mg/L)	0.702	2.57	0.767	0.491	
	Sulfur (S)-Dissolved (mg/L)	18.5	111	17.4	7.12	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00051	<0.00030	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00195	0.00338	0.00262	0.00150	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00119	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	0.342	<0.0010	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00043	<0.00030	<0.00030	

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Aluminum (Al)-Dissolved	DUP-H	L2016822-1
Method Blank	Barium (Ba)-Dissolved	MB-LOR	L2016822-1, -2, -3
Method Blank	Calcium (Ca)-Dissolved	MB-LOR	L2016822-1, -2, -3
Method Blank	Magnesium (Mg)-Dissolved	MB-LOR	L2016822-1, -2, -3
Method Blank	Selenium (Se)-Dissolved	MB-LOR	L2016822-1, -2, -3
Method Blank	Chromium (Cr)-Total	MB-LOR	L2016822-1, -2, -3, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L2016822-1, -3, -4
Matrix Spike	Antimony (Sb)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2016822-4
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2016822-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2016822-1
Matrix Spike	Boron (B)-Dissolved	MS-B	L2016822-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2016822-4
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2016822-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2016822-1
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L2016822-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2016822-4
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2016822-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2016822-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2016822-4
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2016822-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2016822-1
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2016822-1
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L2016822-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2016822-4
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2016822-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2016822-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2016822-4
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2016822-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2016822-1
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2016822-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L2016822-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Reference Information

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

BE-D-L-CCMS-VA Water Diss. Be (low) in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA Water Total Be (Low) in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

CARBONS-DOC-VA Water Dissolved organic carbon by combustion APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-IC-N-VA Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-01 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2016822-COFC

COC Number: 2017-11-01 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report		
Company:	Minto Explorations Ltd.		
Contact:	Minto Environment - Coordinator		
Phone:	1-604-759-4659		
	Company address below will appear on the final report		
Street:	2100-510 West Georgia St.		
City/Province:	Vancouver, British Columbia		
Postal Code:	V6B 0M3		
Invoice To	Same as Report To	☐ YES	☑ NO
	Copy of Invoice with Report	☐ YES	☑ NO
Company:	Minto Explorations Ltd.		
Contact:	Ruth Cayetano		

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: **Shane Stack**

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

								P	F/P	P	F/P	P	F/P					
ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
	W17	30-Oct-17	9:15	Water	R	R	R	R	R	R	R	R	R					7
	W8A	30-Oct-17	10:25	Water	R	R	R	R	R	R	R	R						6
	W3	31-Oct-17	9:50	Water	R	R	R	R	R	R	R	R	R					7
	MC1	31-Oct-17	10:20	Water	R	R	R	R.	R	R	R	R	R					7
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Drinking Water (DW) Samples¹ (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6.0			6.4		

SHIPMENT RELEASE (client use)

Released by: Corey Roberts | Date: 2017-11-01 | Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF | Date: 1 Nov 2017 | Time: 14:50

FINAL SHIPMENT RECEPTION (lab use only)

Received by: TP | Date: Nov 2 | Time: 15:45

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 08-NOV-17
Report Date: 15-DEC-17 19:13 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2020109
Project P.O. #: 226973
Job Reference:
C of C Numbers: 2017-11-08 A
Legal Site Desc:

Comments:

Shane Stack
Account Manager

	Sample ID	L2020109-1	L2020109-2	L2020109-3	L2020109-4	L2020109-5
	Description	water	water	water	water	water
	Sampled Date	06-NOV-17	06-NOV-17	06-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time	09:35	10:45	14:35	10:55	11:10
	Client ID	W17	W8A	MC1	W10	W30
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	504	1450	422	545	607
	Hardness (as CaCO3) (mg/L)	240	762	208	258	289
	pH (pH)	8.25	7.80	8.12	7.95	8.23
	Total Suspended Solids (mg/L)	<3.0	4.7	8.7	<3.0	12.0
	TDS (Calculated) (mg/L)	299	1050	244	336	384
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	215	484	215	213	206
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	215	484	215	213	206
	Ammonia, Total (as N) (mg/L)	<0.0050	0.310	0.0166	0.0677	0.106
	Chloride (Cl) (mg/L)	6.83	14.1	2.23	0.66	3.88
	Nitrate and Nitrite (as N) (mg/L)	0.265	7.08	0.165	19.8	0.755
	Nitrate (as N) (mg/L)	0.265	6.60	0.165	19.8	0.738
	Nitrite (as N) (mg/L)	<0.0010	0.477	<0.0010	0.0158	0.0169
	Sulfate (SO4) (mg/L)	59.4	381	26.3	14.2	133
	Anion Sum (meq/L)	5.76	18.5	4.94	6.00	7.06
	Cation Sum (meq/L)	5.57	17.8	4.74	5.71	6.66
	Cation - Anion Balance (%)	-1.7	-2.1	-2.0	-2.6	-2.9
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	9.20		7.29		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0045	0.168	0.0189	0.0108	0.0567
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00013	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00041	0.00078	0.00039	0.00016	0.00071
	Barium (Ba)-Total (mg/L)	0.0701	0.165	0.0775	0.265	0.122
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000021	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.028	0.030	<0.010	0.017	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.000208	<0.0000050	<0.0000050	0.0000132
	Calcium (Ca)-Total (mg/L)	63.7	209	53.7	77.4	66.0
	Chromium (Cr)-Total (mg/L)	0.00025	0.00092	0.00037	0.00018	0.00022
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00103	<0.00010	0.00023	0.00011
	Copper (Cu)-Total (mg/L)	0.00620	0.142	0.00211	0.00231	0.0176
	Iron (Fe)-Total (mg/L)	<0.010	5.31	0.077	0.587	0.113
	Lead (Pb)-Total (mg/L)	<0.000050	0.000120	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0013	0.0041	0.0016	0.0011	0.0020
	Magnesium (Mg)-Total (mg/L)	21.9	63.2	20.8	19.2	32.4
	Manganese (Mn)-Total (mg/L)	0.0168	2.92	0.0276	0.231	0.452

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2020109-6	L2020109-7	L2020109-8	L2020109-9
	Description	water	water	water	water
	Sampled Date	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time	12:00	12:20	12:25	14:05
	Client ID	W15	W14	W12	W3
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	968	3240	2460	558
	Hardness (as CaCO3) (mg/L)	512	1610	1160	259
	pH (pH)	8.12	8.18	8.12	8.22
	Total Suspended Solids (mg/L)	4.0	18.0	14.0	<3.0
	TDS (Calculated) (mg/L)	660	3050	2140	907
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	325	133	209	256
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	325	133	209	256
	Ammonia, Total (as N) (mg/L)	0.138	3.63	4.10	0.0093
	Chloride (Cl) (mg/L)	4.40	51.4	36.0	4.43 HTD
	Nitrate and Nitrite (as N) (mg/L)	10.9	24.2	17.8	
	Nitrate (as N) (mg/L)	10.8	18.9	12.5	0.212 HTD
	Nitrite (as N) (mg/L)	0.0195	5.23	5.35	<0.0010 HTD
	Sulfate (SO4) (mg/L)	210	1950	1290	57.4 HTD
	Anion Sum (meq/L)	11.8	46.5	33.4	6.77
	Cation Sum (meq/L)	11.2	42.8	30.5	6.10
	Cation - Anion Balance (%)	-2.4	-4.1	-4.5	-5.2
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	18.1			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0499		0.0275	0.0083
	Antimony (Sb)-Total (mg/L)	0.00013		0.00030	<0.00010
	Arsenic (As)-Total (mg/L)	0.00056		0.00056	0.00028
	Barium (Ba)-Total (mg/L)	0.128		0.0958	0.0740
	Beryllium (Be)-Total (mg/L)	<0.000020		<0.000040 DLA	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050		<0.00010 DLA	<0.000050
	Boron (B)-Total (mg/L)	<0.010		0.250	0.025
	Cadmium (Cd)-Total (mg/L)	0.0000086		0.000188	0.0000056
	Calcium (Ca)-Total (mg/L)	132		363	57.8
	Chromium (Cr)-Total (mg/L)	0.00049		<0.00020 DLA	0.00024
	Cobalt (Co)-Total (mg/L)	0.00033		0.00132	<0.00010
	Copper (Cu)-Total (mg/L)	0.0186		0.0866	0.00255
	Iron (Fe)-Total (mg/L)	1.06		0.038	0.025
	Lead (Pb)-Total (mg/L)	<0.000050		<0.00010 DLA	<0.000050
	Lithium (Li)-Total (mg/L)	<0.0010		0.0192	0.0033
	Magnesium (Mg)-Total (mg/L)	45.4		75.8	33.0
	Manganese (Mn)-Total (mg/L)	0.367		1.29	0.0542

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2020109-1	L2020109-2	L2020109-3	L2020109-4	L2020109-5
	Description	water	water	water	water	water
	Sampled Date	06-NOV-17	06-NOV-17	06-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time	09:35	10:45	14:35	10:55	11:10
	Client ID	W17	W8A	MC1	W10	W30
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000111	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.00624	0.0129	0.00158	0.00130	0.00163
	Nickel (Ni)-Total (mg/L)	0.00075	0.00235	0.00098	<0.00050	0.00074
	Phosphorus (P)-Total (mg/L)	<0.050	0.087	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	3.61	7.49	1.46	1.92	4.52
	Selenium (Se)-Total (mg/L)	0.000326	0.00805	0.000139	0.000154	0.000806
	Silicon (Si)-Total (mg/L)	5.39	8.27	7.22	3.73	1.65
	Silver (Ag)-Total (mg/L)	<0.000010	0.000054	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	14.0	43.0	11.5	10.5	16.2
	Strontium (Sr)-Total (mg/L)	0.788	3.13	0.620	0.557	0.786
	Sulfur (S)-Total (mg/L)	20.6	118	9.06	5.14	47.2
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.00030	0.00967	<0.00090 DLM	<0.00030	<0.0018 DLM
	Uranium (U)-Total (mg/L)	0.00227	0.00370	0.00171	0.000384	0.000552
	Vanadium (V)-Total (mg/L)	<0.00050	0.00323	0.00056	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0030	0.501	<0.0030	0.0037	<0.0030
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00059	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0018	0.0077	0.0031	0.0025	0.0014
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00035	0.00050	0.00034	0.00010	0.00064
	Barium (Ba)-Dissolved (mg/L)	0.0725	0.153	0.0801	0.247	0.123
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.028	0.031	<0.010	0.017	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.000339 DTMF	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	63.6	205	52.5	75.1	68.8
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00046	0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00114	<0.00010	0.00021	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00564	0.0760	0.00135	0.00160	0.0115
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.425	0.045	0.324	0.018
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0017	0.0044	0.0020	0.0013	0.0023
	Magnesium (Mg)-Dissolved (mg/L)	19.8	60.7	18.8	17.1	28.6
	Manganese (Mn)-Dissolved (mg/L)	0.00602	3.16	0.0257	0.215	0.321

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2020109-6	L2020109-7	L2020109-8	L2020109-9	
	Description	water	water	water	water	
	Sampled Date	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17	
	Sampled Time	12:00	12:20	12:25	14:05	
	Client ID	W15	W14	W12	W3	
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050		<0.0000050	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	0.00267		0.0843	0.00484	
	Nickel (Ni)-Total (mg/L)	0.00126		0.0039	0.00104	
	Phosphorus (P)-Total (mg/L)	<0.050		<0.10 DLA	<0.050	
	Potassium (K)-Total (mg/L)	3.87		47.3	2.21	
	Selenium (Se)-Total (mg/L)	0.00238		0.0113	0.000306	
	Silicon (Si)-Total (mg/L)	6.84		4.41	6.59	
	Silver (Ag)-Total (mg/L)	<0.000010		0.000023	<0.000010	
	Sodium (Na)-Total (mg/L)	19.2		131	18.0	
	Strontium (Sr)-Total (mg/L)	1.30		8.29	0.921	
	Sulfur (S)-Total (mg/L)	76.8		444	20.5	
	Thallium (Tl)-Total (mg/L)	<0.000010		<0.000020 DLA	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010		<0.00020 DLA	<0.00010	
	Titanium (Ti)-Total (mg/L)	<0.0021 DLM		<0.00090 DLM	<0.00030	
	Uranium (U)-Total (mg/L)	0.00282		0.00768	0.00278	
	Vanadium (V)-Total (mg/L)	0.00063		<0.0010 DLA	<0.00050	
	Zinc (Zn)-Total (mg/L)	<0.0030		0.0104	<0.0030	
	Zirconium (Zr)-Total (mg/L)	<0.00030		<0.00030	<0.00030	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0054	0.0233	0.0040	0.0016	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00033	0.00027	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00038	0.00036	0.00039	0.00021	
	Barium (Ba)-Dissolved (mg/L)	0.125	0.204	0.0841	0.0693	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000040 DLA	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.000050	
	Boron (B)-Dissolved (mg/L)	<0.010	0.204	0.240	0.025	
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.00010 DLM	<0.00020 DLM	<0.0000050	
	Calcium (Ca)-Dissolved (mg/L)	137	508	358	54.3	
	Chromium (Cr)-Dissolved (mg/L)	0.00011	<0.00010	<0.00020 DLA	<0.00010	
	Cobalt (Co)-Dissolved (mg/L)	0.00028	0.00106	0.00121	<0.00010	
	Copper (Cu)-Dissolved (mg/L)	0.0140	0.00361	0.0675	0.00213	
	Iron (Fe)-Dissolved (mg/L)	0.057	<0.010	<0.020 DLA	0.015	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.00010 DLA	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0011	0.0233	0.0181	0.0035	
	Magnesium (Mg)-Dissolved (mg/L)	41.3	82.3	64.1	30.0	
	Manganese (Mn)-Dissolved (mg/L)	0.323	1.08	1.14	0.0490	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2020109-1	L2020109-2	L2020109-3	L2020109-4	L2020109-5
	Description	water	water	water	water	water
	Sampled Date	06-NOV-17	06-NOV-17	06-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time	09:35	10:45	14:35	10:55	11:10
	Client ID	W17	W8A	MC1	W10	W30
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	0.0000077	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00517	0.0114	0.00131	0.00110	0.00147
	Nickel (Ni)-Dissolved (mg/L)	0.00059	0.00148	0.00077	<0.00050	<0.00050
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	3.61	8.06	1.54	1.88	4.43
	Selenium (Se)-Dissolved (mg/L)	0.000331	0.00828	0.000174	0.000136	0.000756
	Silicon (Si)-Dissolved (mg/L)	5.19	7.52	6.94	3.36	1.40
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000012	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	15.5	50.1	12.3	10.9	17.2
	Strontium (Sr)-Dissolved (mg/L)	0.692	2.87	0.538	0.511	0.673
	Sulfur (S)-Dissolved (mg/L)	19.7	124	8.63	4.60	43.2
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	DLM <0.00090	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00195	0.00345	0.00152	0.000355	0.000455
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00137	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0047	0.174	<0.0010	0.0016	0.0015
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00055	<0.00030	<0.00030	<0.00030

	Sample ID	L2020109-6	L2020109-7	L2020109-8	L2020109-9
	Description	water	water	water	water
	Sampled Date	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time	12:00	12:20	12:25	14:05
	Client ID	W15	W14	W12	W3
Grouping	**Analyte**				
WATER					
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00225	0.120	0.0796	0.00431
	Nickel (Ni)-Dissolved (mg/L)	0.00098	0.00364	0.0034	0.00082
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.10 DLA	<0.050
	Potassium (K)-Dissolved (mg/L)	3.80	83.7	45.9	2.32
	Selenium (Se)-Dissolved (mg/L)	0.00216	0.0182	0.0109	0.000357
	Silicon (Si)-Dissolved (mg/L)	6.19	2.39	3.99	6.20
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000020 DLA	<0.000010
	Sodium (Na)-Dissolved (mg/L)	20.3	191	136	19.8
	Strontium (Sr)-Dissolved (mg/L)	1.12	6.95	7.28	0.806
	Sulfur (S)-Dissolved (mg/L)	70.3	697	419	19.4
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000020 DLA	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00020 DLA	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00060 DLM	<0.00060 DLA	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.00252	0.00841	0.00772	0.00250
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.0010 DLA	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0021	<0.0010	0.0074	<0.0010
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Chromium (Cr)-Total	MB-LOR	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L2020109-1, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Silicon (Si)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Sulfur (S)-Total	MS-B	L2020109-1, -2, -3, -4, -5, -6, -8, -9
Matrix Spike	Sulfate (SO4)	MS-B	L2020109-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTMF	Dissolved concentration exceeds total for field-filtered metals sample. Metallic contaminants were likely introduced to dissolved sample during field filtration.
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

Reference Information

CL-IC-N-VA Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CL-L-IC-N-WR Water Chloride in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-WR Water Fluoride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

SO4-IC-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-08 A

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2020109-COFC

COC Number: 2017-11-08 A

Page of

Report To Contact and company name below will appear on the final report
Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659
Company address below will appear on the final report
Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Report Format / Distribution
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply
Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐
EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐
Date and Time Required for all E&P TATs:
For tests that can not be performed according to the service level selected, you will be contacted.

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: 226973 (WUL)
LSD:

Oil and Gas Required Fields (client use)
AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)
ALS Contact: Shane Stack
Sampler: SR/CP

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
✓	W17	6-Nov-17	9:35	Water	R	R	R	R	R	R	R	R	R					7
✓	W8A	6-Nov-17	10:45	Water	R	R	R	R	R	R	R	R						6
✓	MC1	6-Nov-17	14:35	Water	R	R	R	R	R	R	R	R	R					7
✓	W10	7-Nov-17	10:55	Water	R	R	R	R	R	R	R	R						6
✓	W30	7-Nov-17	11:10	Water	R	R	R	R	R	R	R	R						6
✓	W15	7-Nov-17	12:00	Water	R	R	R	R	R	R	R	R	R					7
✓	W14	7-Nov-17	12:20	Water	R	R	R		R		R	R						4
✓	W12	7-Nov-17	12:25	Water	R	R	R	R	R	R	R	R						6
✓	W3	7-Nov-17	14:05	Water	R	R	R	R	R	R	R	R						7

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4°C.			3.7		

SHIPMENT RELEASE (client use)
Released by: Shaun Roberts
Date:2017-11-08
Time: 11:00

INITIAL SHIPMENT RECEPTION (lab use only)
Received by:
Date: NOV 8/17
Time: 16:01

FINAL SHIPMENT RECEPTION (lab use only)
Received by: Cade W.
Date: Nov 10
Time: 1105

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

✓

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 16-NOV-17
Report Date: 28-NOV-17 16:07 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2023151
Project P.O. #: 226973
Job Reference:
C of C Numbers: 2017-11-15 D
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023151-1	L2023151-2	L2023151-3		
	Description	Water	Water	Water		
	Sampled Date	13-NOV-17	13-NOV-17	14-NOV-17		
	Sampled Time	11:15	15:10	09:00		
	Client ID	W17	W16	W3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	495	507	539		
	Hardness (as CaCO3) (mg/L)	264	262	280		
	pH (pH)	8.18	8.21	8.21		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	TDS (Calculated) (mg/L)	303	319	328		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	207	202	252		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	207	202	252		
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0881	0.0099		
	Chloride (Cl) (mg/L)	6.88	7.41	4.54		
	Nitrate and Nitrite (as N) (mg/L)	0.232	1.89	0.199		
	Nitrate (as N) (mg/L)	0.232	1.89	0.199		
	Nitrite (as N) (mg/L)	<0.0010	0.0080	<0.0010		
	Sulfate (SO4) (mg/L)	59.5	71.2	57.9		
	Anion Sum (meq/L)	5.61	5.89	6.40		
	Cation Sum (meq/L)	6.03	5.99	6.48		
	Cation - Anion Balance (%)	3.6	0.9	0.6		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	8.69	12.4	5.02		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0090	0.0114	0.0211		
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00012	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00039	0.00041	0.00026		
	Barium (Ba)-Total (mg/L)	0.0715	0.0879	0.0728		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.030	0.028	0.024		
	Cadmium (Cd)-Total (mg/L)	0.0000058	0.0000137	0.0000075		
	Calcium (Ca)-Total (mg/L)	69.7	73.7	62.9		
	Chromium (Cr)-Total (mg/L)	0.00024	0.00029	0.00014		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00711	0.0230	0.00281		
	Iron (Fe)-Total (mg/L)	0.014	0.086	0.060		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.0014	0.0013	0.0030		
	Magnesium (Mg)-Total (mg/L)	23.0	23.2	34.5		
	Manganese (Mn)-Total (mg/L)	0.0614	0.354	0.0918		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2023151-1	L2023151-2	L2023151-3		
	Description	Water	Water	Water		
	Sampled Date	13-NOV-17	13-NOV-17	14-NOV-17		
	Sampled Time	11:15	15:10	09:00		
	Client ID	W17	W16	W3		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	0.0000072	<0.0000050	0.0000052		
	Molybdenum (Mo)-Total (mg/L)	0.00581	0.00308	0.00419		
	Nickel (Ni)-Total (mg/L)	0.00075	0.00093	0.00095		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Total (mg/L)	3.91	3.56	2.17		
	Selenium (Se)-Total (mg/L)	0.000408	0.000704	0.000355		
	Silicon (Si)-Total (mg/L)	5.81	5.01	6.83		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	15.2	15.3	19.2		
	Strontium (Sr)-Total (mg/L)	0.700	0.653	0.747		
	Sulfur (S)-Total (mg/L)	20.9	25.0	20.3		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00034	0.00040	0.00097		
	Uranium (U)-Total (mg/L)	0.00210	0.00137	0.00257		
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0042	<0.0030		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0019	0.0037	0.0015		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00034	0.00041	0.00021		
	Barium (Ba)-Dissolved (mg/L)	0.0701	0.0859	0.0711		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.028	0.027	0.023		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000096	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	71.0	69.9	61.6		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00011	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00550	0.0207	0.00218		
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.068	0.027		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0015	0.0014	0.0028		
	Magnesium (Mg)-Dissolved (mg/L)	21.0	21.3	30.5		
	Manganese (Mn)-Dissolved (mg/L)	0.00836	0.263	0.0739		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2023151-1 Water 13-NOV-17 11:15 W17	L2023151-2 Water 13-NOV-17 15:10 W16	L2023151-3 Water 14-NOV-17 09:00 W3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00590	0.00317	0.00460		
	Nickel (Ni)-Dissolved (mg/L)	0.00057	0.00071	0.00087		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	3.57	3.20	2.30		
	Selenium (Se)-Dissolved (mg/L)	0.000391	0.000711	0.000307		
	Silicon (Si)-Dissolved (mg/L)	5.49	4.75	6.29		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	15.4	15.0	19.0		
	Strontium (Sr)-Dissolved (mg/L)	0.744	0.677	0.807		
	Sulfur (S)-Dissolved (mg/L)	20.8	25.3	18.5		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00211	0.00144	0.00265		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0010	0.0024	0.0011		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2023151-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2023151-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2023151-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2023151-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2023151-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2023151-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Copper (Cu)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L2023151-1, -2, -3
Matrix Spike	Sulfur (S)-Total	MS-B	L2023151-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-11-15 D

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

ıalytical

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L2023151-COFC

COC Number: 2017-11-15 D

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:

Requisitioner:

Location:

ALS Contact: Shane Stack **Sampler:** SR

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W17	13-Nov-17	11:15	Water	R	R	R	R	R	R	R	R	R					7
	W16	13-Nov-17	15:10	Water	R	R	R	R	R	R	R	R	R					7
	W3	14-Nov-17	9:00	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 2°c.

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-11-15	Time: 12:00	Received by:	Date: NOV 16/17.	Time: 0842	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-NOV-17
Report Date: 14-DEC-17 16:18 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2027459
Project P.O. #: 226973
Job Reference:
C of C Numbers: 2017-11-23 B
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L2027459-1 Water 21-NOV-17 09:30 W3	L2027459-2 Water 21-NOV-17 10:00 W17	L2027459-3 Water 22-NOV-17 15:30 W8A		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	534	500	1560		
	Hardness (as CaCO3) (mg/L)	265	249	770		
	pH (pH)	8.09	8.20	7.91		
	Total Suspended Solids (mg/L)	4.7	4.0	16.0		
	TDS (Calculated) (mg/L)	320	304	1110		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	247	217	565		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	247	217	565		
	Ammonia, Total (as N) (mg/L)	0.0201	0.0053	0.442		
	Chloride (Cl) (mg/L)	4.51	7.01	16.2		
	Nitrate and Nitrite (as N) (mg/L)	0.194	0.192	7.43		
	Nitrate (as N) (mg/L)	0.194	0.192	6.74		
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.683		
	Sulfate (SO4) (mg/L)	57.4	59.9	394		
	Anion Sum (meq/L)	6.31	5.82	20.5		
	Cation Sum (meq/L)	6.13	5.71	17.7		
	Cation - Anion Balance (%)	-1.4	-1.0	-7.3		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.90	8.48			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0235	0.0502	0.204		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00123		
	Arsenic (As)-Total (mg/L)	0.00026	0.00038	0.00090		
	Barium (Ba)-Total (mg/L)	0.0710	0.0867	0.179		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000033		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.025	0.032	0.036		
	Cadmium (Cd)-Total (mg/L)	0.0000088	0.0000164	0.000381		
	Calcium (Ca)-Total (mg/L)	61.5	69.8	246		
	Chromium (Cr)-Total (mg/L)	0.00020	0.00023	0.00152		
	Cobalt (Co)-Total (mg/L)	0.00010	0.00017	0.00132		
	Copper (Cu)-Total (mg/L)	0.00267	0.0156	0.193		
	Iron (Fe)-Total (mg/L)	0.070	0.079	7.79		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	0.000245		
	Lithium (Li)-Total (mg/L)	0.0031	0.0017	0.0045		
	Magnesium (Mg)-Total (mg/L)	29.5	20.8	64.9		
	Manganese (Mn)-Total (mg/L)	0.139	0.485	3.31		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2027459-1	L2027459-2	L2027459-3		
	Description	Water	Water	Water		
	Sampled Date	21-NOV-17	21-NOV-17	22-NOV-17		
	Sampled Time	09:30	10:00	15:30		
	Client ID	W3	W17	W8A		
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000066		
	Molybdenum (Mo)-Total (mg/L)	0.00480	0.00683	0.0159		
	Nickel (Ni)-Total (mg/L)	0.00097	0.00111	0.00270		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.103		
	Potassium (K)-Total (mg/L)	2.27	3.42	8.60		
	Selenium (Se)-Total (mg/L)	0.000314	0.000390	0.00872		
	Silicon (Si)-Total (mg/L)	6.59	5.89	9.42		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000056		
	Sodium (Na)-Total (mg/L)	17.5	15.1	50.0		
	Strontium (Sr)-Total (mg/L)	0.802	0.749	3.23		
	Sulfur (S)-Total (mg/L)	20.2	21.1	146		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00088	0.00216	0.00974		
	Uranium (U)-Total (mg/L)	0.00290	0.00222	0.00470		
	Vanadium (V)-Total (mg/L)	0.00065	0.00067	0.00383		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.603		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00071		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0013	0.0020	0.0053		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00014		
	Arsenic (As)-Dissolved (mg/L)	0.00024	0.00036	0.00047		
	Barium (Ba)-Dissolved (mg/L)	0.0734	0.0728	0.156		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	0.023	0.027	0.030		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000075	<0.0000050	0.000276		
	Calcium (Ca)-Dissolved (mg/L)	59.4	67.1	214		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00010	0.00053		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00108		
	Copper (Cu)-Dissolved (mg/L)	0.00202	0.00579	0.0683		
	Iron (Fe)-Dissolved (mg/L)	0.037	<0.010	0.183		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0030	<0.0010	0.0036		
	Magnesium (Mg)-Dissolved (mg/L)	28.4	19.8	57.0		
	Manganese (Mn)-Dissolved (mg/L)	0.123	0.0115	2.95		

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte					
	Sample ID	L2027459-1	L2027459-2	L2027459-3		
	Description	Water	Water	Water		
	Sampled Date	21-NOV-17	21-NOV-17	22-NOV-17		
	Sampled Time	09:30	10:00	15:30		
	Client ID	W3	W17	W8A		
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00459	0.00611	0.0131		
	Nickel (Ni)-Dissolved (mg/L)	0.00085	0.00062	0.00209		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	2.28	3.63	7.70		
	Selenium (Se)-Dissolved (mg/L)	0.000327	0.000372	0.00830		
	Silicon (Si)-Dissolved (mg/L)	6.40	5.58	7.76		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000011		
	Sodium (Na)-Dissolved (mg/L)	17.6	14.6	46.1		
	Strontium (Sr)-Dissolved (mg/L)	0.782	0.747	2.86		
	Sulfur (S)-Dissolved (mg/L)	18.2	19.4	122		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	DLM <0.00060		
	Uranium (U)-Dissolved (mg/L)	0.00271	0.00224	0.00415		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00103		
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010	0.388		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00055		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Sulfur (S)-Total	B	L2027459-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L2027459-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L2027459-1, -2, -3
Matrix Spike	Calcium (Ca)-Total	MS-B	L2027459-1, -2, -3
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2027459-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L2027459-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L2027459-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L2027459-1, -2, -3
Matrix Spike	Sulfur (S)-Total	MS-B	L2027459-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Reference Information

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-11-23 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2027459-COFC

COC Number: 2017-11-23 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 226973 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Contact: Shane Stack

Sampler: CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	21-11-2017	9:30	Water	R	R	R	R	R	R	R	R	R					7
	W17	21-11-2017	10:00	Water	R	R	R	R	R	R	R	R	R					7
	W8A	22-11-2017	15:30	Water	R	R	R	R	R	R	R	R						6

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3 °c			5		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Corey Roberts	Date: 2017-11-23	Time:	Received by: EHF	Date: 27Nov2017	Time: 10:33	Received by: JC	Date: 11/28/17	Time: 15:10

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 30-NOV-17
Report Date: 12-DEC-17 17:48 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2029332
Project P.O. #: 228617
Job Reference:
C of C Numbers: 2017-11-28 B
Legal Site Desc:

Shane Stack
Account Manager

	Sample ID	L2029332-1	L2029332-2	L2029332-3	L2029332-4	L2029332-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	28-NOV-17	28-NOV-17	28-NOV-17	28-NOV-17	27-NOV-17
	Sampled Time	09:30	15:00	12:20	09:30	14:15
	Client ID	W3	W17	W8A	F-BL	W45
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	534	493	1470	56.1	3110
	Hardness (as CaCO3) (mg/L)	288	266	872	<0.50	1680
	pH (pH)	7.94	8.04	7.70	7.52	7.88
	Total Suspended Solids (mg/L)	<3.0	5.5	18.3	<3.0	87.9
	TDS (Calculated) (mg/L)	326	305	1090	30.9	2980
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	246	213	524	15.8	126
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	246	213	524	15.8	126
	Ammonia, Total (as N) (mg/L)	0.0276	0.0097	0.356	<0.0050	5.17
	Chloride (Cl) (mg/L)	4.58	6.75	15.2	6.87	42
	Nitrate (as N) (mg/L)	0.168	HTD 0.152	6.04	0.155	21.3
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.768	<0.0010	4.60
	Sulfate (SO4) (mg/L)	57.3	58.6	362	1.00	1870
	Anion Sum (meq/L)	6.27	5.71	19.0	0.54	44.5
	Cation Sum (meq/L)	6.61	6.07	19.9	0.56	44.1
	Cation - Anion Balance (%)	2.7	3.0	2.4	1.4	-0.4
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.20	8.80		<0.50	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0443	0.0194	0.0808	<0.0030	0.802
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00018	0.00044	<0.00010	0.00036
	Arsenic (As)-Total (mg/L)	0.00032	0.00038	0.00072	<0.00010	0.00052
	Barium (Ba)-Total (mg/L)	0.0791	0.0783	0.177	0.000244	0.144
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000029	<0.000020	DLA <0.000040
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	DLA <0.00010
	Boron (B)-Total (mg/L)	0.024	0.029	0.033	<0.010	0.342
	Cadmium (Cd)-Total (mg/L)	0.0000141	0.0000095	0.000370	<0.0000050	0.000097
	Calcium (Ca)-Total (mg/L)	59.4	69.9	234	0.179	524
	Chromium (Cr)-Total (mg/L)	0.00014	<0.00010	0.00186	<0.00010	0.00036
	Cobalt (Co)-Total (mg/L)	0.00016	0.00012	0.00121	<0.00010	0.00288
	Copper (Cu)-Total (mg/L)	0.00315	0.00782	0.148	0.00096	0.105
	Iron (Fe)-Total (mg/L)	0.125	0.076	3.96	0.020	1.27
	Lead (Pb)-Total (mg/L)	<0.000050	0.000254	0.000099	0.000201	0.00026
	Lithium (Li)-Total (mg/L)	0.0033	0.0016	0.0044	<0.0010	0.0257
	Magnesium (Mg)-Total (mg/L)	28.2	19.6	60.7	<0.10	77.9
	Manganese (Mn)-Total (mg/L)	0.241	0.157	3.25	0.00051	1.79
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	0.0000063	<0.0000050	DLM <0.000025

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2029332-1	L2029332-2	L2029332-3	L2029332-4	L2029332-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	28-NOV-17	28-NOV-17	28-NOV-17	28-NOV-17	27-NOV-17
	Sampled Time	09:30	15:00	12:20	09:30	14:15
	Client ID	W3	W17	W8A	F-BL	W45
Grouping	**Analyte**					
WATER						
Total Metals	Molybdenum (Mo)-Total (mg/L)	0.00462	0.00626	0.0148	0.000368	0.125
	Nickel (Ni)-Total (mg/L)	0.00114	0.00085	0.00235	<0.00050	0.0057
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.095	<0.050	<0.10 DLA
	Potassium (K)-Total (mg/L)	2.34	3.62	8.40	<0.10	72.3
	Selenium (Se)-Total (mg/L)	0.000305	0.000372	0.00829	<0.000050	0.0160
	Silicon (Si)-Total (mg/L)	6.56	5.59	8.07	0.65	4.66
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000037	<0.000010	0.000032
	Sodium (Na)-Total (mg/L)	18.4	14.7	49.0	11.9	188
	Strontium (Sr)-Total (mg/L)	0.798	0.745	3.12	0.00114	7.60
	Sulfur (S)-Total (mg/L)	20.3	20.6	133	<0.50	680
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000020 DLA
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00010	<0.00020 DLA
	Titanium (Ti)-Total (mg/L)	0.00162	<0.00090 DLM	<0.0060 DLM	<0.00030	<0.045 DLM
	Uranium (U)-Total (mg/L)	0.00255	0.00220	0.00412	0.000133	0.00805
	Vanadium (V)-Total (mg/L)	<0.00050	<0.00050	0.00284	<0.00050	0.0027
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	0.315	0.0231	0.0089
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00065	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0017	0.0015	0.0119	<0.0010	0.0083
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00014	<0.00010	0.00040
	Arsenic (As)-Dissolved (mg/L)	0.00026	0.00038	0.00051	<0.00010	0.00037
	Barium (Ba)-Dissolved (mg/L)	0.0756	0.0732	0.153	0.000205	0.135
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000040 DLA
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.00010 DLA
	Boron (B)-Dissolved (mg/L)	0.024	0.027	0.032	<0.010	0.344
	Cadmium (Cd)-Dissolved (mg/L)	0.0000105	0.0000069	0.000307	<0.0000050	<0.00010 DLM
	Calcium (Ca)-Dissolved (mg/L)	62.4	69.4	236	0.168	519
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00060 DLB	<0.00010	<0.00020 DLA
	Cobalt (Co)-Dissolved (mg/L)	0.00013	<0.00010	0.00115	<0.00010	0.00266
	Copper (Cu)-Dissolved (mg/L)	0.00249	0.00568	0.0765	0.00073	0.00353
	Iron (Fe)-Dissolved (mg/L)	0.065	0.046	0.236	0.015	<0.020 DLA
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	0.000158	<0.00010 DLA
	Lithium (Li)-Dissolved (mg/L)	0.0034	0.0016	0.0044	<0.0010	0.0231
	Magnesium (Mg)-Dissolved (mg/L)	32.1	22.6	68.5	<0.10	93.4
	Manganese (Mn)-Dissolved (mg/L)	0.230	0.103	3.44	0.00047	1.89
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2029332-1	L2029332-2	L2029332-3	L2029332-4	L2029332-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	28-NOV-17	28-NOV-17	28-NOV-17	28-NOV-17	27-NOV-17
	Sampled Time	09:30	15:00	12:20	09:30	14:15
	Client ID	W3	W17	W8A	F-BL	W45
Grouping	**Analyte**					
WATER						
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00431	0.00575	0.0137	0.000332	0.121
	Nickel (Ni)-Dissolved (mg/L)	0.00098	0.00079	0.00174	<0.00050	0.0056
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.10 DLA
	Potassium (K)-Dissolved (mg/L)	2.01	3.64	8.09	<0.10	69.3
	Selenium (Se)-Dissolved (mg/L)	0.000306	0.000402	0.00907	<0.000050	0.0157
	Silicon (Si)-Dissolved (mg/L)	6.57	5.68	7.83	0.610	3.21
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000013	<0.000010	<0.000020 DLA
	Sodium (Na)-Dissolved (mg/L)	18.2	14.8	48.8	12.6	191
	Strontium (Sr)-Dissolved (mg/L)	0.756	0.697	2.98	0.00101	7.01
	Sulfur (S)-Dissolved (mg/L)	19.9	20.3	129	<0.50	721
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000020 DLA
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020 DLA
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00090	<0.00030	<0.00060 DLA
	Uranium (U)-Dissolved (mg/L)	0.00245	0.00206	0.00386	0.000128	0.00752
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00119	<0.00050	<0.0010 DLA
	Zinc (Zn)-Dissolved (mg/L)	0.0032	0.0010	0.212	0.0224	0.0030
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00055	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Barium (Ba)-Dissolved	MB-LOR	L2029332-1, -2, -3, -5
Method Blank	Chromium (Cr)-Dissolved	MB-LOR	L2029332-1, -2, -3, -5
Laboratory Control Sample	Titanium (Ti)-Dissolved	MES	L2029332-4
Matrix Spike	Aluminum (Al)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Iron (Fe)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Nickel (Ni)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L2029332-3
Matrix Spike	Strontium (Sr)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Sulfur (S)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Tin (Sn)-Total	MS-B	L2029332-3
Matrix Spike	Titanium (Ti)-Total	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Nitrite (as N)	MS-B	L2029332-1, -2, -3, -4, -5
Matrix Spike	Nitrate (as N)	MS-B	L2029332-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

Reference Information

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-11-28 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2029332-COFC

COC Number: 2017-11-28 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)

- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY

- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 228617 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	28-11-2017	9:30	Water	R	R	R	R	R	R	R	R	R					7
	W17	28-11-2017	15:00	Water	R	R	R	R	R	R	R	R	R					7
	W8A	28-11-2017	12:20	Water	R	R	R	R	R	R	R	R						6
	F-BL	28-11-2017	9:30	Water	R	R	R	R	R	R	R	R	R					7
	W45	27-11-2017	14:15	Water	R	R	R	R	R	R	R	R						6

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list bel
(electronic COC only)

(lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2°C			2		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:Corey Roberts	Date:29-11-2017	Time:	Received by: DW	Date: NOV 30/17	Time: 12:07	Received by: JL	Date: DEC - 1 2017	Time: 11AM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	08-DEC-17
Report Date:	22-DEC-17 15:34 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2032801

Project P.O. #:	228617
Job Reference:	
C of C Numbers:	2017-12-06 A
Legal Site Desc:	

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2032801-1	L2032801-2	L2032801-3	L2032801-4	L2032801-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	04-DEC-17	04-DEC-17	04-DEC-17	04-DEC-17	05-DEC-17
	Sampled Time	09:25	10:00	14:20	14:45	11:55
	Client ID	W17	W8A	W46	W7	W12
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	490	1490	624	407	2500
	Hardness (as CaCO3) (mg/L)	260	894	318	202	1310
	pH (pH)	8.07	7.83	8.02	7.96	7.98
	Total Suspended Solids (mg/L)	<3.0	42.7	<3.0	3.3	6.0
	TDS (Calculated) (mg/L)	307	1140	375	225	2200
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	217	480	297	207	203
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	217	480	297	207	203
	Ammonia, Total (as N) (mg/L)	<0.0050	0.395	0.0144	0.0148	4.46
	Chloride (Cl) (mg/L)	7.04	15.3	5.78	0.94	36
	Nitrate (as N) (mg/L)	0.136	6.74	0.0130	0.0106	12.6
	Nitrite (as N) (mg/L)	<0.0010	0.568	0.0021	<0.0010	4.68
	Sulfate (SO4) (mg/L)	58.4	416	57.8	18.0	1280
	Anion Sum (meq/L)	5.77	19.2	7.33	4.55	32.9
	Cation Sum (meq/L)	6.03	20.8	7.39	4.60	34.8
	Cation - Anion Balance (%)	2.2	4.0	0.4	0.6	2.8
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	9.82		11.8	9.83	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0109	0.0379	0.0108	0.0330	0.0707
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00029	0.00012	0.00038	0.00032
	Arsenic (As)-Total (mg/L)	0.00034	0.00067	0.00057	0.00050	0.00048
	Barium (Ba)-Total (mg/L)	0.0781	0.168	0.135	0.112	0.0937
	Beryllium (Be)-Total (mg/L)	<0.000020	0.000023	<0.000020	<0.000020	DLA <0.000040
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	DLA <0.00010
	Boron (B)-Total (mg/L)	0.033	0.037	0.013	<0.010	0.296
	Cadmium (Cd)-Total (mg/L)	0.0000081	0.000364	0.0000201	0.0000172	0.000185
	Calcium (Ca)-Total (mg/L)	70.4	233	78.5	50.2	398
	Chromium (Cr)-Total (mg/L)	0.00011	0.00074	0.00079	0.00039	DLA <0.00020
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00137	0.00026	0.00017	0.00148
	Copper (Cu)-Total (mg/L)	0.00715	0.122	0.00394	0.0113	0.0864
	Iron (Fe)-Total (mg/L)	0.015	1.79	0.178	0.137	0.143
	Lead (Pb)-Total (mg/L)	<0.000050	0.000077	<0.000050	<0.000050	DLA <0.00010
	Lithium (Li)-Total (mg/L)	0.0021	0.0047	0.0023	0.0015	0.0203
	Magnesium (Mg)-Total (mg/L)	19.6	60.1	28.9	18.2	67.9
	Manganese (Mn)-Total (mg/L)	0.0895	3.40	0.329	0.136	1.22
	Mercury (Hg)-Total (mg/L)	<0.0000050	0.0000083	<0.0000050	0.0000050	0.0000051

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2032801-6	L2032801-7	L2032801-8	L2032801-9	
	Description	Water	Water	Water	Water	
	Sampled Date	05-DEC-17	05-DEC-17	05-DEC-17	05-DEC-17	
	Sampled Time	13:50	14:00	14:25		
	Client ID	W30	W15	W3	DUP	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	892	1250	533	1250	
	Hardness (as CaCO3) (mg/L)	469	751	266	743	
	pH (pH)	8.02	7.92	8.12	7.93	
	Total Suspended Solids (mg/L)	12.7	<3.0	3.3	<3.0	
	TDS (Calculated) (mg/L)	590	905	317	904	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	332	435	242	436	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	332	435	242	436	
	Ammonia, Total (as N) (mg/L)	0.599	0.432	0.0243	0.434	
	Chloride (Cl) (mg/L)	6.1	6.2	4.39	6.2	
	Nitrate (as N) (mg/L)	1.37	11.5	0.178	11.5	
	Nitrite (as N) (mg/L)	0.0488	0.0452	0.0011	0.0479	
	Sulfate (SO4) (mg/L)	180	286	56.6	287	
	Anion Sum (meq/L)	10.7	15.7	6.18	15.7	
	Cation Sum (meq/L)	10.9	16.5	6.24	16.4	
	Cation - Anion Balance (%)	1.0	2.8	0.5	2.1	
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)		24.1	5.45	26.3	
Total Metals	Aluminum (Al)-Total (mg/L)	0.122	0.0299	0.0423	0.0287	
	Antimony (Sb)-Total (mg/L)	0.00023	0.00023	<0.00010	0.00022	
	Arsenic (As)-Total (mg/L)	0.00131	0.00060	0.00025	0.00059	
	Barium (Ba)-Total (mg/L)	0.257	0.191	0.0831	0.200	
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Total (mg/L)	0.012	<0.010	0.027	<0.010	
	Cadmium (Cd)-Total (mg/L)	0.0000202	0.0000271	0.0000100	0.0000274	
	Calcium (Ca)-Total (mg/L)	118	199	60.7	198	
	Chromium (Cr)-Total (mg/L)	0.00017	0.00038	0.00014	0.00034	
	Cobalt (Co)-Total (mg/L)	0.00106	0.00044	0.00012	0.00044	
	Copper (Cu)-Total (mg/L)	0.0306	0.0459	0.00304	0.0483	
	Iron (Fe)-Total (mg/L)	0.730	0.738	0.106	0.719	
	Lead (Pb)-Total (mg/L)	0.000075	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Total (mg/L)	0.0031	0.0017	0.0036	0.0017	
	Magnesium (Mg)-Total (mg/L)	43.6	53.6	28.9	53.0	
	Manganese (Mn)-Total (mg/L)	5.70	0.765	0.162	0.753	
	Mercury (Hg)-Total (mg/L)	0.0000056	<0.0000050	0.0000070	0.0000070	

	Sample ID	L2032801-1	L2032801-2	L2032801-3	L2032801-4	L2032801-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	04-DEC-17	04-DEC-17	04-DEC-17	04-DEC-17	05-DEC-17
	Sampled Time	09:25	10:00	14:20	14:45	11:55
	Client ID	W17	W8A	W46	W7	W12
Grouping	**Analyte**					
WATER						
Total Metals	Molybdenum (Mo)-Total (mg/L)	0.00613	0.0154	0.00199	0.00116	0.0888
	Nickel (Ni)-Total (mg/L)	0.00085	0.00200	0.00153	0.00120	0.0038
	Phosphorus (P)-Total (mg/L)	<0.050	0.066	<0.050	<0.050	<0.10 DLA
	Potassium (K)-Total (mg/L)	3.71	8.44	3.03	1.61	49.6
	Selenium (Se)-Total (mg/L)	0.000384	0.00805	0.000117	0.000107	0.0121
	Silicon (Si)-Total (mg/L)	5.78	8.04	9.42	7.89	4.68
	Silver (Ag)-Total (mg/L)	<0.000010	0.000035	<0.000010	<0.000010	<0.000020 DLA
	Sodium (Na)-Total (mg/L)	15.4	51.7	20.9	11.4	145
	Strontium (Sr)-Total (mg/L)	0.742	3.29	0.815	0.515	7.63
	Sulfur (S)-Total (mg/L)	20.4	135	20.5	6.36	471
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000020 DLA
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020 DLA
	Titanium (Ti)-Total (mg/L)	<0.00050 DLM	<0.0030 DLM	0.00053	0.00207	<0.0040 DLM
	Uranium (U)-Total (mg/L)	0.00238	0.00440	0.00201	0.00120	0.00859
	Vanadium (V)-Total (mg/L)	<0.00050	0.00225	0.00062	0.00065	<0.0010 DLA
	Zinc (Zn)-Total (mg/L)	<0.0030	0.239	0.0035	0.0238	0.0090
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00064	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0016	0.0070	0.0066	0.0042	0.0050
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00011	<0.00010	0.00011	0.00028
	Arsenic (As)-Dissolved (mg/L)	0.00040	0.00065	0.00061	0.00055	0.00054
	Barium (Ba)-Dissolved (mg/L)	0.0696	0.151	0.127	0.103	0.0843
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000040 DLA
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.00010 DLA
	Boron (B)-Dissolved (mg/L)	0.035	0.040	0.014	<0.010	0.287
	Cadmium (Cd)-Dissolved (mg/L)	0.0000060	0.000391	0.0000217	0.0000208	<0.00020 DLM
	Calcium (Ca)-Dissolved (mg/L)	68.9	250	76.1	48.6	408
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00055	0.00021	0.00023	<0.00020 DLA
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	0.00130	0.00022	0.00014	0.00134
	Copper (Cu)-Dissolved (mg/L)	0.00574	0.0677	0.00299	0.00241	0.0577
	Iron (Fe)-Dissolved (mg/L)	<0.010	0.251	0.095	0.020	<0.020 DLA
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	<0.00010 DLA
	Lithium (Li)-Dissolved (mg/L)	0.0018	0.0053	0.0017	<0.0010	0.0215
	Magnesium (Mg)-Dissolved (mg/L)	21.4	65.6	31.1	19.6	71.1
	Manganese (Mn)-Dissolved (mg/L)	0.0171	3.75	0.337	0.126	1.26
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L2032801-6	L2032801-7	L2032801-8	L2032801-9
	Description	Water	Water	Water	Water
	Sampled Date	05-DEC-17	05-DEC-17	05-DEC-17	05-DEC-17
	Sampled Time	13:50	14:00	14:25	
	Client ID	W30	W15	W3	DUP
Grouping	**Analyte**				
WATER					
Total Metals	Molybdenum (Mo)-Total (mg/L)	0.00368	0.00370	0.00483	0.00356
	Nickel (Ni)-Total (mg/L)	0.00118	0.00175	0.00110	0.00220
	Phosphorus (P)-Total (mg/L)	0.066	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	6.56	5.28	2.35	5.42
	Selenium (Se)-Total (mg/L)	0.00176	0.00282	0.000291	0.00276
	Silicon (Si)-Total (mg/L)	6.20	9.25	6.71	9.27
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	24.0	27.3	19.5	26.8
	Strontium (Sr)-Total (mg/L)	1.16	1.69	0.826	1.69
	Sulfur (S)-Total (mg/L)	65.6	107	20.2	106
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00450	DLM <0.0020	0.00189	0.00140
	Uranium (U)-Total (mg/L)	0.00115	0.00392	0.00299	0.00390
	Vanadium (V)-Total (mg/L)	0.00078	<0.00050	0.00055	<0.00050
	Zinc (Zn)-Total (mg/L)	0.0048	0.0229	<0.0030	0.0221
	Zirconium (Zr)-Total (mg/L)	<0.00030	0.00039	<0.00030	0.00037
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0042	0.0062	0.0018	0.0066
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00016	<0.00010	0.00016
	Arsenic (As)-Dissolved (mg/L)	0.00132	0.00068	0.00029	0.00066
	Barium (Ba)-Dissolved (mg/L)	0.229	0.175	0.0727	0.173
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.011	<0.010	0.027	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.0000124	0.0000297	0.0000113	0.0000309
	Calcium (Ca)-Dissolved (mg/L)	116	206	57.6	202
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00026	<0.00010	0.00026
	Cobalt (Co)-Dissolved (mg/L)	0.00089	0.00040	0.00013	0.00039
	Copper (Cu)-Dissolved (mg/L)	0.00835	0.0367	0.00205	0.0372
	Iron (Fe)-Dissolved (mg/L)	0.088	0.062	0.064	0.061
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0026	0.0018	0.0037	0.0018
	Magnesium (Mg)-Dissolved (mg/L)	43.3	57.6	29.7	57.8
	Manganese (Mn)-Dissolved (mg/L)	5.94	0.820	DTMF 0.229	0.830
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2032801-1	L2032801-2	L2032801-3	L2032801-4	L2032801-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	04-DEC-17	04-DEC-17	04-DEC-17	04-DEC-17	05-DEC-17
	Sampled Time	09:25	10:00	14:20	14:45	11:55
	Client ID	W17	W8A	W46	W7	W12
Grouping	**Analyte**					
WATER						
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00528	0.0126	0.00171	0.00101	0.0790
	Nickel (Ni)-Dissolved (mg/L)	0.00068	0.00182	0.00135	0.00106	0.0035
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.10 DLA
	Potassium (K)-Dissolved (mg/L)	3.74	9.11	2.94	1.57	51.8
	Selenium (Se)-Dissolved (mg/L)	0.000522	0.0104	0.000216	0.000128	0.0128
	Silicon (Si)-Dissolved (mg/L)	5.61	8.28	9.43	7.46	4.50
	Silver (Ag)-Dissolved (mg/L)	<0.000010	0.000011	<0.000010	<0.000010	<0.000020 DLA
	Sodium (Na)-Dissolved (mg/L)	16.9	58.0	21.7	11.9	159
	Strontium (Sr)-Dissolved (mg/L)	0.742	3.03	0.796	0.503	7.16
	Sulfur (S)-Dissolved (mg/L)	20.8	148	21.9	6.49	511
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000020 DLA
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00020 DLA
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00080 DLM	0.00047	<0.00030	<0.00060 DLA
	Uranium (U)-Dissolved (mg/L)	0.00213	0.00395	0.00194	0.00112	0.00795
	Vanadium (V)-Dissolved (mg/L)	<0.00050	0.00126	<0.00050	<0.00050	<0.0010 DLA
	Zinc (Zn)-Dissolved (mg/L)	<0.0025 DLB	0.207	<0.0050 DLB	0.0302	<0.0090 DLB
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	0.00056	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2032801-6	L2032801-7	L2032801-8	L2032801-9
	Description	Water	Water	Water	Water
	Sampled Date	05-DEC-17	05-DEC-17	05-DEC-17	05-DEC-17
	Sampled Time	13:50	14:00	14:25	
	Client ID	W30	W15	W3	DUP
Grouping	**Analyte**				
WATER					
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00304	0.00285	0.00392	0.00283
	Nickel (Ni)-Dissolved (mg/L)	0.00093	0.00158	0.00088	0.00160
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	6.73	5.58	2.18	5.59
	Selenium (Se)-Dissolved (mg/L)	0.00242 DTMF	0.00387 DTMF	0.000390	0.00371
	Silicon (Si)-Dissolved (mg/L)	5.61	9.41	6.38	9.53
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	25.1	30.4	19.6	30.7
	Strontium (Sr)-Dissolved (mg/L)	1.08	1.55	0.748	1.50
	Sulfur (S)-Dissolved (mg/L)	66.4	111	20.5	115
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00050 DLM	<0.00030	<0.00060 DLM
	Uranium (U)-Dissolved (mg/L)	0.00104	0.00345	0.00257	0.00341
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0050 DLB	0.0228	<0.0020 DLB	0.0231
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Zinc (Zn)-Dissolved	MB-LOR	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L2032801-1, -3, -4, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L2032801-1, -3, -4, -7, -8, -9
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sodium (Na)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Strontium (Sr)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfur (S)-Total	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Sulfate (SO4)	MS-B	L2032801-1, -2, -3, -4, -5, -6, -7, -8, -9

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DTMF	Dissolved concentration exceeds total for field-filtered metals sample. Metallic contaminants were likely introduced to dissolved sample during field filtration.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

Reference Information

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

Chain of Custody Numbers:

2017-12-06 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2032801-COFC

COC Number: 2017-12-06 A

Page of

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To Same as Report To ☐ YES ☑ NO

Copy of Invoice with Report ☐ YES ☑ NO

Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 228617 (WUL)

LSD:

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Shane Stack **Sampler:** SR/CP

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserve	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W17	4-Dec-17	9:25	Water	R	R	R	R	R	R	R	R	R					7
	W8A	4-Dec-17	10:00	Water	R	R	R	R	R	R	R	R						6
	W46	4-Dec-17	14:20	Water	R	R	R	R	R	R	R	R	R					7
	W7	4-Dec-17	14:45	Water	R	R	R	R	R	R	R	R	R					7
	W12	5-Dec-17	11:55	Water	R	R	R	R	R	R	R	R						6
	W30	5-Dec-17	13:50	Water	R	R	R	R	R	R	R	R						6
	W15	5-Dec-17	14:00	Water	R	R	R	R	R	R	R	R	R					7
	W3	5-Dec-17	14:25	Water	R	R	R	R	R	R	R	R	R					7
	DUP	5-Dec-17		Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3°C.	3°C.				

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 2017-12-06	Time: 12:00	Received by:	Date: DEC 8/17	Time: 09:10	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 13-DEC-17
Report Date: 22-DEC-17 16:42 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2035054

Project P.O. #: 228617
Job Reference:
C of C Numbers: 2017-12-13 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2035054-1				
	Description	Water				
	Sampled Date	12-DEC-17				
	Sampled Time	10:15				
	Client ID	W3				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	514				
	Hardness (as CaCO3) (mg/L)	266				
	pH (pH)	8.03				
	Total Suspended Solids (mg/L)	5.6				
	TDS (Calculated) (mg/L)	318				
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	246				
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0				
	Alkalinity, Total (as CaCO3) (mg/L)	246				
	Ammonia, Total (as N) (mg/L)	0.0117				
	Chloride (Cl) (mg/L)	4.35				
	Nitrate and Nitrite (as N) (mg/L)	0.200				
	Nitrate (as N) (mg/L)	0.200				
	Nitrite (as N) (mg/L)	<0.0010				
	Sulfate (SO4) (mg/L)	56.5				
	Anion Sum (meq/L)	6.22				
	Cation Sum (meq/L)	6.19				
	Cation - Anion Balance (%)	-0.3				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.01				
Total Metals	Aluminum (Al)-Total (mg/L)	0.315				
	Antimony (Sb)-Total (mg/L)	0.00101				
	Arsenic (As)-Total (mg/L)	0.00037				
	Barium (Ba)-Total (mg/L)	0.0864				
	Beryllium (Be)-Total (mg/L)	<0.000020				
	Bismuth (Bi)-Total (mg/L)	<0.000050				
	Boron (B)-Total (mg/L)	0.025				
	Cadmium (Cd)-Total (mg/L)	0.0000163				
	Calcium (Ca)-Total (mg/L)	58.2				
	Chromium (Cr)-Total (mg/L)	0.00039				
	Cobalt (Co)-Total (mg/L)	0.00027				
	Copper (Cu)-Total (mg/L)	0.0654				
	Iron (Fe)-Total (mg/L)	0.603				
	Lead (Pb)-Total (mg/L)	0.000153				
	Lithium (Li)-Total (mg/L)	0.0034				
	Magnesium (Mg)-Total (mg/L)	28.8				
	Manganese (Mn)-Total (mg/L)	0.165				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2035054-1				
	Description	Water				
	Sampled Date	12-DEC-17				
	Sampled Time	10:15				
	Client ID	W3				
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050				
	Molybdenum (Mo)-Total (mg/L)	0.00467				
	Nickel (Ni)-Total (mg/L)	0.00114				
	Phosphorus (P)-Total (mg/L)	0.055				
	Potassium (K)-Total (mg/L)	2.34				
	Selenium (Se)-Total (mg/L)	0.000364				
	Silicon (Si)-Total (mg/L)	7.20				
	Silver (Ag)-Total (mg/L)	0.000032				
	Sodium (Na)-Total (mg/L)	17.9				
	Strontium (Sr)-Total (mg/L)	0.783				
	Sulfur (S)-Total (mg/L)	22.2				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	0.0230				
	Uranium (U)-Total (mg/L)	0.00298				
	Vanadium (V)-Total (mg/L)	0.00170				
	Zinc (Zn)-Total (mg/L)	0.0032				
	Zirconium (Zr)-Total (mg/L)	<0.00030				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0020				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00027				
	Barium (Ba)-Dissolved (mg/L)	0.0838				
	Beryllium (Be)-Dissolved (mg/L)	<0.000020				
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050				
	Boron (B)-Dissolved (mg/L)	0.023				
	Cadmium (Cd)-Dissolved (mg/L)	0.0000069				
	Calcium (Ca)-Dissolved (mg/L)	58.9				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	0.00226				
	Iron (Fe)-Dissolved (mg/L)	0.031				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.0031				
	Magnesium (Mg)-Dissolved (mg/L)	28.8				
	Manganese (Mn)-Dissolved (mg/L)	0.137				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2035054-1				
	Description	Water				
	Sampled Date	12-DEC-17				
	Sampled Time	10:15				
	Client ID	W3				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050				
	Molybdenum (Mo)-Dissolved (mg/L)	0.00421				
	Nickel (Ni)-Dissolved (mg/L)	0.00079				
	Phosphorus (P)-Dissolved (mg/L)	<0.050				
	Potassium (K)-Dissolved (mg/L)	2.43				
	Selenium (Se)-Dissolved (mg/L)	0.000329				
	Silicon (Si)-Dissolved (mg/L)	6.38				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	18.6				
	Strontium (Sr)-Dissolved (mg/L)	0.763				
	Sulfur (S)-Dissolved (mg/L)	19.9				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.00030				
	Uranium (U)-Dissolved (mg/L)	0.00274				
	Vanadium (V)-Dissolved (mg/L)	<0.00050				
	Zinc (Zn)-Dissolved (mg/L)	0.0023				
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Magnesium (Mg)-Dissolved	MB-LOR	L2035054-1
Laboratory Control Sample	Antimony (Sb)-Total	MES	L2035054-1
Laboratory Control Sample	Barium (Ba)-Total	MES	L2035054-1
Matrix Spike	Silver (Ag)-Dissolved	MES	L2035054-1
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L2035054-1
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L2035054-1
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L2035054-1
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L2035054-1
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L2035054-1
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L2035054-1
Matrix Spike	Potassium (K)-Dissolved	MS-B	L2035054-1
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L2035054-1
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L2035054-1
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L2035054-1
Matrix Spike	Barium (Ba)-Total	MS-B	L2035054-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L2035054-1
Matrix Spike	Magnesium (Mg)-Total	MS-B	L2035054-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L2035054-1
Matrix Spike	Potassium (K)-Total	MS-B	L2035054-1
Matrix Spike	Sodium (Na)-Total	MS-B	L2035054-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L2035054-1
Matrix Spike	Sulfur (S)-Total	MS-B	L2035054-1
Matrix Spike	Nitrite (as N)	MS-B	L2035054-1
Matrix Spike	Nitrate (as N)	MS-B	L2035054-1
Matrix Spike	Sulfate (SO4)	MS-B	L2035054-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

EC-SCREEN-VA Water Conductivity Screen (Internal Use Only) APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

Reference Information

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-12-13 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Custody Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2035054-COFC

COC Number: 2017-12-13 A

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 228617 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack **Sampler:** SR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	12-Dec-17	10:15	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3°C.					1.7

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date:2017-12-13	Time: 12:00	Received by:	Date: DEC 13/17	Time: 16:42	Received by: TP	Date: Dec 14	Time: 16:15

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 20-DEC-17
Report Date: 12-JAN-18 17:01 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2037961
Project P.O. #: 228617
Job Reference:
C of C Numbers: 2017-12-20 B
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2037961-1	L2037961-2	L2037961-3	L2037961-4	L2037961-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-DEC-17	18-DEC-17	19-DEC-17	19-DEC-17	19-DEC-17
	Sampled Time	15:15	15:30	09:30	10:15	13:35
	Client ID	W45	W14	W3	W17	W8A
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	3260	3550	560	530	1600
	Hardness (as CaCO3) (mg/L)	1650	1660	281	268	929
	pH (pH)	7.80	8.18	8.18	8.23	7.80
	Total Suspended Solids (mg/L)	86.9	45.3	<3.0	4.8	16.1
	TDS (Calculated) (mg/L)	2960	3190	320	311	1100
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	134	105	240	218	530
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	134	105	240	218	530
	Ammonia, Total (as N) (mg/L)	4.69	8.32	0.0114	0.0060	0.330
	Chloride (Cl) (mg/L)	41	46	4.41	7.02	8.21
	Nitrate and Nitrite (as N) (mg/L)	23.4	33.4	0.211	0.102	4.67
	Nitrate (as N) (mg/L)	17.6	28.8	0.211	0.102	3.49
	Nitrite (as N) (mg/L)	5.79	4.53	<0.0010	<0.0010	1.18
	Sulfate (SO4) (mg/L)	1870	2020	57.8	60.0	361
	Anion Sum (meq/L)	44.4	47.8	6.14	5.80	18.7
	Cation Sum (meq/L)	43.6	45.8	6.48	6.13	21.4
	Cation - Anion Balance (%)	-0.9	-2.0	2.7	2.8	6.7
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	73.3	108	5.35	8.95	
Total Metals	Aluminum (Al)-Total (mg/L)	0.637	0.268	0.0283	0.0711	0.0436
	Antimony (Sb)-Total (mg/L)	0.00033	0.00060	<0.00010	0.00011	0.00023
	Arsenic (As)-Total (mg/L)	0.00064	0.00076	0.00030	0.00044	0.00071
	Barium (Ba)-Total (mg/L)	0.125	0.136	0.0727	0.0805	0.151
	Beryllium (Be)-Total (mg/L)	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.361	0.456	0.028	0.032	0.042
	Cadmium (Cd)-Total (mg/L)	<0.00016 DLM	<0.00013 DLM	0.0000060	0.0000172	0.000464
	Calcium (Ca)-Total (mg/L)	512	545	60.2	70.1	252
	Chromium (Cr)-Total (mg/L)	0.00023	0.00042	0.00015	0.00021	0.00071
	Cobalt (Co)-Total (mg/L)	0.00381	0.00071	<0.00010	0.00016	0.00129
	Copper (Cu)-Total (mg/L)	0.0480	0.0972	0.00260	0.0206	0.167
	Iron (Fe)-Total (mg/L)	0.938	0.288	0.057	0.102	1.95
	Lead (Pb)-Total (mg/L)	0.00043	0.00016	<0.000050	0.000076	0.000085
	Lithium (Li)-Total (mg/L)	0.0278	0.0294	0.0039	0.0020	0.0051
	Magnesium (Mg)-Total (mg/L)	88.9	104	31.9	21.6	70.3
	Manganese (Mn)-Total (mg/L)	1.88	1.29	0.0917	0.372	3.50

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2037961-6	L2037961-7			
	Description	Water	Water			
	Sampled Date	19-DEC-17	19-DEC-17			
	Sampled Time	15:55	16:00			
	Client ID	W10	UG1			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	612	2800			
	Hardness (as CaCO3) (mg/L)	316	1530			
	pH (pH)	7.73	7.86			
	Total Suspended Solids (mg/L)	202	37.3			
	TDS (Calculated) (mg/L)	370	2600			
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	286	180			
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0			
	Alkalinity, Total (as CaCO3) (mg/L)	286	180			
	Ammonia, Total (as N) (mg/L)	1.52	16.5			
	Chloride (Cl) (mg/L)	0.73	12			
	Nitrate and Nitrite (as N) (mg/L)	8.99	34.5			
	Nitrate (as N) (mg/L)	8.96	32.9 HTD			
	Nitrite (as N) (mg/L)	0.0349	1.53 HTD			
	Sulfate (SO4) (mg/L)	16.1	1600			
	Anion Sum (meq/L)	6.72	39.7			
	Cation Sum (meq/L)	7.61	37.0			
	Cation - Anion Balance (%)	6.2	-3.6			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	13.1	3.36			
Total Metals	Aluminum (Al)-Total (mg/L)	0.714	0.951			
	Antimony (Sb)-Total (mg/L)	0.00035	0.00062			
	Arsenic (As)-Total (mg/L)	0.00132	0.00160			
	Barium (Ba)-Total (mg/L)	0.441	0.0627			
	Beryllium (Be)-Total (mg/L)	0.000023	<0.000040 DLA			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.00010 DLA			
	Boron (B)-Total (mg/L)	0.014	0.774			
	Cadmium (Cd)-Total (mg/L)	0.0000331	0.000145			
	Calcium (Ca)-Total (mg/L)	96.2	557			
	Chromium (Cr)-Total (mg/L)	0.00139	0.00042			
	Cobalt (Co)-Total (mg/L)	0.00204	0.00118			
	Copper (Cu)-Total (mg/L)	0.0177	0.126			
	Iron (Fe)-Total (mg/L)	14.8	1.24			
	Lead (Pb)-Total (mg/L)	0.000267	0.00132			
	Lithium (Li)-Total (mg/L)	0.0016	0.0140			
	Magnesium (Mg)-Total (mg/L)	19.9	45.8			
	Manganese (Mn)-Total (mg/L)	2.09	0.227			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2037961-1	L2037961-2	L2037961-3	L2037961-4	L2037961-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-DEC-17	18-DEC-17	19-DEC-17	19-DEC-17	19-DEC-17
	Sampled Time	15:15	15:30	09:30	10:15	13:35
	Client ID	W45	W14	W3	W17	W8A
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.00010 DLM	<0.0000050	<0.0000050	0.0000055 DLM
	Molybdenum (Mo)-Total (mg/L)	0.113	0.119	0.00457	0.00601	0.0149
	Nickel (Ni)-Total (mg/L)	0.0050	0.0020	0.00083	0.00104	0.00171
	Phosphorus (P)-Total (mg/L)	<0.10 DLA	<0.10 DLA	<0.050	<0.050	0.055
	Potassium (K)-Total (mg/L)	72.4	86.9	2.38	3.81	8.89
	Selenium (Se)-Total (mg/L)	0.0135	0.0120	0.000255	0.000294	0.00798
	Silicon (Si)-Total (mg/L)	4.46	3.01	6.27	5.73	7.80
	Silver (Ag)-Total (mg/L)	0.000026	<0.000020 DLA	<0.000010	<0.000010	0.000029
	Sodium (Na)-Total (mg/L)	198	231	19.3	14.9	52.2
	Strontium (Sr)-Total (mg/L)	7.08	7.76	0.763	0.782	3.35
	Sulfur (S)-Total (mg/L)	661	733	19.5	20.3	144
	Thallium (Tl)-Total (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.0363	<0.0066 DLM	<0.0012 DLM	0.00345	<0.0033 DLM
	Uranium (U)-Total (mg/L)	0.00898	0.0110	0.00292	0.00236	0.00448
	Vanadium (V)-Total (mg/L)	0.0023	0.0010	0.00068	0.00087	0.00245
	Zinc (Zn)-Total (mg/L)	0.0061	<0.0060 DLA	<0.0030	0.0034	0.238
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00054
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0123	0.0279	0.0023	0.0013	0.0090
	Antimony (Sb)-Dissolved (mg/L)	0.00037	0.00062	<0.00010	<0.00010	0.00018
	Arsenic (As)-Dissolved (mg/L)	0.00045	0.00056	0.00023	0.00034	0.00053
	Barium (Ba)-Dissolved (mg/L)	0.129	0.166	0.0731	0.0766	0.168
	Beryllium (Be)-Dissolved (mg/L)	<0.000040 DLA	<0.000040 DLA	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	0.324	0.381	0.023	0.027	0.036
	Cadmium (Cd)-Dissolved (mg/L)	0.000042	<0.000010 DLA	<0.0000050	<0.0000050	0.000518
	Calcium (Ca)-Dissolved (mg/L)	524	502	60.8	71.3	254
	Chromium (Cr)-Dissolved (mg/L)	<0.00020 DLA	<0.00020 DLA	0.00016	<0.00010	0.00044
	Cobalt (Co)-Dissolved (mg/L)	0.00365	0.00054	<0.00010	<0.00010	0.00136
	Copper (Cu)-Dissolved (mg/L)	0.00287	0.00236	0.00226	0.00632	0.108
	Iron (Fe)-Dissolved (mg/L)	0.062	<0.020 DLA	0.024	<0.010	0.311
	Lead (Pb)-Dissolved (mg/L)	<0.00010 DLA	<0.00010 DLA	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	0.0237	0.0243	0.0033	0.0018	0.0047
	Magnesium (Mg)-Dissolved (mg/L)	83.9	98.2	31.4	21.9	71.5
	Manganese (Mn)-Dissolved (mg/L)	1.88	1.25	0.0848	0.00925	4.01

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2037961-6	L2037961-7			
	Description	Water	Water			
	Sampled Date	19-DEC-17	19-DEC-17			
	Sampled Time	15:55	16:00			
	Client ID	W10	UG1			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.000025 DLM	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00139	0.0271			
	Nickel (Ni)-Total (mg/L)	0.00192	0.0032			
	Phosphorus (P)-Total (mg/L)	0.135	<0.10 DLA			
	Potassium (K)-Total (mg/L)	2.37	12.9			
	Selenium (Se)-Total (mg/L)	0.000136	0.00093			
	Silicon (Si)-Total (mg/L)	6.79	8.67			
	Silver (Ag)-Total (mg/L)	0.000013	0.000084			
	Sodium (Na)-Total (mg/L)	11.8	105			
	Strontium (Sr)-Total (mg/L)	0.570	7.83			
	Sulfur (S)-Total (mg/L)	5.76	519			
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000030			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00020 DLA			
	Titanium (Ti)-Total (mg/L)	0.0304	0.0578			
	Uranium (U)-Total (mg/L)	0.000449	0.00868			
	Vanadium (V)-Total (mg/L)	0.00330	0.0035			
	Zinc (Zn)-Total (mg/L)	0.0137	0.0143			
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0158	0.0067			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00067			
	Arsenic (As)-Dissolved (mg/L)	0.00067	0.00137			
	Barium (Ba)-Dissolved (mg/L)	0.373	0.0510			
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000040 DLA			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.00010 DLA			
	Boron (B)-Dissolved (mg/L)	0.012	0.627			
	Cadmium (Cd)-Dissolved (mg/L)	0.0000096	0.000110			
	Calcium (Ca)-Dissolved (mg/L)	93.9	537			
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00020 DLA			
	Cobalt (Co)-Dissolved (mg/L)	0.00168	0.00085			
	Copper (Cu)-Dissolved (mg/L)	0.00112	0.0104			
	Iron (Fe)-Dissolved (mg/L)	9.49	<0.020 DLA			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.00010 DLA			
	Lithium (Li)-Dissolved (mg/L)	0.0013	0.0119			
	Magnesium (Mg)-Dissolved (mg/L)	19.7	46.9			
	Manganese (Mn)-Dissolved (mg/L)	2.18	0.202			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2037961-1	L2037961-2	L2037961-3	L2037961-4	L2037961-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	18-DEC-17	18-DEC-17	19-DEC-17	19-DEC-17	19-DEC-17
	Sampled Time	15:15	15:30	09:30	10:15	13:35
	Client ID	W45	W14	W3	W17	W8A
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.00025 DLM	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.118	0.123	0.00428	0.00556	0.0144
	Nickel (Ni)-Dissolved (mg/L)	0.0047	0.0018	0.00075	0.00071	0.00178
	Phosphorus (P)-Dissolved (mg/L)	<0.10 DLA	<0.10 DLA	<0.050	<0.050	<0.050
	Potassium (K)-Dissolved (mg/L)	70.7	83.8	2.31	3.81	9.55
	Selenium (Se)-Dissolved (mg/L)	0.0140	0.0141	0.000281	0.000354	0.00865
	Silicon (Si)-Dissolved (mg/L)	2.95	2.47	6.21	5.53	7.88
	Silver (Ag)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	0.000014
	Sodium (Na)-Dissolved (mg/L)	192	228	18.3	15.4	54.4
	Strontium (Sr)-Dissolved (mg/L)	7.46	7.43	0.863	0.817	3.71
	Sulfur (S)-Dissolved (mg/L)	638	715	19.5	20.0	145
	Thallium (Tl)-Dissolved (mg/L)	<0.000020 DLA	<0.000020 DLA	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00020 DLA	<0.00020 DLA	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLA	<0.00060 DLA	<0.00030	<0.00030	0.00067
	Uranium (U)-Dissolved (mg/L)	0.00883	0.0113	0.00262	0.00220	0.00420
	Vanadium (V)-Dissolved (mg/L)	<0.0010 DLA	<0.0010 DLA	<0.00050	<0.00050	0.00127
	Zinc (Zn)-Dissolved (mg/L)	0.0023	<0.0020 DLA	<0.0010	0.0015	0.212
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	0.00060

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2037961-6	L2037961-7
	Description	Water	Water
	Sampled Date	19-DEC-17	19-DEC-17
	Sampled Time	15:55	16:00
	Client ID	W10	UG1
Grouping	**Analyte**		
WATER			
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00123	0.0274
	Nickel (Ni)-Dissolved (mg/L)	0.00089	0.0031
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.10 DLA
	Potassium (K)-Dissolved (mg/L)	2.28	13.5
	Selenium (Se)-Dissolved (mg/L)	0.000085	0.00113
	Silicon (Si)-Dissolved (mg/L)	5.80	7.22
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000020 DLA
	Sodium (Na)-Dissolved (mg/L)	12.6	110
	Strontium (Sr)-Dissolved (mg/L)	0.590	7.97
	Sulfur (S)-Dissolved (mg/L)	5.35	540
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000020 DLA
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00020 DLA
	Titanium (Ti)-Dissolved (mg/L)	<0.00060 DLM	<0.00060 DLA
	Uranium (U)-Dissolved (mg/L)	0.000384	0.00808
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.0010 DLA
	Zinc (Zn)-Dissolved (mg/L)	0.0101	0.0085
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Total (as CaCO3)	B	L2037961-1, -2, -3, -4, -5, -6, -7
Method Blank	Manganese (Mn)-Dissolved	MB-LOR	L2037961-2
Matrix Spike	Dissolved Organic Carbon	MS-B	L2037961-1, -2, -3
Matrix Spike	Sulfate (SO4)	MS-B	L2037961-7

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
HTD	Hold time exceeded for re-analysis or dilution, but initial testing was conducted within hold time.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are

Reference Information

included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-12-20 B

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2037961-COFC

COC Number: 2017-12-20 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	228617 (WUL)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Shane Stack	**Sampler:** CR

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W45	18-12-2017	15:15	Water	R	R	R	R	R	R	R	R	R					7
	W14	18-12-2017	15:30	Water	R	R	R	R	R	R	R	R	R					7
	W3	19-12-2017	9:30	Water	R	R	R	R	R	R	R	R	R					7
	W17	19-12-2017	10:15	Water	R	R	R	R	R	R	R	R	R					7
	W8A	19-12-2017	13:35	Water	R	R	R	R	R	R	R	R						6
	W10	19-12-2017	15:55	Water	R	R	R	R	R	R	R	R	R					7
	UG1	19-12-2017	16:00	Water	R	R	R	R	R	R	R	R	R					7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
7°C.			2		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Corey Roberts	Date: 20-12-2017	Time:	Received by: dw.	Date: DEC 20/17.	Time: 15:30	Received by: JC	Date: 12/22/17	Time: 14:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-DEC-17
Report Date: 15-JAN-18 19:12 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2039348
Project P.O. #: 228617
Job Reference:
C of C Numbers: 2017-12-27 A
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2039348-1	L2039348-2	L2039348-3	L2039348-4
	Description	Water	Water	Water	Water
	Sampled Date	26-DEC-17	26-DEC-17	26-DEC-17	26-DEC-17
	Sampled Time	09:50	10:20	11:10	
	Client ID	W3	W17	W8A	DUP
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	558	534	1560	535
	Hardness (as CaCO3) (mg/L)	291	279	914	284
	pH (pH)	8.23	8.28	7.96	8.26
	Total Suspended Solids (mg/L)	3.2	4.4	8.0	<3.0
	TDS (Calculated) (mg/L)	331	320	1150	324
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	251	229	575	230
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0
	Alkalinity, Total (as CaCO3) (mg/L)	251	229	575	230
	Ammonia, Total (as N) (mg/L)	0.0106	<0.0050	0.282	<0.0050
	Chloride (Cl) (mg/L)	4.41	6.90	16.1	7.05
	Nitrate and Nitrite (as N) (mg/L)	0.204	0.0916	7.62	0.0903
	Nitrate (as N) (mg/L)	0.204	0.0916	7.02	0.0903
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.602	<0.0010
	Sulfate (SO4) (mg/L)	57.0	58.2	367	59.7
	Anion Sum (meq/L)	6.34	5.98	20.1	6.04
	Cation Sum (meq/L)	6.78	6.40	21.1	6.50
	Cation - Anion Balance (%)	3.3	3.4	2.4	3.6
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.40	9.40		9.55
Total Metals	Aluminum (Al)-Total (mg/L)	0.0184	0.0481	0.0323	0.0462
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00011	0.00020	0.00010
	Arsenic (As)-Total (mg/L)	0.00029	0.00039	0.00071	0.00039
	Barium (Ba)-Total (mg/L)	0.0786	0.0818	0.177	0.0840
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	0.000022	<0.000020
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	0.027	0.031	0.039	0.030
	Cadmium (Cd)-Total (mg/L)	0.0000065	0.0000124	0.000456	0.0000121
	Calcium (Ca)-Total (mg/L)	62.3	74.4	249	71.0
	Chromium (Cr)-Total (mg/L)	0.00011	0.00021	0.00085	0.00017
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00012	0.00147	0.00013
	Copper (Cu)-Total (mg/L)	0.00289	0.0133	0.165	0.0139
	Iron (Fe)-Total (mg/L)	0.042	0.058	2.15	0.062
	Lead (Pb)-Total (mg/L)	<0.000050	0.000107	0.000080	0.000069
	Lithium (Li)-Total (mg/L)	0.0039	0.0020	0.0048	0.0018
	Magnesium (Mg)-Total (mg/L)	32.6	22.6	67.8	22.7
	Manganese (Mn)-Total (mg/L)	0.0868	0.207	4.52	0.246

	Sample ID	L2039348-1	L2039348-2	L2039348-3	L2039348-4	
	Description	Water	Water	Water	Water	
	Sampled Date	26-DEC-17	26-DEC-17	26-DEC-17	26-DEC-17	
	Sampled Time	09:50	10:20	11:10		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	0.00499	0.00638	0.0144	0.00653	
	Nickel (Ni)-Total (mg/L)	0.00087	0.00093	0.00168	0.00100	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	0.076	<0.050	
	Potassium (K)-Total (mg/L)	2.33	4.00	9.03	3.93	
	Selenium (Se)-Total (mg/L)	0.000333	0.000324	0.00766	0.000339	
	Silicon (Si)-Total (mg/L)	7.08	6.04	8.50	6.07	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	0.000028	<0.000010	
	Sodium (Na)-Total (mg/L)	20.5	16.3	53.0	16.0	
	Strontium (Sr)-Total (mg/L)	0.864	0.797	3.47	0.767	
	Sulfur (S)-Total (mg/L)	21.8	21.5	138	21.7	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	DLM <0.00060	0.00266	0.00205	DLM <0.0030	
	Uranium (U)-Total (mg/L)	0.00297	0.00235	0.00451	0.00247	
	Vanadium (V)-Total (mg/L)	<0.00050	0.00058	0.00281	0.00059	
	Zinc (Zn)-Total (mg/L)	0.0033	<0.0030	0.197	<0.0030	
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	0.00065	<0.00030	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0015	0.0020	0.0071	0.0014	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	0.00010	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00023	0.00034	0.00058	0.00037	
	Barium (Ba)-Dissolved (mg/L)	0.0775	0.0811	0.178	0.0815	
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Dissolved (mg/L)	0.025	0.029	0.036	0.029	
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.000426	<0.0000050	
	Calcium (Ca)-Dissolved (mg/L)	62.5	73.9	247	75.9	
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	0.00012	0.00060	<0.00010	
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00147	<0.00010	
	Copper (Cu)-Dissolved (mg/L)	0.00201	0.00628	0.0907	0.00633	
	Iron (Fe)-Dissolved (mg/L)	0.016	<0.010	0.290	<0.010	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0036	0.0018	0.0045	0.0017	
	Magnesium (Mg)-Dissolved (mg/L)	32.8	22.9	72.3	23.0	
	Manganese (Mn)-Dissolved (mg/L)	0.0825	0.0209	4.55	0.0218	

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2039348-1	L2039348-2	L2039348-3	L2039348-4	
	Description	Water	Water	Water	Water	
	Sampled Date	26-DEC-17	26-DEC-17	26-DEC-17	26-DEC-17	
	Sampled Time	09:50	10:20	11:10		
	Client ID	W3	W17	W8A	DUP	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000080	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00414	0.00526	0.0120	0.00551	
	Nickel (Ni)-Dissolved (mg/L)	0.00091	0.00076	0.00172	0.00076	
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Dissolved (mg/L)	2.40	4.00	9.50	4.03	
	Selenium (Se)-Dissolved (mg/L)	0.000343	0.000330	0.00716	0.000400	
	Silicon (Si)-Dissolved (mg/L)	6.84	5.93	8.04	5.95	
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	0.000011	<0.000010	
	Sodium (Na)-Dissolved (mg/L)	20.8	16.7	55.3	16.3	
	Strontium (Sr)-Dissolved (mg/L)	0.871	0.805	3.52	0.842	
	Sulfur (S)-Dissolved (mg/L)	20.9	20.7	129	20.9	
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	0.00095	<0.00030	
	Uranium (U)-Dissolved (mg/L)	0.00278	0.00222	0.00416	0.00227	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00136	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	0.0015	0.0014	0.176	<0.0010	
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	0.00072	<0.00030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Manganese (Mn)-Dissolved	B	L2039348-1, -2, -3, -4
Matrix Spike	Dissolved Organic Carbon	MS-B	L2039348-1, -2, -4
Matrix Spike	Sulfate (SO4)	MS-B	L2039348-2, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0
Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).			
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.			
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)
Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.			
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)
This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.			
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510
Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.			
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)
Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E
Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero. Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as: Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]			
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2017-12-27 A

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2039348-COFC

COC Number: 2017-12-27 A

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 228617 (WUL)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Shane Stack Sampler: CR

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	W3	26-12-2017	9:50	Water	R	R	R	R	R	R	R	R	R					7
	W17	26-12-2017	10:20	Water	R	R	R	R	R	R	R	R	R					7
	W8A	26-12-2017	11:10	Water	R	R	R	R	R	R	R	R						6
	DUP	26-12-2017		Water	R	R	R	R	R	R	R	R	R					7

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 3°C.

FINAL COOLER TEMPERATURES °C: 0.3

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Corey Roberts	Date: 27-12-2017	Time:	Received by:	Date: DEC 27/17.	Time: 15:24	Received by: JC	Date: DEC 2 9 2017	Time: 11 AM

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Appendix J – Minto Mine Phase 4 EEM Interpretive Report

minnow
environmental inc.
A Trinity Consultants Company

Minto Mine
Phase 4 Environmental Effects Monitoring Interpretive Report

Prepared for:
Minto Mine
Whitehorse, Yukon

Prepared by:
Minnow Environmental Inc.
Victoria, British Columbia

With Major Contributions by:
Alexco Environmental Group
Whitehorse, Yukon

January 2018

Minto Mine
Phase 4 Environmental Effects Monitoring
Interpretive Report

Pierre Stecko, M.Sc., EP, RPBio
Project Manager

Cynthia Russel

Cynthia Russel, B.Sc.
Technical Reviewer

EXECUTIVE SUMMARY

The Minto Mine, operated by the Capstone Mining Corporation, is an open pit copper/gold/silver mine located approximately 240 km northwest of Whitehorse in the Yukon Territory. The mine is located in the upper reaches of the Minto Creek watershed approximately 10 km west of the Minto Creek confluence with the Yukon River. Commercial production at the Minto Mine commenced in October 2007 and the mine is projected to run to 2020. Milling (concentrating) is done on site and tailings are stored in a dry stack Tailings Storage Facility (TSF; now closed) and in mined-out open pits (active). Site water is ultimately managed in a Water Storage Pond located approximately 1.5 kilometers to the east (down-gradient) of the mill. The Minto Mine has one point of effluent discharge to Minto Creek from the Water Storage Pond, and discharge is intermittent as needed. The Minto Mine is required to undertake Environmental Effects Monitoring (EEM) under the federal Metal Mining Effluent Regulations (MMER). The current phase of EEM (Phase 4) is a “biological monitoring study to assess effects” following the completion of a “biological monitoring study to investigate confirmed effects” in Phase 3. The Minto Mine Phase 4 EEM was completed between June and September 2016, and provided sublethal toxicity testing of Minto Mine effluent, an assessment of the influence of Minto Mine effluent discharge on water chemistry and benthic invertebrate community condition of Minto Creek relative to reference sites, and an assessment of the controlled exposure of a sentinel fish (kokanee as a surrogate for chinook salmon) to Minto Mine effluent.

Effluent sublethal toxicity tests conducted by the mine from 2015 to present (the Phase 4 EEM period) showed no effects to the survival of rainbow trout embryos, the survival or reproduction of *Ceriodaphnia dubia* (a cladoceran invertebrate often referred to as a water flea), nor to the growth of *Pseudokirchneriella subcapitata* (a green algae) or *Lemna minor* (a plant). This suggests a low probability of toxicity in the receiving environment.

Routine water quality monitoring indicated an influence of the Minto Mine on Minto Creek evident in conductivity, hardness, nitrate, aluminum, arsenic, iron, and selenium that were greater than reference. Of these, concentrations of nitrate were most strongly associated with the release of water from the Water Storage Pond, but remained below the Canadian Water Quality Guideline for the protection of aquatic life (CWQG). Aluminum and arsenic had mean concentrations greater CWQG, but this occurred at both the effluent-exposed and reference stations. During the Phase 4 EEM benthic survey (in September 2016) water of upper Minto Creek had concentrations of nitrate, total Kjeldahl nitrogen, total phosphorus, copper, and molybdenum greater than the range of reference concentrations. Of these, only copper was present at a concentration greater than the CWQG, but did not exceed the applicable site-specific water quality objective (SSWQO). Of the analytes identified as elevated relative to reference in routine water quality monitoring or during the EEM benthic survey (conductivity, hardness, nitrate, phosphorus, aluminum, arsenic, copper, iron, molybdenum, and selenium), all except for aluminum and arsenic increased in the fish exposure vessels in proportion to effluent concentration.

The benthic invertebrate community of Minto Creek was evaluated using two approaches: a reference condition approach (RCA) that evaluates individual sites relative to a range of reference (based on ten reference sites) and a control-impact (CI) comparison of the exposed area mean against the reference mean. The latter, completed at the request of Environment and Climate Change Canada (ECCC), assumes that within-area variability (upper Minto Creek) and among-area variability (reference sites) are comparable, which may not be true. Mine-exposed benthic invertebrate communities of upper Minto Creek were within reference condition for all four primary EEM metrics (density, taxon richness, Simpson's evenness, and Bray Curtis [BC] distance [also known as the BC index of dissimilarity]). Evaluation by control-impact comparison indicated that mean taxon richness, mean Simpson's evenness, and mean BC distance did not differ from the reference means, whereas mean density of the effluent-exposed upper Minto Creek area was significantly lower than reference. The difference in density was at a magnitude of -1.2 standard deviations, which is below the Critical Effect Size (CES) of ±2 standard deviations and therefore may not be ecologically meaningful. Supplementary examination of taxon proportions indicated lower relative abundances of EPT taxa (Ephemereoptera, Plecoptera, and Trichoptera; mayflies, stoneflies, and caddisflies) at effluent-exposed upper Minto Creek than reference, which was primarily due to lower relative abundance of Plecoptera (individually), and also indicated higher relative abundances of Trichoptera and oligochaetes. As Plecoptera and Trichoptera are considered to be sensitive organisms and oligochaetes are considered to be tolerant organisms, these results are equivocal with respect to a potential effluent-related influence. Correlation analysis indicated negative relationships between benthic invertebrate density and water quality, and a negative relationship between the proportion of oligochaetes and dissolved oxygen.

Fish population health was evaluated using an on-site laboratory exposure to Minto Mine effluent at two concentrations (14% and 25%) in comparison to Yukon River reference water. The fish survey indicated that fish exposed to the higher effluent concentration (25%) for 47 days were slightly larger and of better condition than those exposed to reference water. Fish exposed to the lower effluent concentration (14%) for 47 days did not differ from reference on the basis of size, but had slightly lower condition than reference fish. In all cases, the magnitudes of the observed differences were very small, and were presumably detected due to the high power associated with large sample size (minimum 152 fish) and uniform fish size. In the case of condition (fish weight-at-length) - the key effect endpoint evaluated in this fish survey - the magnitudes of difference (-2.7% and +2.3% for 14% effluent and 25% effluent, respectively) were well below the CES of 10%. These differences are therefore not considered to be ecologically meaningful.

The results of the Phase 4 EEM were generally consistent with those of the previous EEM (i.e., the Phase 3 benthic invertebrate community survey and the Phase 2 fish survey). Specifically, the results of the Phase 4 EEM benthic invertebrate community survey were consistent with the results of the Phase 3 EEM - RCA analysis in two consecutive EEM Phases has indicated no effect. A supporting CI comparison in this study (Phase 4) suggested lower density at the effluent-exposed area, but this result was opposite from the apparent greater density observed at one of three sites evaluated by RCA in Phase 3. The results of the Phase 4 EEM fish study were similar to those of the Phase 2 EEM fish study (no fish study was completed in association with the Phase 3 Investigation of Cause study of differences in benthic invertebrate communities). These two consecutive EEM Phases have indicated slightly greater fish size and condition associated with effluent exposure. However, the associated magnitudes of difference for the EEM-effect endpoint (condition) was less than 3%, well below the CES of 10%.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Site Description

The Minto Mine is a high grade copper mine located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A approximately 240 km northwest of Whitehorse, Yukon Territory (62° 37' N latitude and 137 °15' W longitude; Figure 1.1). It is owned and operated by the Minto Explorations Ltd. a wholly owned subsidiary of Capstone Mining Corporation. Development of the mine was initiated in 1997, commercial operations started in October 2007, and the currently anticipated operating life is to 2020. The Minto Mine is permitted to conduct open pit and underground mining, and to mill the copper/gold/silver ore at a rate of 4,200 tonnes of per day. In 2016 (the most recent year of record), the Minto Mine produced 69.3 million pounds of copper from milling approximately 1.49 million tones or ore.

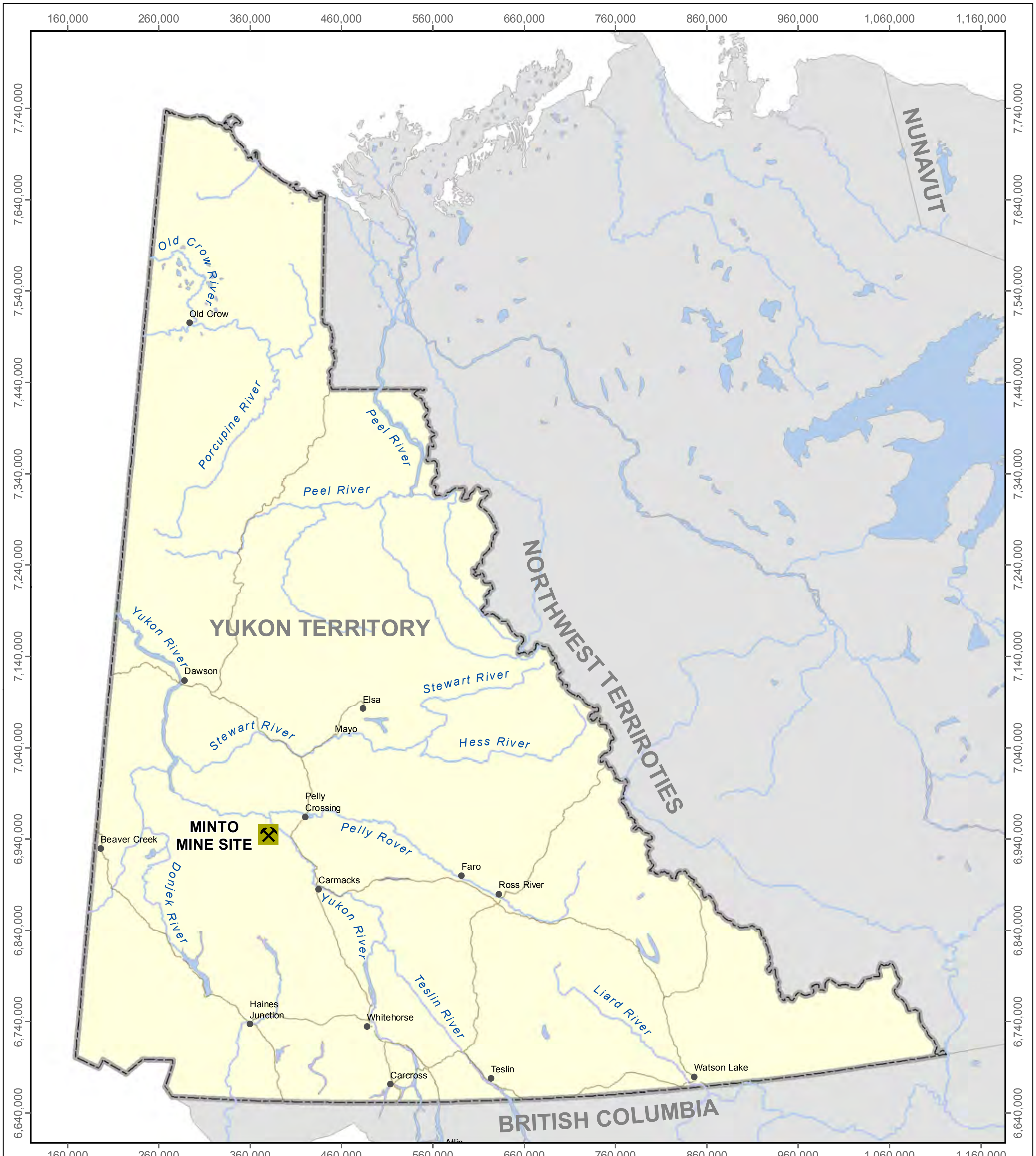
In addition to open pit mines, underground mines, and the mill, the Minto Mine site includes a number of waste rock dumps, a concentrate storage shed, a tailings storage facility (TSF), a water retention dam with a water storage pond (WSP), a water treatment plant, administrative offices, an airstrip, and a camp (Figure 1.2). Mill tailings are stored in a dry stack TSF and in mined-out open pits. Mine-impacted seepage from the TSF and under the Mill Valley Fill (MVF) is collected at the toe of the MVF in sump W62 and is pumped to the main pit (Figure 1.2). Non-impacted water and treated mine-impacted water are collected in the WSP (Figure 1.2). Effluent from the WSP is periodically discharged to Minto Creek under conditions specified in Water Use Licence (WUL) QZ14-031 (August 2015). Minto Creek, in turn, discharges to the Yukon River approximately 7.7 km south-east of the WSP (Figure 1.2).

1.2 Regulatory Context

Federal effluent regulations for the metal mining industry (Metal Mining Effluent Regulations; MMER) were most recently amended in September 2017 (Government of Canada 2017a). These regulations, administered under the federal *Fisheries Act*, apply to mining and milling operations that have discharged effluent at a rate greater than 50 m^3/day and therefore apply to the Minto Mine. The MMER outline requirements for routine effluent monitoring, acute lethality testing, and Environmental Effects Monitoring (EEM). The objective of EEM is to determine whether mine effluent discharge is causing an effect on fish, benthic invertebrate communities, and/or the use of fisheries resources. The Minto Mine triggered the MMER on July 10th 2006.

1.3 Background

In accordance with the MMER, the Minto Mine has completed three phases of EEM (Minnow and Access 2009, 2012; Minnow 2015) and is presently in Phase 4. The Phase 3 EEM



Map of Canada

Location of the Minto Mine

0 100 200 400
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 8U
Reproduced under licence from Her Majesty the Queen in Right of Canada,
Department of Natural Resources Canada. All rights reserved.

Date December 2017
Project 157202.0087

minnow environmental inc.

Figure 1.1

Document Path: S:\Projects\157202\157202.0087 Minto C4 EEM\Mapping\Interpretive Report\15-87 Fig 1.1 Minto Mine Location-.mxd

LEGEND

● Final Effluent Discharge Point	■ Water Retention Dam
▢ Mine Footprint	■ Minto Creek Detention Structure
	■ Building

0 0.25 0.5 1
km

N W E S

Projection: North American Datum 1983 UTM Zone 8U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Minto Mine Site Layout and Receiving Environment

Date December 2017
Project 157202.0087

minnow environmental inc.

Figure 1.2

Document Path: S:\Projects\157202\157202.0087 Minto C4 EEM\Mapping\Interpretive Report\15-87 Fig 1.2 Minto Mine Site Layout and Recieving.mxd biological study was an Investigation of Cause (IOC) study (or “biological monitoring study to investigate confirmed effects”; Environment Canada 2012). The requirement for IOC was triggered by a finding of consistent differences in the structure of the benthic invertebrate community of Minto Creek compared to reference (as indicated by the Bray-Curtis Index of Dissimilarity) through the first two phases of EEM. The IOC indicated that the differences were likely due to comparison to too few reference areas (limited characterization of the range of reference conditions) and that the benthic invertebrate community of Minto Creek was within reference condition defined by a larger group of physically comparable reference sites. Accordingly, the Phase 4 EEM returned to periodic monitoring (or “biological monitoring studies to assess effects”; Environment Canada 2012). A study design for the Minto Mine Phase 4 EEM was prepared and submitted to Environment and Climate Change Canada (ECCC) in February 2016 (Minnow 2016). Some adjustments to the study design were made following discussion with ECCC in July 2016. Biological monitoring was implemented between June and September 2016 and the study results are presented and interpreted in this report. Briefly, the Phase 4 EEM included a benthic invertebrate community study of Minto Creek using the Reference Condition Approach (RCA), *in situ* fishing at lower Minto Creek and reference, an on-site laboratory based fish exposure study of Minto Mine effluent and reference water mixtures, and supporting physical, chemical and biological measures (described in detail in Section 2.0).

1.4 Effluent Discharge and Quality

Minto Mine final effluent is discharged to Minto Creek via a control structure located at monitoring Station W3 (Figure 1.2). This location captures effluent discharged from the WSP as well as surface and groundwater inputs to the section of Minto Creek between the toe of the WSP and Station W3 (Figure 1.2). A total of 576,734 m^3 of effluent was discharged to Minto Creek at Station W3 over the period from 2015 to end of August 2017 (the Phase 4 EEM period for which data were available; 328,526 m^3 in 59 discharge days in 2015, 166,897 m^3 in 167 discharge days in 2016, and 81,311 m^3 in 72 discharge days in 2017; Appendix Table A.1). Highest rates of discharge in 2015 and 2016 were in April during freshet whereas the highest rate in 2017 was mid-June (Figure 1.3). Maximum daily rates of discharge in 2015, 2016, and 2017 were 12,614 m^3/d in 2015, 2,253 m^3/d in 2016, and 4,411 m^3/d in 2017 (Figure 1.3). The Minto Mine targets an effluent concentration in lower Minto Creek of no more than 25% effluent (1 part effluent to 3 parts creek water). Concurrent monitoring of effluent discharge rates and water flow rates in lower Minto Creek in 2016 and 2017 (not completed in 2015) documented an average of 17.7% effluent on days when the mine was discharging (Appendix Figure A.1).

Minto Mine effluent quality met all limits specified under the MMER over the period from 2015 to end of August 2017 (Appendix Table A.2). No acute toxicity to rainbow trout or to *Daphnia magna*

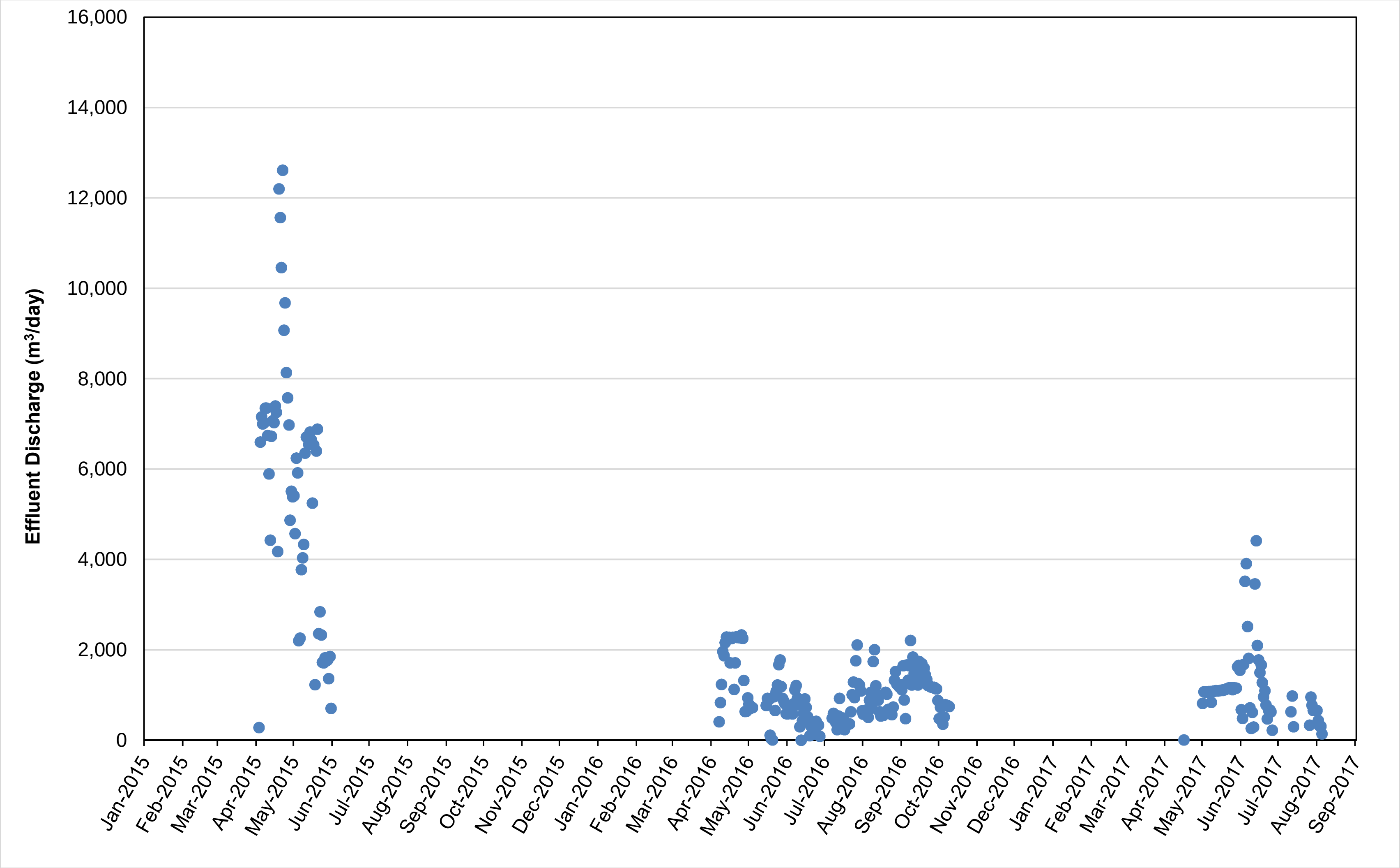


Figure 1.3: **Daily Minto Mine Effluent Discharge Volume, 2015 to August 2017**

were observed over this period (Appendix Table A.3). Lastly, routine effluent quality monitoring (Appendix Table A.2) and effluent characterization (conducted four times per year; Appendix Table A.4) indicate that effluent has been of consistent quality through the Phase 4 EEM period.

2 METHODS

2.1 Overview

The Phase 4 EEM study for the Minto Mine consisted of the following components: 1) effluent sublethal toxicity testing; 2) receiving water quality monitoring; 3) a benthic invertebrate community survey; 4) *in situ* fish collection and measurement; and 5) a fish exposure study implemented at an on-site laboratory. A fish tissue (mercury) assessment was not required because mercury concentrations in final effluent have not exceeded 0.0001 mg/L (Appendix Table A.4; Environment Canada 2012).

The benthic invertebrate community survey, supported by physical measures and water quality, was conducted from September 22nd to 25th, 2016. The benthic survey included an evaluation of upper Minto Creek (5 replicate sites) using a Reference Condition Approach (RCA) that included 10 reference sites (Table 2.1; Figure 2.1). At the request of Environment and Climate Change Canada (ECCC), additional evaluation of the upper Minto Creek was completed using a Control-Impact (CI) approach[1]. The fish survey was comprised of two parts. An *in situ* non-lethal survey in lower Minto Creek with lower Big Creek serving as reference was attempted, with monthly sampling from June to September 2016 (Minto 2017; Table 2.1; Figure 2.1). However, because the abundance of fish in Minto Creek is typically too low to support a statistically meaningful *in situ* fish survey (i.e., per Environment Canada 2012), an on-site laboratory exposure study was completed at the Minto Mine site from August 7th to September 22nd 2016 (Table 2.1; Figure 2.1).

2.2 Effluent Sublethal Toxicity

Under the MMER, the Minto Mine implements sublethal toxicity testing of final effluent on an annual frequency. Sublethal toxicity samples were collected into 20 litre plastic containers. Following collection, samples were placed on ice inside coolers and shipped to Nautilus Environmental via ALS Environmental Laboratory (Burnaby BC) where they arrived within 48 hours. Sample appearance, odour, temperature, and hardness were recorded upon arrival at the laboratory. Tests were conducted using rainbow trout (*Oncorhynchus mykiss*) embryos, the invertebrate *Ceriodaphnia dubia*, the green algae *Pseudokirchneriella subcapitata* and the plant *Lemna minor* using Environment Canada test methods (1998, 2007a,b,c). Sublethal toxicity data were subsequently reported to ECCC as part of Minto Mine annual reports and are synthesized in this report.

---

[1] It is noted that this requested comparison assumes that within-area variability (upper Minto Creek) and among-area variability (reference sites) are comparable, which may not be true.

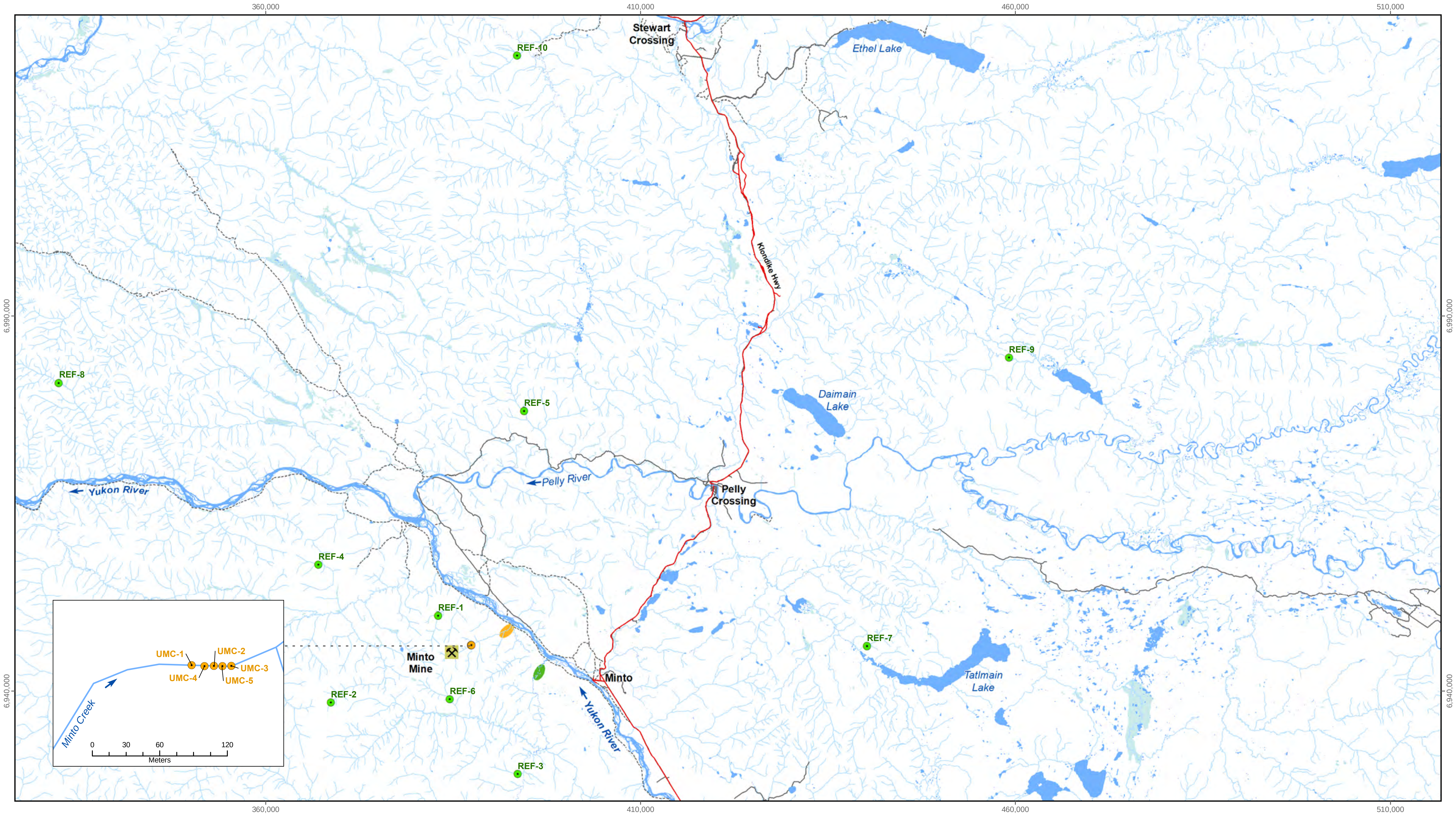
Table 2.1: Overview of the Minto Mine Phase 4 EEM Study Design for Biological Monitoring

Area	Benthic Invertebrate Survey		Fish Survey	
	Overview	Supporting Data	Overview	Supporting Data
Effluent-Exposed Areas				
Minto Creek - Upper	Reference Condition Approach (RCA) conducted in September 2016[1]. Erosional habitat, five replicate stations. One sample per station with each a 3-grab composite using a Surber sampler equipped with 500 µm mesh.	Substrate characterization, water velocity, sample depth, field-based water quality[2], habitat notes, and GPS coordinates at each station. One water sample at three of five replicate stations collected during the benthic invertebrate survey. Parameter suite included all MMER compliance monitoring analytes and additional nutrients[3].		
Minto Creek - Lower			Non-lethal survey commencing in June 2016 and repeated monthly through September. Target the collection and measurement (length and fresh body weight) of 100 juvenile Chinook salmon. Any external abnormalities noted on all fish captured.	Fishing effort, station description, wet and bankfull width, mean depth, field-based water quality[2], habitat description and GPS coordinates. One water sample collected during each fishing effort. Parameter suite included all MMER compliance monitoring analytes and additional nutrients[3].
Exposure Vessels in Laboratory			Exposure of 160 juvenile kokanee salmon to each of two effluent concentrations (1 part effluent and 3 parts reference water, and 1 part effluent and 6 parts reference water) for 47 days from early August to late September. Survival, length, weight, and physical condition were monitored. Results compared to the control fish.	Water flow, dissolved oxygen and temperature monitored daily. One water quality sample collected each week from each exposure vessel during testing. Parameter suite included all MMER compliance monitoring analytes and additional nutrients[3].
Reference Areas				
10 RCA Reference Creeks	Reference Condition Approach (RCA) conducted in September 2016[1]. Erosional habitat. One sample per site with each a 3-grab composite using a Surber sampler equipped with 500 µm mesh.	Substrate characterization, water velocity, sample depth, field-based water quality[2], habitat notes, and GPS coordinates at each station. One water sample at each site collected during the benthic invertebrate survey. Parameter suite included all MMER compliance monitoring analytes and additional nutrients[3].		
Lower Big Creek			Non-lethal survey commencing in June 2016 and repeated monthly through September. Target the collection and measurement (length and fresh body weight) of 100 juvenile Chinook salmon. Any external abnormalities noted on all fish captured.	Fishing effort, station description, wet and bankfull width, mean depth, field-based water quality[2], habitat description and GPS coordinates. One water sample collected during each fishing effort. Parameter suite included all MMER compliance monitoring analytes and additional nutrients[3].
Control Vessels in Laboratory			Exposure of 160 juvenile kokanee salmon to reference water for 47 days from early August to late September. Survival, length, weight, and physical condition were monitored.	Water flow, dissolved oxygen and temperature monitored daily. One water quality sample collected each week during testing. Parameter suite included all MMER compliance monitoring analytes and additional nutrients[3].

[1] Additional Control-Impact comparisons were made at the request of Environment and Climate Change Canada (ECCC).

[2] Field-based water quality parameter suite includes water temperature, dissolved oxygen, pH and conductivity.

[3] Analytical water quality parameter suite includes hardness, alkalinity, pH, total suspended solids, total dissolved solids, ammonia, nitrate, total Kjeldahl nitrogen, total phosphorus, total organic carbon, and ICP total metal scan (including aluminum, arsenic, cadmium, copper, iron, lead, molybdenum, selenium, nickel, and zinc).



LEGEND

⚒ Minto Mine Site
● Exposure Site
● Reference Site

➔ Water Flow Direction
🟧 Exposure Fishing Area
🟩 Reference Fishing Area

— Road
— Limited-use road
------ Trail

0 5 10 20
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 8U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Minto Mine C4 EEM Benthic Invertebrate Community (RCA Design) and Fish Sampling Locations

Date December 2017
Project 157202.0087

minnow environmental inc.

Figure 2.1

Document Path: S:\Projects\157202\157202.0087 Minto C4 EEM\Mapping\Interpretive Report\15-87 Fig 2.1 Bentic Invertebrate Community.mxd

2.3 Water Quality

Under the MMER, the Minto Mine monitors receiving water quality at a frequency of four times per year. Monitoring is conducted at lower Minto Creek (Station W2) and a north-flowing tributary to Minto Creek (Station W7), representing mine-exposed and reference conditions, respectively (Figure 2.2). In addition to routine water quality monitoring, water samples were collected to support the EEM biological surveys, including one sample at each benthic invertebrate sampling site (September 22nd to 25th 2016) and samples collected from each of the fish exposure vessels at weekly intervals (seven samples between August 8th and September 19th 2016). Results from both the routine monitoring and the EEM water quality monitoring were incorporated into the overall assessment of receiving water quality.

2.3.1 Sample Collection

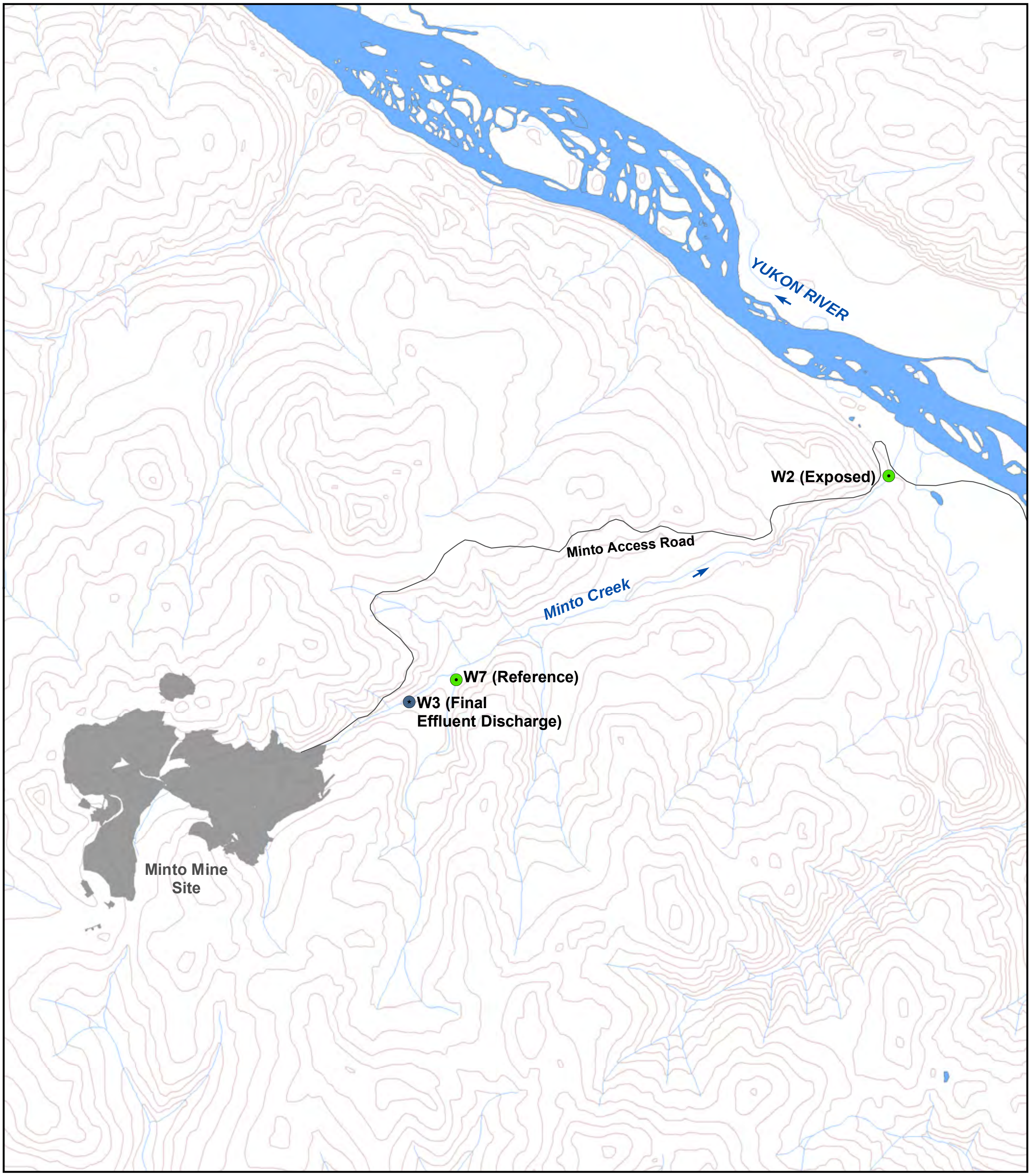
During the EEM field survey, *in situ* measures of water temperature, dissolved oxygen (DO) concentration and saturation, pH, and specific conductance were collected at each benthic invertebrate community sampling site. *In situ* measurements were taken using a YSI 650MDS hand held field meter equipped with a YSI 600XLM sonde (Yellow Springs, OH) that was checked against standards daily and calibrated as required. One water sample was collected at each benthic site during the benthic invertebrate community survey. Samples were collected into pre-labelled sample bottles. All samples were maintained in coolers with ice packs during transportation or at 4°C in an on-site refrigerator until submitted to ALS Environmental (ALS; Whitehorse, Yukon).

2.3.2 Laboratory Analyses

At ALS, water samples were analyzed for the analytes required under EEM (hardness, alkalinity, aluminum, arsenic, cadmium, copper, iron, lead, mercury, molybdenum, nickel, selenium, zinc, total suspended solids, ammonia, and nitrate; Environment Canada 2012) and for a number of additional analytes (dissolved organic carbon, total Kjeldahl nitrogen, and total phosphorus). Briefly, alkalinity was determined by potentiometric titration, anions by ion chromatography, metals by collision reaction cell ICP-MS (inductively coupled plasma - mass spectrometry) or ICP-OES (inductively coupled plasma - optical emission spectrophotometry), mercury by CVAFS (cold vapour atomic fluorescence spectrophotometry), dissolved organic carbon by combustion, ammonia and total Kjeldahl nitrogen by fluorescence, and phosphorus by colour. Hardness was calculated from calcium and magnesium concentrations.

2.3.3 Data Analysis

Water quality data were subject to a Data Quality Review, including the evaluation of laboratory blank results, laboratory spikes and laboratory duplicates (Appendix B). Water quality data were



LEGEND

- ● Final Effluent Discharge Point
- ● Water Quality Stations

Minto Mine Effluent and Routine Water Quality Monitoring Stations

Projection: North American Datum 1983 UTM Zone 8U
Reproduced under licence from Her Majesty the Queen in Right of Canada,
Department of Natural Resources Canada. All rights reserved.

Date December 2017
Project 157202.0087

minnow environmental inc.

Figure 2.2

Document Path: S:\Projects\157202\157202.0087 Minto C4 EEM\Mapping\Interpretive Report\15-87 Fig 2.2 Water Quality.mxd evaluated relative to Canadian Water Quality Guidelines for the protection of aquatic life (CWQG; CCME 1999). Water quality of Minto Creek was also evaluated relative to reference areas. As part of the benthic invertebrate community data interpretation, Principal Components Analysis (PCA) was used to reduce the supporting water quality dataset for correlation analysis against benthic metrics. Analytes for which more than 90% of the available data were below laboratory method detection limits (MDL) were excluded from the data matrix. Principal component axes were then generated from the remaining data matrix.

For analytes that were present at greater concentrations in Minto Creek than reference, and/or analytes present at concentrations greater than CWQG, data analysis was enhanced by examining additional water quality data collected by the Minto Mine under their Water Use Licence (WUL). Specifically, data from the Phase 4 EEM period (2015-2017) were plotted with periods of discharge highlighted in order to further identify and interpret the influence of the Minto Mine on the water quality of Minto Creek.

2.4 Benthic Invertebrate Community

The benthic invertebrate community survey included an evaluation of upper Minto Creek using a Reference Condition Approach (RCA) that included 10 reference sites. The reference sites were selected based on their similarity to upper Minto Creek as determined through a combination of GIS analysis (Minnow 2014, 2015), key habitat variables measured during previous EEM (Minnow 2015), and benthic invertebrate community characteristics measured during previous EEM (Minnow 2015). Of the 10 reference sites identified in this manner (Minnow 2015), only one could not be accessed (NRC-7; the helicopter could not land nearby) and a backup site was sampled instead. Although not part of the original study design (Minnow 2015), ECCC requested a control-impact comparison of upper Minto Creek to the reference sites, which was also completed.

2.4.1 Sample Collection

Benthic invertebrate samples were collected from each of the study sites using a one-foot square (0.093 m^2) Surber sampler equipped with a 500-µm mesh collection net. The Surber sampler was used after attempts to use the 0.1 m^2 Hess sampler (as proposed in the study design; Minnow 2015) failed due to low water depths in the exposed area. One sample was collected at each site (five sites in upper Minto Creek and 10 reference sites) with each sample representing a composite of three-grabs to ensure that the sample was representative of the station (0.279 m^2 in total). Each sub-sample was collected by carefully placing the base of the Surber sampler onto the substrate and pushing the sampler into the substrate after which gravel and cobble contained within the base of the sampler were carefully washed using a scrub brush while allowing the current to carry dislodged organisms into the mesh collection net. After the area within the sampler was completely washed, any organisms adhering to the mesh were rinsed into the collection net using creek water. At that point, the sampler was moved to the next sub-sampling location and the procedure repeated. After collection of the third sub-sample, all organisms were carefully rinsed to the end of the mesh collection net and carefully transferred into a one-litre, wide-mouth plastic jar labelled with the project number, sample location and collection date. Internal labels were also used to ensure correct identification if the external labelling were to become illegible due to wear. Benthic samples were preserved with buffered formalin to a nominal concentration of 10%. Preservation occurred within six hours of collection to eliminate the potential effects of within-sample predation that could affect abundance estimates. All samples were maintained in coolers or totes at the Minto Mine until submitted to Cordillera Consulting (Summerland, British Columbia).

2.4.2 Laboratory Processing

At Cordillera, samples were analyzed following standard sorting methods and incorporating recommended Environment Canada (2012) QA/QC procedures for assessing organism recovery and sub-sampling error. Upon arrival at the laboratory, a biological stain was added to each benthic invertebrate community sample to facilitate greater sorting accuracy. The samples were washed free of formalin in a 500 µm sieve and the remaining sample material was then examined under a stereomicroscope at a magnification of at least ten times by a technician. All benthic invertebrates were removed from the sample debris and placed into vials containing a 70% ethanol solution according to major taxonomic groups (e.g., phyla, orders). A senior taxonomist later enumerated and identified the benthic organisms to the lowest practical level (typically to genus or species) using up-to-date taxonomic keys. Following identification and enumeration of benthic organisms, representative specimens of each new taxon were preserved in 75% ethanol (with 3% glycerol) in separately-labelled vials and added to the Minto Mine benthic invertebrate voucher collection. As required by Environment Canada, 10% of samples were re-sorted to verify that fewer than 10% of total organisms were missed, and 10% of the sub-samples were evaluated against a second sub-sample to verify that sub-sampling error was lower than 20% (Glozier et al. 2002; Environment Canada 2012).

2.4.3 Data Analysis – Reference Condition Approach

Benthic invertebrate community data were subject to a Data Quality Review (DQR), which included an evaluation of sorting efficiency and sub-sampling error (Appendix B). The RCA was initiated by evaluating the appropriateness of the reference sites for defining the reference condition. Indirect correlation of environmental variables with site scores derived from a reference Correspondence Analysis (CA) was used to identify the strongest (Pearson correlation with

$p < 0.10$) environmental predictors of reference benthic invertebrate community structure. Principal components analysis (PCA) of all reference sites and the exposed sites was then conducted using the significant environmental variable predictors of reference community structure to ensure that the range of ‘natural’ environmental conditions found at the mine-exposed sites was encompassed by the reference sites.

Benthic invertebrate communities were evaluated at the family level of taxonomy (as recommended by Environment Canada 2012) using EEM primary metrics of mean invertebrate density (organisms per m^2), mean taxon richness, Simpson’s Evenness Index (calculated as in Smith and Wilson 1996; Environment Canada 2012) and the Bray-Curtis Index of Dissimilarity (calculated as in Bray and Curtis 1957). These endpoints were calculated following the exclusion of Collembola, Ostracods, Copepods, Nemata, and Turbellaria from the analysis as these taxa are either non-benthic or are generally smaller than 500 μm in size. The relative proportions of the most abundant taxa were also computed (calculated as the abundance of each respective dominant/indicator taxon relative to the total number of organisms in the sample). Dominant/indicator taxon groups were defined as those groups representing more than 5% of total organism abundance or any groups considered to be important indicators of environmental stress. All required and supplementary endpoints were summarized by reporting mean, median, minimum, maximum, standard deviation, standard error, and sample size for each sampling site.

Correspondence analysis (CA) was also used to assess benthic invertebrate community structure of mine-exposed and reference stations. CA is a multivariate technique, which is used to create synthetic species prevalence axes extracted in a sequential manner. Each score (number) on a CA axis is the sum of a weighted vector of species proportion. Species with correlated proportions vary together and will have similar weights and scores on a CA axis. When depicted in two-dimensional plots, taxa that tend to co-occur plot together, while those that rarely co-occur plot farther apart. Similarly, stations sharing many taxa plot closest to one another, while those with little in common plot farthest apart. The greatest variation among either taxa or stations is explained by the first axis, with other axes accounting for progressively less variation. This type of multivariate analysis describes not only which stations have distinct benthic communities but also how these benthic communities differ among stations (i.e., which particular taxa differ). Prior to CA, the data were screened for rare taxa, as these can distort results. Taxa occurring at 5% or fewer of the stations were removed. After screening and data reduction, a proportional data matrix was used to conduct a CA using Minitab 17 (Minitab 2015). Scores for both taxa and stations were calculated and plotted to evaluate the associations of organisms and stations.

The RCA experimental design evaluates individual mine-exposed sites against a reference condition, which is comprised of multiple reference sites (10 in this study). Therefore, a traditional

ANOVA evaluation cannot be used in an RCA design. When testing for statistical differences between a single exposed site (test site) and multiple reference sites, two non-central tests can be used; a one-sample, non-central, equivalence test; and a one-sample, non-central, interval test (Kilgour et al. 1998). Determination that a test site is different from the reference condition (i.e., outside the range of reference values) is assessed using a critical effect size of 1.96 reference standard deviations and tested using two null hypotheses: H_{01} – the absolute value of the reference mean minus the test site value is ≥ 1.96 reference standard deviations (equivalence test), and H_{02} – the absolute value of the reference mean minus the test site value is ≤ 1.96 reference standard deviations (interval test). This testing results in three possible outcomes: a non-central p-value (ncP) < 0.1 (interval test) that indicates a community endpoint is outside of the reference condition; a ncP > 0.9 (equivalence test) that indicates a community endpoint is within the reference condition; and a ncP-value between 0.1 and 0.9 that is inconclusive with respect to potential difference from the reference condition (Kilgour et al. 1998). The interval and equivalence tests can also be conducted and presented graphically using tolerance limits (Kilgour et al. 2017). The tolerance limits can be interpreted as confidence limits on the percentiles of the reference site distribution. Using an effect size if 1.96 standard deviations and an alpha of 0.1, the interval and equivalence tests are the same as comparing a value from an exposed site to the 90% one-sided confidence limits on the 2.5th and 97.5th percentiles of the reference site data set. Any exposed sites found to be statistically outside the range of reference condition (exposed value below the 90% lower limit of the 2.5th percentile or above the 90% upper limit of the 97.5th percentile) were further evaluated through inspection of the raw data and taxonomic proportions. Data were transformed and assumptions of normality were assessed prior to calculating the tolerance limits. Calculations were conducted suing the RealStats add-in (Zaiontz 2017) in Microsoft Excel©. Ecological requirements and pollution sensitivity or tolerance of the dominant taxa were assessed using standard references (Edmunds et al. 1976; Clarke 1981; Chapman et al. 1982; Weiderholm 1983; Kiffney and Clements 1994; Wiggins 1996; Resh et al. 1996; Rosenberg and Resh 1996; Taylor and Bailey 1997; Barbour et al. 1999; Bode et al. 2002; Mandaville 2002; Merritt et al. 2008) in order to consider the statistical results of the benthic invertebrate community survey in the context of ecological requirements and pollution sensitivity or tolerance.

2.4.4 Data Analysis – Control-Impact

Although not part of the original study design (Minnow 2015), a control-impact comparison was also completed at the request of ECCC. Specifically, the exposed area of upper Minto Creek (replicated with 5 stations) was compared to reference (10 sites). As previously indicated, this comparison assumes that within-area variability (upper Minto Creek) and among-area variability (reference sites) are comparable, which may not be true. The CI comparisons were made on the basis of mean values of the same metrics as used for the RCA design. Benthic metrics were plotted to explore spatial patterns in the benthic community data. T-tests were used to test for differences in mean benthic metrics between "areas" (effluent-exposed upper Minto Creek and the population of 10 reference sites). Data were transformed as necessary to satisfy assumptions of normality and homogeneity of variance. In instances where variances could not be homogenized by transformation, the t-test for unequal variances was used. When assumptions of normality could not be met, the non-parametric Mann-Whitney test was used. Statistical tests were conducted using the RealStats add-in (Zaiontz 2017) in Microsoft Excel© and plots were generated using Microsoft Excel©. Interpretation of benthic invertebrate community metrics was enhanced by inspection of raw data and taxonomic proportions to detect patterns of ecologically relevant differences between the exposed area and reference. Ecological requirements and pollution sensitivity or tolerance of the dominant taxa were assessed using standard references (Edmunds et al. 1976; Clarke 1981; Chapman et al. 1982; Weiderholm 1983; Kiffney and Clements 1994; Wiggins 1996; Resh et al. 1996; Rosenberg and Resh 1996; Taylor and Bailey 1997; Barbour et al. 1999; Bode et al. 2002; Mandaville 2002; Merritt et al. 2008).

In instances when a significant difference between effluent-exposed and reference area means was detected using ANOVA, the magnitude of the difference was calculated for that metric. The magnitude of the difference was calculated to reflect the number of reference standard deviations (SDs) as follows:

$$(\text{exposure mean} - \text{reference mean}) / \text{reference SD}$$

The reference SD was estimated as the pooled SD in the t-test or the reference areas SD when the mine-exposed and reference areas SDs were significantly different. The design had n = 5 mine effluent-exposed stations and n = 10 reference sites. This design has a power of 0.96 to detect a two SD change in the exposed mean relative to the mean of the reference areas.

2.4.5 Additional Supporting Measures

In addition to *in situ* water quality measurements and the water chemistry data collected as described above, supporting information collected at each benthic invertebrate community station included global positioning system (GPS) coordinates recorded in latitude and longitude using WGS 1984 map datum, water velocity, sampling depth, stream gradient, stream wetted width, stream bankfull width, percent cobble/gravel/sand, median intermediate pebble axis length, and median embeddedness. Additional data collected to characterize each benthic invertebrate sampling station included: water appearance, creek morphology, bank condition, instream cover, residual pool depth, instream features, overhead canopy, aquatic vegetation, riparian vegetation, surrounding land use, anthropogenic disturbance, and photographs.

GPS coordinates were recorded using a Garmin Oregon 300 handheld GPS. Water velocity was measured using a Marsh-McBirney Flo-Mate 2000 portable flow meter and depth was measured using a meter stick. Stream gradient was measured using a Suunto clinometer. Wetted and bankfull widths were measured at each sampling site using a tape measure. Percent cobble/gravel/sand was estimated visually. The intermediate axis length of 100 rocks that were washed in the Surber sampler at each station were measured and recorded. In addition, the percent embeddedness of ten rocks was evaluated and recorded. This type of substrate characterization is similar to the Canadian Aquatic Biomonitoring Network (CABIN) protocol (CABIN 2012) for characterizing benthic invertebrate habitat and provided additional information to assess and standardize habitat conditions among sampling sites. Summary statistics of intermediate axis lengths and embeddedness were calculated for each station/site per CABIN protocol.

2.4.6 Correlation Analysis

Potential relationships between benthic invertebrate community metrics and physical/chemical conditions of the study sites were explored using correlation analysis as part of causal assessment (Suter et al. 2015). In order to reduce the number of comparisons made, benthic invertebrate community metrics were compared to a reduced set of physical and chemical variables (e.g., meter measures, water velocity, water depth, median substrate size, key water chemistry analytes identified in the water quality data evaluation, water chemistry PCA axes, and habitat PCA axes). Any significant correlations found at a p-value of 0.05 were further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were “leveraged” by outlying points (or groups of points). The effects of leverage were carefully considered because any difference in benthic community attributes of the effluent-exposed sites relative to reference might be correlated with mine-related differences in water quality regardless of cause. Significant correlations, coupled with careful examination of scatterplots, were used to identify the factors that most contribute to variability in benthic invertebrate community endpoints. The causative merit of these factors were then considered in light of known physical and chemical influences on benthic invertebrate communities (e.g., stimulation by nutrient enrichment, toxicity by exposure to high metal concentrations).

2.5 Supporting Field-Based Fish Study

The Minto Phase 4 EEM fish survey consisted of a field-laboratory exposure study (described in the next section) and a supporting field-based fishing effort. The field-based fishing was implemented by the Minto Mine, and focussed on lower Minto Creek with lower Big Creek serving as the reference area (Capstone 2017a).

2.5.1 Fish Collection

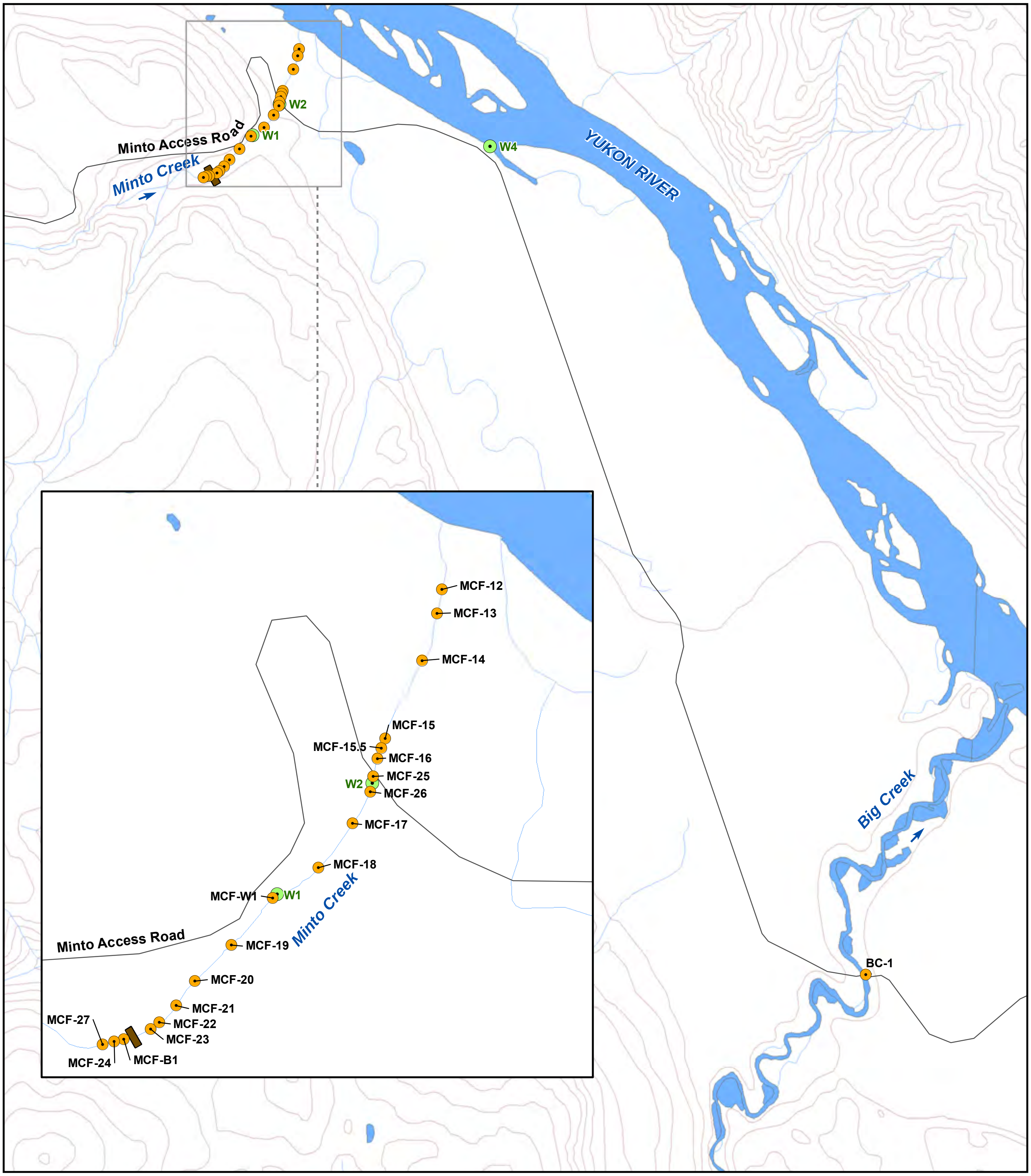
Fish communities of lower Minto Creek and lower Big Creek were sampled on June 8-9, July 6-7, August 5-6, and Sept 22-23, 2016 (Capstone 2017a). Fish were collected using minnow traps set in lower Minto Creek (17 to 20 traps per sampling event) between the mouth and just above of a natural fish barrier located approximately 1.2 km upstream (Figure 2.3). Similar habitat was sampled at Big Creek (Figure 2.3) using the same methodology as for lower Minto Creek (but four traps per sampling event). Fish were sampled using ¼" mesh cylindrical minnow traps baited with Yukon River Chinook salmon roe and set on the bottom for approximately 24 hours. Supporting information recorded for each minnow trap set included sampling effort (set duration based on deployment and retrieval date and time) and GPS coordinates in latitude and longitude. All captured fish were identified to species and enumerated to characterize the fish community. Juvenile chinook salmon were briefly retained in buckets prior to being processed on shore near the capture location.

2.5.2 Fish Processing

All juvenile chinook salmon were measured for fork length using electronic calipers (± 1 mm precision) and for weight to the nearest 0.01 g (with ± 1% precision) using a Scout-Pro Balance (Model HS-120; Ohaus Corp., Pine Brook, NJ). The presence of any external lesions, tumours, parasites or other abnormalities was also noted. Following processing, all fish were released near their capture location.

2.5.3 Data Analysis

All raw field data were transcribed from field sheets into an electronic spreadsheet and were checked for potential data entry errors as part of routine QA/QC procedures. Minnow trapping catch-per-unit-effort (CPUE) was calculated as the number of fish captured per minnow trap-day for each area and fish species. Consistent with EEM Technical Guidance (Environment Canada 2012), summary statistics including mean, median, minimum, maximum, standard deviation, standard error and sample size were calculated for length and weight of juvenile chinook salmon captured in lower Minto Creek and lower Big Creek. The field study provided confirmation of the appropriate life stage to use in the on-site laboratory exposure (i.e., 0+ age fry) and that the duration of the exposure study was sufficient to represent the short duration that chinook salmon fry spend in lower Minto Creek.



LEGEND

- → Direction of Flow
- ● Fish Monitoring Station
- ● Water Quality Monitoring Station
- ▬ Fish Barrier
- ⚒ Minto Mine Site

Minto Creek and Big Creek Fish Monitoring Stations

0 0.5 1 2 km

N W E S

Projection: North American Datum 1983 UTM Zone 8U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Date December 2017
Project 157202.0087

minnow environmental inc.

Figure 2.3

Document Path: S:\Projects\157202\157202.0087 Minto C4 EEM\Mapping\Interpretive Report\15-87 Fig 2.3 Fishing Stations.mxd

2.6 Laboratory Fish Exposure Study

2.6.1 Sentinel Fish Species

As described in the Phase 4 Study Design (Minnow 2016), naturally limited fish use of Minto Creek make a conventional EEM fish survey unfeasible (i.e., numbers are too low to support robust statistical contrasts). Therefore, an alternative approach - a controlled fish exposure study - was applied. Specifically, an on-site laboratory exposure was used to determine if combinations of Minto Mine effluent and reference water cause differences in survival, growth, and/or condition of fish reared over a 47-day period. This approach was similar to that applied in Phase 2 (Minnow and Access 2012), with some differences:

1. Kokanee salmon (*Oncorhynchus nerka*) were used as the sentinel species rather than Yukon River chinook salmon (*O. tshawytscha*) as the latter were unavailable.
2. The study was implemented at the Minto Mine rather than at a hatchery facility in Whitehorse.
3. Two concentrations of mine effluent were evaluated (i.e., two exposure groups) as opposed to just one (1 part effluent to 3 parts reference water [25% effluent] and 1 part effluent to 6 parts reference water [14% effluent]).
4. Yukon River water was used as reference water rather than Minto Creek water because Minto Creek flows were extremely low in 2016 (Capstone 2017b) and could not be relied upon as a water supply.

Because chinook salmon were not available from Yukon hatchery facilities in 2016, kokanee salmon (fry) were chosen as the surrogate sentinel species. Although kokanee salmon are not native to the Yukon River, they are native to the Yukon. Rationale for the selection of kokanee salmon for this exposure study included:

- Kokanee salmon are reared locally in the Yukon and were available in sufficient quantity for the study.
- The kokanee are from a group indigenous to the Yukon (Kathleen River system, Kluane National Park) and are fourth generation hatchery stock. Therefore, they are well adapted to artificial rearing systems and their behaviour and nutritional requirements are well known.
- The kokanee rearing program involves annual disease screening which indicates that the Whitehorse Rapids hatchery population is free of certain pathogens that are known to occur in other kokanee stocks.

- The Yukon reared kokanee have relatively high growth rates in cold water as they have adapted to cold water conditions in both their natural and hatchery environments. Therefore, it can be expected that their metabolic rate will be higher in colder creek water than might be the case for another surrogate species such as rainbow trout (and thus are more similar to chinook salmon).
- The kokanee present a very consistent growth rate among individuals.
- Kokanee are not aggressive towards each other in artificial rearing vessels and thus do not inflict harm on each other which could otherwise influence growth rates and overall fish health.

2.6.2 Exposure Facility and Conditions Overview

The rearing infrastructure for the exposure study was assembled inside the water treatment building at the Minto Mine site (Figure 2.4). The use of a shelter allowed for better control of critical variables such as temperature and light, and sheltered the system from wind and precipitation. The rearing infrastructure (Figure 2.4) consisted of three circular fibreglass rearing tanks 1.47 m in diameter and 0.30 m deep fitted with a centre stand-pipe system which provided a water depth of 0.225 m and approximately 0.38 m^3 of wetted rearing volume. All three rearing tanks were configured identically and included an air stone connected to a supply of pure oxygen (compressed oxygen in 100 pound cylinders), a water re-circulator/aerator and a water supply inlet with a flow control valve. A plastic (polyethylene) cover was kept on top of each tank to avoid airborne contamination and to minimise visual disturbance to the fish (see photos in Appendix F).

Rearing tanks received water from three individual water supply tanks with a circular diameter of 2.2 m, height of 1.85 m providing a total volume of 5.0 m^3 per tank. The water supply tanks were situated just outside of the water treatment facility and placed on top of a sand berm at a height that allowed water to gravity feed, via 2.5 cm (1”) diameter polyvinyl chloride (PVC) and polyethylene pipe to the rearing tanks inside the building. The water supply tanks were wrapped in insulated tarps to reduce solar heating of the water stored in them (see photos in Appendix F).

As it was imperative that all fish groups were exposed to exactly the same water temperatures throughout the study, a passive heat exchange system was constructed to equalize water temperatures among the tanks and maintain cool temperatures independent from ambient air temperature. The exchanger consisted of an 8.0 metre long x 20 cm (8”) diameter PVC pipe fitted internally with 3 runs of 2.5 cm (1”) diameter PVC pipe and enclosed on both ends except for a water inlet and outlet at either end (see Figure 2.4). The three 2.5 cm pipes inside the larger pipe extended beyond both ends of the larger pipe allowing it to be connected to supply water, and allowing water to pass through the exchanger and then be delivered to the rearing tanks. Cooling

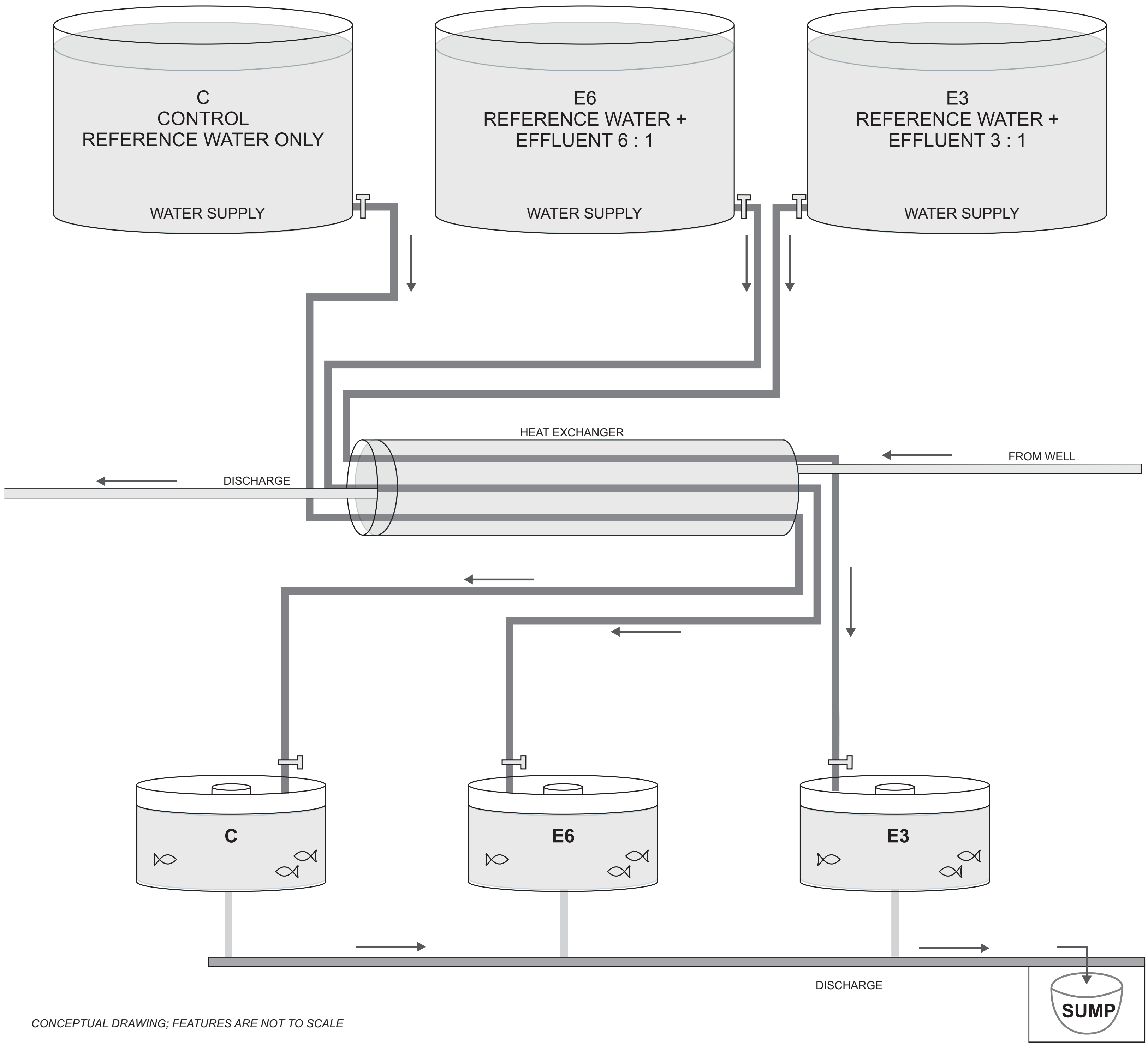
MINTO MINE

capstone
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

ENVIRONMENTAL EFFECTS MONITORING PROGRAM PHASE 4

FIGURE 2.4

FISH EXPOSURE STUDY REARING SYSTEM SCHEMATICS



CONCEPTUAL DRAWING; FEATURES ARE NOT TO SCALE

ALEXCO ENVIRONMENTAL GROUP

minnow environmental inc.

This drawing has been prepared for the use of Alexco Environmental Group Inc.'s client and may not be used, reproduced or relied upon by third parties, except as agreed by Alexco Environmental Group Inc. and its client, as required by law or for use of governmental reviewing agencies. Alexco Environmental Group Inc. accepts no responsibility, and denies any liability whatsoever, to any party that modifies this drawing without Alexco Environmental Group Inc.'s express written consent.

D:\Project\AllProjects\Minto\gis\mxd\Studies\Fisheries_Benthic_Studies water for the exchanger was supplied by a groundwater well (approximately 3°C) which flowed through the larger pipe continuously in a counter-current direction to the fish rearing water. This allowed for cooling and equilibration of the fish rearing water while being isolated from mixing with the water being delivered to the fish tanks.

Water temperature was monitored continuously every hour in each rearing tank using Tidbit temperature loggers. Temperatures were also taken manually twice/day using a mercury thermometer and/or a handheld water quality meter (YSI).

2.6.3 Fish Processing

On August 4th (pre-exposure) at the Whitehorse Rapids Fish Hatchery (located in Whitehorse, Yukon) 480 kokanee salmon fry were sedated in a dilute solution of MS222, measured (total length and fork length) using electronic calipers (to the nearest 0.01 mm), weighed to the nearest 0.01 g with a Mettler Toledo Balance (ModelJS4002G), assessed for abnormalities, and divided into three groups (C [control], E6 [1 part effluent to 6 parts reference water] and E3 [1 part effluent to 3 parts reference water]) of 160 fish each. Fish were held until August 7th and then transported to the Minto Mine site. Fish were transported in 20 litre collapsible potable water jugs filled to one-third of capacity. After placing fish in each jug, the containers were collapsed by compressing the containers, forcing the air out of the top two-thirds of the container. This space was then filled with pure oxygen to ensure that fish were not oxygen deprived during their transport to site. Sealed jugs with fish, water, and pure oxygen were then placed in an insulated fish tote (approximately 1 m^3 in volume) with approximately 10 centimeters of ice-water to keep containers and fish cool for transport to site. Fish were transported to the Minto Mine site on August 7th and then transferred to their respective rearing tanks for the study (Day 1 of exposure). Transit time from loading fish into the transport jugs to transfer to their rearing tanks was approximately five hours. One mortality occurred during the holding period subsequent to processing on August 4th. This mortality was part of the control group. Thus rearing at the mine site was initiated with 159 fish in the Control group (C) and 160 fish in each of the two exposure groups (E6 and E3).

At the approximate mid-point to of the exposure (September 1st 2016; Day 26), sub-samples of 50 fry were randomly collected from each tank, sedated in a dilute solution of MS222, measured (total length and fork length) and weighed as outlined above (with the exception that an A&D Balance [Model E5-610] was used at the Minto Mine site), and examined for abnormalities. All measurements and additional observations were recorded on data sheets and later transcribed to a spreadsheet which was cross-checked for accuracy. Following initial and mid-point processing, fish were placed in a recovery container (20 litre pail with 10 litres of water and aeration) and placed back in their respective tank once fully recovered. The average weight of the fish in each group was then used to adjust feed rations which are determined by water temperature and biomass of fish in each tank. On the last day of the exposure (September 22nd 2016; Day 47), fish were removed from each tank and were exposed to a lethal dose of MS222 followed by measurement, weighing, and abnormality examination as described above. All carcasses were disposed of by incineration afterwards.

2.6.4 Water Quality and Flow Monitoring

Water was supplied to each tank at a flow rate ranging between 0.6 to 1.7 litres per minute, with higher flows required as the exposure study advanced in order to maintain dissolved oxygen (DO) concentrations and to manage ammonia concentrations[2]. Water flow was measured twice daily using a graduated cylinder and stop-watch and adjusted when required. Dissolved oxygen levels were kept at 6.0 mg/L or higher (as recommended for salmonid hatcheries; Sigma 1983) by increasing flow rates, by aeration, and/or by direct input of oxygen. Aeration of the rearing tanks occurred from day one and continued throughout the study. When it was determined that water temperatures (and accompanying fish consumption of oxygen) were going to be higher than anticipated and that increasing flow rates and aeration would not keep DO levels in each tank above 6.0 mg/L, pure oxygen (bottled) was delivered to each rearing tank using air lines and stones.

Ammonia concentrations typically do not present an issue with flow-through fish rearing systems. However, because DO levels were not exclusively maintained by flow (i.e., were partially maintained by aeration and injection of pure oxygen to reduce demand on water supply), ammonia levels were monitored closely (daily) using a HACH spectrophotometer. When ammonia levels approached those that could potentially compromise fish health (Sigma 1983), water flows were increased. The toxicity of ammonia increases with increasing temperature and pH, which were both monitored closely along with ammonia. Flow rates were increased if ammonia levels started to approach those that could compromise the health of the fish (Sigma 1983). DO (mg/L and percent saturation), temperature, specific conductivity, and pH were monitored twice daily over the course of the exposures using a YSI Professional Plus field meter. Temperature was also measured and digitally recorded every hour with submersible TidbiT temperature loggers (Onset) UTBI-001.

Water from the Yukon River was delivered to the water supply tanks about once per week during the first part of the study. Delivery frequency increased to about once every two to three days towards the end of the study as flow rates to the rearing tanks were increased to manage DO and

---

[2] Ammonia, an excretion product, can become toxic to fish at high concentrations and was therefore carefully monitored, with water flow adjusted as required to maintain ammonia concentrations below those that could be harmful to salmonids (per Sigma 1983).

ammonia as outlined above. Concurrent with each water delivery from the Yukon River, effluent was also collected from the water storage pond. Rearing tank water was sampled weekly, for chemical analysis at a ALS Environmental (Burnaby BC). A total of seven samples were collected over the course of study starting on August 8th with the final sampling occurring on September 19th. Water quality samples were collected and handled as described in Section 2.3 and were analysed for required EEM analytes and additional supporting analytes as also described in Section 2.3.

2.6.5 Data Analysis

Raw laboratory data were transcribed from bench sheets into electronic spreadsheets and were checked by a separate individual for potential entry errors as part of routine QA/QC procedures. Scatterplots of body weight vs. fork length were used to identify potential measurement or recording errors. Summary statistics (mean, median, minimum, maximum, standard deviation, standard error, and sample size) were calculated for fork length, total length, and fresh body weight by exposure group.

Data were subject to detailed analyses required to satisfy the requirements of a non-lethal EEM fish population survey, with steps undertaken as follows. Body weight and fork length were plotted using boxplots by species and study area. The boxplots were defined using the minimum value, the first quartile (Q1), the median, the third quartile (Q3), and the maximum value. Extreme values in the boxplots were plotted as individual values and the whiskers of the box were truncated to the next value in the data set. Extreme values were defined as values more than 1.5 times the height of the box beyond Q1 or Q3 (i.e., less than Q1 – 1.5(Q3 – Q1) or greater than Q3 + 1.5(Q3 – Q1)). Length-frequency distributions were plotted by exposure group using histograms. Scatterplots and linear regressions of body weight on fork length (both axes log10-scaled) were also generated by exposure group. These plots were used to support the statistical analyses.

Detailed statistical analyses were performed using Minitab 17 software on fish endpoints representing three response categories: survival (length-frequency distribution), energy use (fork length and body weight), and energy storage (condition). The statistical analyses were consistent with procedures outlined in the Technical Guidance Document (Environment Canada 2012). Statistical analyses were conducted by comparing the effluent-exposed groups to reference separately (i.e., by pairwise comparison).

Length-frequency distributions were compared among exposures using two-sample Kolmogorov-Smirnov (K-S) tests. The K-S test is a non-parametric test of potential differences between two distributions (Zar 1984). The test is conducted as a comparison of the cumulative relative distribution functions of the two samples. The maximum difference in the cumulative relative distributions at any given fish length is computed and tested to determine whether it is large enough to suggest that the two samples were generated from different statistical populations. The maximum difference in the cumulative relative distributions was reported as a measure of the magnitude of difference between the length frequency distributions between exposures. For example, if the maximum difference in the cumulative relative distribution functions between exposures was 0.25 at a fish length of 15 cm, then one exposure had 25% fewer fish smaller than 15 cm compared to the other exposure. A negative sign was applied to the magnitude of difference when the effluent-exposed fish were smaller than reference (e.g., when there were more fish < 15 cm) and a positive sign was applied to the magnitude of difference when the effluent-exposed fish were larger than reference (i.e., fewer fish < 15 cm).

Body weight and fork length were compared among exposures using two-sample t-tests or the non-parametric equivalent (Mann-Whitney test). The residuals from the tests were tested for normality (Shapiro-Wilks test, $\alpha = 0.05$) and equality of variances (Levene's test, $\alpha = 0.05$). When the assumptions of normality were not met, a log10-transformation was conducted and the assumptions assessed again. When normality could not be achieved, the Mann-Whitney test was used. When the assumption of equal variances could not be achieved, the two-sample t-test for unequal variances was used.

Fish condition was compared among exposures using analysis of covariance (ANCOVA) with log10(body weight) as the response variable and log10(fork length) as the covariate. The ANCOVA was conducted by fitting a regression model with exposure, covariate, and the interaction between exposure and covariate as predictor variables (the interaction ANCOVA model). If the covariate term is significant, then the covariate is a significant predictor of the response variable and the ANCOVA analysis is needed. If the covariate term is not significant, then the analysis can proceed as an ANOVA (or t-test) on the response variable among exposures. Testing the significance of the interaction term (exposure×covariate) is equivalent to testing whether the regression slopes between exposures are equal. If the interaction term is not significant, then it can be dropped from the model and the ANCOVA can proceed using the parallel slope ANCOVA model (using only exposure and the covariate as predictor variables). In this case, a test for a difference in body weight among exposures (adjusted for fork length) is conducted by testing the significance of the exposure term in the parallel slope ANCOVA model. This test is equivalent to testing whether the intercepts between the two parallel slope regression lines are equal. The tests for significance of the covariate and interaction terms were conducted using $\alpha = 0.05$ and the tests for differences between exposures were conducted using $\alpha = 0.1$, consistent with the recommendations of Environment Canada (2012).

When regression slopes were not parallel (i.e., there was a significant interaction in the ANCOVA model), the scatterplots were examined to assess whether the regression lines appeared to be parallel. When there is low variability (i.e., high R^2 value), very small differences in regression slopes can be detected as being significant although the slopes are practically the same. To assess whether the difference in slopes is small enough to consider them to be parallel, the R^2 value of the interaction ANCOVA model was compared to the R^2 value of the parallel slope ANCOVA model. When the difference in R^2 between models was less than 2%, the ANCOVA proceeded assuming that the slopes are practically parallel (Environment Canada 2012).

Observations with studentized residuals of magnitude greater than four were removed from parametric tests (t-test and ANCOVA; Environment Canada 2012). The magnitude of difference for body weight, fork length, and condition among the exposures were calculated using the appropriate measure of central tendency depending on the statistical test used. The measure of central tendency was selected as the mean for t-test, geometric mean (i.e., mean on log10-scale) when a log10-transformation was used for a t-test, the median for the Mann-Whitney test, and the adjusted mean for an ANCOVA. The adjusted means for an ANCOVA are the predicted values on the parallel slope regression lines for each exposure at the average value of the covariate (i.e., the adjusted body weights at the average fish fork length). The ANCOVAs were conducted using log10-transformed data so the adjusted means were back-transformed to the original data scale (i.e., antilogged). The magnitude of difference was calculated as a difference between the exposures (e.g., effluent-exposed and reference), expressed as a percentage of the reference area as:

$$\text{Magnitude of Difference} = \frac{Exp_{MCT} - Ref_{MCT}}{Ref_{MCT}} \times 100\%,$$

where MCT = measure of central tendency.

The magnitude of difference was compared to Critical Effect Sizes (CES) of 10% for condition and 25% for the other endpoints and was used to help identify statistically significant differences that may (or may not) be biologically meaningful.

When there was no significant difference detected between exposures, the minimum detectable difference (MDD) was estimated as a percent difference from the reference mean for ANOVA, or adjusted reference mean for ANCOVA. The MDD was estimated using the observed measure of variability (standard deviation of residuals), the average sample size between exposures, and assuming that differences in body weight and fork length would be tested using a t-test on log10-transformed data (even if tested using another test). The probability of type I error (α) was set equal to the probability of Type II error (β) for the estimate of the MDD. The MDD was computed on the log10-scale and transformed to a percent difference relative to reference in the original data units. The MDD estimates were generated using the sample size and power calculator in Minitab 17.

3 EFFLUENT SUBLETHAL TOXICITY

Effluent sublethal toxicity tests conducted by the mine in 2015 and 2016 (data for 2017 have not yet been reported by the testing laboratory) showed no effects to the survival of rainbow trout embryos, the survival or reproduction of *Ceriodaphnia dubia* (a cladoceran invertebrate often referred to as a water flea), nor to the growth of *Pseudokirchneriella subcapitata* (a green algae) or *Lemna minor* (a plant; Table 3.1). This suggests a low probability of toxicity in the receiving environment, which is consistent with previous EEM Phases (Table 3.1).

Table 3.1: Minto Mine Effluent Sublethal Toxicity Test Results Collected at W3 (as % Effluent), 2007-2016

EEM Cycle	Date	Rainbow trout embryo	*Ceriodaphnia dubia*		*Pseudokirchneriella subcapitata*	*Lemna minor*	
		EC25 Survival	LC50 Survival	IC25 Reproduction	IC25 Growth[a]	IC25 Dry Weight[a]	IC25 Frond Increase[a]
Cycle 1	5 & 7-Jun-07	> 100%[b]	> 100%	> 100%	> 90.0%	> 97%	> 97%
	29-Oct-07	> 100%	> 100%	> 100%	> 90.0%	> 97%	> 97%
	3-June-08	88%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	28-Oct-08	> 100%	> 100%	0.33%	> 90.9%	> 97%	> 97%
Geometric Mean		**97%**	**> 100%**	**24%**	**> 90.9%**	**> 97%**	**> 97%**
Cycle 2	26-May-09	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	15-Sep-09	-	> 100%	> 100%	-	-	-
	16-Nov-09	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	11-May-10	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	22-Nov-11	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
Geometric Mean		**> 100%**	**> 100%**	**> 100%**	**> 90.9%**	**> 97%**	**> 97%**
Cycle 3	16-Oct-12	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	5-Nov-13	> 100%	> 100%	38.6%	> 90.9%	> 97%	> 97%
	27-Oct-14	> 100%	> 100%	>100%	> 90.9%	> 97%	> 97%
Geometric Mean		**> 100%**	**> 100%**	**73%**	**> 90.9%**	**> 97%**	**> 97%**
Cycle 4	Oct-15 [c]	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	23-Oct-16	> 100%	> 100%	> 100%	> 95.2%	> 97%	> 97%
	9-Oct-17	dp	dp	dp	dp	dp	dp
Geometric Mean		**> 100%**	**> 100%**	**> 100%**	**> 93.0%**	**> 97%**	**> 97%**

[a] Highest concentration tested.

[b] 2007 June Test invalid due to non-viable eggs - the quality control criteria for viability in controls were not met.

[c] Rainbow trout test on sample collected October 5th; remaining tests on samples collected on October 13th.

dp = data pending

4 WATER QUALITY AND SUPPORTING MEASURES

Water quality has been routinely monitored by the Minto Mine at lower Minto Creek (Station W2) and a reference tributary (Station W7; Figure 2.2). Water quality was also characterized during the benthic invertebrate community survey in September 2016, when *in situ* measurements of water quality, water samples for laboratory chemical analysis, and supporting physical and biological measures were collected at all benthic invertebrate community sampling sites (Figure 2.1). Lastly, water quality samples were collected weekly from each of the on-site laboratory fish exposure tanks to characterize exposure conditions.

4.1 Routine Water Quality Monitoring

Water quality at effluent-exposed lower Minto Creek (Station W2) differed from reference (Station W7; Figure 2.2) primarily on the basis of conductivity, hardness, nitrate, total aluminum, total arsenic, total iron, and total selenium, which were the only analytes with mean concentrations in 2015, 2016, or 2017 greater than the upper 95% confidence limit of the reference mean (Table 4.1; Appendix Table C.1). Plots of these analytes indicate that nitrate was the only analyte with a clear pattern of higher concentrations at Station W2 during periods of discharge (including when discharge was under non-freshet conditions; Appendix Figure C.1). Of the analytes elevated in lower Minto Creek relative to reference, total aluminum and total iron occurred at mean concentrations greater than Canadian Water Quality Guidelines (CWQG) at the effluent-exposed area and the reference area (Table 4.1). Concentrations of copper were also greater than CWQG at the effluent-exposed and reference areas, but were not elevated at the effluent-exposed area to greater than the upper 95% confidence limit of the reference mean and did not exceed the site-specific water quality objective (SSWQO) of 0.013 mg/L applicable when dissolved organic carbon (DOC) is lower than 10 mg/L (Table 4.1). Concentrations of total aluminum, total iron, and total copper were positively related to concentrations of total suspended solids (TSS; Appendix Figure C.2), and dissolved concentrations of these metals (which better represent the bioavailable fraction and for which the SSWQO apply) were typically elevated only during freshet (Appendix Figure C.3).

4.2 Water Quality and Supporting Measures Collected during the Benthic Survey

4.2.1 *In situ* Water Quality Measures

During the Phase 4 EEM benthic survey, the mean temperature of upper Minto Creek (8.6 °C) was notably higher than at the reference creeks (mean 0.99 °C; Figure 4.1; Appendix Table C.2), presumably due to effluent discharge at the time of sampling. *In situ* dissolved oxygen concentrations measured at Minto Creek during the benthic invertebrate community survey were

Table 4.1: Summary of Routine Water Quality Monitoring under MMER, Minto Mine, 2015-2017 [a]

Analyte	Units	Guideline [b]	SSWQO [c]	Station W7 (Reference)				Station W2 (Exposure)		
				2015 mean	2016 mean	2017 mean	Reference [d]	2015 mean	2016 mean	2017 mean
Physical										
Water Temperature	°C	-	-	1.1	1.9	1.8	-0.10 to 4.5	3.9	3.5	3.8
Field Conductivity	µS/cm	-	-	147	147	132	178	188	174	187
Laboratory Conductivity	µS/cm	-	-	269	253	230	302	319	331	309
Dissolved Oxygen	mg/L	> 6.5	-	12.0	12.7	13.3	10.6 to 15.4	12.8	12.6	12.9
pH	pH units	6.5 - 9.0	6.0 - 9.0	7.64	7.71	7.70	7.50 to 8.13	7.87	7.92	7.73
Ions, Nutrients and Solids										
Total Hardness	mg/L	-	-	142	-	-	-	160	-	-
Dissolved Hardness	mg/L	-	-	126	130	113	156	151	173	153
Alkalinity	mg/L	-	-	130	131	118	164	142	151	148
Ammonia	mg/L	0.41 [e]	0.25	0.034	0.016	0.012	0.043	0.028	0.0054	0.0077
Nitrate (as N)	mg/L	3.0	9.1	0.11	0.10	0.096	0.20	0.19	0.63	0.15
Total Suspended Solids	mg/L	narrative [f]	-	60	9.0	13	161	39	4.5	18
Total Metals										
Aluminum	mg/L	0.10 [g]	0.10	**0.24**	**0.22**	**0.42**	**0.74**	**0.74**	0.061	**0.28**
Arsenic	mg/L	0.0050	0.0050	0.00054	0.00052	0.00064	0.00075	0.00093	0.00050	0.00070
Cadmium	mg/L	0.00016 [h]	0.00021	<0.000010	0.0000062	0.000011	0.000014	<0.000021	<0.0000060	0.000011
Copper	mg/L	0.0024 [h]	0.013 / 0.02 [i]	**0.0026**	0.0022	**0.0035**	**0.0062**	**0.0057**	**0.0033**	**0.0045**
Iron	mg/L	0.30	1.1	**0.50**	**0.41**	**0.77**	**1.36**	**1.42**	0.20	**0.49**
Lead	mg/L	0.0032 [h]	0.0040	<0.00022	0.00013	0.00021	0.00039	<0.00054	<0.000054	0.00013
Mercury	mg/L	0.000026	-	<0.000010	<0.0000068	<0.0000050	0.000012	<0.000010	<0.0000063	<0.0000050
Molybdenum	mg/L	0.073	0.073	0.0015	0.0013	0.0013	0.0019	0.0015	0.0016	0.0015
Nickel	mg/L	0.096 [h]	0.11	0.0015	0.0015	0.0022	0.0028	0.0025	0.0012	0.0018
Selenium	mg/L	0.0010	0.0020	0.00014	0.00014	0.00014	0.00018	<0.00018	0.00024	0.00015
Zinc	mg/L	0.030	0.030	<0.0050	<0.0030	0.0037	0.0055	<0.0071	<0.0030	0.0040

🟧 Out of reference range.

Bold font Concentration greater than the lowest guideline or SSWQO.

[a] If greater than 50% of samples were less than method detection limit, the mean was presented with a less than symbol (i.e., <).

[b] Water quality guidelines for the protection of aquatic life (CCME 1999 with updates). Guideline for dissolved oxygen is for "Other life stages" of coldwater biota.

[c] Site-specific water quality objectives for Station W2 per the Minto Mine Water Use Licence. For metals, the SSWQO are applicable on a dissolved basis.

[d] Reference values are the 95th percentile of the 2015-2017 mean (Appendix Table C.1). Temperature, dissolved oxygen and pH are ranges from the 5th to 95th percentile.

[e] At temperature 5°C and pH 8.5; values which are inclusive of all temperature and pH data recorded in this time period (maximum temperature = 4.5°C, maximum pH = 8.13; see Appendix Table C.1).

[f] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[g] At pH 8.5 (slightly conservative conditions).

[h] At hardness of 100 mg/L (slightly conservative conditions).

[i] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

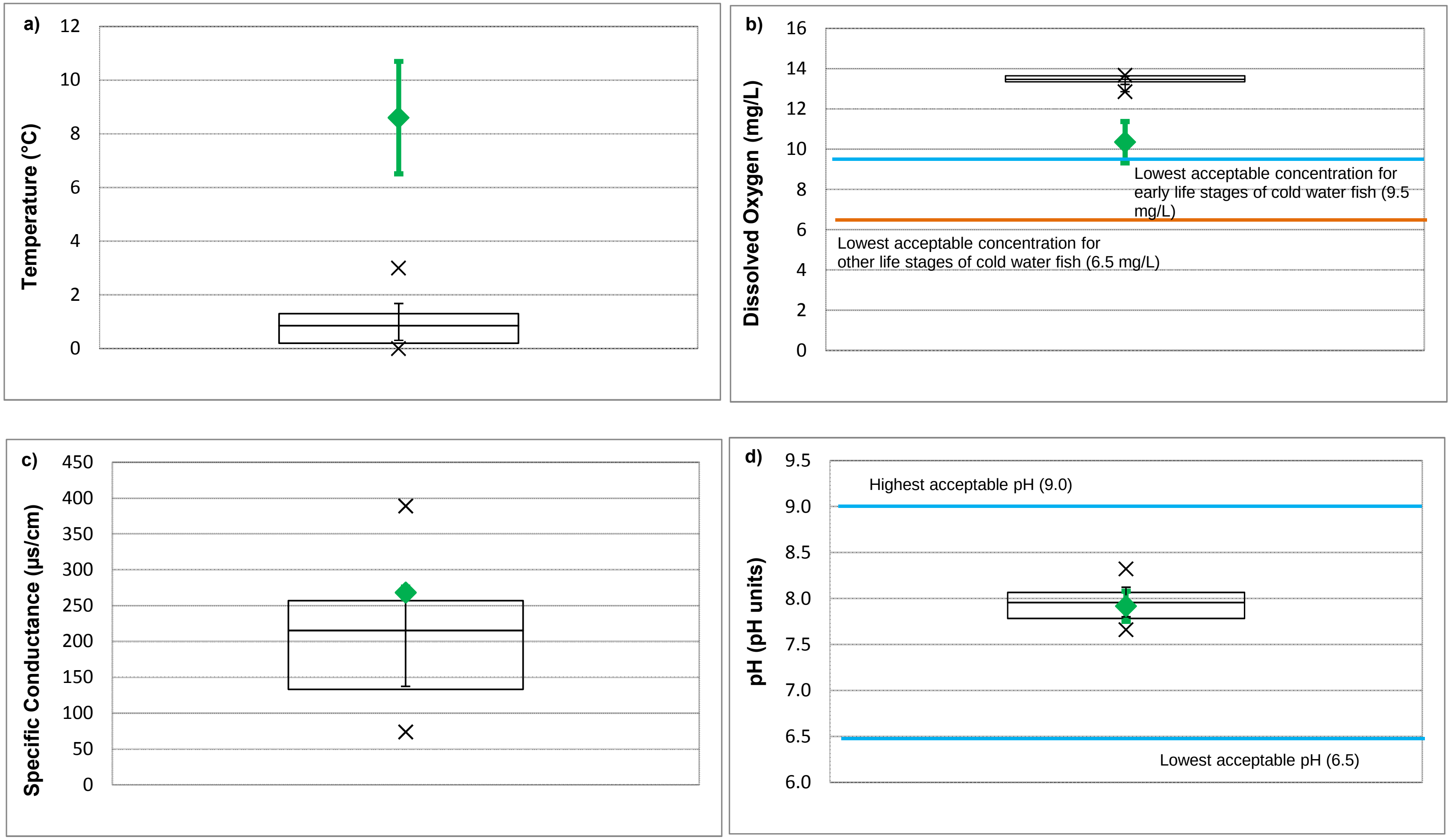


Figure 4.1: Supporting *In situ* Water Quality Measures, Minto Mine Phase 4 EEM, September 2016 [a]

a - box-and-whisker plot of reference site data (n=10; quartiles, 95% confidence limits of the mean, minimum, maximum) in black. Mean and 95% confidence limits of effluent exposed sites in green.

above the CWQG (i.e., within an acceptable range specified in the CWQG; mean 10.4 mg/L), but lower than at reference areas (Figure 4.1 and Appendix Table C.2). Specific conductance of upper Minto Creek (mean 268 µS/cm) was greater than at most reference sites (Figure 4.1), but lower than the highest specific conductance reported at a reference site (389 µS/cm; Figure 4.1 and Appendix Table C.2). Lastly, mean pH of Minto Creek was slightly alkaline (mean 7.96), but was similar to pH observed at the reference sites and was within the acceptable range specified in the CWQG (6.5 to 9.0; Figure 4.1).

4.2.2 Analytical Laboratory Measures

A Data Quality Review (DQR) indicated that the laboratory analytical data collected as part of the Phase 4 EEM benthic survey were of good quality and suitable for addressing the objectives of this study (Appendix B). During the survey, a total of five analytes in upper Minto Creek were present at concentrations outside the range of reference (nitrate, total Kjeldahl nitrogen [TKN], total phosphorus, copper, and molybdenum; Table 4.2). Of the analytes outside the range of reference, only copper was present at a concentration greater than CWQG. However, copper concentrations did not exceed the SSWQO of 0.013 mg/L applicable when DOC is lower than 10 mg/L (Table 4.2).

4.2.3 Other Supporting Measures

Water velocity and depth at the effluent-exposed upper Minto Creek sampling sites and at the reference sites had similar mean values and overlapping ranges (Figure 4.2; Appendix Table C.2). Median intermediate axis length of pebbles/cobbles cleaned for benthic invertebrate community sampling in upper Minto Creek (3.9 cm) was similar to reference (4.3 cm), as was the overall distribution of pebble/cobble size (Figure 4.2; Appendix Table C.3).

4.3 Water Quality Measures Collected During the Fish Exposures

4.3.1 *In situ* Water Quality Measures

During the on-site laboratory fish exposures, supporting measures were consistent among the exposure tanks, with only slightly greater dissolved oxygen, specific conductance, and ammonia in the exposure tanks than in the reference tank (Table 4.3). Dissolved oxygen (DO) levels were successfully maintained above 6.0 mg/L (as recommended for salmonid hatcheries; Sigma 1983) for most of the study, except for very slight excursions below this target for the effluent-exposed groups (5.94 mg/L for groups E6 [14% effluent; one part effluent to 6 parts reference water] and E3 [25% effluent; one part effluent to three parts reference water]; Table 4.3; Appendix Table C.4). Ammonia concentrations were successfully maintained below the threshold that would compromise fish health (Sigma 1983). Temperature data logging at hourly intervals throughout the exposures indicated that temperatures in the rearing tanks were

Table 4.2: Water Quality Data Collected during the Minto Mine EEM Phase 4, September 2016

Analyte	Units	Guidelines [a]	SSWQO [b]	Reference													Effluent-Exposed		
				REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10	Reference Minimum	Reference Mean [c]	Reference Maximum	UMC-1	UMC-2	UMC-3
Ions, Nutrients and Solids																			
Total Hardness (as $CaCO_3$)	mg/L	-	-	64	58	105	52	115	125	213	116	154	33	33	103	213	119	124	122
Total Alkalinity (as $CaCO_3$)	mg/L	-	-	65	76	100	43	81	145	165	72	129	37	37	91	165	105	105	105
Total Ammonia (as N)	mg/L	0.28 [d]	0.25	0.0051	0.0060	<0.0050	0.019	<0.0050	0.0054	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0065	0.019	<0.0050	0.0051	<0.0050
Nitrate (as N)	mg/L	3.0	9.1	0.040	0.021	0.072	0.084	0.078	0.082	0.032	0.30	0.17	0.042	0.021	0.092	0.30	1.9	1.9	1.9
Total Kjeldahl Nitrogen	mg/L	-	-	0.37	0.41	0.42	0.48	0.19	0.43	0.41	0.22	0.16	0.13	0.13	0.32	0.48	0.81	2.2	0.28
Total Phosphorus (P)	mg/L	-	-	0.016	0.012	0.011	0.040	0.0073	0.024	0.011	0.010	0.0076	0.0073	0.0073	0.015	0.040	0.013	0.049	0.016
Total Suspended Solids	mg/L	narrative [e]	-	<3.0	3.9	21	21	<3.0	<3.0	<3.0	4.1	<3.0	<3.0	<3.0	<6.9	21	6.3	8.7	4.1
Total Dissolved Solids	mg/L	-	-	125	122	175	101	171	202	299	170	181	75	75	162	299	196	188	188
Organic / Inorganic Carbon																			
Dissolved Organic Carbon	mg/L	narrative [f]	-	15	15	15	13	6.6	14	15	6.6	4.3	4.2	4.2	11	15	5.5	5.4	5.5
Total Metals																			
Aluminum (Al)	mg/L	0.10 [g]	-	0.050	0.063	0.092	**0.52**	0.022	0.029	0.047	**0.12**	0.021	0.066	0.021	**0.10**	**0.52**	0.093	**0.32**	0.085
Antimony (Sb)	mg/L	0.0090	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)	mg/L	0.0050	-	0.00055	<0.00050	0.00058	0.00070	<0.00050	0.00066	<0.00050	<0.00050	0.00099	<0.00050	<0.00050	0.00060	0.00099	<0.00050	<0.00050	<0.00050
Barium (Ba)	mg/L	1.0	-	0.033	<0.020	0.070	0.057	0.051	0.039	0.056	0.079	0.058	0.033	<0.020	0.050	0.079	0.048	0.053	0.048
Beryllium (Be)	mg/L	0.00013	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)	mg/L	1.5	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)	mg/L	0.00016 [h]	-	<0.0000050	<0.0000050	0.0000057	0.000015	0.0000074	<0.0000050	0.0000062	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000065	0.000015	<0.0000050	0.0000071	<0.0000050
Calcium (Ca)	mg/L	-	-	19	13	29	14	29	29	53	30	33	9.9	9.9	26	53	31	31	31
Chromium (Cr)	mg/L	0.0010 / 0.0090 [i]	-	<0.0010	<0.0010	<0.0010	0.0012	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	<0.0010	<0.0010	<0.0010
Cobalt (Co)	mg/L	0.0040	-	<0.00030	<0.00030	<0.00030	0.00083	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00035	0.00083	<0.00030	<0.00030	<0.00030
Copper (Cu)	mg/L	0.0024 [h]	-	0.0015	0.0013	0.0018	**0.0035**	<0.0010	0.0012	0.0014	0.0016	<0.0010	<0.0010	<0.0010	0.0015	**0.0035**	**0.0057**	**0.0068**	**0.0057**
Iron (Fe)	mg/L	0.30	-	**0.48**	**0.45**	0.28	**1.7**	0.13	0.19	0.24	0.16	0.092	0.20	0.092	**0.39**	**1.7**	0.15	**0.47**	0.18
Lead (Pb)	mg/L	0.0032 [h]	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0010	<0.0010	0.0052	<0.0010	0.0013	<0.0010	0.0012	<0.0010	<0.0010	<0.0015	0.0052	<0.0010	<0.0010	<0.0010
Magnesium (Mg)	mg/L	-	-	5.7	7.5	7.1	5.2	11	13	20	8.1	17	2.5	2.5	9.6	20	11	11	11
Manganese (Mn)	mg/L	1.0	-	0.030	0.032	0.036	0.13	0.027	0.017	0.028	0.019	0.036	0.0033	0.0033	0.036	0.13	0.025	0.048	0.024
Mercury (Hg)	mg/L	0.000026	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)	mg/L	0.073	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0016	<0.0010	<0.0010	<0.0010	<0.0010	<0.0011	0.0016	0.0023	0.0023	0.0024
Nickel (Ni)	mg/L	0.096 [h]	-	0.0012	<0.0010	0.0014	0.0015	<0.0010	0.0018	0.0032	<0.0010	<0.0010	<0.0010	<0.0010	0.0014	0.0032	<0.0010	0.0012	<0.0010
Potassium (K)	mg/L	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.1	<2.0	<2.0	<2.0	<2.0	<2.1	3.1	<2.0	<2.0	<2.0
Selenium (Se)	mg/L	0.0010	-	0.00026	0.00012	0.000079	0.00011	0.00051	0.00041	0.00015	0.00015	0.00025	0.000063	0.000063	0.00021	0.00051	0.00051	0.00050	0.00050
Silver (Ag)	mg/L	0.00025	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Sodium (Na)	mg/L	-	-	4.2	9.7	6.5	4.1	4.8	18	4.9	3.8	<2.0	3.0	<2.0	6.1	18	12	12	12
Thallium (Tl)	mg/L	0.00080	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin (Sn)	mg/L	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium (Ti)	mg/L	-	-	<0.010	<0.010	<0.010	0.032	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.012	0.032	<0.010	0.021	<0.010
Uranium (U)	mg/L	0.015	-	0.00033	0.00036	0.00039	<0.00020	0.00085	0.00082	0.00059	0.00070	0.00090	0.00030	<0.00020	0.00054	0.00090	0.00069	0.00070	0.00068
Vanadium (V)	mg/L	-	-	0.00073	0.0025	0.0011	0.0027	<0.00050	0.0014	0.00064	0.00070	<0.00050	<0.00050	<0.00050	0.0011	0.0027	0.00079	0.0013	0.00067
Zinc (Zn)	mg/L	0.030	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Bold text	Concentration greater than the lowest guideline or SSWQO.
🟧	Out reference range.

[b] Site-specific water quality objectives for Station W2 per the Minto Mine Water Use Licence. For metals, the SSWQO are applicable on a dissolved basis.

[c] If greater than 50% of samples were less than method detection limit than the mean was presented with a less than symbol.

[d] At temperature 10°C and pH 8.5; values that are inclusive of *in situ* temperature and pH data associated with these water samples (maximum temperature = 9.1°C, maximum pH = 8.32; see Appendix Table C.2).

[e] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[f] 30-day median ± 20% of median background concentration.

[g] At pH 8.5 (slightly conservative conditions).

[h] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[i] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[j] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

Table 4.2: Water Quality Data Collected during the Minto Mine EEM Phase 4, September 2016

Analyte	Units	Guidelines [a]	SSWQO [b]	Reference													Effluent-Exposed		
				REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10	Reference Minimum	Reference Mean [c]	Reference Maximum	UMC-1	UMC-2	UMC-3
Dissolved Metals																			
Aluminum (Al)	mg/L	-	0.10	0.031	0.034	0.020	0.05	0.009	0.012	0.018	0.02	0.009	0.023	0.0090	0.023	0.052	<0.0050	<0.0050	<0.0050
Antimony (Sb)	mg/L	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)	mg/L	-	0.0050	0.00051	<0.00050	<0.00050	<0.00050	<0.00050	0.00064	<0.00050	<0.00050	0.00098	<0.00050	<0.00050	<0.00056	0.00098	<0.00050	<0.00050	<0.00050
Barium (Ba)	mg/L	-	-	0.029	<0.020	0.063	0.043	0.046	0.035	0.052	0.075	0.055	0.029	<0.020	0.045	0.075	0.042	0.044	0.044
Beryllium (Be)	mg/L	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Boron (B)	mg/L	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)	mg/L	-	0.00021	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000056	<0.0000050	0.0000053	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000051	0.0000056	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	-	-	17	12	32	13	30	31	56	34	37	9.5	9.5	27	56	32	33	32
Chromium (Cr)	mg/L	-	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cobalt (Co)	mg/L	-	-	<0.00030	<0.00030	<0.00030	0.00048	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00032	0.00048	<0.00030	<0.00030	<0.00030
Copper (Cu)	mg/L	-	0.013 / 0.02 [j]	0.0016	0.0011	0.0014	0.0021	<0.0010	0.0011	0.0013	0.0014	<0.0010	<0.0010	<0.0010	0.0013	0.0021	0.0046	0.0047	0.0046
Iron (Fe)	mg/L	-	1.1	0.33	0.33	0.14	0.6	0.08	0.15	0.15	<0.030	0.056	0.04	<0.030	0.19	0.57	<0.030	<0.030	<0.030
Lead (Pb)	mg/L	-	0.0040	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0010	<0.0010	0.0051	<0.0010	0.0015	<0.0010	0.0014	<0.0010	<0.0010	0.0015	0.0051	<0.0010	<0.0010	<0.0010
Magnesium (Mg)	mg/L	-	-	5.0	6.7	6.5	4.5	10	12	18	7.6	15	2.3	2.3	8.7	18	10	10	10
Manganese (Mn)	mg/L	-	-	0.026	0.029	0.025	0.11	0.024	0.014	0.023	0.013	0.032	0.0021	0.0021	0.030	0.11	0.012	0.013	0.013
Mercury (Hg)	mg/L	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)	mg/L	-	0.073	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0016	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	0.0016	0.0022	0.0022	0.0022
Nickel (Ni)	mg/L	-	0.11	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0013	0.0028	<0.0010	<0.0010	<0.0010	<0.0010	0.0012	0.0028	<0.0010	<0.0010	<0.0010
Potassium (K)	mg/L	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.9	<2.0	<2.0	<2.0	<2.0	2.1	2.9	<2.0	<2.0	<2.0
Selenium (Se)	mg/L	-	0.0020	0.00026	0.00012	0.000077	0.00009	0.00046	0.00039	0.00014	0.00012	0.00026	0.00006	0.000060	0.00020	0.00046	0.00049	0.00052	0.00052
Silver (Ag)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Sodium (Na)	mg/L	-	-	4.1	9.5	6.3	3.9	4.6	17	4.7	3.6	<2.0	2.8	<2.0	5.9	17	11	12	12
Thallium (Tl)	mg/L	-	-	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Tin (Sn)	mg/L	-	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Titanium (Ti)	mg/L	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)	mg/L	-	-	0.00031	0.00033	0.00036	<0.00020	0.00079	0.00081	0.00057	0.00065	0.00088	0.00028	<0.00020	0.00052	0.00088	0.00064	0.00063	0.00064
Vanadium (V)	mg/L	-	-	0.00051	0.0019	0.0007	0.0009	<0.00050	0.0012	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00076	0.0019	<0.00050	<0.00050	<0.00050
Zinc (Zn)	mg/L	-	0.030	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

Bold text	Concentration greater than the lowest guideline or SSWQO.
🟧	Out reference range.

[a] Water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2017); blue text are BC Water Quality Guidelines (BCMOE 2017a,b).

[b] Site-specific water quality objectives for Station W2 per the Minto Mine Water Use Licence. For metals, the SSWQO are applicable on a dissolved basis.

[c] If greater than 50% of samples were less than method detection limit than the mean was presented with a less than symbol.

[d] At temperature 10°C and pH 8.5; values that are inclusive of *in situ* temperature and pH data associated with these water samples (maximum temperature = 9.1°C, maximum pH = 8.32; see Appendix Table C.2).

[e] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[f] 30-day median ± 20% of median background concentration.

[g] At pH 8.5 (slightly conservative conditions).

[h] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[i] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[j] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

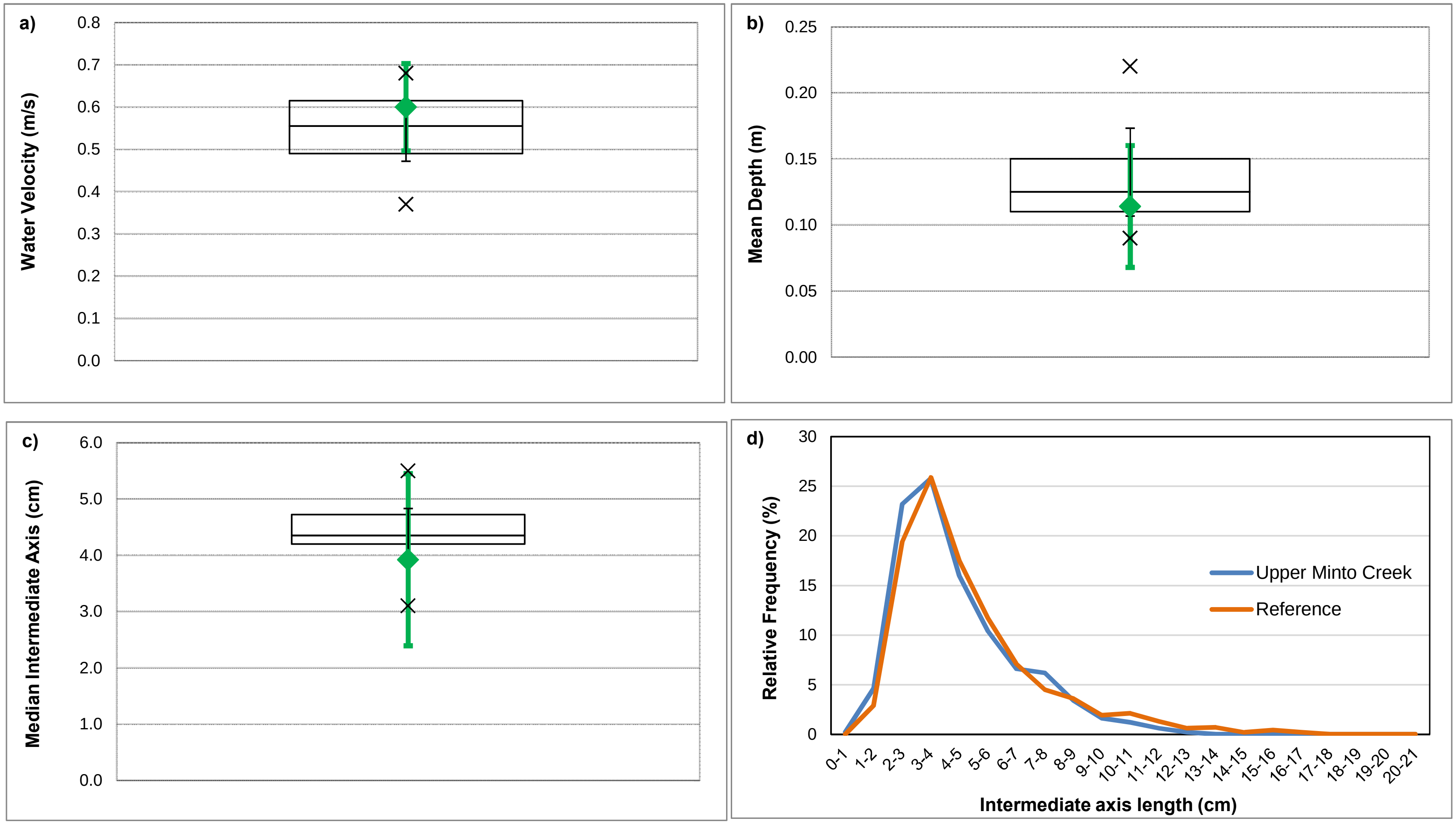


Figure 4.2: Additional Supporting Measures, Minto Mine Phase 4 EEM, September 2016 [a]

a - box-and-whisker plot of reference site data (n=10; quartiles, 95% confidence limits of the mean, minimum, maximum) in black. Mean and 95% confidence limits of effluent exposed sites in green.

Table 4.3: ***In situ*** **Water Quality Measures for the Fish Exposure Study, August 8 to September 22, 2016** [a].

Analyte	Statistic	Reference	E6 [b]	E3 [c]
Temperature (°C)	Mean	10.8	10.5	10.7
	Minimum	8.0	7.7	7.7
	Maximum	15.6	15.5	15.5
Dissolved Oxygen (mg/L)	Mean	8.48	9.37	9.19
	Minimum	6.09	5.94	5.94
	Maximum	12.20	15.56	15.56
pH (pH units)	Mean	7.37	7.33	7.36
	Minimum	6.45	6.71	6.71
	Maximum	8.29	8.01	8.01
Specific Conductance (µS/cm)	Mean	183	244	249
	Minimum	156	232	233
	Maximum	292	337	337
Ammonia (mg/L)	Mean	0.45	0.65	0.63
	Minimum	0.06	0.11	0.11
	Maximum	0.74	1.02	1.02

[a] based on a minimum of 94 measurements, with the exception of ammonia, which was based on a minimum of 43 measurements.

[b] E6 = 1 part effluent to 6 parts reference water.

[c] E3 = 1 part effluent to 3 parts reference water.

maintained at an average of 10.6 °C for the three groups, fluctuating between a minimum temperature of 7.7 °C and maximum temperature of 14.4 °C (Figure 4.3).

4.3.2 Analytical Laboratory Measures

A Data Quality Review (DQR) indicated that the laboratory analytical data collected as part of the fish exposures were of good quality and suitable for addressing the objectives of this study (Appendix B). Water quality of the exposure tanks confirmed the expected greater concentrations of mine-related analytes with greater effluent concentrations (Table 4.4; Appendix Table C.5). Of the analytes identified as elevated relative to reference in routine water quality monitoring or during the EEM benthic survey (conductivity, hardness, nitrate, phosphorus, aluminum, arsenic, copper, iron, molybdenum, and selenium), all except for aluminum and arsenic increased in proportion to effluent concentration (Table 4.4). Mean water quality of the exposure tanks met CWQGs and SSWQOs for all analytes except for ammonia, copper, and chromium (Table 4.4). Ammonia, which was elevated due to fish excretion rather than mine-effluent, was present at concentrations slightly greater than the SSWQO, and was higher in the 25% effluent exposure (E3) than in the 14% effluent exposure (E6) and the reference exposure (Table 4.4; Appendix Table C.5). However, although average ammonia concentrations were greater than the conservative CWQG used to screen mean concentrations (based on the highest individual temperature and pH values observed through the exposures), no ammonia concentrations exceeded CWQG based on concurrent temperature and pH values (Appendix Table C.5).

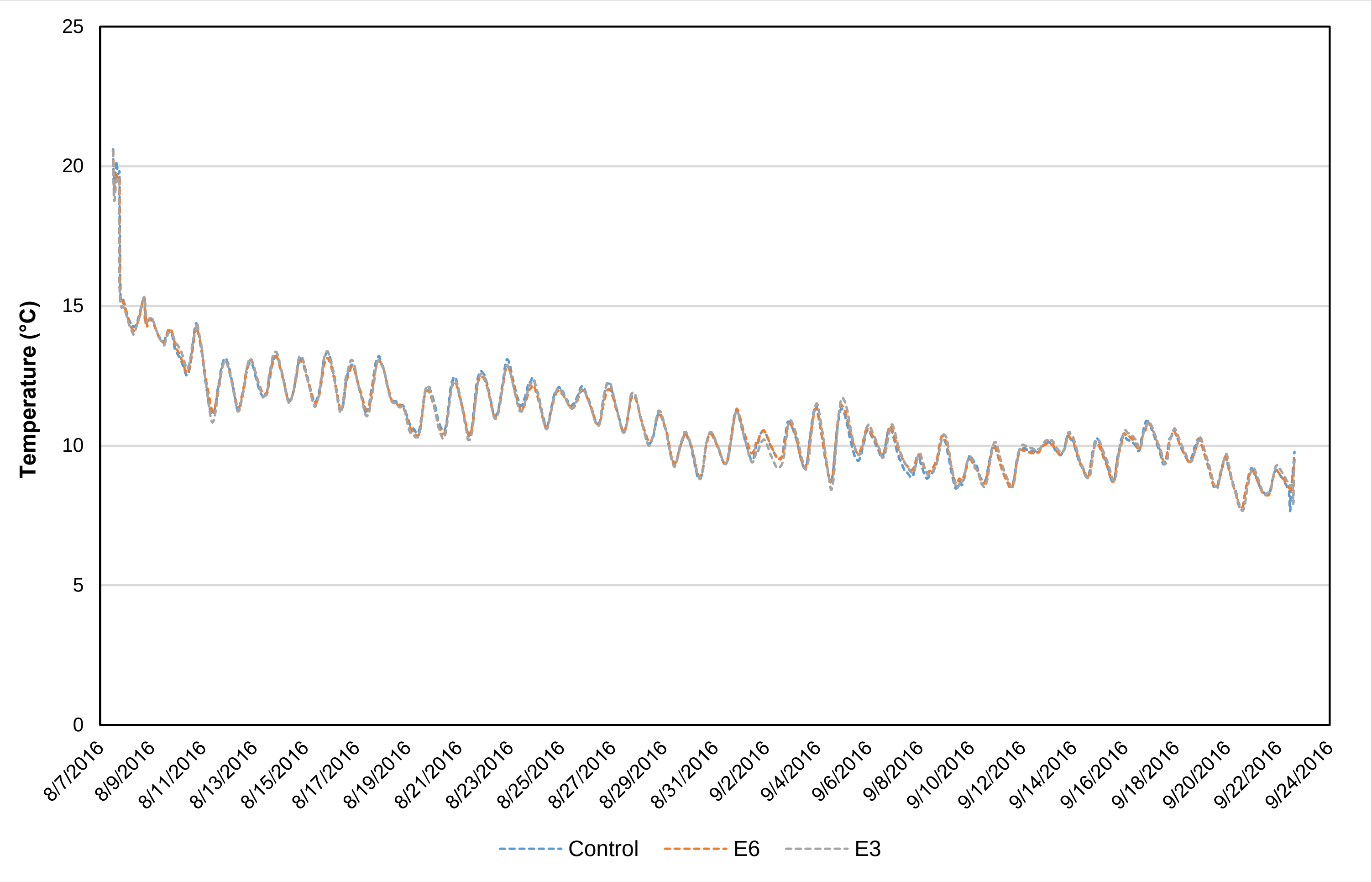


Figure 4.3: Water Temperature in the Fish Exposure Tanks, August 7 to September 22, 2016

Table 4.4: Mean Water Quality during the Minto Mine EEM Phase 4 Fish Exposure Study, August 7 to September 22, 2016

Analyte	Units	Guideline [a]	SSWQO	Reference	E6	E3
Physical						
Water Temperature	°C	-	-	11	11	11
Specific Conductance	µS/cm	-	-	177	228	256
Cond-F	µS/cm	-	-	159	191	205
Cond-L	µS/cm	-	-	178	224	250
Dissolved Oxygen	mg/L	> 6.5	-	8.6	8.6	9.0
Dissolved Oxygen	%	-	-	78	77	81
pH-F	pH units	6.5 - 9.0	6.0 - 9.0	7.51	7.46	7.37
pH-L	pH units			7.82	7.88	7.86
Ions, Nutrients and Solids						
Dissolved Hardness	mg/L	-	-	83	103	118
Alkalinity	mg/L	-	-	78	90	98
Sulphate	mg/L	309 [b]	-	11	18	23
Chloride	mg/L	120	-	<4.1	5.2	4.9
Ammonia (as N)	mg/L	0.20 [c]	0.25	0.33	0.33	0.50
Nitrite (as N)	mg/L	0.060	0.060	<0.001	0.0055	0.011
Nitrate (as N)	mg/L	3.0	9.1	<0.065	0.85	1.4
Total Suspended Solids	mg/L	narrative [d]	-	<3.2	3.9	<4.6
Total Dissolved Solids	mg/L	-	-	97	126	145
Total Metals						
Aluminum (Al)	mg/L	0.10 [e]	-	0.066	0.067	0.068
Antimony (Sb)	mg/L	0.0090	-	0.000113	0.000101	0.000100
Arsenic (As)	mg/L	0.0050	-	0.00076	0.00072	0.00074
Barium (Ba)	mg/L	-	-	0.042	0.047	0.049
Beryllium (Be)	mg/L	-	-	<0.00002	<0.00002	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.00005	<0.00005	<0.00005
Boron (B)	mg/L	1.5	-	<0.01	0.0104	0.015
Cadmium (Cd)	mg/L	0.00016 [b]	-	0.0000084	0.0000094	0.000011
Calcium (Ca)	mg/L	-	-	23	29	33
Chromium (Cr)	mg/L	0.0010 / 0.0090 [f]	-	0.00028	0.00026	0.0015
Cobalt (Co)	mg/L	0.0040	-	<0.00011	<0.00011	<0.00011
Copper (Cu)	mg/L	0.0024 [b]	-	0.0021	0.0053	0.0077
Iron (Fe)	mg/L	0.30	-	0.13	0.14	0.15
Lead (Pb)	mg/L	0.0032 [b]	-	0.00013	0.00016	0.00015
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0010
Magnesium (Mg)	mg/L	-	-	6.0	7.5	8.5
Manganese (Mn)	mg/L	1.0	-	0.0067	0.014	0.019
Mercury (Hg)	mg/L	0.000026	-	<0.000005	<0.000005	<0.000005
Molybdenum (Mo)	mg/L	0.073	-	0.0014	0.0019	0.0022
Nickel (Ni)	mg/L	0.096 [b]	-	0.00073	0.00077	0.00089
Phosphorus (P)	mg/L	-	-	0.074	0.088	0.12
Potassium (K)	mg/L	-	-	1.0	1.5	1.7
Selenium (Se)	mg/L	0.0010	-	0.00015	0.00035	0.00046
Silicon (Si)	mg/L	-	-	3.8	3.7	3.5
Silver (Ag)	mg/L	0.00025	-	<0.00001	<0.00001	<0.00001
Sodium (Na)	mg/L	-	-	4.2	6.1	7.2
Strontium (Sr)	mg/L	-	-	0.15	0.23	0.27
Sulphur (S)	mg/L	-	-	3.9	6.7	8.3
Thallium (Tl)	mg/L	0.00080	-	<0.00001	<0.00001	<0.00001
Tin (Sn)	mg/L	-	-	<0.0001	<0.0001	<0.0001
Titanium (Ti)	mg/L	-	-	0.0023	0.0022	0.0023
Uranium (U)	mg/L	0.015	-	0.0011	0.0012	0.0012
Vanadium (V)	mg/L	-	-	0.00076	0.00075	0.00073
Zinc (Zn)	mg/L	0.030	-	0.0061	0.010	0.013
Zirconium (Ze)	mg/L	-	-	<0.0003	<0.0003	<0.0003
Dissolved Metals						
Aluminum (Al)	mg/L	-	0.10	0.014	0.016	0.014
Antimony (Sb)	mg/L	-	-	<0.0001	<0.0001	<0.0001
Arsenic (As)	mg/L	-	0.0050	0.00059	0.00056	0.00054
Barium (Ba)	mg/L	-	-	0.041	0.046	0.049
Beryllium (Be)	mg/L	-	-	<0.00002	<0.00002	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.00005	<0.00005	<0.00005
Boron (B)	mg/L	-	-	<0.01	<0.010	0.014
Cadmium (Cd)	mg/L	-	0.00021	0.0000060	0.0000063	0.0000065
Calcium (Ca)	mg/L	-	-	24	29	33
Chromium (Cr)	mg/L	-	0.0010	0.00014	0.00012	0.00013
Cobalt (Co)	mg/L	-	-	<0.00010	<0.00010	<0.00010
Copper (Cu)	mg/L	-	0.013 / 0.02 [h]	0.0013	0.0042	0.0059
Iron (Fe)	mg/L	-	1.1	0.029	0.031	0.030
Lead (Pb)	mg/L	-	0.0040	<0.000052	<0.000053	<0.000050
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0013
Magnesium (Mg)	mg/L	-	-	6.0	7.4	8.4
Manganese (Mn)	mg/L	-	-	0.0021	0.0047	0.0051
Mercury (Hg)	mg/L	-	-	<0.000005	<0.000005	<0.000005
Molybdenum (Mo)	mg/L	-	0.073	0.0013	0.0017	0.0021
Nickel (Ni)	mg/L	-	0.11	0.00058	0.00055	0.00061
Phosphorus (P)	mg/L	-	-	0.056	<0.056	0.089
Potassium (K)	mg/L	-	-	0.99	1.4	1.7
Selenium (Se)	mg/L	-	0.0020	0.00013	0.00034	0.00049
Silicon (Si)	mg/L	-	-	3.7	3.5	3.4
Silver (Ag)	mg/L	-	0.00010	<0.00001	<0.00001	<0.00001
Sodium (Na)	mg/L	-	-	4.1	5.9	7.1
Strontium (Sr)	mg/L	-	-	0.15	0.22	0.28
Sulphur (S)	mg/L	-	-	3.7	6.3	8.1
Thallium (Tl)	mg/L	-	-	<0.00001	<0.00001	<0.00001
Tin (Sn)	mg/L	-	-	<0.0001	<0.0001	<0.0001
Titanium (Ti)	mg/L	-	-	<0.00032	<0.00038	<0.00031
Uranium (U)	mg/L	-	-	0.0011	0.0011	0.0011
Vanadium (V)	mg/L	-	-	<0.00052	<0.00051	<0.00050
Zinc (Zn)	mg/L	-	0.030	0.0050	0.0082	0.011
Zirconium (Ze)	mg/L	-	-	<0.0003	<0.0003	<0.0003

Notes: Means are represented with a "<" symbol if greater than 50% of data used in their calculation were below the Method Detection Limit (MDL).

▨ Mean concentration greater than the lowest guideline or SSWQO (lower in the case of dissolved oxygen, or outside the guideline or SSWQO range in the case of pH).

[a] Water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2017); blue text are BC Water Quality Guidelines (BCMOE 2017a,b). Guideline for dissolved oxygen is for "Other life stages" of coldwater biota.

[b] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[c] At temperature 10°C and pH 8.5; values that are inclusive of all *in situ* temperature and pH data associated with these water samples (maximum temperature = 14.5°C, maximum pH = 8.28; see Appendix Table C.4).

[d] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[e] At pH 8.5 (slightly conservative conditions).

[f] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[g] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

5 BENTHIC INVERTEBRATE COMMUNITY

Benthic invertebrate community samples were collected at five upper Minto Creek effluent-exposed sites and 10 reference sites (Figure 2.1). The effluent-exposed sites were evaluated relative to reference using a Reference Condition Approach (RCA). At the request of ECCC, the effluent-exposed area mean was also evaluated using a Control-Impact (CI) approach[3]. All benthic invertebrate samples were collected using a Surber sampler outfitted with a 500-µm mesh net. In the laboratory, samples were identified and enumerated to the lowest practical level; however, this evaluation is based on family level taxonomic results (Appendix Tables D.1 to D.4). Benthic invertebrate community data were subject to a Data Quality Review and were of good quality (Appendix B).

5.1 Primary EEM Metrics

The benthic invertebrate community of the mine-exposed sites on upper Minto Creek was compared to the reference condition (defined by 10 reference sites) for the four primary EEM metrics: density, taxon richness, Simpson's evenness, and Bray-Curtis (BC) distance. All effluent exposed sites (UMC-1 to UMC-5) were within reference condition (ncP > 0.9) for all four primary metrics (Figure 5.1; Appendix Table D.5; Appendix Figure D.1). Based on CI comparison, mean density at the effluent-exposed area (990 organisms/m^2) was lower than the reference mean (2,671 organisms/m^2), whereas mean taxon richness, Simpson's evenness, and Bray-Curtis (BC) distance did not differ significantly from the reference mean (Table 5.1; Figure 5.2; Appendix Table D.6). Despite statistical significance, the difference in density was modest (-1.2 standard deviations) and below the ±2 standard deviation Critical Effect Size (CES[4]) for benthic invertebrate density.

5.2 Community Composition

The average reference community was composed of 45% Chironomidae (non-biting midge larvae), 39% EPT taxa (Ephemeroptera, Plecoptera, and Trichoptera or mayflies, stoneflies, and caddisflies), 11% Diptera (true flies) excluding Chironomidae, and 4% oligochaetae (worms; Figure 5.3; Appendix Table D.4). Proportions of Chironomidae and EPT were within reference condition (ncP > 0.9) at all effluent-exposed sites except for UMC-4 which had a slightly lower proportion of EPT taxa than the other effluent-exposed sites and was within a range that was inconclusive with respect to potential difference from reference condition (i.e., 0.1<nCP<0.9;

---

[3] It is noted that this requested comparison assumes that within-area variability (upper Minto Creek) and among-area variability (reference sites) are comparable, which may not be true.

[4] The critical effect size is a threshold above which an effect may be indicative of a higher risk to the environment (Environment Canada 2012).

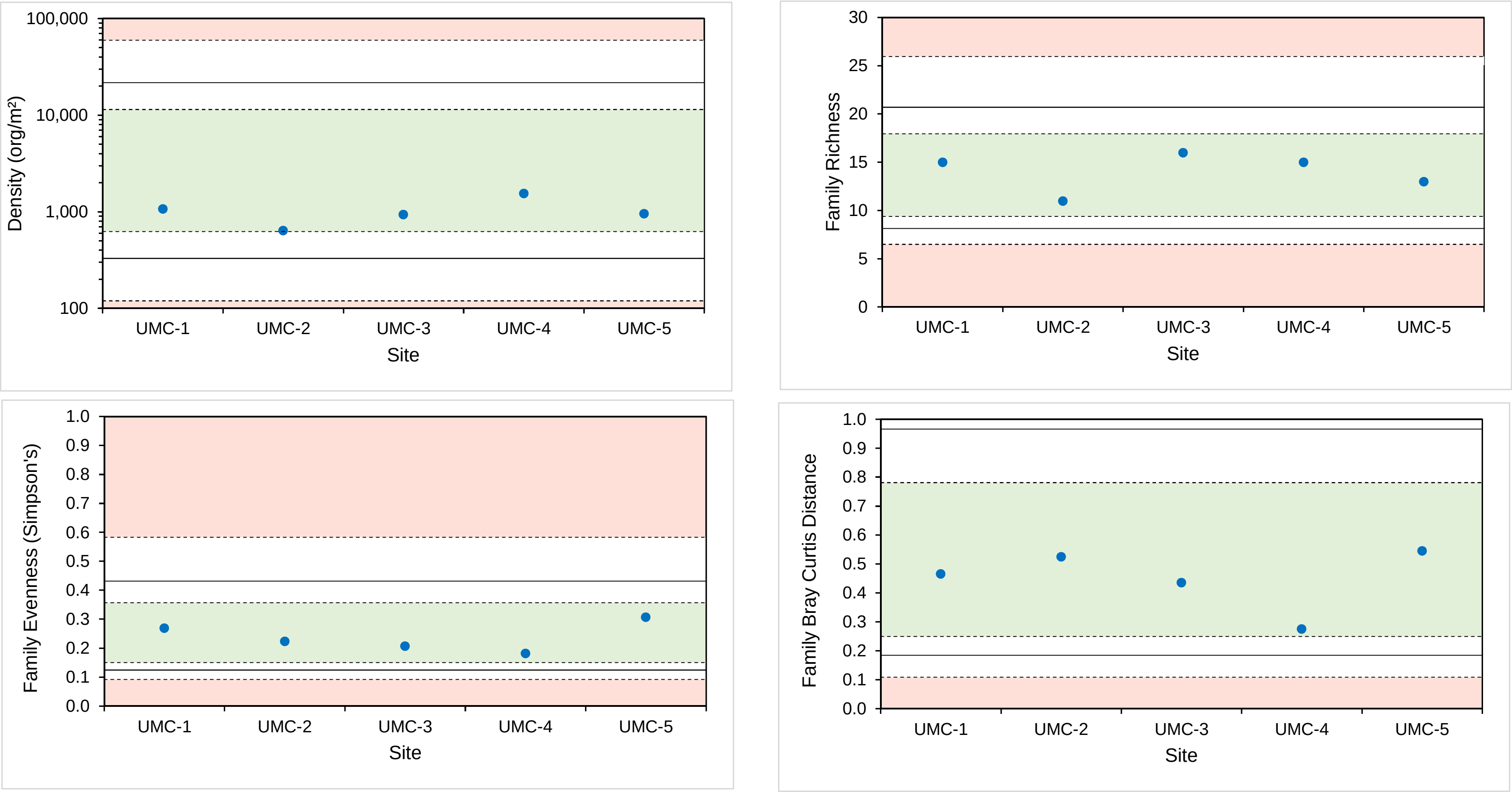


Figure 5.1: Individual Value Plot of Primary EEM Benthic Invertebrate Community Endpoints for Exposed Sites (n = 5) Relative to the Reference Condition (n = 10), September 2016

Notes: solid lines = 2.5th and 97.5th percentiles, dashed lines = 90% confidence limits on the percentiles.

green shading = within reference condition; pink shading = out of reference condition; no shading = inconclusive

Table 5.1: Summary of Statistical Comparisons in Benthic Invertebrate Community Endpoints between Reference (n = 10) and Exposed (n = 5) Sites, 2016

Endpoint	Data Transformation	Test	Test P-value	Mean or Median[1]		Observed ES[2] (Exposed - Reference)/SD
				Reference	Exposed	
Density	log	T	0.059	2,671	990	-1.2
Family Richness	log	T	0.567	13	14	0.33
Family Evenness (Simpson's)	log	T	0.955	0.23	0.23	0.033
Family BC Distance	square root	T	0.795	0.47	0.44	-0.15
% EPT	fourth root	Tunequal	0.009	37	22	-1.3
% Ephemeroptera	log(X+1)	T	0.942	9.8	10	0.042
% Plecoptera	log	Tunequal	0.018	17	8.2	-1.2
% Trichoptera	fourth root	Tunequal	0.019	0.5	4.30	1.1
% Chironomidae	none	T	0.451	45	51	0.44
% Diptera (excluding Chironomidae)	fourth root	Tunequal	0.746	9.1	9.9	0.14
% Oligochaeta	fourth root	T	0.006	2.8	14.0	1.9

▨ P-value < 0.1.

[1] For transformed data, the mean was calculated on the transformed scale, and back-transformed to original data units; the median is reported for the Mann-Whitney test.

[2] The observed effect size is calculated on the transformed scale when the data were transformed for analysis. An effect size is not reported with the data were analyzed using the Mann-Whitney test.

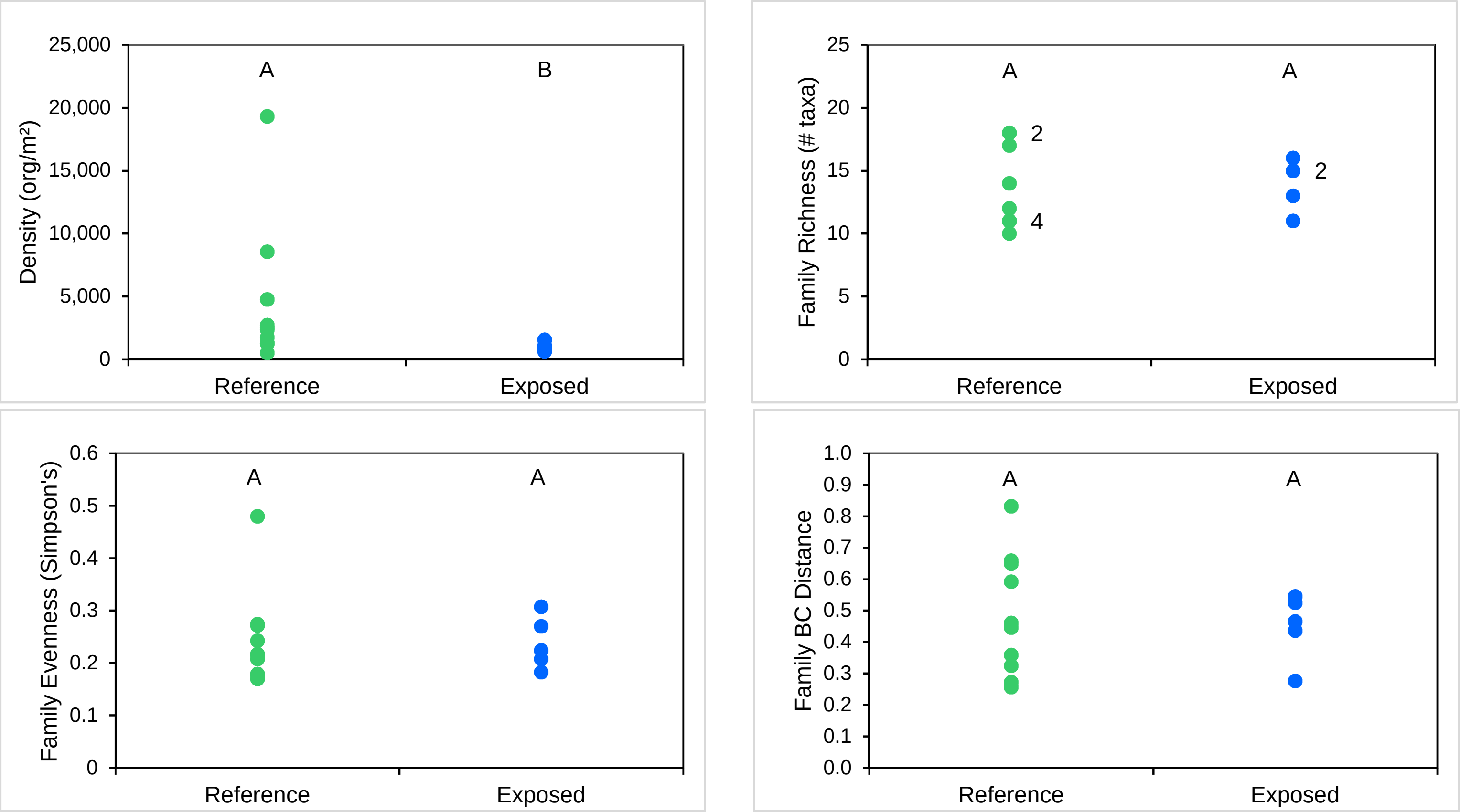


Figure 5.2: **Individual Value Plot of Primary EEM Benthic Invertebrate Community Endpoints for Reference (n = 10) and Exposed (n = 5) Sites, 2016**

Notes: The letter B above the exposed group indicates a significant difference relative to reference (A) α = 0.1. The letter A above the exposed group indicates no significant difference relative to reference (A) α = 0.1.

Numbers next to individual points represent the number of overlapping points at that value.

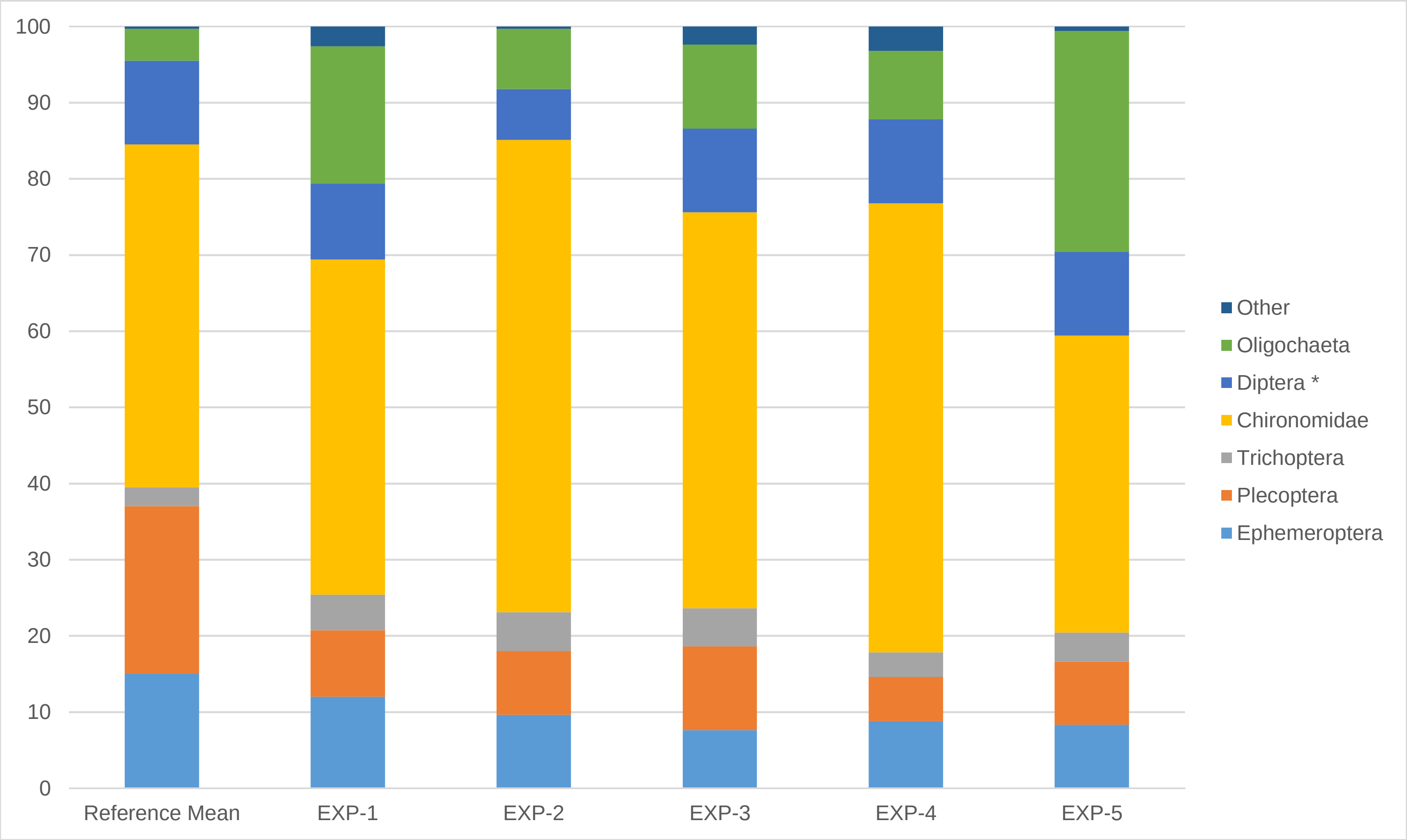


Figure 5.3: **Benthic Invertebrate Community Composition of Reference (mean; n=10) and Effluent-Exposed Sites**

* Diptera excluding Chironomidae.

Figure 5.4; Appendix Figure D.1). Proportions of Ephemeroptera, Plecoptera, and Trichoptera, evaluated individually, were within reference condition at all effluent-exposed sites (Figure 5.4; Appendix Table D.5). Similarly, the proportion of Diptera (excluding Chironomidae) was within reference condition at all effluent-exposed sites (Figure 5.4). The proportion of oligochaetes (worms) was in reference condition at two of the five effluent-exposed sites, and at the remaining three (UMC-1, UMC-3, and UMC-5), was within a range that was inconclusive with respect to potential difference from reference condition (i.e., 0.1<nCP<0.9; Figure 5.4).

Based on CI comparison, the effluent-exposed area differed significantly from reference on the basis of lower mean relative abundances of EPT taxa and Plecoptera, and higher mean relative abundances of Trichoptera and oligochaetes (Table 5.1; Figure 5.5; Appendix Figure D.2). Effect sizes associated with these significant differences were modest in all cases (from 1.3 to 1.9 reference standard deviations; Table 5.1). Ephemeroptera, Plecoptera, and Trichoptera are generally considered to be sensitive taxa (e.g., Kiffney and Clements 1994; Resh et al. 1996; Rosenberg and Resh 1996; Taylor and Bailey 1997; Barbour et al. 1999; Mandaville 2002) and oligochaetes are typically considered to be tolerant taxa (e.g., Chapman et al. 1982; Taylor and Bailey 1997; Barbour et al. 1999; Mandaville 2002). The lower abundance of Plecoptera (stoneflies) at the effluent-exposed area was associated with the absence of the families *Leuctridae*, *Perlodidae*, and *Taeniopterygidae*, and the notably lower abundance of *Nemouridae* (Appendix Table D.2). All of these stoneflies are considered pollution sensitive (Resh et al. 1996). The greater abundance of Trichoptera at the effluent-exposed area was associated with *Lemnephilidae* (Appendix Table D.2), which are also considered to be pollution sensitive (Resh et al. 1996; Barbour et al. 1999). Lastly, the greater abundance of oligochaetes at the effluent-exposed area was associated with *Lumbriculidae* (Appendix Table D.2), which are considered to be pollution tolerant (Barbour et al. 1999; Bode et al. 2002). Symmetric representation of Correspondence Analysis (CA) results confirm the association of *Lumbriculidae* with effluent-exposed sites and the lack of association of *Nemouridae* with effluent-exposed sites (Appendix Figure D.3).

5.3 Correlation Analysis

Correlation analysis was applied to evaluate potential causes of differences in effluent-exposed and reference benthic invertebrate communities. Correlations included all *in situ* measures of water and habitat quality, water quality analytes identified as elevated at effluent-exposed sites relative to reference (Section 4), and other supporting water quality and habitat data. The latter (other supporting water quality and habitat data) were first reduced by Principal Component Analysis (PCA) to extract the main gradients of site separation (Appendix Tables D.7 to D.11; Appendix Figures D.4 and D.5). Consideration of the benthic invertebrate community metrics that

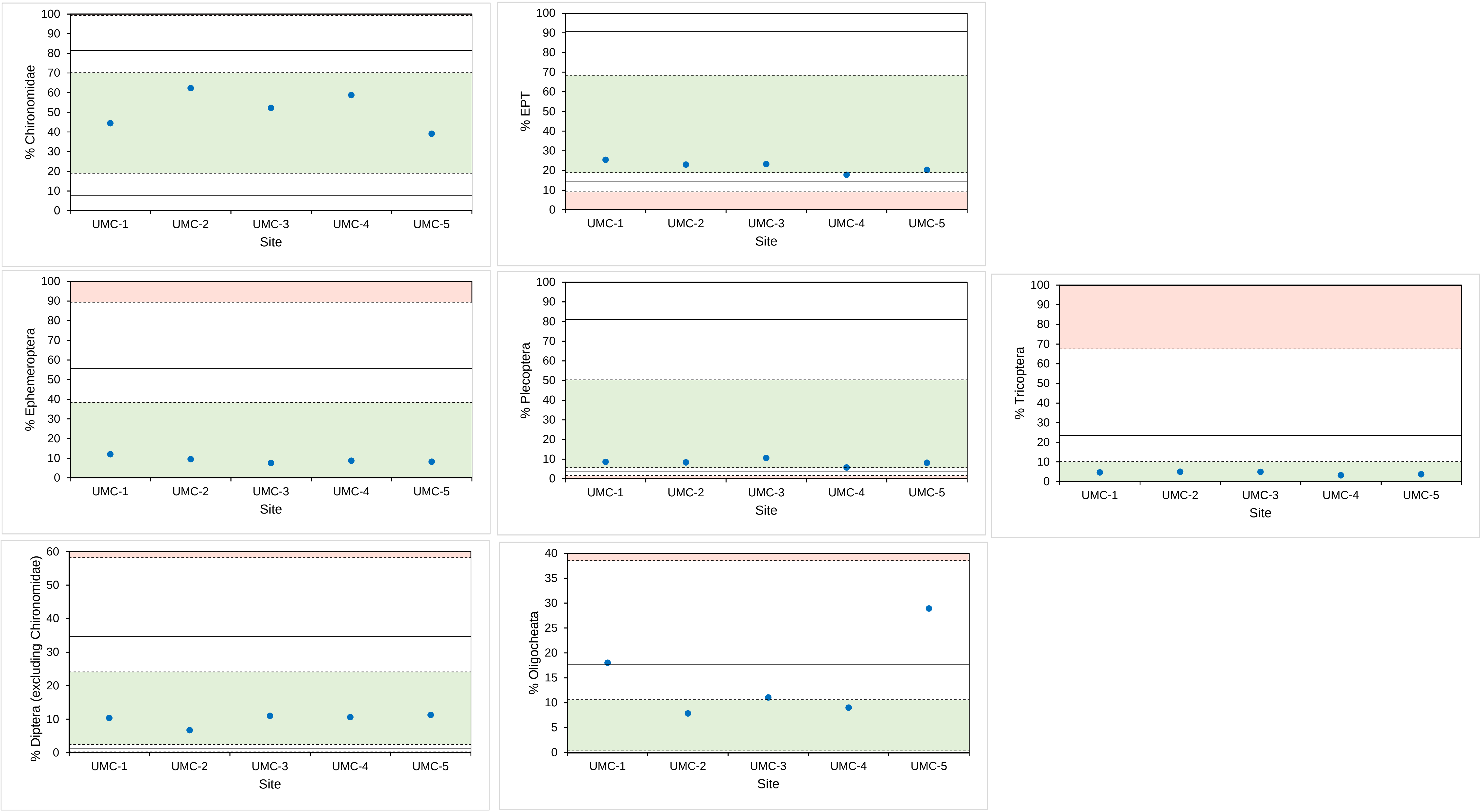


Figure 5.4: Individual Value Plot of Benthic Invertebrate Community Taxon Proportions for Exposed Sites (n = 5), Relative to the Reference Condition (n = 10), September 2016

Notes: solid lines = 2.5th and 97.5th percentiles, dashed lines = 90% confidence limits on the percentiles.
green shading = within reference condition; pink shading = out of reference condition; no shading = inconclusive

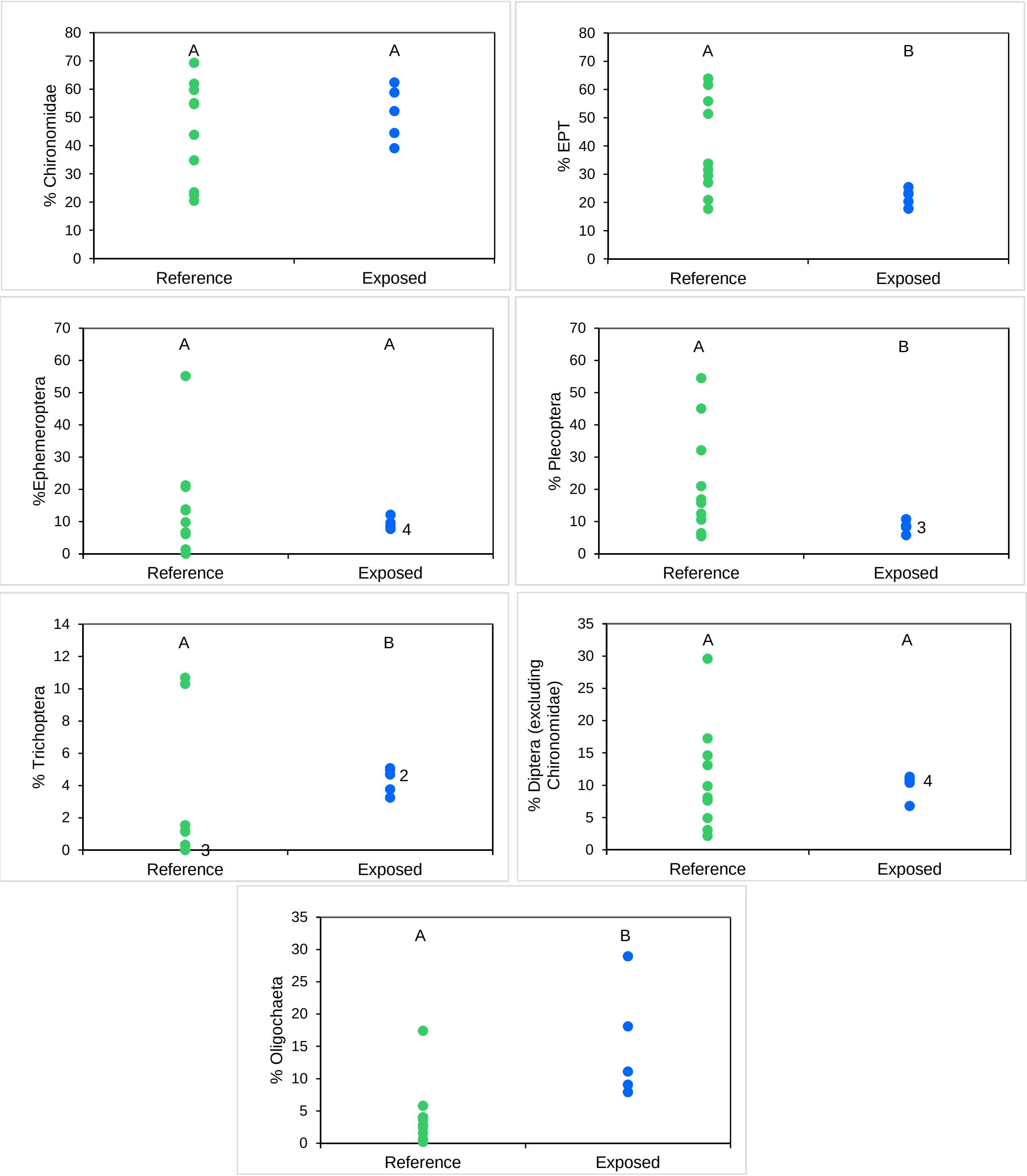


Figure 5.5: **Individual Value Plot of Benthic Invertebrate Community Taxon Proportions for Reference (n = 10) and Exposed (n = 5) Sites, 2016**

Notes: The letter B above the exposed group indicates a significant difference relative to reference (A) α = 0.1. The letter A above the exposed group indicates no significant difference relative to reference (A) α = 0.1.
Numbers next to individual points represent the number of overlapping points at that value.

were either out of reference condition (none) or inconclusive with respect to reference condition (RCA), or had effluent-exposed area means that differed significantly from reference (CI comparison), indicated 12 statistically significant correlations at $p < 0.05$ and $r > 0.6$ (Table 5.2; correlations with all benthic invertebrate community metrics are provided in Appendix Table D.12). Benthic invertebrate density was positively related to median cobble size and negatively related to several analytes that were elevated in Minto Creek relative to reference (total Kjeldahl nitrogen, phosphorus, aluminum, copper, and water quality PC-2; Table 5.2; Appendix Figure D.6). The consistent negative correlations with water chemistry suggest a mine-related influence of benthic invertebrate density and one of the relationships (a negative relationship between density and total Kjeldahl nitrogen) was observed previously (Minnow 2015). In addition to the relationships with benthic invertebrate density, the proportion of Plecoptera (stoneflies) was negatively correlated with hardness and nitrate, the proportion of Trichoptera (caddisflies) was negatively correlated with dissolved oxygen and positively correlated with selenium, and the proportion of oligochaetes was negatively correlated with dissolved oxygen and positively correlated with copper (Table 5.2). Plots of these relationships are leveraged or inconsistent with typical response mechanisms (e.g., a decrease in Trichoptera would not be expected with increasing dissolved oxygen and an increase in Trichoptera would not be expected with increasing selenium concentration; Appendix Figure D.6). However, a negative relationship between dissolved oxygen and percent oligochaetes (Appendix Figure D.6) is a typical response (e.g., Chapman et al. 1982; Brinkhurst et al. 1983; Reynoldson 1987), and suggests that the greater proportion of oligochaetes observed at the effluent-exposed sites may be related to moderately lower dissolved oxygen than at the reference sites (which, in turn, may be related to the higher temperature at the effluent-exposed sites).

5.4 Summary and Comparison to Previous EEM

In summary, mine-exposed benthic invertebrate communities of upper Minto Creek were within reference condition for all four primary EEM metrics (density, taxon richness, Simpson's evenness, and BC distance). Evaluation by control-impact comparison indicated that mean taxon richness, mean Simpson's evenness, and mean BC distance did not differ from the reference mean, whereas mean density at effluent-exposed upper Minto Creek area was significantly lower than reference, but at a magnitude lower than the CES of ±2 standard deviations (which suggests that the difference may not be ecologically meaningful). Examination of taxon proportions indicated lower relative abundances of EPT taxa and Plecoptera, and higher relative abundances of Trichoptera and oligochaetes at effluent-exposed upper Minto Creek. As Plecoptera and Trichoptera are considered to be sensitive organisms, and oligochaetes are considered to be tolerant organisms, these results are equivocal with respect to a potential effluent-related influence. Correlation analysis indicated a negative relationship between benthic invertebrate

Table 5.2: Spearman Correlation of Benthic Invertebrate Endpoints vs. Principal Components Results, *In situ* Measures, and Water Quality Results, Minto Mine Phase 4 EEM, 2016

Endpoint		*In situ* Measures																Water Quality					
		Temperature (°C)		Specific Conductance (µs/cm)		Dissolved Oxygen (mg/L)		Dissolved Oxygen (%)		pH (pH units)		Water Velocity (m/s)		Mean Depth (m)		Median Intermediate Axis (cm)		Hardness (as CaCO3, mg/L)		Nitrate (as N, mg/L)		Total Kjeldahl Nitrogen (mg/L)	
		n=15		n=15		n=15		n=15		n=15		n=15		n=15		n=15		n=13		n=13		n=13	
		r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value
Density *		-0.453	0.090	-0.179	0.524	0.525	0.044	0.481	0.070	0.252	0.365	0.159	0.571	-0.052	0.853	0.652	0.008	-0.181	0.553	-0.514	0.072	-0.764	0.002
Relative Density	EPT (%) *	-0.397	0.142	-0.314	0.254	0.143	0.612	0.304	0.271	-0.118	0.675	-0.478	0.072	0.300	0.278	-0.122	0.664	-0.170	0.578	-0.492	0.087	-0.011	0.972
	Plecoptera (%) *	-0.288	0.297	-0.564	0.028	0.200	0.475	0.372	0.172	-0.341	0.213	0.007	0.980	-0.090	0.749	0.241	0.386	-0.632	0.021	-0.627	0.022	-0.060	0.845
	Trichoptera (%) *	0.199	0.476	0.043	0.879	-0.591	0.020	-0.782	<0.001	-0.425	0.114	0.223	0.425	-0.074	0.792	-0.249	0.370	0.000	1.000	0.357	0.231	-0.160	0.601
	Oligocheata (%) *	0.358	0.190	0.275	0.321	-0.554	0.032	-0.810	<0.001	-0.023	0.934	0.052	0.854	-0.213	0.446	-0.227	0.416	0.253	0.405	0.556	0.049	0.511	0.074

Endpoint		Water Quality (continued)														Principal Components							
		Total Phosphorus (mg/L)		Total Aluminum (mg/L)		Total Arsenic (mg/L)		Total Copper (mg/L)		Total Iron (mg/L)		Total Molybdenum (mg/L)		Total Selenium (mg/L)		Water Quality PC-1 (30.0%)		Water Quality PC-2 (23.7%)		Habitat PC-1 (45.0%)		Habitat PC-2 (28.0%)	
		n=13		n=13		n=13		n=13		n=13		n=13		n=13		n=13		n=13		n=14		n=14	
		r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value
Density		-0.847	<0.001	-0.604	0.029	0.025	0.935	-0.805	<0.001	-0.401	0.174	-0.599	0.031	-0.357	0.231	-0.220	0.471	-0.758	0.003	0.279	0.334	-0.495	0.072
Relative Density	EPT (%)	0.168	0.584	-0.495	0.086	0.442	0.131	-0.451	0.122	0.264	0.384	-0.424	0.149	0.011	0.972	0.110	0.721	-0.313	0.297	-0.244	0.401	0.130	0.659
	Plecoptera (%)	-0.050	0.872	0.011	0.972	0.147	0.631	-0.089	0.774	0.544	0.055	-0.326	0.277	-0.456	0.117	0.495	0.086	-0.434	0.138	0.200	0.493	-0.244	0.401
	Trichoptera (%)	0.058	0.850	-0.055	0.858	-0.387	0.191	0.120	0.697	-0.204	0.503	0.257	0.397	0.707	0.007	-0.243	0.424	-0.044	0.886	0.210	0.472	0.581	0.029
	Oligocheata (%)	0.501	0.081	0.544	0.055	-0.269	0.373	0.808	<0.001	0.027	0.929	0.575	0.040	0.484	0.094	0.071	0.817	0.571	0.041	-0.068	0.817	0.226	0.436

▨ statistically significant correlation at a p-value < 0.05.

🟦 strong relationship at r > 0.6 or r < -0.6.

* = benthic invertebrate community endpoint that was one or more of: 1) out of reference condition (no instances); 2) inconclusive with respect to the reference condition; and/or 3) statistically different from reference following the Control-Impact comparison.

Notes: All correlations were calculated using data < Method Detection Limit (MDL) at the MDL value. N = 13 for all analyses of water quality (n = 10 for reference, n = 3 for exposed). N = 14 for all habitat analyses (n = 9 for reference due to exclusion of REF-1 and n = 5 for the effluent-exposed area).

density and water quality, and a negative relationship between the proportion of oligochaetes and dissolved oxygen.

The results of the Phase 4 EEM, as evaluated using the RCA approach, were consistent with the result of the Phase 3 EEM (Minnow 2015). In Phase 3, two of three effluent exposed sites were within reference condition for all EEM effect metrics (density, taxon richness, Simpson's evenness, and BC distance), with the one remaining site having higher density than reference condition and a BC distance that could not be categorized as either within reference condition or out of reference condition (i.e., $0.1<nCP<0.9$). Thus, RCA analysis in two consecutive EEM Phases has indicated no effect. However, a supporting CI comparison in this study (Phase 4) suggested lower density at the effluent-exposed area, but this result was opposite from the apparent greater density observed at one of three sites evaluated by RCA in Phase 3. In terms of the supporting metrics, a greater proportion of Trichoptera and lower proportion of Plecoptera was observed in Phase 3 and in Phase 4, whereas other differences observed in Phases 3 and/or 4 (e.g., lower EPT taxa, more oligochaetes, and more diptera excluding chironomidae) were not consistent between phases. As Trichoptera and Plecoptera are both considered to be sensitive taxa, the opposite differences in their proportions (i.e., more Trichoptera and fewer Plecoptera) at effluent-exposed areas, as observed in successive EEM Phases, are equivocal with respect to an effluent-related influence.

6 SUPPORTING FIELD-BASED FISH STUDY

6.1 Fish Community

Fish sampling was conducted monthly during the Phase 4 EEM from June through September 2016 in order to verify fish presence, abundance, and life-stage in lower Minto Creek and to relate this information to the on-site laboratory study. The only fish species captured in lower Minto Creek was chinook salmon (*Oncorhynchus tsawytscha*), all captures (6 fish) occurred in September, and all were juveniles (Table 6.1). This result is consistent with results from previous EEM (Minnow and Access 2012) and confirms the limited usage of lower Minto Creek by fish and the fact that a conventional EEM fish survey was not practicable (e.g., a non-lethal survey requires 100 individuals from each exposed and reference area). No fish were captured upstream of a small cascade located approximately 1.2 km upstream of the Minto Creek confluence with the Yukon River (Figure 2.3), indicating that this structure continues to be a barrier to upstream fish movement in Minto Creek (Capstone 2017a). In lower Big Creek (reference), juvenile chinook salmon were captured in all months (June to September) and at higher catch-per-unit-effort (CPUE) than in lower Minto Creek (Table 6.1). Slimy sculpin (*Cottus cognatus*) were also captured in lower Big Creek at lower CPUE than juvenile chinook salmon, and only in June and July (Table 6.1).

6.2 Fish Population Data

Chinook salmon captured in lower Minto Creek in September 2016 were all 0+ fry. Mean fork length was 72.8 ± 9.5 mm and mean body weight was 4.73 ± 1.57 g, which was similar to those captured in lower Big Creek (Figure 6.1; Appendix Tables E.1 and E.2). No statistically significant differences were observed in fork length or body weight of the juvenile chinook salmon captured in lower Minto Creek and lower Big Creek in September 2016, and weight-length relationships overlapped (Figure 6.1).

Table 6.1: Summary of Minnow Trapping in Minto Creek (Exposed) and Big Creek (Reference) in 2016

A) Minto Creek

Month	Effort (trap-hours)	Effort(trap-days)	Juvenile Chinook Salmon (*Onchoryhnchus tshawytscha*)	
			Catch	CPUE [1]
June	424	17.7	0	0
July	391	16.3	0	0
August	424	17.7	0	0
September	424	17.7	6	0.339
Total	**1,663**	**69.4**	**6**	**0.085**

B) Big Creek

Month	Effort (trap-hours)	Effort(trap-days)	Juvenile Chinook Salmon (Onchoryhnchus tshawytscha)		Slimy Sculpin (*Cottus cognatus*)	
			Catch	CPUE [1]	Catch	CPUE [1]
June [2]	58	2.4	2	0.83	7	2.92
July	97	4.0	21	5.22	2	0.50
August	92	3.8	16	4.17	0	0
September	92	3.8	12	3.13	0	0
Total	**338**	**14**	**51**	**3.62**	**9**	**0.639**

[1] CPUE = fish/trap-day (for actual 24-hr period).

[2] Several small fish (10-25 mm in length) were observed near one of the minnow traps but not captured.

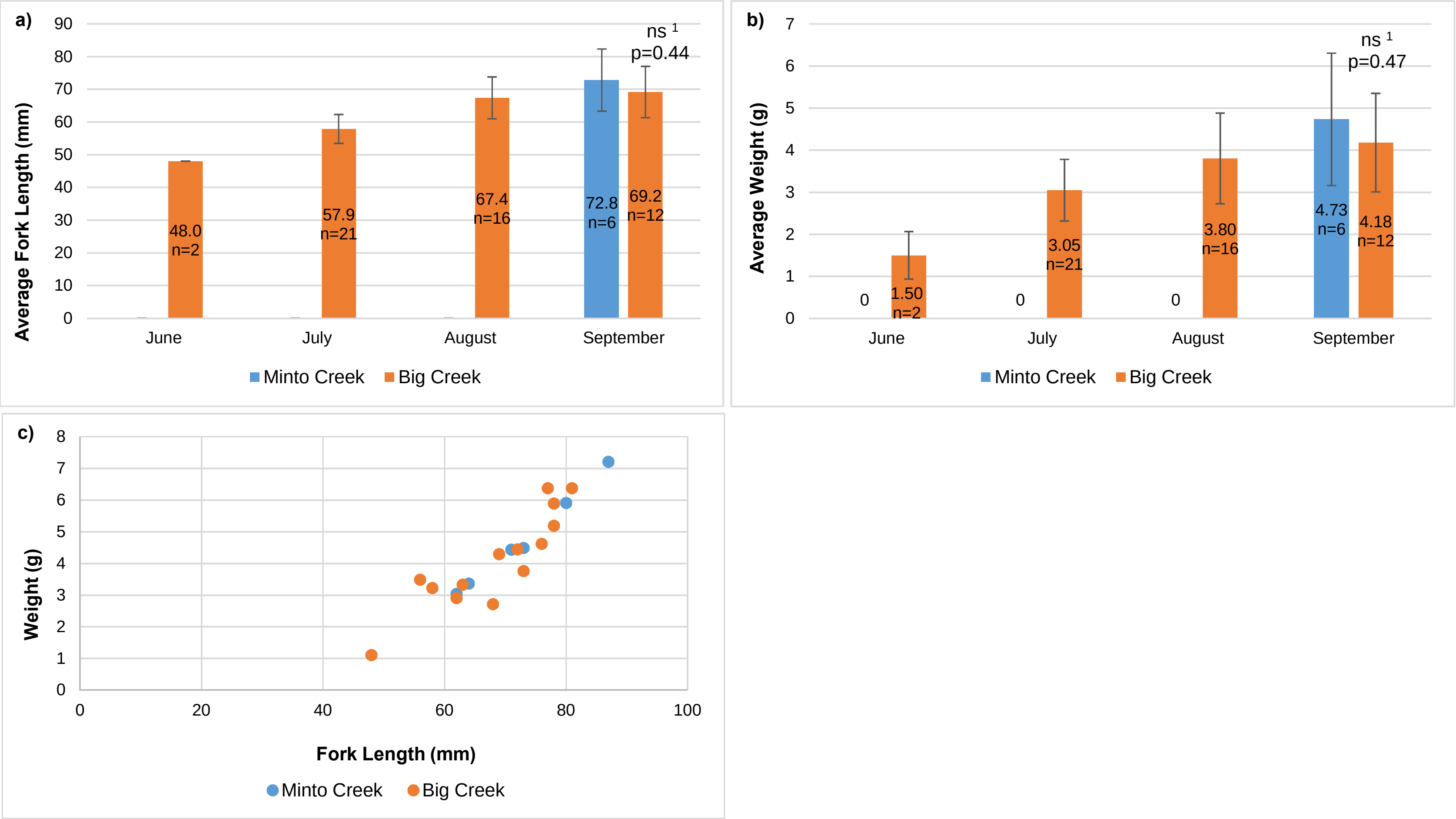


Figure 6.1: **Juvenile Chinook Salmon Meristic Data (mean ± standard deviation), June-September 2016. A) Mean Fork Length; B) Mean Body Weight; and C) Body Weight at Fork Length in September 2016.**

[1] ns = non-significant as determined by T-test following verification of normality and equal variance

7 LABORATORY FISH EXPOSURE STUDY

7.1 Fish Population Health

A total of 160 kokanee fry were used for each of the on-site laboratory exposures (reference water, E6 [14% effluent; one part effluent to 6 parts reference water], and E3 [25% effluent; one part effluent to 3 parts reference water]). Very few mortalities occurred over the course of the field laboratory exposure study. One mortality occurred in the reference group just prior to transport to site and another was recorded approximately two weeks after the study was initiated. No additional mortalities were observed in any of the groups. However, a small number of fish could not be accounted for at the end of the study (and presumably escaped over the side of the exposure vessel or down the stand-pipe to the sump). Thus, meristic data from a total of 153, 156, and 159 kokanee fry from reference, E6 and E3, respectively (Appendix Tables E.3 to E.6), were used for the analysis of population health.

No statistically significant differences between the fish assigned to the two exposure groups and reference were observed pre-exposure (Appendix Table E.7; Appendix Figures E.1 and E.2). At the termination of the exposure (Day 47), kokanee fry exposed to the highest effluent concentration (25% effluent) differed from the reference group on the basis of length-frequency distribution, with a slightly greater proportion of larger fish (Table 7.1; Figure 7.1). The maximum difference from reference was evident for fish with fork length of less than approximately 9.8 cm, which made up 17% less of the highest exposure group than reference. This is consistent with greater mean fork length and mean body weight of kokanee in the highest exposure group relative to reference (Table 7.1; Figure 7.2). Despite statistical significance, the differences in fork length and body weight were very small (1.6% and 6.9%, respectively; Table 7.1). Kokanee exposed to the lower effluent concentration (14% effluent) did not differ from reference on the basis of length-frequency distribution, mean fork length, or mean body weight (Table 7.1; Figure 7.1, and Figure 7.2). Condition (weight-at-length) differed from reference in both exposure groups, with the lower exposure group (14% effluent) having a slightly lower condition than reference and the higher exposure group (25% effluent) having a slightly greater condition than reference (Table 7.1; Figure 7.2). Despite statistical significance, the differences in condition were small (-2.7% and +2.3%, respectively) and were well below the 10% Critical Effect Size (CES[5]) for fish condition.

---

[5] The critical effect size is a threshold above which an effect may be indicative of a higher risk to the environment (Environment Canada 2012).

Table 7.1: Statistical Differences on Day 47 between Exposure and Reference Kokanee Used in the Hatchery Exposure, Minto Mine Phase 4 EEM, 2016

Indicator	Endpoint	Variables		Comparison	Sample Size		Test	ANCOVA Statistics			Summary Statistics			Test *P*-value	Magnitude of Difference Relative to Control (%)	Estimated Minimum Detectable Difference Between Groups (%) with α=β=0.1	
		Response	Covariate		Ref	Exp		Interaction *P*-value	Covariate *P*-value	Covariate Value for Comparisons [a]	Statistic	Ref	Exp			Decrease (%)	Increase (%)
Survival	Length Frequency Distribution	Fork Length (cm)	-	E6 vs. Ref	153	156	2-sample K-S	-	-	-	-	-	-	0.160	1.0 [b]	-	-
				E3 vs. Ref	153	159	2-sample K-S				-	-	-	0.024	-8.0 [b]	-	-
Energy Usage	Fork Length	Fork Length (cm)	-	E6 vs. Ref	153	156	T-test	-	-	-	Mean	9.59	9.61	0.709	-	-2.2	2.2
				E3 vs. Ref	153	159	T-test				Mean	9.59	9.75	0.005	1.6	-	-
	Body Weight	Body Weight (g)	-	E6 vs. Ref	153	156	T-test	-	-	-	Mean	8.56	8.36	0.162	-	-5.8	5.8
				E3 vs. Ref	153	159	T-test				Mean	8.56	9.15	<0.001	6.9	-	-
Energy Storage	Condition	Log10 [Body Weight (g)]	Log10 [Fork Length (cm)]	E6 vs. Ref	152 [c]	156	ANCOVA	0.490	<0.001	9.59	Adjusted Mean (Geometric)	8.47	8.24	<0.001	-2.7	-	-
				E3 vs. Ref	152 [c]	159	ANCOVA	0.614	<0.001	9.66	Adjusted Mean (Geometric)	8.65	8.84	<0.001	2.3	-	-

Notes:

▨ *P*-value < 0.05.

Bold text Magnitude of Difference > 25% (10% if compared to Condition).

[a] Mean for all data with outliers removed. For log-transformed data, the geometric mean is reported.

[b] Magnitude of difference is the largest difference (as a percentage) between the cumulative relative frequency distributions for the two sampling areas. A negative difference implies the exposure area has smaller fish compared to reference.

[c] One fish was identified as an outlier (Control Fish #90) with a Studentized residual of 4.847.

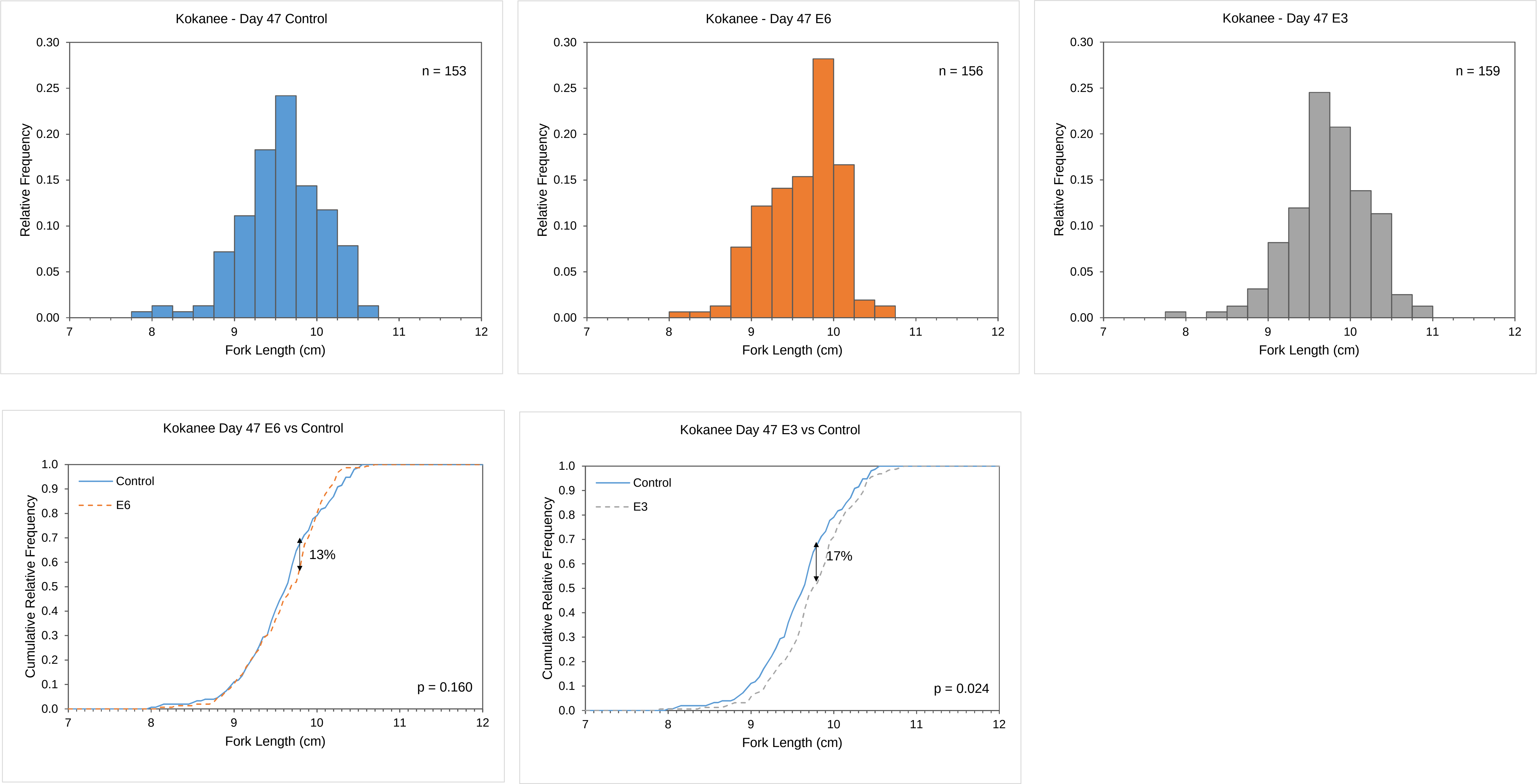


Figure 7.1: Length-frequency Distributions and Cumulative Length-frequency Distributions for Day 47 Kokanee in Control, E6, and E3 Treatments for Minto Mine Fish Hatchery Exposure, August 2016

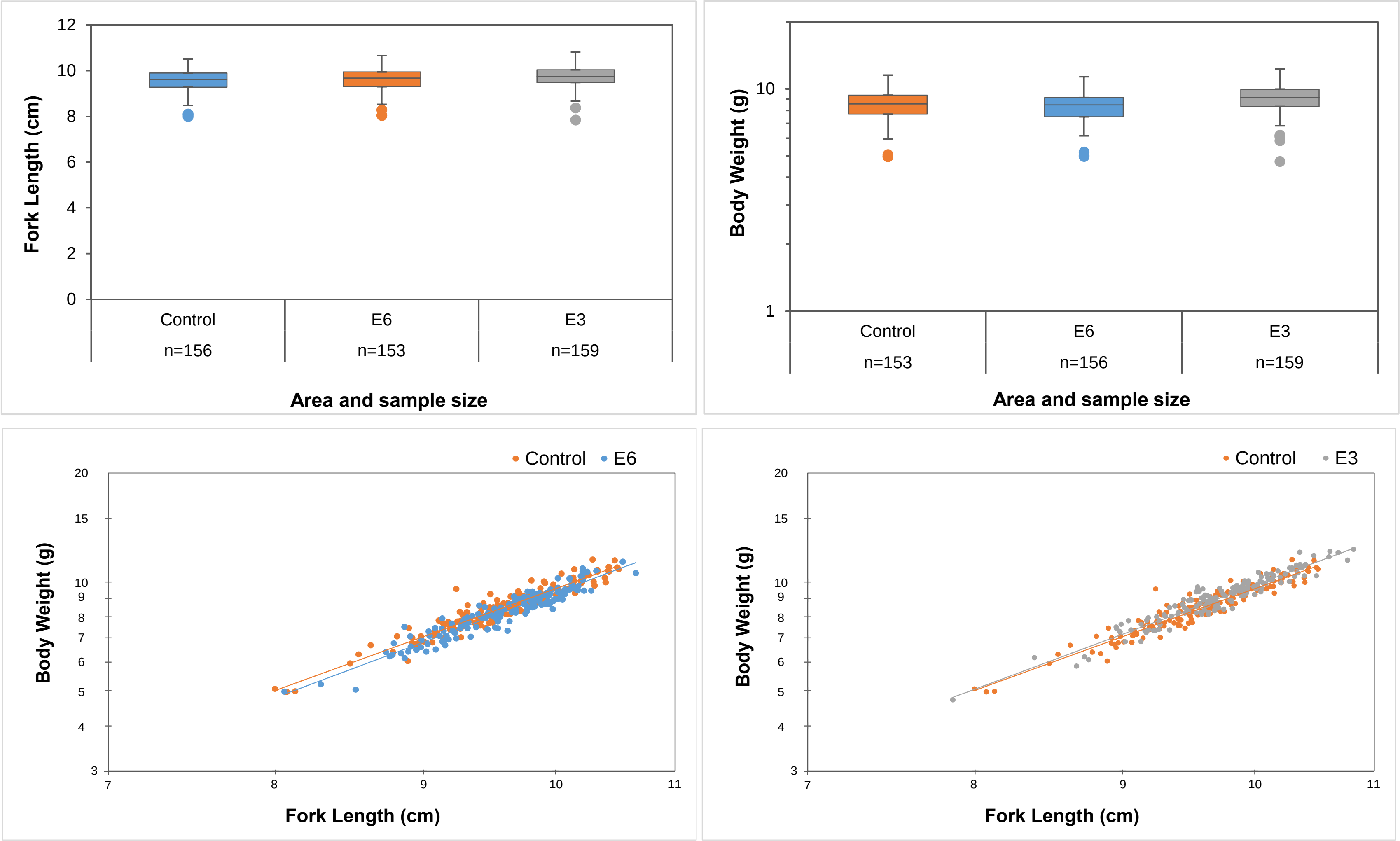


Figure 7.2: **Boxplots of Fork Length, Body Weight, and Regression (Body Weight on Fork Length) for Day 47 Kokanee in Control, E6, and E3 Treatments, Minto Mine Fish Hatchery Exposure, August 2016**

Note: Boxplots for body weight and regressions are plotted on a log scale.

7.2 Summary and Comparison to Previous EEM

In summary, the on-site laboratory exposure study indicated that fish exposed to the highest effluent concentration (25%) for 47 days were slightly larger and of better condition than those exposed to reference water. Fish exposed to the lower effluent concentration (14%) for 47 days did not differ on the basis of size, but had slightly lower condition than reference fish. In all cases, the magnitudes of the observed differences were very small, and were presumably detected due to the high power associated with large sample size (minimum 152 fish) and uniform fish size. In the case of the condition - the key effect endpoint evaluated in this fish survey - the magnitudes of difference (-2.7% and +2.3% for 14% effluent and 25% effluent, respectively) were well below the CES of 10%. These differences are therefore not considered to be ecologically meaningful.

The results of the Phase 4 EEM fish study were similar to those of the Phase 2 EEM fish study (no fish study was completed in association with the Phase 3 Investigation of Cause of differences in benthic invertebrate communities). Specifically, the Phase 2 fish study (hatchery-based exposure of juvenile chinook salmon) also documented slight increase in size (maximum 5%) and condition (maximum 3%) in association with effluent exposure. Thus, the difference in condition through two consecutive EEM Phases is a confirmed response, albeit at magnitudes well below the CES.

8 CONCLUSIONS

The Minto Mine Phase 4 EEM conducted between June and September 2016 provided sublethal toxicity testing of Minto Mine effluent, an assessment of the influence of Minto Mine effluent discharge on water chemistry and benthic invertebrate community condition of Minto Creek relative to reference sites, and an assessment of the controlled exposure of a sentinel fish (kokanee as a surrogate for chinook salmon) to Minto Mine effluent. Conclusions of this EEM, by monitoring component, are provided below.

Effluent sublethal toxicity tests conducted by the Minto Mine in 2015 and 2016 (data for 2017 have not yet been reported) showed no effects to rainbow trout embryos, the invertebrate *Ceriodaphnia dubia*, the green alga *Pseudokirchneriella subcapitata*, or the plant *Lemna minor*.

Routine water quality monitoring indicated an influence of the Minto Mine on Minto Creek evident in conductivity, hardness, nitrate, aluminum, arsenic, iron, and selenium that were greater than reference. Of these, concentrations of nitrate were most strongly associated with release of water from the water storage pond, but remained below the CWQG. Aluminum and arsenic had mean concentrations greater CWQG, but this occurred at both the effluent-exposed and reference stations. During the Phase 4 EEM benthic survey (in September 2016) water of upper Minto Creek had concentrations of nitrate, total Kjeldahl nitrogen, total phosphorus, copper, and molybdenum greater than the range of reference. Of these, only copper was present at a concentration greater than CWQG, but did not exceed the applicable SSWQO. Of the analytes identified as elevated relative to reference in routine water quality monitoring or during the EEM benthic survey (conductivity, hardness, nitrate, phosphorus, aluminum, arsenic, copper, iron, molybdenum, and selenium), all except for aluminum and arsenic increased in proportion to effluent concentration in the fish exposure vessels.

Mine-exposed benthic invertebrate communities of upper Minto Creek were within reference condition for all four primary EEM metrics (density, taxon richness, Simpson's evenness, and BC distance). Evaluation by control-impact comparison indicated that mean taxon richness, mean Simpson's evenness, and mean BC distance did not differ from the reference mean, whereas mean density of the effluent-exposed upper Minto Creek area was significantly lower than reference. The difference in density was at a magnitude of -1.2 standard deviations, which is below the CES of ±2 standard deviations and therefore may not be ecologically meaningful. Supplementary examination of taxon proportions indicated lower relative abundances of EPT taxa (Ephemereoptera, Plecoptera, and Trichoptera; mayflies, stoneflies, and caddisflies) at effluent-exposed upper Minto Creek than reference, which was primarily due to lower relative abundance of Plecoptera (individually), and also indicated higher relative abundances of Trichoptera and oligochaetes. As Plecoptera and Trichoptera are considered to be sensitive organisms and oligochaetes are considered to be tolerant organisms, these results are equivocal with respect to a potential effluent-related influence. Correlation analysis indicated negative relationships between benthic invertebrate density and water quality, and a negative relationship between the proportion of oligochaetes and dissolved oxygen.

The fish survey (an on-site laboratory exposure) indicated that fish exposed to the highest effluent concentration (25%) for 47 days were slightly larger and of better condition than those exposed to reference water. Fish exposed to a lower effluent concentration (14%) for 47 days did not differ on the basis of size, but had slightly lower condition than reference fish. In all cases, the magnitudes of the observed differences were very small, and were presumably detected due to the high power associated with large sample size (minimum 152 fish) and uniform fish size. In the case of the condition - the key effect endpoint evaluated in this fish survey - the magnitudes of difference (-2.7% and +2.3% for 14% effluent and 25% effluent, respectively) were well below the CES of 10%. These differences are therefore not considered to be ecologically meaningful.

The results of the Phase 4 EEM were generally consistent with those of the previous EEM (i.e., the Phase 3 benthic invertebrate community survey and the Phase 2 fish survey). Specifically, the results of the Phase 4 EEM benthic invertebrate community survey were consistent with the results of the Phase 3 EEM - RCA analysis in two consecutive EEM Phases has indicated no effect. A supporting CI comparison in this study (Phase 4) suggested lower density at the effluent-exposed area, but this result was opposite from the apparent greater density observed at one of three sites evaluated by RCA in Phase 3. The results of the Phase 4 EEM fish study were similar to those of the Phase 2 EEM fish study (no fish study was completed in association with the Phase 3 Investigation of Cause study of differences in benthic invertebrate communities). These two consecutive EEM Phases have indicated slightly greater fish size and condition associated with effluent exposure. However, the associated magnitudes of difference for the EEM-effect endpoint (condition) was less than 3%, well below the CES of 10%.

Based on the findings of the Phase 4 EEM and the prescribed EEM frequency under the MMER, the Minto Mine will be required to submit a fifth EEM interpretive report in three years (January 10th 2021). A Phase 5 EEM Study Design, informed by the results of this Phase 4 EEM, must be submitted to Environment and Climate Change Canada (ECCC) no later than six months prior to implementing field collections in 2019 or 2020. Under the current EEM framework (Environment Canada 2012), the next phase of biological monitoring (Phase 5) will require an investigation of confirmed effects to fish. However, proposed amendments to the MMER (ECCC 2016; Government of Canada 2017b) could alter the framework, particularly in cases where observed differences are below applicable CES as observed in this Minto Phase 4 EEM.

9 REFERENCES

Barbour, M.T., J. Gerristen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish - Second Edition. EPA 841-B-99-002

BCMOE (British Columbia Ministry of Environment). 2017a. British Columbia Approved Water Quality Guidelines: Aquatic Life, Wildlife & Agriculture. Water Protection and Sustainability Branch. January 2017.

BCMOE (British Columbia Ministry of Environment). 2017b. Working Water Quality Guidelines for British Columbia. Water Protection and Sustainability Branch. June 2017.

Bode, R.W., M.A. Novak, and L.E. Abele. 2002. Quality Assurance Work Plan for Biological Monitoring in New York State.

Bray, J.T., and J.T. Curtis. 1957. An Ordination of Upland Forest Communities of Southern Wisconsin. Ecological Monographs 27: 325-349.

Brinkhurst, R.P., P.M. Chapman, and M.A. Farrell. 1983. A Comparative Study of Respiration Rates of Some Aquatic Oligochaetes in relation to Sublethal Stress. Int. Rev. Hydrobiol. 68(5): 683-699.

CABIN (Canadian Aquatic Biomonitoring Network). 2012. Field Manual: Wadeable Streams. Environment Canada. March 2012.

Capstone (Capstone Minto Mine). 2017a. Minto Mine Fisheries Monitoring Program 2016 Summary Report. March 2017.

Capstone (Capstone Minto Mine). 2017b. Minto Mine Environmental Monitoring, Surveillance, and Reporting Plan Annual Report. Prepared by Minto Explorations Ltd. Minto Mine. March 2017.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life. With Updates. Accessed online at http://st-ts.ccme.ca/, November 2017.

Chapman, P.M., M.A. Farrell and R.O. Brinkhurst. 1982. Relative tolerances of selected aquatic oligochaetes to combinations of pollutants and environmental factors. Aquat Toxicol 2: 47 – 67.

Clarke, A.H. 1981. The Freshwater Molluscs of Canada. National Museums of Canada, Ottawa 446 pp.

Edmunds, G.F. Jr., S.L. Jensen, and L. Berner. 1976. The Mayflies of North and Central America. Univ. Minnesota Press, Minneapolis. 330 pp.

Environment Canada. 1998. Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout). Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/28. July 1998.

Environment Canada. 2007a. Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia. Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/21. Second Edition. February 2007.

Environment Canada. 2007b. Biological Test Method: Growth Inhibition Test Using a Freshwater Alga. Environmental Technology Centre, Ottawa, Ontario. Report EPS 1/RM/25. Second Edition. March 2007.

Environment Canada. 2007c. Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte Lemna minor. Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report 1/RM/37. Second Edition. January 2007.

Environment Canada. 2012. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada Report EEM/2002/1. June, 2012.

ECCC (Environment and Climate Chamge Canada). 2016. Proposed Amendments to the Metal Mining Effluent Regulations – Overview for Information. December 2016.

Glozier, N.E., J.M. Culp, and D. Halliwell. 2002. Revised Guidance for Sample Sorting and Subsampling Protocols for EEM Benthic Invertebrate Community Surveys.

Government of Canada. 2017a. Metal Mining Effluent Regulations, Consolidation. SOR/2002-222. Current to September 27th, 2017.

Government of Canada. 2017b. Regulations Amending the Metal Mining Effluent Regulations. Canada Gazette. Vol. 151, No. 19. May 13, 2017.

Kiffney, P.M. and W.H. Clements. 1994. Effects of Heavy Metals on a Macroinvertebrate Assemblage from a Rocky Mountain Stream in Experimental Microcosms. J. N. Am. Benth. Soc. 13(4): 511-523.

Kilgour, B.W., K.M. Somers and D.E. Mathews. 1998. Using the Normal Range as a Criterion for Ecological Significance in Environmental Monitoring and Assessment. Ecoscience 5: 542 – 550.

Kilgour, B.W., Somers, K.M., Barrett, T.J., Munkittrick, K.R., Francis, A.P. 2017. Testing against "normal" with environmental data. Integrated Environmental Assessment and Management 13: 188-197.

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwaters – Taxa Tolerance Values, Metrics and Protocols. Project H-1. Soil and Water Conservation Society of Metro Halifax.

Merritt, R.L., K.M. Cummins, and M.B. Berg, Editors. 2008. An Introduction to the Aquatic Insects of North America. 4th Ed. Kendall/Hunt Publishing, Dubuque. 1158 pp.

Minitab Inc. 2015. Minitab 18 Statistical Software. Minitab Inc. State College, PA.

Minnow and Access (Minnow Environmental Inc. and Access Consulting Group). 2009. Environmental Effects Monitoring First Interpretive Report, Minto Project, Yukon Territory. Prepared for Minto Explorations Ltd. January 2009.

Minnow and Access (Minnow Environmental Inc. and Access Consulting Group). 2012. Minto Mine Cycle 2 Environmental Effects Monitoring (EEM). Prepared for Minto Explorations Ltd. January 2012.

Minnow (Minnow Environmental Inc.). 2014. Capstone Mining Corp. Minto Mine Phase 3 EEM Study Design - Investigation of Cause. Prepared for Capstone Mining Corp. March 2014.

Minnow (Minnow Environmental Inc.). 2015. Minto Mine Phase 3 EEM - Investigation of Cause Interpretive Report. Prepared for Capstone Mining Corp. – Minto Mine. January 2015.

Minnow (Minnow Environmental Inc.). 2016. Minto Mine Phase 4 EEM Study Design Report. Prepared for Capstone Mining Corp. – Minto Mine. February 2016.

Minto (Capstone Minto Mine). 2017. Minto Mine Fisheries Monitoring Program 2016 Summary Report. March 2017.

Resh, V.H., M.J. Meyers and M.J. Hannaford. 1996. Macrionvertebrates as Biotic Indicators of Environmental Quality. In: Stream Ecology. Hauer, F.R. and G.A. Lamberti (Eds.). Chapter 31. Pp. 647-667. Academic Press, London.

Reynoldson, T.B. 1987. The Role of Environmental Factors in the Ecology of Tubificid Oligochaetes – An Experimental Study. Ecography 10(4): 241-248.

Rosenberg, D.M. and V.H. Resh. 1996. Use of Aquatic Insects in Biomonitoring. Chapter 7. In: R.W. Merritt and K.W. Cummins (Eds.). An Introduction to the Aquatic Insects of North America. Third Edition. ISBN 0-7872-3241-6. Kendall Hunt Publishing

Sigma (Sigma Environmental Consultants Ltd.). 1983. Summary of Water Quality Criteria for Salmonid Hatcheries. SECL 8067. Revised Edition. October 1983. 163 pp.

Smith, B. and J.B. Wilson. 1996. A Consumer's Guide to Evenness Indices. Oikos 76: 70-82.

Suter, G.W.II., S.M. Cormier and S.B. Norton. 2015. Forming Causal Conclusions. In: S.B. Norton S.M. Cormier and G.W. Suter II (Eds.) - Ecological Causal Assessment. CRC Press, Boca Raton pp. 251-270.

Taylor, B.R. and R.C. Bailey. 1997. Technical Evaluation on Methods for Benthic Invertebrate Analysis and Interpretation. Report for AETE Program, CANMET. Natural Resources Canada, Ottawa, Ontario.

Weiderholm, T. (ed.) 1983. Chironomidae of the Holartic Region. Keys and Diagnoses, Part 1. - Larvae Ent. Scand. Suppl. 19. 457 pp.

Wiggins, G.B. 1996. Larvae of the North American Caddisfly Genera (Trichoptera), 2nd Ed.

Zaiontz C. (2017) Real Statistics Using Excel. www.real-statistics.com

Zar, J.H. 1984. Biostatistical Analysis. Prentice-Hall, Inc., Englewood Cliffs, N.J.

APPENDIX A

MINTO MINE EFFLUENT DATA

Table A.1: Minto Mine Effluent Discharge, 2015 to August 2017

2015	
Days of Discharge:	**59**
Date	**Flow (m^3)**
4/3/2015	277
4/4/2015	6,599
4/5/2015	7,157
4/6/2015	7,001
4/7/2015	7,025
4/8/2015	7,348
4/9/2015	7,348
4/10/2015	6,745
4/11/2015	5,893
4/12/2015	4,428
4/13/2015	6,724
4/14/2015	7,067
4/15/2015	7,025
4/16/2015	7,395
4/17/2015	7,256
4/18/2015	4,177
4/19/2015	12,200
4/20/2015	11,566
4/21/2015	10,454
4/22/2015	12,614
4/23/2015	9,072
4/24/2015	9,677
4/25/2015	8,133
4/26/2015	7,576
4/27/2015	6,978
4/28/2015	4,870
4/29/2015	5,511
4/30/2015	5,384
5/1/2015	5,407
5/2/2015	4,570
5/3/2015	6,239
5/4/2015	5,918
5/5/2015	2,203
5/6/2015	2,259
5/7/2015	3,774
5/8/2015	4,035
5/9/2015	4,334
5/10/2015	6,353
5/11/2015	6,706
5/12/2015	6,698
5/13/2015	6,542
5/14/2015	6,819
5/15/2015	6,646
5/16/2015	5,247
5/17/2015	6,533
5/18/2015	1,231
5/19/2015	6,399
5/20/2015	6,883
5/21/2015	2,360
5/22/2015	2,840
5/23/2015	2,329
5/24/2015	1,725
5/25/2015	1,710
5/26/2015	1,821
5/27/2015	1,760
5/28/2015	1,770
5/29/2015	1,363
5/30/2015	1,849
5/31/2015	705
TOTAL	**328,526**

2016	
Days of Discharge:	**167**
Date	**Flow (m^3)**
4/7/2016	407
4/8/2016	834
4/9/2016	1,233
4/10/2016	1,960
4/11/2016	1,871
4/12/2016	2,163
4/13/2016	2,284
4/14/2016	2,270
4/15/2016	2,277
4/16/2016	1,712
4/17/2016	2,247
4/18/2016	2,275
4/19/2016	1,124
4/20/2016	1,711
4/21/2016	2,287
4/22/2016	2,271
4/23/2016	2,292
4/24/2016	2,264
4/25/2016	2,331
4/26/2016	2,253
4/27/2016	1,321
4/28/2016	633
4/29/2016	643
4/30/2016	936
5/1/2016	801
5/2/2016	706
5/3/2016	718
5/4/2016	720
5/15/2016	771
5/16/2016	925
5/17/2016	896
5/18/2016	110
5/19/2016	35
5/20/2016	4
5/21/2016	963
5/22/2016	659
5/23/2016	1,081
5/24/2016	1,224
5/25/2016	1,673
5/26/2016	1,776
5/27/2016	1,188
5/28/2016	925
5/29/2016	870
5/30/2016	807
5/31/2016	590
6/1/2016	580
6/2/2016	715
6/3/2016	731
6/4/2016	630
6/5/2016	582
6/6/2016	809
6/7/2016	1,118
6/8/2016	1,213
6/9/2016	929
6/10/2016	780
6/11/2016	294
6/12/2016	0
6/13/2016	434
6/14/2016	589
6/15/2016	915
6/16/2016	731
6/17/2016	522
6/18/2016	396
6/19/2016	101
6/20/2016	304
6/21/2016	129
6/22/2016	382
6/23/2016	201
6/24/2016	419
6/25/2016	363
6/26/2016	330
6/27/2016	87
7/7/2016	490
7/8/2016	597
7/9/2016	439
7/10/2016	388
7/11/2016	236
7/12/2016	538
7/13/2016	926
7/14/2016	398
7/15/2016	289
7/16/2016	490
7/17/2016	232
7/18/2016	363
7/19/2016	352
7/20/2016	358
7/21/2016	360
7/22/2016	631
7/23/2016	1,005
7/24/2016	1,288
7/25/2016	943
7/26/2016	1,759
7/27/2016	2,106
7/28/2016	1,252
7/29/2016	1,215
7/30/2016	1,088
7/31/2016	653
8/1/2016	579
8/2/2016	617
8/3/2016	650
8/4/2016	678
8/5/2016	504
8/6/2016	886
8/7/2016	1,058
8/8/2016	711
8/9/2016	1,742
8/10/2016	2,001
8/11/2016	1,203
8/12/2016	1,008
8/13/2016	885
8/14/2016	628
8/15/2016	538
8/16/2016	550
8/17/2016	548
8/18/2016	622
8/19/2016	1,058
8/20/2016	1,022
8/21/2016	683
8/22/2016	686
8/23/2016	605
8/24/2016	567
8/25/2016	734
8/26/2016	1,328
8/27/2016	1,519
8/28/2016	1,242
8/29/2016	1,222
8/30/2016	1,179
8/31/2016	1,230
9/1/2016	1,119
9/2/2016	1,649
9/3/2016	893
9/4/2016	480
9/5/2016	1,663
9/6/2016	1,328
9/7/2016	1,650
9/8/2016	2,205
9/9/2016	1,222
9/10/2016	1,840
9/11/2016	1,484
9/12/2016	1,639
9/13/2016	1,426
9/14/2016	1,225
9/15/2016	1,742
9/16/2016	1,410
9/17/2016	1,697
9/18/2016	1,504
9/19/2016	1,594
9/20/2016	1,437
9/21/2016	1,340
9/22/2016	1,213
9/23/2016	1,205
9/24/2016	1,180
9/25/2016	1,179
9/26/2016	1,166
9/27/2016	1,168
9/28/2016	1,139
9/29/2016	1,138
9/30/2016	879
10/1/2016	475
10/2/2016	728
10/3/2016	745
10/4/2016	357
10/5/2016	510
10/6/2016	787
10/7/2016	773
10/8/2016	765
10/9/2016	747
TOTAL	**166,897**

2017 (data to August 5th only)	
Days of Discharge:	**72**
Date	**Flow (m^3)**
4/16/2017	7
5/1/2017	818
5/2/2017	1,070
5/3/2017	1,068
5/4/2017	1,066
5/5/2017	1,070
5/6/2017	1,074
5/7/2017	1,076
5/8/2017	838
5/9/2017	1,084
5/10/2017	1,085
5/11/2017	1,094
5/12/2017	1,095
5/13/2017	1,091
5/14/2017	1,096
5/15/2017	1,101
5/16/2017	1,107
5/17/2017	1,100
5/18/2017	1,118
5/19/2017	1,118
5/20/2017	1,134
5/21/2017	1,142
5/22/2017	1,159
5/23/2017	1,161
5/24/2017	1,165
5/25/2017	1,116
5/26/2017	1,161
5/27/2017	1,153
5/28/2017	1,152
5/29/2017	1,623
5/30/2017	1,653
5/31/2017	1,550
6/1/2017	676
6/2/2017	483
6/3/2017	1,677
6/4/2017	3,516
6/5/2017	3,909
6/6/2017	2,516
6/7/2017	1,812
6/8/2017	717
6/9/2017	261
6/10/2017	619
6/11/2017	291
6/12/2017	3,459
6/13/2017	4,411
6/14/2017	2,095
6/15/2017	1,777
6/16/2017	1,499
6/17/2017	1,666
6/18/2017	1,277
6/19/2017	960
6/20/2017	1,096
6/21/2017	778
6/22/2017	474
6/23/2017	663
6/24/2017	672
6/25/2017	628
6/26/2017	223
7/11/2017	631
7/12/2017	977
7/13/2017	296
7/26/2017	333
7/27/2017	955
7/28/2017	772
7/29/2017	660
7/30/2017	673
7/31/2017	662
8/1/2017	658
8/2/2017	434
8/3/2017	313
8/4/2017	310
8/5/2017	137
TOTAL	**81,311**

Table A.2: Minto Mine Weekly MMER Effluent Quality Data, 2015-2017

Date		pH	Total Suspended Solids	Arsenic	Copper	Lead	Nickel	Zinc	Radium-226
		pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L
	MMER limit (grab)	6.0 - 9.5	30	1.0	0.60	0.40	1.0	1.0	1.11
2-Jan-15	Grab	8.11	3.6	0.00025	0.0031	<0.00020	0.0012	<0.0050	
6-Jan-15	Grab	8.04		0.00027	0.0024	<0.00020	<0.0010	<0.0050	
13-Jan-15	Grab	8.26	1.5	0.00024	0.0023	<0.00020	<0.0010	<0.0050	
21-Jan-15	Grab	8.28	1.7	0.00023	0.0019	<0.00020	<0.0010	<0.0050	
29-Jan-15	Grab	8.29	1.2	0.00024	0.0023	<0.00020	<0.0010	<0.0050	
3-Feb-15	Grab	8.19	2.9	0.00042	0.0034	<0.00020	0.0016	<0.0050	
11-Feb-15	Grab	7.91	<1.0	0.00023	0.0033	<0.00020	0.0011	<0.0050	
18-Feb-15	Grab	7.88	<1.0	0.00022	0.0021	<0.00020	0.0011	<0.0050	
26-Feb-15	Grab	8.08	<1.0	0.00021	0.0018	<0.00020	0.0012	<0.0050	
3-Mar-15	Grab	7.88	<1.0	0.00021	0.0038	<0.00020	0.0012	0.032	
9-Mar-15	Grab	8.06	<1.0	0.00023	0.0033	<0.00020	<0.0010	<0.0050	
16-Mar-15	Grab	8.11	<1.0	0.00021	0.0034	<0.00020	0.0011	0.021	<0.010
25-Mar-15	Grab	8.09	<1.0	0.00022	0.0017	<0.00020	0.0011	<0.0050	
30-Mar-15	Grab	8.45	<1.0	0.00023	0.0046	<0.00020	0.0012	0.16	
6-Apr-15	Grab	8.11	2.8	0.00048	0.011	<0.00020	<0.0010	0.014	
14-Apr-15	Grab	8.22	4.3	0.00041	0.015	0.00058	<0.0010	<0.0050	<0.010
21-Apr-15	Grab	8.13	9.4	0.00049	0.019	0.00021	<0.0010	<0.0050	
27-Apr-15	Grab	8.14	4.2	0.00035	0.023	<0.00020	<0.0010	<0.0050	
10-May-15	Grab	8.16	<1.0	0.00033	0.010	<0.00020	<0.0010	0.016	
14-May-15	Grab	8.06	11	0.00043	0.021	<0.00020	<0.0010	<0.0050	
20-May-15	Grab	8.07	5.4	0.00049	0.024	<0.00020	0.0012	<0.0050	
29-May-15	Grab	8.13	1.4	0.00035	0.012	<0.00020	<0.0010	<0.0050	
31-May-15	Grab	8.24	2.0	0.00041	0.013	<0.00020	<0.0010	<0.0050	
4-Jun-15	Grab	8.15	<1.0	0.00025	0.0030	<0.00020	<0.0010	0.051	
9-Jun-15	Grab	8.19	<1.0	0.00025	0.0029	<0.00020	<0.0010	<0.0050	
15-Jun-15	Grab	8.21	13	0.00053	0.020	0.00028	0.0018	<0.0050	
22-Jun-15	Grab	8.32	<1.0	0.00026	0.0024	<0.00020	<0.0010	<0.0050	
29-Jun-15	Grab	8.32	<1.0	0.00022	0.0030	<0.00020	<0.0010	<0.0050	
7-Jul-15	Grab	8.31	8.3	0.00027	0.0027	<0.00020	<0.0010	<0.0050	
14-Jul-15	Grab	8.16	<1.0	0.00023	0.0026	<0.00020	<0.0010	<0.0050	
20-Jul-15	Grab	8.26	<1.0	0.00028	0.0024	<0.00020	<0.0010	<0.0050	
29-Jul-15	Grab	8.22	<1.0	0.00029	0.0025	<0.00020	<0.0010	<0.0050	
5-Aug-15	Grab	8.34	<1.0	0.00027	0.0021	<0.00020	<0.0010	<0.0050	
14-Aug-15	Grab	8.18	<1.0	0.00028	0.0029	<0.00020	<0.0010	<0.0050	
18-Aug-15	Grab	8.32	<1.0	0.00032	0.0033	<0.00020	<0.0010	<0.0050	
24-Aug-15	Grab	8.04	<1.0	0.00025	0.0022	<0.00020	<0.0010	<0.0050	
31-Aug-15	Grab	8.19	4.6	0.00033	0.0053	<0.00020	0.0012	<0.0050	<0.010
8-Sep-15	Grab	8.27	17	0.00029	0.0058	<0.00020	0.0011	<0.0050	
15-Sep-15	Grab	8.34	<1.0	0.00029	0.0030	<0.00020	<0.0010	<0.0050	
23-Sep-15	Grab	8.43	<1.0	0.00026	0.0026	<0.00020	<0.0010	<0.0050	
30-Sep-15	Grab	8.42	<1.0	0.00030	0.0026	<0.00020	<0.0010	<0.0050	
5-Oct-15	Grab	8.38	<1.0	0.00025	0.0021	<0.00020	<0.0010	<0.0050	<0.010
13-Oct-15	Grab	8.28	<1.0	0.00021	0.0027	<0.00020	<0.0010	<0.0050	
22-Oct-15	Grab	8.16	<1.0	0.00028	0.0025	<0.00020	<0.0010	<0.0050	
28-Oct-15	Grab	8.12	<1.0	0.00026	0.0025	<0.00020	<0.0010	<0.0050	
2-Nov-15	Grab	8.15	<1.0	0.00017	0.0021	<0.00020	<0.0010	<0.0050	
9-Nov-15	Grab	8.20	<1.0	0.00023	0.0025	<0.00020	<0.0010	<0.0050	
16-Nov-15	Grab	8.42	<1.0	0.00030	0.0031	<0.00020	<0.0010	<0.0050	
23-Nov-15	Grab	8.23	<1.0	0.00024	0.0020	<0.00020	<0.0010	<0.0050	
6-Dec-15	Grab	8.25	<1.0	0.00031	0.0020	<0.00020	0.0029	<0.0050	
8-Dec-15	Grab	8.46	<1.0	0.00017	0.0021	<0.00020	0.0015	<0.0050	
19-Dec-15	Grab	8.10	5.6	0.00023	0.0023	<0.00020	<0.0010	0.0083	
26-Dec-15	Grab	8.22	6.1	0.00022	0.0033	<0.00020	0.0010	0.0094	
2015 Summary Statistics	**Count**	**53**	**52**	**53**	**53**	**53**	**53**	**53**	**4**
	Count < MDL	**0**	**33**	**0**	**0**	**50**	**37**	**45**	**4**
	Count > MDL	**53**	**19**	**53**	**53**	**3**	**16**	**8**	**0**
	Mean [1]	**8.20**	**<2.7**	**0.00029**	**0.0054**	**<0.00021**	**<0.0011**	**<0.010**	**<0.010**
	Median	**8.19**	**<1**	**0.00026**	**0.0029**	**<0.00020**	**<0.0010**	**<0.0050**	**<0.010**
	Maximum	**8.46**	**17**	**0.00053**	**0.024**	**0.00058**	**0.0029**	**0.16**	**<0.010**

🟨 Highlight indicates a result greater than the applicable MMER limit.

[1] If greater than 50% of samples were less than method detection limit than the mean was presented with a less than symbol.

Table A.2: Minto Mine Weekly MMER Effluent Quality Data, 2015-2017

Date		pH	Total Suspended Solids	Arsenic	Copper	Lead	Nickel	Zinc	Radium-226
		pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L
	MMER limit (grab)	6.0 - 9.5	30	1.0	0.60	0.40	1.0	1.0	1.11
1-Jan-16	Grab	8.19	<1.0	0.00026	0.0022	<0.00020	<0.0010	<0.0050	
8-Jan-16	Grab	8.22	1.0	0.00027	0.0032	<0.00020	0.0011	<0.0050	
14-Jan-16	Grab	8.16	3.1	0.00026	0.0037	<0.00020	<0.0010	0.0068	
19-Jan-16	Grab	8.23	1.1	0.00031	0.0020	<0.00020	0.0011	<0.0050	
25-Jan-16	Grab	8.10	1.1	0.00029	0.0022	<0.00020	<0.0010	<0.0050	
1-Feb-16	Grab	8.43	1.1	0.00031	0.0033	<0.00020	<0.0010	<0.0050	
14-Feb-16	Grab	8.01	4.1	0.00037	0.011	0.00021	<0.0010	<0.0050	
20-Feb-16	Grab	8.35	18	0.00024	0.0021	<0.00020	<0.0010	<0.0050	
28-Feb-16	Grab	8.21	4.7	0.00031	0.0029	<0.00020	<0.0010	<0.0050	
1-Mar-16	Grab	8.39	2.6	0.00037	0.0022	<0.00020	<0.0010	<0.0050	
8-Mar-16	Grab	8.11	5.1	0.00029	0.0040	<0.00020	0.0011	<0.0050	
19-Mar-16	Grab	8.23	2.8	0.00028	0.0019	<0.00020	<0.0010	<0.0050	
24-Mar-16	Grab	8.12	2.5	0.00031	0.0045	<0.00020	<0.0010	0.0095	
30-Mar-16	Grab	7.84	30	0.00056	0.014	0.00021	0.0015	0.0034	
4-Apr-16	Grab	8.14	6.7	0.00036	0.0049	0.000074	0.0011	<0.0030	
12-Apr-16	Grab	7.99	7.3	0.00052	0.020	0.00021	0.0020	0.0035	
19-Apr-16	Grab	8.28	<3.0	0.00033	0.012	<0.000050	0.0011	<0.0030	
26-Apr-16	Grab	8.08	<3.0	0.00032	0.012	0.000053	0.0010	<0.0030	
2-May-16	Grab	8.32	5.3	0.00027	0.0089	<0.000050	0.0010	<0.0030	
12-May-16	Grab	8.24	<3.0	0.00029	0.0072	<0.000050	0.0015	<0.0030	
17-May-16	Grab	8.15	4.0	0.00035	0.015	<0.000050	0.0013	<0.0030	
24-May-16	Grab	7.99	<3.0	0.00029	0.014	<0.000050	0.0011	<0.0030	
31-May-16	Grab	8.09	<3.0	0.00030	0.012	<0.000050	0.0011	<0.0030	
7-Jun-16	Grab	8.15	<3.0	0.00029	0.012	<0.000050	0.0012	<0.0030	
14-Jun-16	Grab	8.06	<3.0	0.00030	0.0097	<0.000050	0.0010	<0.0030	
21-Jun-16	Grab	8.03	<3.0	0.00028	0.0071	<0.000050	0.0012	<0.0030	
28-Jun-16	Grab	8.13	<3.0	0.00023	0.0035	<0.000050	0.00096	<0.0030	
5-Jul-16	Grab	8.39	<3.0	0.00026	0.0029	<0.000050	0.0011	<0.0030	
12-Jul-16	Grab	8.01	<3.0	0.00028	0.0039	<0.000050	0.0011	<0.0030	
19-Jul-16	Grab	8.20	<3.0	0.00027	0.0059	<0.000050	0.0011	<0.0030	
26-Jul-16	Grab	7.98	4.7	0.00040	0.012	<0.000050	0.0014	<0.0030	
2-Aug-16	Grab	8.05	<3.0	0.00032	0.0096	<0.000050	0.0010	<0.0030	
9-Aug-16	Grab	8.16	<3.0	0.00035	0.0095	<0.000050	0.0010	<0.0030	
15-Aug-16	Grab	8.09	<3.0	0.00029	0.0086	<0.000050	0.00095	<0.0030	
17-Aug-16	Grab	7.93	<3.0	0.00031	0.0082	<0.000050	0.0010	<0.0030	
23-Aug-16	Grab	8.13	<3.0	0.00035	0.0087	<0.000050	0.00092	<0.0030	
30-Aug-16	Grab	8.31	<3.0	0.00033	0.012	<0.000050	0.00092	<0.0030	
6-Sep-16	Grab	8.10	<3.0	0.00025	0.0083	<0.000050	0.00050	<0.0030	
13-Sep-16	Grab	7.86	<3.0	0.00022	0.0072	0.000081	0.00054	<0.0030	
20-Sep-16	Grab	7.87	<3.0	0.00022	0.0074	<0.000050	0.00056	<0.0030	
27-Sep-16	Grab	7.99	<3.0	0.00020	0.0063	0.000067	0.00056	<0.0030	
3-Oct-16	Grab	7.96	<3.0	0.00016	0.0048	<0.000050	<0.00050	<0.0030	
4-Oct-16	Grab	8.15	<3.0	0.00023	0.0067	<0.000050	0.00070	<0.0030	
11-Oct-16	Grab	8.22	<3.0	0.00029	0.0094	<0.000050	0.0010	<0.0030	
18-Oct-16	Grab	8.20	<3.0	0.00036	0.013	0.000052	0.00088	<0.0030	
23-Oct-16	Grab	8.27	<3.0	0.00034	0.013	0.000050	0.00076	<0.0030	
25-Oct-16	Grab	8.23	<3.0	0.00030	0.013	0.00031	0.00078	0.0031	
1-Nov-16	Grab	8.46	<3.0	0.00024	0.0041	<0.000050	0.00088	<0.0030	
8-Nov-16	Grab	8.25	<3.0	0.00026	0.0033	<0.000050	0.00099	<0.0030	
15-Nov-16	Grab	8.13	3.7	0.00027	0.0029	<0.000050	0.00095	<0.0030	
22-Nov-16	Grab	7.88	3.5	0.00028	0.0027	<0.000050	0.0010	<0.0030	
29-Nov-16	Grab	8.14	<3.0	0.00027	0.0035	<0.000050	0.0011	<0.0030	
6-Dec-16	Grab	8.35	<3.0	0.00026	0.0056	<0.000050	0.00094	<0.0030	
13-Dec-16	Grab	8.05	<3.0	0.00024	0.0022	<0.000050	0.00090	<0.0030	
20-Dec-16	Grab	8.00	6.5	0.00024	0.0083	0.000052	0.0012	0.0030	
27-Dec-16	Grab	7.81	<3.0	0.00025	0.0030	<0.000050	0.00086	<0.0030	
2016 Summary Statistics	**Count**	**56**	**56**	**56**	**56**	**56**	**56**	**56**	**-**
	Count < MDL	**0**	**35**	**0**	**0**	**45**	**11**	**50**	**-**
	Count > MDL	**56**	**21**	**56**	**56**	**11**	**45**	**6**	**-**
	Mean [1]	**8.13**	**<3.1**	**0.00030**	**0.0072**	**<0.000065**	**0.0010**	**<0.0032**	**-**
	Median	**8.14**	**2.5**	**0.00029**	**0.0069**	**<0.000050**	**0.0010**	**<0.0030**	**-**
	Maximum	**8.46**	**30**	**0.00056**	**0.020**	**0.00031**	**0.0020**	**0.0095**	**-**

🟧 Highlight indicates a result greater than the applicable MMER limit.

[1] If greater than 50% of samples were less than method detection limit than the mean was presented with a less than symbol.

Table A.2: Minto Mine Weekly MMER Effluent Quality Data, 2015-2017

Date		pH	Total Suspended Solids	Arsenic	Copper	Lead	Nickel	Zinc	Radium-226
		pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L
	MMER limit (grab)	6.0 - 9.5	30	1.0	0.60	0.40	1.0	1.0	1.11
3-Jan-17	Grab	7.92	<3.0	0.00027	0.0027	<0.000050	0.00088	<0.0030	
10-Jan-17	Grab	7.97	<3.0	0.00024	0.0039	<0.000050	0.00091	<0.0030	
17-Jan-17	Grab	8.17	<3.0	0.00027	0.0031	<0.000050	0.0010	<0.0030	
24-Jan-17	Grab	8.01	18	0.00057	0.0099	0.00030	0.0023	0.0061	
31-Jan-17	Grab	8.12	<3.0	0.00035	0.0034	<0.000050	0.00086	<0.0030	
7-Feb-17	Grab	8.16	9.3	0.00037	0.0037	0.00011	0.0014	0.0056	
14-Feb-17	Grab	8.24	<3.0	0.00033	0.011	<0.000050	0.00091	0.0037	
21-Feb-17	Grab	8.16	<3.0	0.00023	0.0039	<0.000050	0.00085	<0.0030	
28-Feb-17	Grab	8.10	3.0	0.00030	0.0036	0.000061	0.0010	<0.0030	
7-Mar-17	Grab	8.14	<3.0	0.00024	0.0029	<0.000050	0.00093	<0.0030	
14-Mar-17	Grab	8.00	<3.0	0.00029	0.0062	<0.000050	0.0013	0.010	0.070
21-Mar-17	Grab	8.30	<3.0	0.00029	0.0028	<0.000050	0.0012	<0.0030	
28-Mar-17	Grab	8.09	<3.0	0.00024	0.0029	<0.000050	0.0013	<0.0030	
4-Apr-17	Grab	8.03	<3.0	0.00027	0.0019	<0.000050	0.0018	<0.0030	
6-Apr-17	Grab	8.27	<3.0	0.00036	0.0067	<0.000050	0.0012	<0.0030	
11-Apr-17	Grab	8.25	<3.0	0.00026	0.0078	<0.000050	0.00093	<0.0030	
18-Apr-17	Grab	8.24	<3.0	0.00024	0.0090	<0.000050	0.00092	<0.0030	
25-Apr-17	Grab	8.30	<3.0	0.00022	0.0043	<0.000050	0.00086	<0.0030	
2-May-17	Grab	8.04	10	0.00039	0.030	0.00018	0.0015	<0.0030	
9-May-17	Grab	8.08	<3.0	0.00037	0.013	<0.000050	0.00094	0.0030	
16-May-17	Grab	8.32	<3.0	0.00030	0.014	<0.000050	0.00090	<0.0030	
23-May-17	Grab	8.13	9.4	0.00038	0.016	0.00011	0.0013	<0.0030	
23-May-17	Grab	8.13	11	0.00037	0.016	0.00011	0.0013	<0.0030	
30-May-17	Grab	8.18	3.4	0.00038	0.015	0.00012	0.0013	0.0050	
30-May-17	Grab	8.29	<3.0	0.00049	0.024	0.00023	0.0016	0.0039	
6-Jun-17	Grab	8.21	5.7	0.00039	0.027	0.000078	0.0012	<0.0030	0.0082
13-Jun-17	Grab	8.03	<3.0	0.00043	0.026	0.000074	0.0014	<0.0030	
20-Jun-17	Grab	8.20	<3.0	0.00036	0.017	<0.000050	0.0012	<0.0030	
20-Jun-17	Grab	8.19	<3.0	0.00040	0.016	<0.000050	0.0012	<0.0030	
27-Jun-17	Grab	8.19	3.4	0.00027	0.0053	<0.000050	0.0011	<0.0030	
4-Jul-17	Grab	8.31	<3.0	0.00025	0.0035	<0.000050	0.00093	<0.0030	
11-Jul-17	Grab	8.33	<3.0	0.00029	0.0036	<0.000050	0.00098	<0.0030	
18-Jul-17	Grab	8.19	5.4	0.00035	0.0090	0.000092	0.0014	0.0037	
25-Jul-17	Grab	8.11	<3.0	0.00034	0.0049	<0.000050	0.0012	<0.0030	
1-Aug-17	Grab	8.05	3.0	0.00044	0.014	<0.000050	0.0012	<0.0030	<0.0096
8-Aug-17	Grab	8.09	<3.0	0.00029	0.0050	<0.000050	0.0011	<0.0030	
15-Aug-17	Grab	8.34	<3.0	0.00029	0.0035	<0.000050	0.0010	<0.0030	
22-Aug-17	Grab	8.38	<3.0	0.00025	0.0029	<0.000050	0.0011	<0.0030	
23-Aug-17	Grab	8.46	8.0	0.00036	0.0061	0.00011	0.0013	<0.0030	
29-Aug-17	Grab	8.25	<3.0	0.00026	0.0029	<0.000050	0.00093	<0.0030	
5-Sep-17	Grab	8.35	<3.0	0.00027	0.0030	<0.000050	0.0010	<0.0030	
12-Sep-17	Grab	8.50	<3.0	0.00025	0.0032	<0.000050	0.0010	<0.0030	
2017 Summary Statistics (Till 12-Sep-17)	**Count**	**42**	**42**	**42**	**42**	**42**	**42**	**42**	**3**
	Count < MDL	**0**	**30**	**0**	**0**	**30**	**0**	**34**	**1**
	Count > MDL	**42**	**12**	**42**	**42**	**12**	**42**	**8**	**2**
	Mean [1]	**8.19**	**<4.3**	**0.00032**	**0.0088**	**<0.000073**	**0.0012**	**<0.0034**	**0.029**
	Median	**8.19**	**<3.0**	**0.00030**	**0.0052**	**<0.000050**	**0.0011**	**<0.0030**	**0.0082**
	Maximum	**8.50**	**18**	**0.00057**	**0.030**	**0.00030**	**0.0023**	**0.010**	**0.070**

🟨 Highlight indicates a result greater than the applicable MMER limit.

[1] If greater than 50% of samples were less than method detection limit than the mean was presented with a less than symbol.

Table A.3: Acute Toxicity Test Results for Minto Mine Effluent (Station W3), 2015-2017

Year	Sample Date	Discharge [1]	Rainbow Trout		*Daphnia magna*
			Survival at 100% effluent	Pass/Fail	Survival at 100% effluent
2015	9-Mar-15	ND	100	pass	100
	22-Jun-15	ND	100	pass	100
	31-Aug-15	ND	100	pass	100
	5-Oct-15	ND	100	pass	100
2016	24-Mar-16	ND	100	pass	100
	23-Jun-16	D	test missed	-	100
	12-Jul-16	D	100	pass	100
	6-Sep-16	D	100	pass	100
	23-Oct-16	D	90	pass	100
2017	14-Mar-17	ND	100	pass	100
	6-Jun-17	D	100	pass	100

▨ Indicates a test failure.

[1] D = discharge; ND = non-discharge.

Table A.4: Minto Mine MMER Effluent Characterization Data, 2015-2017

Date		Temperature	Field Conductivity	Laboratory Conductivity	Total Hardness	Dissolved Hardness	Alkalinity	Ammonia	Nitrate	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Selenium
		°C	µS/cm	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
10-May-15	Grab	2.6	315	558	223	241	184	0.10	2.8	0.020	<0.000010	0.061	<0.000010	0.0059	0.0011
15-Jun-15	Grab	5.4	232	533	305	247	217	0.025	0.37	0.57	0.000018	0.88	<0.000010	0.0058	0.00037
5-Aug-15	Grab	1.1	307	527	246	245	224	0.018	0.23	0.0099	<0.000010	0.025	<0.000010	0.0045	0.00031
13-Oct-15	Grab	0.50	282	515	252	230	222	0.028	0.19	0.0076	<0.000010	0.036	<0.000010	0.0046	0.00037
2015 Summary Statistics	**Count**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Count < MDL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**0**	**0**
	Count > MDL	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**1**	**4**	**0**	**4**	**4**
	Mean [1]	**2.4**	**284**	**533**	**257**	**241**	**212**	**0.043**	**0.89**	**0.15**	**<0.000012**	**0.25**	**<0.000010**	**0.0052**	**0.00054**
	Median	**1.8**	**295**	**530**	**249**	**243**	**220**	**0.027**	**0.30**	**0.015**	**<0.000010**	**0.049**	**<0.000010**	**0.0052**	**0.00037**
	Maximum	**5.4**	**315**	**558**	**305**	**247**	**224**	**0.10**	**2.8**	**0.57**	**0.000018**	**0.88**	**<0.000010**	**0.0059**	**0.0011**
26-Apr-16	Grab	1.7	266	474	-	223	187	0.096	0.77	0.055	<0.0000050	0.12	<0.0000050	0.0036	0.00037
23-Jun-16	Grab	5.8	280	439	-	217	180	<0.0050	1.3	0.011	<0.0000050	0.030	<0.0000050	0.0046	0.00052
17-Aug-16	Grab	7.9	310	449	-	227	183	0.0066	2.0	0.018	<0.0000050	0.039	<0.0000050	0.0046	0.00065
23-Oct-16	Grab	2.7	265	466	-	231	180	0.030	4.5	0.014	<0.0000050	0.072	<0.0000050	0.0040	0.0013
2016 Summary Statistics	**Count**	**4**	**4**	**4**	**-**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Count < MDL	**0**	**0**	**0**	**-**	**0**	**0**	**1**	**0**	**0**	**4**	**0**	**4**	**0**	**0**
	Count > MDL	**4**	**4**	**4**	**-**	**4**	**4**	**3**	**4**	**4**	**0**	**4**	**0**	**4**	**4**
	Mean [1]	**4.5**	**280**	**457**	**-**	**225**	**183**	**0.034**	**2.1**	**0.025**	**<0.0000050**	**0.065**	**<0.0000050**	**0.0042**	**0.00070**
	Median	**4.3**	**273**	**458**	**-**	**225**	**182**	**0.018**	**1.6**	**0.016**	**<0.0000050**	**0.056**	**<0.0000050**	**0.0043**	**0.00059**
	Maximum	**7.9**	**310**	**474**	**-**	**231**	**187**	**0.096**	**4.5**	**0.055**	**<0.0000050**	**0.12**	**<0.0000050**	**0.0046**	**0.0013**
16-May-17	Grab	6.6	252	367	-	170	143	0.0069	1.6	0.021	<0.0000050	0.069	<0.0000050	0.0034	0.00054
27-Jun-17	Grab	5.2	315	490	-	234	214	0.0078	0.23	0.011	<0.0000050	0.026	<0.0000050	0.0047	0.00028
1-Aug-17	Grab	11	339	451	-	223	185	0.0069	1.3	0.013	<0.0000050	0.053	<0.0000050	0.0041	0.00044
3-Oct-17	Grab	1	291	541	-	261	242	0.0053	0.18	0.0051	<0.0000050	0.026	<0.0000050	0.0047	0.00037
2017 Summary Statistics	**Count**	**4**	**4**	**4**	**-**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Count < MDL	**0**	**0**	**0**	**-**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**4**	**0**	**0**
	Count > MDL	**4**	**4**	**4**	**-**	**4**	**4**	**4**	**4**	**4**	**0**	**4**	**0**	**4**	**4**
	Mean [1]	**6.0**	**299**	**462**	**-**	**222**	**196**	**0.0067**	**0.82**	**0.012**	**<0.0000050**	**0.044**	**<0.0000050**	**0.0042**	**0.00041**
	Median	**5.9**	**303**	**471**	**-**	**229**	**200**	**0.0069**	**0.78**	**0.012**	**<0.0000050**	**0.040**	**<0.0000050**	**0.0044**	**0.00040**
	Maximum	**11**	**339**	**541**	**-**	**261**	**242**	**0.0078**	**1.6**	**0.021**	**<0.0000050**	**0.069**	**<0.0000050**	**0.0047**	**0.00054**

[1] If greater than 50% of samples were less than method detection limit than the mean was presented with a less than symbol.

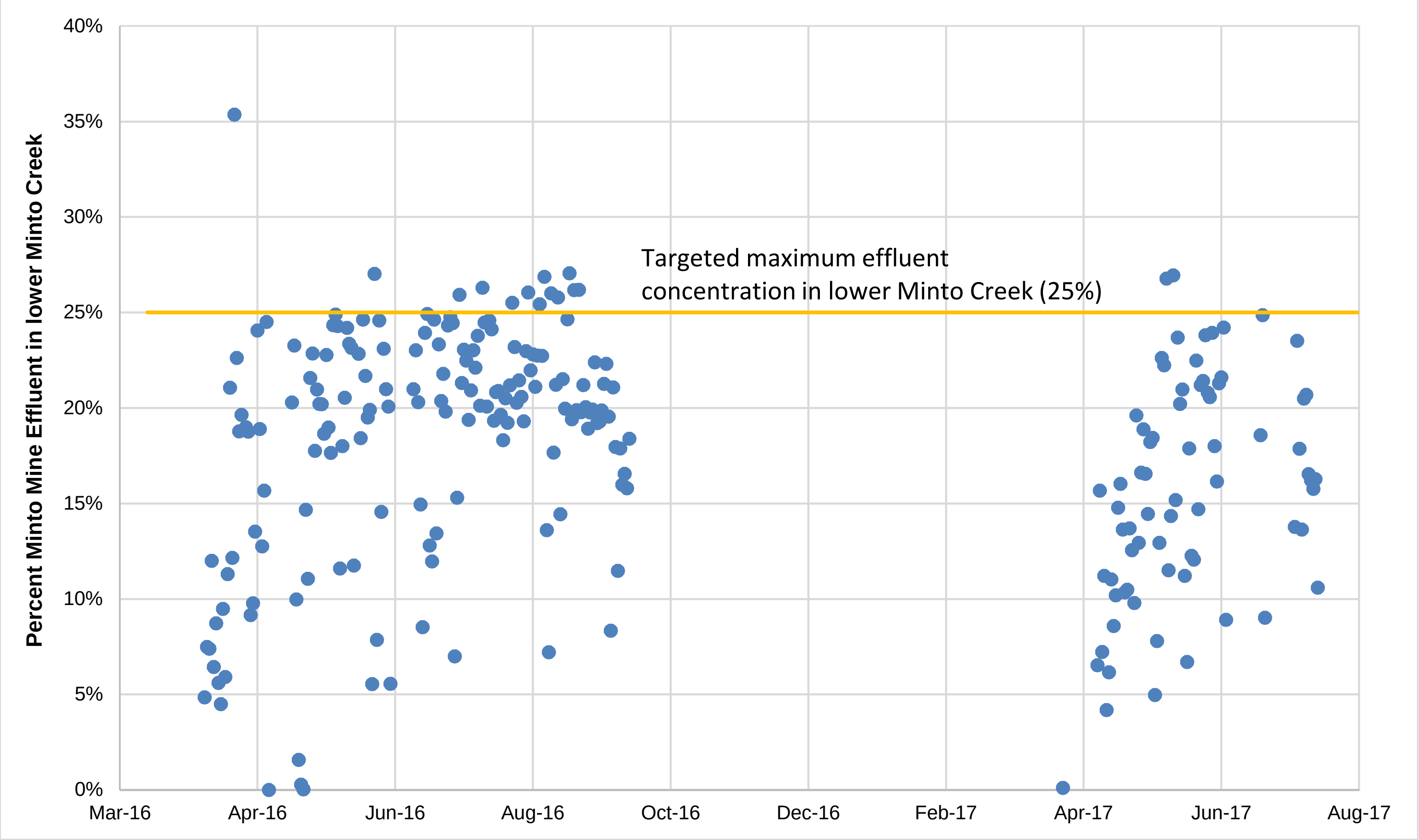


Figure A.1: Calculated Minto Mine Effluent Concentrations (% Effluent) in Lower Minto Creek 2015 to August 5th 2017 *

* calculated only for days when effluent flows and flows at lower Minto Creek (Station W1) were both available (the latter were not available in 2015).

APPENDIX B

DATA QUALITY REVIEW

APPENDIX B DATA QUALITY REVIEW

LIST OF TABLES

B1 INTRODUCTION

B1.1 Background

Data Quality Review (DQR) was conducted on data collected as part of the Minto Mine Phase 4 Environmental Effects Monitoring (EEM) to define the overall quality of the data collected for the program, and by extension, the confidence with which the data can be used to derive conclusions. A variety of factors can influence the physical, chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Depending on the magnitude of these influences, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, the context in which the data will be interpreted must be known in order to establish a relevant basis for judging whether or not the data set is adequate. The Minto Mine Phase 4 EEM DQR involved comparison of field performance to generic data quality objectives (DQOs) established for the field components of environmental studies, including those for field blanks, field duplicates, data precision, and data accuracy. DQOs were established a-priori to reflect reasonable and achievable performance expectations. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but rather to evaluate whether, based on the available data and using a weight-of-evidence approach, the field and/or analytical sample data adequately reflected actual conditions and can therefore be used with confidence to derive conclusions. Thus, questionable data, if any, receive more scrutiny to determine what effect, if any, they had on interpretation of results within the context of this project.

B1.2 Types of Quality Control Samples

Field Quality Control (QC) samples assessed for the Minto Mine Phase 4 EEM included one water field duplicate and one water trip blank. Laboratory QC samples included laboratory duplicates, method blanks, certified reference material (CRM) samples, laboratory control samples (LCS), and matrix spike (MS) samples for water, and the verification of the accuracy of sub-sampling and organism recovery for the benthic invertebrate component. These QC samples are defined as follows:

- **Field Duplicates** are sub-sample pairs collected from a randomly selected field station using identical collection and handling methods that are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field duplicate samples reflect natural variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.

- **Laboratory Duplicates** are sub-sample pairs which are split from a sample in the laboratory and then analyzed separately in an identical manner. The data from laboratory duplicate samples provide a measure of laboratory precision.

- **Blanks** are samples of de-ionized water, rinsate of sampling devices, and/or appropriate reagent(s) that are handled and analyzed the same way as regular samples. These samples will reflect any contamination that occurred in the field (in the case of field or trip blanks) or the laboratory (in the case of laboratory or method blanks). Analyte concentrations should be non-detectable, although a data quality objective of twice the method detection limit allows for slight “noise” around the detection limit.

- **CRM, LCS, and MS** are standardized samples of a particular matrix with a known concentration of analyte. They are used by the laboratory for calibrating instruments as well as for checking the quality of analytical results.

- **Sub-Sampling Checks** are performed on benthic invertebrate community samples when high sample volume and/or organism density results in only a fraction of the original sample being analyzed. By comparing the numbers of benthic invertebrates recovered between at least two sub-samples, this measure provides an evaluation of how effective the sub-sampling method was in evenly dividing the original sample, providing a measure of sub-sampling precision. Sub-sampling accuracy can be evaluated by processing an entire sample in representative fractions, and comparing the organism count in each of these fractions (multiplied by the number of fractions) to the total organism count of the entire sample.

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

B2 WATER SAMPLES

B2.1 Detection Limits

Method detection limits (MDLs) achieved by ALS Environmental for the thirty six supporting water samples from eight separate lab reports, one of which pertains to field Benthic Invertebrate Community sampling (L1834209), and seven which pertain to the Laboratory Fish Exposure study L1811593, L1813894, L1818233, L1822573, L1825883, L1829581, and L1831166; see Appendix C) were examined and assessed in all cases where sample results were reported as less than the MDL. For analytes for which a water quality guideline for the protection of aquatic life and/or a site-specific water quality objective (SSWQO) is available, the MDL should be lower than the available guideline and SSWQO values (Table B.1). Reported MDLs for all analytes with the exception of total beryllium and total chromium were lower than the applicable guideline values (Table B.1). For total beryllium, the MDL of 15 of the 36 samples (42%) exceeded the guideline, whereas for total chromium the MDL was equal to the guideline for all results. Beryllium is not of particular concern for the present monitoring program and chromium is a regionally-elevated analyte. Therefore, although the MDLs for these two analytes should be considered in data analysis, the impact on data interpretation will be very limited.

B2.2 Blank Sample Analysis

B2.2.1 Laboratory Blanks

The majority of laboratory blank results reported for the eight ALS Environmental laboratory reports (101 samples, 630 results) were non-detectable for the parameters reported (Appendix C; total and dissolved metals, total alkalinity, total ammonia, total and dissolved organic carbon, chloride, conductivity, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, pH, total suspended and dissolved solids, and sulphate). Two blank results (one result for each of total alkalinity and total thallium) did not meet the laboratory criteria (representing 0.3% of results). For one of these results (total alkalinity), all associated sample results were > 5 times higher than the blank result, therefore data quality was not affected. For the second result (total thallium), limits of reporting were adjusted for all results within 5 times of the reported blank concentration of this sample. Overall, this indicates negligible contamination of samples within the laboratory during analysis.

B2.2.2 Trip Blanks

One unopened trip blank accompanied a shipment of water samples from the field sampling site to the laboratory, and was submitted for analysis (Appendix C). All results for this sample

Table B.1: Maximum Laboratory Method Detection Limits (MDL) for Analytes <MDL Relative to Water Quality Guidelines and Site-Specific Water Quality Objectives (SSWQO) for Minto Mine Phase 4 EEM, 2016

Parameter	Units	Guidelines [a]	SSWQO [b]	Maximum Method Detection Limit Achieved
Physical Tests, Anions and Nutrients				
Carbonate Alkalinity (as CaCO3)	mg/L	-	-	1.0
Hydroxide Alkalinity (as CaCO3)	mg/L	-	-	1.0
Total Alkalinity (as CaCO3)	mg/L	-	-	2.0
Total Ammonia (as N)	mg/L	0.41 [c]	0.25	0.0050
Chloride (Cl)	mg/L	120	-	0.50
Hardness (as CaCO3)	mg/L	-	-	0.50
Total Suspended Solids	mg/L	narrative [d]	-	3.0
Total Dissolved Solids	mg/L	-	-	10.0
Nitrate (as N)	mg/L	3.0	9.1	0.0050
Nitrate and Nitrite (as N)	mg/L	-	-	0.0051
Nitrite (as N)	mg/L	0.06	0.06	0.0010
Total Kjeldahl Nitrogen	mg/L	-	-	0.050
Total Phosphorus (P)	mg/L	-	-	0.050
Dissolved Phosphorus (P)	mg/L	-	-	0.050
Total Organic Carbon	mg/L	-	-	0.50
Total Metals				
Aluminum (Al)	mg/L	0.10 [e]	-	0.0050
Antimony (Sb)	mg/L	0.0090	-	0.00050
Arsenic (As)	mg/L	0.0050	-	0.00050
Barium (Ba)	mg/L	1.0	-	0.020
Beryllium (Be)	mg/L	0.00013	-	0.0010
Bismuth (Bi)	mg/L	-	-	0.000050
Boron (B)	mg/L	1.5	-	0.10
Cadmium (Cd)	mg/L	0.00016 [f]	-	0.0000050
Calcium (Ca)	mg/L	-	-	0.10
Chromium (Cr)	mg/L	0.0010 / 0.0090 [g]	-	0.0010
Cobalt (Co)	mg/L	0.0040	-	0.00030
Copper (Cu)	mg/L	0.0024 [f]	-	0.0010
Iron (Fe)	mg/L	0.30	-	0.030
Lead (Pb)	mg/L	0.0032 [f]	-	0.00050
Lithium (Li)	mg/L	-	-	0.0010
Magnesium (Mg)	mg/L	-	-	0.10
Manganese (Mn)	mg/L	1.0	-	0.00030
Mercury (Hg)	mg/L	0.000026	-	0.0000050
Molybdenum (Mo)	mg/L	0.073	-	0.0010
Nickel (Ni)	mg/L	0.096 [f]	-	0.0010
Potassium (K)	mg/L	-	-	2.0
Selenium (Se)	mg/L	0.0010	-	0.000050
Silver (Ag)	mg/L	0.00025	-	0.000020
Sodium (Na)	mg/L	-	-	2.0
Thallium (Tl)	mg/L	0.0008	-	0.00020
Tin (Sn)	mg/L	-	-	0.00050
Titanium (Ti)	mg/L	-	-	0.010
Uranium (U)	mg/L	0.015	-	0.00020
Vanadium (V)	mg/L	-	-	0.00050
Zinc (Zn)	mg/L	0.03	-	0.0050
Zirconium (Zr)	mg/L	-	-	0.00030
Dissolved Metals				
Aluminum (Al)	mg/L	-	0.10	0.0050
Antimony (Sb)	mg/L	-	-	0.00050
Arsenic (As)	mg/L	-	0.0050	0.00050
Barium (Ba)	mg/L	-	-	0.020
Beryllium (Be)	mg/L	-	-	0.0010
Bismuth (Bi)	mg/L	-	-	0.000050
Boron (B)	mg/L	-	-	0.10
Cadmium (Cd)	mg/L	-	0.00021	0.0000050
Chromium (Cr)	mg/L	-	0.0010	0.0010
Cobalt (Co)	mg/L	-	-	0.00030
Copper (Cu)	mg/L	-	0.013 / 0.02 [h]	0.0010
Iron (Fe)	mg/L	-	1.1	0.030
Lead (Pb)	mg/L	-	0.0040	0.00050
Lithium (Li)	mg/L	-	-	0.0010
Mercury (Hg)	mg/L	-	-	0.0000050
Molybdenum (Mo)	mg/L	-	0.073	0.0010
Nickel (Ni)	mg/L	-	0.11	0.0010
Potassium (K)	mg/L	-	-	2.0
Silver (Ag)	mg/L	-	0.00010	0.000020
Sodium (Na)	mg/L	-	-	2.0
Thallium (Tl)	mg/L	-	-	0.00020
Tin (Sn)	mg/L	-	-	0.00050
Titanium (Ti)	mg/L	-	-	0.010
Uranium (U)	mg/L	-	-	0.00020
Vanadium (V)	mg/L	-	-	0.00050
Zinc (Zn)	mg/L	-	0.030	0.0050
Zirconium (Zr)	mg/L	-	-	0.00030

🟧 Maximum MDLs that are greater or equal to Guideline or SSWQO values are highlighted.

Note: Only parameters with one or more results < MDL were included in the comparison to Guidelines and SSWQO.

[a] Water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2017); blue text are BC Water Quality Guidelines (BCMOE 2017a,b).

[b] Site-specific water quality objectives for Station W2 per the Minto Mine Water Use Licence. For metals, the SSWQO are applicable on a dissolved basis.

[c] At temperature 5°C and pH 8.5 (slightly conservative conditions).

[d] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[e] At pH 8.5 (slightly conservative conditions).

[f] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[g] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[h] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

were below the laboratory MDLs, therefore indicating no contamination of samples during transport to and from the field sampling site or laboratory.

B2.3 Data Precision

B2.3.1 Field Duplicate Samples

One duplicate water sample was collected in the field. The duplicates showed excellent agreement in concentrations of all analytes except for total phosphorus, which had a relative percent difference (RPD) between the duplicates of 76% (Table B.2). Although the data quality objective of a RPD of ≤ 25% was not met for this analyte, it had low reported concentrations. Consequently, although the absolute difference was small (0.0042 mg/L) the relative percent difference exceeded the DQO (Table B.2). Overall, the field duplicate sampling did not indicate any inconsistencies in sampling technique nor issues that could impair data interpretability.

B2.3.2 Laboratory Duplicate Samples

All laboratory duplicate results evaluated (14 samples, 139 results) in the eight laboratory reports met ALS Environmental’s data quality objectives (generally < 20% RPD) for the parameters reported (Appendix C; total and dissolved metals, total alkalinity, total ammonia, chloride, conductivity, nitrate, nitrite, total Kjeldahl nitrogen, total phosphorus, pH, and sulphate). Therefore, the laboratory precision achieved in this study is considered good.

B2.4 Data Accuracy

The accuracy of laboratory data from the eight laboratory reports was assessed based on the results of certified reference materials (CRM), laboratory control samples (LCS) and matrix spike samples (MS; Appendix C). Specifically, twenty five CRM samples were used among the laboratory reports to assess the accuracy of total alkalinity, conductivity, total phosphorus, and pH analyses (Appendix C), and all results of these CRM samples (25 results) met laboratory quality control criteria. Eighty four LCS samples were used to evaluate the accuracy of total and dissolved metals, as well as physical, anion, and nutrient parameters (total alkalinity, total ammonia, chloride, conductivity, nitrate, nitrite, total Kjeldahl nitrogen, total and dissolved organic carbon, pH, total dissolved and suspended solids, and sulphate). All LCS results (626 results) met the laboratory quality control criteria for these samples. Finally, thirteen MS samples were also used to assess the accuracy of multiple parameters (total and dissolved metals, total ammonia, chloride, nitrate, nitrite, total Kjeldahl nitrogen, dissolved organic carbon, total phosphorus, and sulphate). The majority of MS results met the laboratory quality control criteria for these samples, however 10 of the 76 reported results (13%) could not be accurately calculated due to high analyte background concentration in the sample

Table B.2: Field Duplicate Results for Analysis of Water Quality Samples, Minto Mine Phase 4 EEM, 2016

Sample ID	Units	REF-9	REF-9X	RPD (%) [a]
Date Sampled		23-Sep-2016	23-Sep-2016	
Physical Tests, Anions and Nutrients				
Hardness (as CaCO3)	mg/L	154	157	2%
Total Suspended Solids	mg/L	<3.0	<3.0	-
Total Dissolved Solids	mg/L	181	214	17%
Total Alkalinity (as CaCO3)	mg/L	129	127	2%
Total Ammonia (as N)	mg/L	<0.0050	<0.0050	-
Nitrate (as N)	mg/L	0.166	0.165	1%
Total Kjeldahl Nitrogen	mg/L	0.159	0.146	9%
Total Phosphorus (P)	mg/L	0.0076	0.0034	76%
Dissolved Organic Carbon	mg/L	4.25	4.34	2%
Total Metals				
Aluminum (Al)	mg/L	0.0212	0.0246	15%
Antimony (Sb)	mg/L	<0.00050	<0.00050	-
Arsenic (As)	mg/L	0.00099	0.00102	3%
Barium (Ba)	mg/L	0.058	0.059	2%
Beryllium (Be)	mg/L	<0.0010	<0.0010	-
Boron (B)	mg/L	<0.10	<0.10	-
Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	-
Calcium (Ca)	mg/L	33.3	33.8	1%
Chromium (Cr)	mg/L	<0.0010	<0.0010	-
Cobalt (Co)	mg/L	<0.00030	<0.00030	-
Copper (Cu)	mg/L	<0.0010	<0.0010	-
Iron (Fe)	mg/L	0.092	0.092	0%
Lead (Pb)	mg/L	<0.00050	<0.00050	-
Lithium (Li)	mg/L	0.0012	0.0011	9%
Magnesium (Mg)	mg/L	16.7	16.9	1%
Manganese (Mn)	mg/L	0.0360	0.0370	3%
Mercury (Hg)	mg/L	<0.0000050	<0.0000050	-
Molybdenum (Mo)	mg/L	<0.0010	<0.0010	-
Nickel (Ni)	mg/L	<0.0010	<0.0010	-
Potassium (K)	mg/L	<2.0	<2.0	-
Selenium (Se)	mg/L	0.000249	0.000268	7%
Silver (Ag)	mg/L	<0.000020	<0.000020	-
Sodium (Na)	mg/L	<2.0	<2.0	-
Thallium (Tl)	mg/L	<0.00020	<0.00020	-
Tin (Sn)	mg/L	<0.00050	<0.00050	-
Titanium (Ti)	mg/L	<0.010	<0.010	-
Uranium (U)	mg/L	0.00090	0.00091	1%
Vanadium (V)	mg/L	<0.00050	<0.00050	-
Zinc (Zn)	mg/L	<0.0050	<0.0050	-
Dissolved Metals				
Aluminum (Al)	mg/L	0.0094	0.0091	3%
Antimony (Sb)	mg/L	<0.00050	<0.00050	-
Arsenic (As)	mg/L	0.00098	0.00093	5%
Barium (Ba)	mg/L	0.055	0.057	4%
Beryllium (Be)	mg/L	<0.0010	<0.0010	-
Boron (B)	mg/L	<0.10	<0.10	-
Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	-
Calcium (Ca)	mg/L	36.5	36.9	1%
Chromium (Cr)	mg/L	<0.0010	<0.0010	-
Cobalt (Co)	mg/L	<0.00030	<0.00030	-
Copper (Cu)	mg/L	<0.0010	<0.0010	-
Iron (Fe)	mg/L	0.056	0.057	2%
Lead (Pb)	mg/L	<0.00050	<0.00050	-
Lithium (Li)	mg/L	0.0014	0.0013	7%
Magnesium (Mg)	mg/L	15.3	15.7	3%
Manganese (Mn)	mg/L	0.0323	0.0319	1%
Mercury (Hg)	mg/L	<0.0000050	<0.0000050	-
Molybdenum (Mo)	mg/L	<0.0010	<0.0010	-
Nickel (Ni)	mg/L	<0.0010	<0.0010	-
Potassium (K)	mg/L	<2.0	<2.0	-
Selenium (Se)	mg/L	0.000260	0.000293	12%
Silver (Ag)	mg/L	<0.000020	<0.000020	-
Sodium (Na)	mg/L	<2.0	<2.0	-
Thallium (Tl)	mg/L	<0.00020	<0.00020	-
Tin (Sn)	mg/L	<0.00050	<0.00050	-
Titanium (Ti)	mg/L	<0.010	<0.010	-
Uranium (U)	mg/L	0.00088	0.00089	1%
Vanadium (V)	mg/L	<0.00050	<0.00050	-
Zinc (Zn)	mg/L	<0.0050	<0.0050	-

🟧 Calculated Relative Percent Difference (RPD) did not meet the Data Quality Objective (DQO) of ≤ 25% RPD.

[a] RPD was calculated using < Method Detection Limit (MDL) results at 1x MDL if one result in a duplicate pair was below the MDL and one was above the MDL. RPD was not calculated if both results were < MDL.

(parameters included dissolved organic carbon, total aluminum, barium, manganese, silicon, sodium, and strontium, and dissolved barium, silicon, sodium, and strontium). All CRM, LCS, and MS results met ALS Environmental's data quality objectives for accuracy (Appendix C), with the exception of MS results that could not be calculated due to analyte concentrations in the spiked sample. Thus, laboratory accuracy associated with water samples in this study is considered excellent.

B2.5 Holding Time and General Laboratory Flags

A number of hold time exceedances were reported in the eight laboratory reports (Appendix C) due to the combination of short optimal hold times and remote sampling (sample shipment from Minto Mine, YT site to Burnaby, BC), factors which cannot readily be changed. Specifically, pH exceeded recommended hold times (15-minute hold times) in all 21 samples submitted in support of the Laboratory Fish Exposure study (L1811593, L1813894, L1818233, L1822573, L1825883, L1829581, and L1831166). However, the similarity of these laboratory pH data to corresponding *in situ* measures indicate these results are likely not highly impacted by this hold time exceedance. Additionally, the recommended hold times for nitrate and total alkalinity were each exceeded by one day in three samples, the former for samples UMC-1 to UMC-3 collected in support of the field Benthic Invertebrate Community sampling (laboratory report L1834209; Appendix C), and the latter for samples collected on August 29th, 2016 in support of the Laboratory Fish Exposure study (laboratory report L1822573; Appendix C). The hold time for total alkalinity in these samples was exceeded despite receipt of samples at the laboratory within the recommended hold time (laboratory report L1822573; Appendix C). Finally, recommended hold times for both nitrate and nitrite (3 days) were each exceeded by 4 days in three samples collected in support of the Laboratory Fish Exposure study on September 12th, 2016 (laboratory report L1829581; Appendix C). The exceedance of the nitrite hold time in particular may result in inaccurate results due to sample oxidation. These hold time exceedances should be considered during data interpretation, in particular for nitrite.

B3 BENTHIC INVERTEBRATE COMMUNITY SAMPLES

B3.1 Organism Recovery

Sorting efficiency (i.e., percent recovery) of the benthic invertebrate samples was high, achieving 98% for each of the two samples evaluated (Table B.3). Sorting efficiency for these samples achieved the DQO of ≥ 90% recovery, and therefore the benthic invertebrate community sample recovery was acceptable.

B3.2 Subsampling Accuracy

The entire sample was sorted for eight of the fifteen benthic invertebrate community samples analysed, and between 6% and 75% of the remaining 7 samples was sorted (Table B.4). The precision and accuracy of the one benthic invertebrate sample evaluated for sub-sampling precision (4.4%) met the DQO of ≤ 20% (Table B.5). Overall, this indicated that precision and accuracy for sub-sampling of the benthic invertebrate community samples was acceptable. It should be noted that measures of sub-sampling precision and accuracy did not meet the DQO for the first two samples that were examined by the laboratory, due to an issue with the sub-sampling device (Appendix D). As a result, analysis all of the sub-sampled samples was repeated after resolving the issue. The sub-sampling results presented (Table B.5) reflect the quality control results following the resolution of the issue.

Table B.3: Benthic Invertebrate Community Organism Recovery, Minto Mine Phase 4 EEM, 2016

Sample ID	Number of Organisms Recovered (Initial Sort)	Number of Organisms in Re-sort	Percent Recovery
UMC-2	180	4	98%
UMC-3	264	6	98%

▨ Highlighted values did not meet the Data Quality Objective (DQO) for sorting efficiencies of ≥ 90%.

Table B.4: Percent of Benthic Invertebrate Community Sample Sorted and Total Number of Invertebrate Recovered from Sampled Fraction (500 µm), Minto Mine Phase 4 EEM, 2016

Sample ID	Date	% Sampled	# Invertebrates
UMC-1	25-Sep-16	100%	301
UMC-2	22-Sep-16	100%	180
UMC-3	22-Sep-16	100%	264
UMC-4	25-Sep-16	100%	435
UMC-5	22-Sep-16	100%	267
REF-1	25-Sep-16	75%	370
REF-2	24-Sep-16	25%	332
REF-3	24-Sep-16	50%	351
REF-4	24-Sep-16	100%	145
REF-5	23-Sep-16	50%	381
REF-6	24-Sep-16	100%	354
REF-7	24-Sep-16	100%	357
REF-8	25-Sep-16	50%	328
REF-9	23-Sep-16	6%	324
REF-10	23-Sep-16	25%	597

Table B.5: Benthic Invertebrate Community Sub-Sampling Precision, Minto Mine Phase 4 EEM, 2016

Sample ID	Organisms in Subsample Fraction		Actual Density	Precision		Accuracy	
	1	2		Min (%)	Max (%)	Min (%)	Max (%)
REF-8	326	341	667	4.4	4.4	2.3	2.3

▨ Highlighted values did not meet the Data Quality Objective (DQO) for sub-sampling error of ≤ 20%.

B4 DATA QUALITY STATEMENT

Data collected for the Minto Mine Phase 4 EEM was of good quality as characterized by good detectability, negligible analyte concentrations in method blanks, good field and laboratory precision, and good laboratory accuracy. The recommended hold times were exceeded for nitrate in a subset of supporting samples collected for the field Benthic Invertebrate Community sampling, and for pH, total alkalinity, nitrate, and nitrite in a subset of supporting samples collected for the Laboratory Fish Exposure study. These hold time exceedances were due to the combination of short optimal hold times and remote sampling (factors which cannot readily be changed), however the hold time exceedances for these analytes should be considered during data interpretation. Overall, the supporting water quality and benthic invertebrate community data reviewed can be used with a good level of confidence in the derivation of conclusions.

APPENDIX C

WATER QUALITY DATA

CONTENTS OF APPENDIX C: WATER QUALITY DATA

PART 1: ALS Water Quality Laboratory Reports

PART 2: Water Quality Figure and Tables

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 10-AUG-16
Report Date: 23-AUG-16 18:31 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1811593
Project P.O. #: 221837 (WUL)
Job Reference:
C of C Numbers: 2016-08-10 B
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1811593-1	L1811593-2	L1811593-3		
	Description	Water	Water	Water		
	Sampled Date	08-AUG-16	08-AUG-16	08-AUG-16		
	Sampled Time	10:25	10:30	10:35		
	Client ID	E6	E3	C1		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	322	324	273		
	Hardness (as CaCO3) (mg/L)	136	139	119		
	pH (pH)	8.10	8.05	8.07		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	Total Dissolved Solids (mg/L)	176	180	148		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	107	110	95.0		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	107	110	95.0		
	Ammonia, Total (as N) (mg/L)	0.0712	0.0889	0.0485		
	Chloride (Cl) (mg/L)	26.9	22.0	23.8		
	Nitrate and Nitrite (as N) (mg/L)	1.06	1.55	0.402		
	Nitrate (as N) (mg/L)	1.05	1.53	0.402		
	Nitrite (as N) (mg/L)	0.0043	0.0135	<0.0010		
	Sulfate (SO4) (mg/L)	16.6	21.6	11.1		
	Anion Sum (meq/L)	3.32	3.37	2.83		
	Cation Sum (meq/L)	3.28	3.33	2.85		
	Cation - Anion Balance (%)	-0.6	-0.6	0.3		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0690	0.0719	0.0809		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00048	0.00053	0.00052		
	Barium (Ba)-Total (mg/L)	0.0495	0.0494	0.0446		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.011	0.016	<0.010		
	Cadmium (Cd)-Total (mg/L)	0.0000091	0.0000110	0.0000086		
	Calcium (Ca)-Total (mg/L)	42.2	42.2	36.2		
	Chromium (Cr)-Total (mg/L)	0.00020	0.00020	0.00022		
	Cobalt (Co)-Total (mg/L)	0.00018	0.00017	0.00016		
	Copper (Cu)-Total (mg/L)	0.00552	0.00864	0.00278		
	Iron (Fe)-Total (mg/L)	0.150	0.172	0.152		
	Lead (Pb)-Total (mg/L)	0.000342	0.000196	0.000198		
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Total (mg/L)	8.31	9.07	6.99		
	Manganese (Mn)-Total (mg/L)	0.0204	0.0330	0.00733		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00237	0.00259	0.00185		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1811593-1	L1811593-2	L1811593-3		
	Description	Water	Water	Water		
	Sampled Date	08-AUG-16	08-AUG-16	08-AUG-16		
	Sampled Time	10:25	10:30	10:35		
	Client ID	E6	E3	C1		
Grouping	**Analyte**					
WATER						
Total Metals	Nickel (Ni)-Total (mg/L)	0.00074	0.00080	0.00074		
	Phosphorus (P)-Total (mg/L)	<0.050	0.052	<0.050		
	Potassium (K)-Total (mg/L)	2.43	2.54	1.92		
	Selenium (Se)-Total (mg/L)	0.000328	0.000492	0.000153		
	Silicon (Si)-Total (mg/L)	4.39	4.03	4.41		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	12.0	12.2	9.56		
	Strontium (Sr)-Total (mg/L)	0.298	0.327	0.227		
	Sulfur (S)-Total (mg/L)	6.15	7.92	4.01		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00200	0.00227	0.00244		
	Uranium (U)-Total (mg/L)	0.00142	0.00136	0.00137		
	Vanadium (V)-Total (mg/L)	0.00072	0.00071	0.00070		
	Zinc (Zn)-Total (mg/L)	0.0195	0.0206	0.0092		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0204	0.0195	0.0173		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00043	0.00043	0.00045		
	Barium (Ba)-Dissolved (mg/L)	0.0488	0.0518	0.0438		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	0.015	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000057	0.0000084	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	41.3	41.4	36.4		
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	0.00013	0.00013	0.00013		
	Copper (Cu)-Dissolved (mg/L)	0.00365	0.00636	0.00140		
	Iron (Fe)-Dissolved (mg/L)	0.028	0.034	0.027		
	Lead (Pb)-Dissolved (mg/L)	0.000069	0.000050	0.000062		
	Lithium (Li)-Dissolved (mg/L)	0.0012	<0.0010	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	7.99	8.65	6.84		
	Manganese (Mn)-Dissolved (mg/L)	0.0129	0.0240	0.00311		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00220	0.00238	0.00183		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1811593-1 Water 08-AUG-16 10:25 E6	L1811593-2 Water 08-AUG-16 10:30 E3	L1811593-3 Water 08-AUG-16 10:35 C1		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00058	0.00064	0.00059		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Dissolved (mg/L)	2.30	2.41	1.85		
	Selenium (Se)-Dissolved (mg/L)	0.000304	0.000456	0.000156		
	Silicon (Si)-Dissolved (mg/L)	4.24	3.91	4.37		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	11.3	11.1	9.49		
	Strontium (Sr)-Dissolved (mg/L)	0.290	0.335	0.224		
	Sulfur (S)-Dissolved (mg/L)	5.83	7.55	3.95		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00130	0.00121	0.00134		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0186	0.0208	0.0094		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1811593-1, -2, -3
Matrix Spike	Aluminum (Al)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Titanium (Ti)-Total	MS-B	L1811593-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1811593-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Reference Information

CL-IC-N-WR Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-LOW-ICP-VA Water Dissolved Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-TOT-LOW-ICP-VA Water Total Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

Reference Information

S-DIS-ICP-VA Water Dissolved Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

S-TOT-ICP-VA Water Total Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

SO4-IC-N-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-08-10 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1811593 Report Date: 20-DEC-17

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3
Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-VA	**Water**							
Batch R3530741								
WG2371545-13 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			98.9		%		85-115	20-AUG-16
WG2371545-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	20-AUG-16
BE-D-L-CCMS-VA	**Water**							
Batch R3523960								
WG2365363-2 LCS								
Beryllium (Be)-Dissolved			101.2		%		80-120	11-AUG-16
BE-T-L-CCMS-VA	**Water**							
Batch R3529596								
WG2370965-2 LCS								
Beryllium (Be)-Total			102.8		%		80-120	19-AUG-16
WG2370965-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	19-AUG-16
CL-IC-N-WR	**Water**							
Batch R3531122								
WG2366021-10 LCS								
Chloride (Cl)			102.2		%		90-110	11-AUG-16
WG2366021-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	11-AUG-16
EC-PCT-VA	**Water**							
Batch R3530741								
WG2371545-14 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			101.5		%		90-110	20-AUG-16
WG2371545-11 MB								
Conductivity			<2.0		uS/cm		2	20-AUG-16
HG-D-CVAA-VA	**Water**							
Batch R3523987								
WG2365361-2 LCS								
Mercury (Hg)-Dissolved			95.5		%		80-120	11-AUG-16
WG2365361-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.000005C		mg/L		0.000005	11-AUG-16
HG-T-CVAA-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-T-CVAA-VA	**Water**							
Batch R3524172								
WG2366202-2 LCS								
Mercury (Hg)-Total			96.1		%		80-120	11-AUG-16
WG2366202-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	11-AUG-16
MET-D-CCMS-VA	**Water**							
Batch R3523960								
WG2365363-2 LCS								
Aluminum (Al)-Dissolved			103.0		%		80-120	11-AUG-16
Antimony (Sb)-Dissolved			96.8		%		80-120	11-AUG-16
Arsenic (As)-Dissolved			100.6		%		80-120	11-AUG-16
Barium (Ba)-Dissolved			97.0		%		80-120	11-AUG-16
Bismuth (Bi)-Dissolved			97.0		%		80-120	11-AUG-16
Boron (B)-Dissolved			95.6		%		80-120	11-AUG-16
Cadmium (Cd)-Dissolved			94.0		%		80-120	11-AUG-16
Chromium (Cr)-Dissolved			99.3		%		80-120	11-AUG-16
Cobalt (Co)-Dissolved			98.3		%		80-120	11-AUG-16
Copper (Cu)-Dissolved			98.4		%		80-120	11-AUG-16
Lead (Pb)-Dissolved			100.1		%		80-120	11-AUG-16
Lithium (Li)-Dissolved			105.2		%		80-120	11-AUG-16
Manganese (Mn)-Dissolved			99.0		%		80-120	11-AUG-16
Molybdenum (Mo)-Dissolved			104.1		%		80-120	11-AUG-16
Nickel (Ni)-Dissolved			98.6		%		80-120	11-AUG-16
Selenium (Se)-Dissolved			92.5		%		80-120	11-AUG-16
Silver (Ag)-Dissolved			103.1		%		80-120	11-AUG-16
Sodium (Na)-Dissolved			101.1		%		80-120	11-AUG-16
Strontium (Sr)-Dissolved			97.5		%		80-120	11-AUG-16
Thallium (Tl)-Dissolved			98.5		%		80-120	11-AUG-16
Tin (Sn)-Dissolved			97.7		%		80-120	11-AUG-16
Titanium (Ti)-Dissolved			94.6		%		80-120	11-AUG-16
Uranium (U)-Dissolved			102.8		%		80-120	11-AUG-16
Vanadium (V)-Dissolved			100.7		%		80-120	11-AUG-16
Zinc (Zn)-Dissolved			95.9		%		80-120	11-AUG-16
Zirconium (Zr)-Dissolved			99.3		%		80-120	11-AUG-16
MET-DIS-LOW-ICP-VA	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3523991								
WG2365363-2 LCS								
Calcium (Ca)-Dissolved			100.5		%		80-120	11-AUG-16
Iron (Fe)-Dissolved			89.5		%		80-120	11-AUG-16
Magnesium (Mg)-Dissolved			96.4		%		80-120	11-AUG-16
Phosphorus (P)-Dissolved			97.1		%		80-120	11-AUG-16
Potassium (K)-Dissolved			95.7		%		80-120	11-AUG-16
Silicon (Si)-Dissolved			97.5		%		80-120	11-AUG-16
WG2365363-1 MB		**NP**						
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	11-AUG-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	11-AUG-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	11-AUG-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	11-AUG-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	11-AUG-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	11-AUG-16
MET-T-CCMS-VA	**Water**							
Batch R3529596								
WG2370965-2 LCS								
Aluminum (Al)-Total			104.8		%		80-120	19-AUG-16
Antimony (Sb)-Total			104.7		%		80-120	19-AUG-16
Arsenic (As)-Total			108.6		%		80-120	19-AUG-16
Barium (Ba)-Total			106.1		%		80-120	19-AUG-16
Bismuth (Bi)-Total			103.2		%		80-120	19-AUG-16
Boron (B)-Total			102.5		%		80-120	19-AUG-16
Cadmium (Cd)-Total			104.4		%		80-120	19-AUG-16
Chromium (Cr)-Total			103.7		%		80-120	19-AUG-16
Cobalt (Co)-Total			103.4		%		80-120	19-AUG-16
Copper (Cu)-Total			101.2		%		80-120	19-AUG-16
Lead (Pb)-Total			104.2		%		80-120	19-AUG-16
Lithium (Li)-Total			103.7		%		80-120	19-AUG-16
Manganese (Mn)-Total			105.6		%		80-120	19-AUG-16
Molybdenum (Mo)-Total			108.7		%		80-120	19-AUG-16
Nickel (Ni)-Total			104.9		%		80-120	19-AUG-16
Selenium (Se)-Total			103.3		%		80-120	19-AUG-16
Silver (Ag)-Total			106.0		%		80-120	19-AUG-16
Sodium (Na)-Total			107.5		%		80-120	19-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3529596								
WG2370965-2 LCS								
Strontium (Sr)-Total			103.0		%		80-120	19-AUG-16
Thallium (Tl)-Total			102.8		%		80-120	19-AUG-16
Tin (Sn)-Total			102.5		%		80-120	19-AUG-16
Titanium (Ti)-Total			104.9		%		80-120	19-AUG-16
Uranium (U)-Total			106.2		%		80-120	19-AUG-16
Vanadium (V)-Total			105.5		%		80-120	19-AUG-16
Zinc (Zn)-Total			97.8		%		80-120	19-AUG-16
Zirconium (Zr)-Total			97.9		%		80-120	19-AUG-16
WG2370965-1 MB								
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	19-AUG-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	19-AUG-16
Barium (Ba)-Total			<0.000050		mg/L		0.00005	19-AUG-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	19-AUG-16
Boron (B)-Total			<0.010		mg/L		0.01	19-AUG-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	19-AUG-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	19-AUG-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	19-AUG-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	19-AUG-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	19-AUG-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	19-AUG-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	19-AUG-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	19-AUG-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	19-AUG-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	19-AUG-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	19-AUG-16
Sodium (Na)-Total			<0.050		mg/L		0.05	19-AUG-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	19-AUG-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	19-AUG-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	19-AUG-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	19-AUG-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	19-AUG-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	19-AUG-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	19-AUG-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	19-AUG-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3530225								
WG2370965-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	19-AUG-16
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3529516								
WG2370965-2 LCS								
Calcium (Ca)-Total			101.2		%		80-120	19-AUG-16
Iron (Fe)-Total			96.3		%		80-120	19-AUG-16
Magnesium (Mg)-Total			99.7		%		80-120	19-AUG-16
Phosphorus (P)-Total			96.9		%		80-120	19-AUG-16
Potassium (K)-Total			99.9		%		80-120	19-AUG-16
Silicon (Si)-Total			103.7		%		80-120	19-AUG-16
WG2370965-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	19-AUG-16
Iron (Fe)-Total			<0.010		mg/L		0.01	19-AUG-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	19-AUG-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	19-AUG-16
Potassium (K)-Total			<0.10		mg/L		0.1	19-AUG-16
Silicon (Si)-Total			<0.050		mg/L		0.05	19-AUG-16
NH3-F-VA	**Water**							
Batch R3531576								
WG2372738-6 LCS								
Ammonia, Total (as N)			99.8		%		85-115	23-AUG-16
WG2372738-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	23-AUG-16
NO2-L-IC-N-WR	**Water**							
Batch R3531122								
WG2366021-10 LCS								
Nitrite (as N)			99.9		%		90-110	11-AUG-16
WG2366021-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	11-AUG-16
NO3-L-IC-N-WR	**Water**							
Batch R3531122								
WG2366021-10 LCS								
Nitrate (as N)			101.9		%		90-110	11-AUG-16
WG2366021-9 MB								

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WR	**Water**							
Batch R3531122								
WG2366021-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	11-AUG-16
PH-PCT-VA	**Water**							
Batch R3530741								
WG2371545-12 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	20-AUG-16
S-DIS-ICP-VA	**Water**							
Batch R3523991								
WG2365363-2 LCS								
Sulfur (S)-Dissolved			94.1		%		80-120	11-AUG-16
WG2365363-1 MB		**NP**						
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	11-AUG-16
S-TOT-ICP-VA	**Water**							
Batch R3529516								
WG2370965-2 LCS								
Sulfur (S)-Total			103.4		%		80-120	19-AUG-16
WG2370965-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	19-AUG-16
SO4-IC-N-WR	**Water**							
Batch R3531122								
WG2366021-10 LCS								
Sulfate (SO4)			102.8		%		90-110	11-AUG-16
WG2366021-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	11-AUG-16
TSS-MAN-WR	**Water**							
Batch R3526741								
WG2366093-2 LCS								
Total Suspended Solids			89.8		%		85-115	11-AUG-16
WG2366093-1 MB								
Total Suspended Solids			<3.0		mg/L		3	11-AUG-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	08-AUG-16 10:25	20-AUG-16 09:55	0.25	288	hours	EHTR-FM
	2	08-AUG-16 10:30	20-AUG-16 09:55	0.25	288	hours	EHTR-FM
	3	08-AUG-16 10:35	20-AUG-16 09:55	0.25	287	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1811593 were received on 10-AUG-16 15:45.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1811593-COFC

COC Number: 2016-08-10 B

Page of

Report To Contact and company name below will appear on the final report
Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659
Company address below will appear on the final report
Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To
Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Report Format / Distribution
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply
Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐
EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐
Date and Time Required for all E&P TATs:
For tests that can not be performed according to the service level selected, you will be contacted.

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: 221837 (WUL)
LSD:

Oil and Gas Required Fields (client use)
AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)
ALS Contact: Ariel Tang
Sampler: SR/SB

Analysis Request
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	E6	8-Aug-16	10:25	Water	R	R	R	R	R	R	R	R						7
	E3	8-Aug-16	10:30	Water	R	R	R	R	R	R	R	R						7
	C1	8-Aug-16	10:35	Water	R	R	R	R	R	R	R	R						7

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System? ☐ YES ☑ NO
Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ S/F Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6.8	5.1	5.7	7.2	4.3	9

SHIPMENT RELEASE (client use)
Released by: Shaun Roberts Date: 2016-08-10 Time: 11:00

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: Date: 10-Aug-16 Time: 3:45

FINAL SHIPMENT RECEPTION (lab use only)
Received by: JC Date: 11 Aug Time: 15:00

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	16-AUG-16
Report Date:	26-AUG-16 14:14 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1813894

Project P.O. #:	221837 (WUL)
Job Reference:	
C of C Numbers:	2016-08-15 B
Legal Site Desc:	

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1813894-1	L1813894-2	L1813894-3		
	Description	Water	Water	Water		
	Sampled Date	15-AUG-16	15-AUG-16	15-AUG-16		
	Sampled Time	08:10	08:38	07:30		
	Client ID	E6	E3	C1		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	209	236	169		
	Hardness (as CaCO3) (mg/L)	95.3	110	78.6		
	pH (pH)	7.82	7.82	7.76		
	Total Suspended Solids (mg/L)	4.0	5.3	3.3		
	Total Dissolved Solids (mg/L)	117	136	91.0		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	87.4	95.4	76.2		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	87.4	95.4	76.2		
	Ammonia, Total (as N) (mg/L)	0.464	0.475	0.403		
	Chloride (Cl) (mg/L)	3.09	3.04	1.92		
	Nitrate and Nitrite (as N) (mg/L)	0.768	1.33	0.0283		
	Nitrate (as N) (mg/L)	0.761	1.32	0.0283		
	Nitrite (as N) (mg/L)	0.0070	0.0129	<0.0010		
	Sulfate (SO4) (mg/L)	17.0	22.1	10.4		
	Anion Sum (meq/L)	2.24	2.55	1.80		
	Cation Sum (meq/L)	2.19	2.56	1.78		
	Cation - Anion Balance (%)	-1.2	0.2	-0.5		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0614	0.0838	0.0537		
	Antimony (Sb)-Total (mg/L)	0.00010	0.00010	0.00010		
	Arsenic (As)-Total (mg/L)	0.00086	0.00097	0.00087		
	Barium (Ba)-Total (mg/L)	0.0433	0.0486	0.0406		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	0.011	0.016	<0.010		
	Cadmium (Cd)-Total (mg/L)	0.0000091	0.0000127	0.0000114		
	Calcium (Ca)-Total (mg/L)	28.8	31.9	22.8		
	Chromium (Cr)-Total (mg/L)	0.00026	0.00030	0.00027		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00538	0.00785	0.00196		
	Iron (Fe)-Total (mg/L)	0.156	0.177	0.121		
	Lead (Pb)-Total (mg/L)	0.000166	DLB <0.00030	0.000125		
	Lithium (Li)-Total (mg/L)	0.0011	<0.0010	<0.0010		
	Magnesium (Mg)-Total (mg/L)	7.19	8.12	5.92		
	Manganese (Mn)-Total (mg/L)	0.0147	0.0277	0.00594		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00178	0.00216	0.00132		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1813894-1	L1813894-2	L1813894-3		
	Description	Water	Water	Water		
	Sampled Date	15-AUG-16	15-AUG-16	15-AUG-16		
	Sampled Time	08:10	08:38	07:30		
	Client ID	E6	E3	C1		
Grouping	**Analyte**					
WATER						
Total Metals	Nickel (Ni)-Total (mg/L)	0.00074	0.00083	0.00074		
	Phosphorus (P)-Total (mg/L)	0.124	0.124	0.109		
	Potassium (K)-Total (mg/L)	1.42	1.73	0.98		
	Selenium (Se)-Total (mg/L)	0.000327	0.000481	0.000137		
	Silicon (Si)-Total (mg/L)	3.73	3.61	3.88		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	5.32	6.77	3.59		
	Strontium (Sr)-Total (mg/L)	0.208	0.260	0.141		
	Sulfur (S)-Total (mg/L)	6.28	8.01	3.90		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00200	0.00259	0.00171		
	Uranium (U)-Total (mg/L)	0.00112	0.00110	0.00108		
	Vanadium (V)-Total (mg/L)	0.00070	0.00077	0.00075		
	Zinc (Zn)-Total (mg/L)	0.0142	0.0179	0.0096		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0137	0.0140	0.0129		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00060	0.00060	0.00066		
	Barium (Ba)-Dissolved (mg/L)	0.0396	0.0442	0.0378		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	0.015	<0.010		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000054	0.0000064	0.0000073		
	Calcium (Ca)-Dissolved (mg/L)	26.7	31.3	22.1		
	Chromium (Cr)-Dissolved (mg/L)	0.00013	0.00015	0.00015		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00390	0.00611	0.00137		
	Iron (Fe)-Dissolved (mg/L)	0.034	0.033	0.031		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	6.96	7.84	5.70		
	Manganese (Mn)-Dissolved (mg/L)	0.00221	0.00248	0.00134		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00159	0.00187	0.00117		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1813894-1	L1813894-2	L1813894-3		
	Description	Water	Water	Water		
	Sampled Date	15-AUG-16	15-AUG-16	15-AUG-16		
	Sampled Time	08:10	08:38	07:30		
	Client ID	E6	E3	C1		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00057	0.00066	0.00060		
	Phosphorus (P)-Dissolved (mg/L)	0.062	0.081	0.068		
	Potassium (K)-Dissolved (mg/L)	1.33	1.62	0.93		
	Selenium (Se)-Dissolved (mg/L)	0.000308	0.000490	0.000142		
	Silicon (Si)-Dissolved (mg/L)	3.55	3.37	3.73		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	4.98	6.28	3.49		
	Strontium (Sr)-Dissolved (mg/L)	0.206	0.248	0.135		
	Sulfur (S)-Dissolved (mg/L)	5.91	7.66	3.61		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	0.00033	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00104	0.00106	0.00102		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	0.00056		
	Zinc (Zn)-Dissolved (mg/L)	0.0109	0.0137	0.0076		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Antimony (Sb)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Arsenic (As)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1813894-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1813894-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLB	Detection Limit Raised. Analyte detected at comparable level in Method Blank.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

Reference Information

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-LOW-ICP-VA Water Dissolved Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-TOT-LOW-ICP-VA Water Total Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

S-DIS-ICP-VA Water Dissolved Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

S-TOT-ICP-VA Water Total Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

Reference Information

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

SO4-IC-N-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-08-15 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3
Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-VA	**Water**							
Batch R3530970								
WG2372376-13 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			96.3		%		85-115	22-AUG-16
WG2372376-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	22-AUG-16
BE-D-L-CCMS-VA	**Water**							
Batch R3527994								
WG2369236-2 LCS								
Beryllium (Be)-Dissolved			104.3		%		80-120	17-AUG-16
WG2369236-1 MB		**NP**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	17-AUG-16
Batch R3533654								
WG2369236-17 DUP		**L1813894-3**						
Beryllium (Be)-Dissolved		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	24-AUG-16
BE-T-L-CCMS-VA	**Water**							
Batch R3532912								
WG2373588-2 LCS								
Beryllium (Be)-Total			99.8		%		80-120	24-AUG-16
WG2373588-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	24-AUG-16
CL-IC-N-WR	**Water**							
Batch R3532062								
WG2369969-2 LCS								
Chloride (Cl)			100.7		%		90-110	17-AUG-16
WG2369969-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	17-AUG-16
EC-PCT-VA	**Water**							
Batch R3530970								
WG2372376-14 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			102.4		%		90-110	22-AUG-16
WG2372376-11 MB								
Conductivity			<2.0		uS/cm		2	22-AUG-16
HG-D-CVAA-VA	**Water**							
Batch R3528752								
WG2370111-2 LCS								
Mercury (Hg)-Dissolved			108.2		%		80-120	18-AUG-16
WG2370111-1 MB		**NP**						

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-CVAA-VA	**Water**							
Batch R3528752								
WG2370111-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	18-AUG-16
HG-T-CVAA-VA	**Water**							
Batch R3528752								
WG2370800-2 LCS								
Mercury (Hg)-Total			105.8		%		80-120	18-AUG-16
WG2370800-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	18-AUG-16
MET-D-CCMS-VA	**Water**							
Batch R3527994								
WG2369236-2 LCS								
Aluminum (Al)-Dissolved			110.9		%		80-120	17-AUG-16
Antimony (Sb)-Dissolved			101.5		%		80-120	17-AUG-16
Arsenic (As)-Dissolved			105.8		%		80-120	17-AUG-16
Barium (Ba)-Dissolved			102.4		%		80-120	17-AUG-16
Bismuth (Bi)-Dissolved			103.0		%		80-120	17-AUG-16
Boron (B)-Dissolved			100.5		%		80-120	17-AUG-16
Cadmium (Cd)-Dissolved			104.4		%		80-120	17-AUG-16
Chromium (Cr)-Dissolved			108.6		%		80-120	17-AUG-16
Cobalt (Co)-Dissolved			105.7		%		80-120	17-AUG-16
Copper (Cu)-Dissolved			105.0		%		80-120	17-AUG-16
Lead (Pb)-Dissolved			104.5		%		80-120	17-AUG-16
Lithium (Li)-Dissolved			107.2		%		80-120	17-AUG-16
Manganese (Mn)-Dissolved			107.3		%		80-120	17-AUG-16
Molybdenum (Mo)-Dissolved			108.9		%		80-120	17-AUG-16
Nickel (Ni)-Dissolved			104.8		%		80-120	17-AUG-16
Selenium (Se)-Dissolved			105.4		%		80-120	17-AUG-16
Silver (Ag)-Dissolved			103.2		%		80-120	17-AUG-16
Sodium (Na)-Dissolved			105.8		%		80-120	17-AUG-16
Strontium (Sr)-Dissolved			103.3		%		80-120	17-AUG-16
Thallium (Tl)-Dissolved			103.8		%		80-120	17-AUG-16
Tin (Sn)-Dissolved			101.9		%		80-120	17-AUG-16
Titanium (Ti)-Dissolved			101.1		%		80-120	17-AUG-16
Uranium (U)-Dissolved			101.9		%		80-120	17-AUG-16
Vanadium (V)-Dissolved			106.1		%		80-120	17-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3527994								
WG2369236-2 LCS								
Zinc (Zn)-Dissolved			102.3		%		80-120	17-AUG-16
Zirconium (Zr)-Dissolved			99.8		%		80-120	17-AUG-16
WG2369236-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	17-AUG-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	17-AUG-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	17-AUG-16
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	17-AUG-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	17-AUG-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	17-AUG-16
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	17-AUG-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	17-AUG-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	17-AUG-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	17-AUG-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	17-AUG-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	17-AUG-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	17-AUG-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	17-AUG-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	17-AUG-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	17-AUG-16
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	17-AUG-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	17-AUG-16
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	17-AUG-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	17-AUG-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	17-AUG-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	17-AUG-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	17-AUG-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	17-AUG-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	17-AUG-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	17-AUG-16
Batch R3533654								
WG2369236-17 DUP		**L1813894-3**						
Aluminum (Al)-Dissolved		0.0129	0.0127		mg/L	1.7	20	24-AUG-16
Antimony (Sb)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	24-AUG-16
Arsenic (As)-Dissolved		0.00066	0.00062		mg/L	5.6	20	24-AUG-16
Barium (Ba)-Dissolved		0.0378	0.0381		mg/L	0.9	20	24-AUG-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3533654								
WG2369236-17 DUP		**L1813894-3**						
Bismuth (Bi)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	24-AUG-16
Boron (B)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	24-AUG-16
Cadmium (Cd)-Dissolved		0.0000073	0.0000072		mg/L	1.1	20	24-AUG-16
Chromium (Cr)-Dissolved		0.00015	0.00018		mg/L	16	20	24-AUG-16
Cobalt (Co)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	24-AUG-16
Copper (Cu)-Dissolved		0.00137	0.00134		mg/L	2.4	20	24-AUG-16
Lead (Pb)-Dissolved		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	24-AUG-16
Lithium (Li)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	24-AUG-16
Manganese (Mn)-Dissolved		0.00134	0.00125		mg/L	6.7	20	24-AUG-16
Molybdenum (Mo)-Dissolved		0.00117	0.00119		mg/L	1.5	20	24-AUG-16
Nickel (Ni)-Dissolved		0.00060	0.00063		mg/L	4.3	20	24-AUG-16
Selenium (Se)-Dissolved		0.000142	0.000131		mg/L	8.0	20	24-AUG-16
Silver (Ag)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	24-AUG-16
Sodium (Na)-Dissolved		3.49	3.45		mg/L	1.2	20	24-AUG-16
Strontium (Sr)-Dissolved		0.135	0.135		mg/L	0.2	20	24-AUG-16
Thallium (Tl)-Dissolved		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	24-AUG-16
Tin (Sn)-Dissolved		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	24-AUG-16
Titanium (Ti)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	24-AUG-16
Uranium (U)-Dissolved		0.00102	0.00101		mg/L	1.4	20	24-AUG-16
Vanadium (V)-Dissolved		0.00056	0.00053		mg/L	4.1	20	24-AUG-16
Zinc (Zn)-Dissolved		0.0076	0.0075		mg/L	1.8	20	24-AUG-16
Zirconium (Zr)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	24-AUG-16
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3527812								
WG2369236-1 MB		**NP**						
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	17-AUG-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	17-AUG-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	17-AUG-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	17-AUG-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	17-AUG-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	17-AUG-16
Batch R3527985								
WG2369236-2 LCS								
Calcium (Ca)-Dissolved			99.6		%		80-120	17-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3527985								
WG2369236-2 LCS								
Iron (Fe)-Dissolved			95.5		%		80-120	17-AUG-16
Magnesium (Mg)-Dissolved			100.1		%		80-120	17-AUG-16
Phosphorus (P)-Dissolved			99.3		%		80-120	17-AUG-16
Potassium (K)-Dissolved			97.3		%		80-120	17-AUG-16
Silicon (Si)-Dissolved			103.7		%		80-120	17-AUG-16
Batch R3532688								
WG2369236-17 DUP		**L1813894-3**						
Calcium (Ca)-Dissolved		22.1	22.1		mg/L	0.2	20	23-AUG-16
Iron (Fe)-Dissolved		0.031	0.030		mg/L	3.0	20	23-AUG-16
Magnesium (Mg)-Dissolved		5.70	5.71		mg/L	0.2	20	23-AUG-16
Phosphorus (P)-Dissolved		0.068	0.078		mg/L	13	20	23-AUG-16
Potassium (K)-Dissolved		0.93	0.92		mg/L	0.9	20	23-AUG-16
Silicon (Si)-Dissolved		3.73	3.76		mg/L	0.7	20	23-AUG-16
MET-T-CCMS-VA	**Water**							
Batch R3532912								
WG2373588-2 LCS								
Aluminum (Al)-Total			104.1		%		80-120	24-AUG-16
Antimony (Sb)-Total			104.4		%		80-120	24-AUG-16
Arsenic (As)-Total			106.2		%		80-120	24-AUG-16
Barium (Ba)-Total			105.4		%		80-120	24-AUG-16
Bismuth (Bi)-Total			102.8		%		80-120	24-AUG-16
Boron (B)-Total			99.2		%		80-120	24-AUG-16
Cadmium (Cd)-Total			99.2		%		80-120	24-AUG-16
Chromium (Cr)-Total			95.9		%		80-120	24-AUG-16
Cobalt (Co)-Total			102.1		%		80-120	24-AUG-16
Copper (Cu)-Total			99.5		%		80-120	24-AUG-16
Lead (Pb)-Total			101.3		%		80-120	24-AUG-16
Lithium (Li)-Total			106.4		%		80-120	24-AUG-16
Manganese (Mn)-Total			100.4		%		80-120	24-AUG-16
Molybdenum (Mo)-Total			104.0		%		80-120	24-AUG-16
Nickel (Ni)-Total			103.5		%		80-120	24-AUG-16
Selenium (Se)-Total			102.7		%		80-120	24-AUG-16
Silver (Ag)-Total			97.9		%		80-120	24-AUG-16
Sodium (Na)-Total			102.0		%		80-120	24-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3532912								
WG2373588-2 LCS								
Strontium (Sr)-Total			100.6		%		80-120	24-AUG-16
Thallium (Tl)-Total			105.5		%		80-120	24-AUG-16
Tin (Sn)-Total			98.3		%		80-120	24-AUG-16
Titanium (Ti)-Total			98.8		%		80-120	24-AUG-16
Uranium (U)-Total			98.9		%		80-120	24-AUG-16
Vanadium (V)-Total			102.7		%		80-120	24-AUG-16
Zinc (Zn)-Total			97.0		%		80-120	24-AUG-16
Zirconium (Zr)-Total			95.8		%		80-120	24-AUG-16
WG2373588-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	24-AUG-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	24-AUG-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	24-AUG-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	24-AUG-16
Boron (B)-Total			<0.010		mg/L		0.01	24-AUG-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	24-AUG-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	24-AUG-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	24-AUG-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	24-AUG-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	24-AUG-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	24-AUG-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	24-AUG-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	24-AUG-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	24-AUG-16
Sodium (Na)-Total			<0.050		mg/L		0.05	24-AUG-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	24-AUG-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	24-AUG-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	24-AUG-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	24-AUG-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	24-AUG-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	24-AUG-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	24-AUG-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	24-AUG-16
MET-TOT-LOW-ICP-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3532688								
WG2373588-2 LCS								
Calcium (Ca)-Total			100.1		%		80-120	23-AUG-16
Iron (Fe)-Total			93.8		%		80-120	23-AUG-16
Magnesium (Mg)-Total			98.3		%		80-120	23-AUG-16
Phosphorus (P)-Total			96.9		%		80-120	23-AUG-16
Potassium (K)-Total			101.4		%		80-120	23-AUG-16
Silicon (Si)-Total			102.7		%		80-120	23-AUG-16
WG2373588-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	23-AUG-16
Iron (Fe)-Total			<0.010		mg/L		0.01	23-AUG-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	23-AUG-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	23-AUG-16
Potassium (K)-Total			<0.10		mg/L		0.1	23-AUG-16
Silicon (Si)-Total			<0.050		mg/L		0.05	23-AUG-16
NH3-F-VA	**Water**							
Batch R3532986								
WG2374307-6 LCS								
Ammonia, Total (as N)			101.6		%		85-115	24-AUG-16
WG2374307-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-AUG-16
Batch R3533269								
WG2374311-2 LCS								
Ammonia, Total (as N)			100.2		%		85-115	25-AUG-16
WG2374311-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	25-AUG-16
NO2-L-IC-N-WR	**Water**							
Batch R3532062								
WG2369969-2 LCS								
Nitrite (as N)			99.4		%		90-110	17-AUG-16
WG2369969-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	17-AUG-16
NO3-L-IC-N-WR	**Water**							
Batch R3532062								
WG2369969-2 LCS								
Nitrate (as N)			100.7		%		90-110	17-AUG-16
WG2369969-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	17-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R3530970								
WG2372376-12 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	22-AUG-16
S-DIS-ICP-VA	**Water**							
Batch R3527812								
WG2369236-1 MB		**NP**						
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	17-AUG-16
Batch R3527985								
WG2369236-2 LCS								
Sulfur (S)-Dissolved			105.2		%		80-120	17-AUG-16
Batch R3532688								
WG2369236-17 DUP		**L1813894-3**						
Sulfur (S)-Dissolved		3.61	3.65		mg/L	1.1	20	23-AUG-16
S-TOT-ICP-VA	**Water**							
Batch R3532688								
WG2373588-2 LCS								
Sulfur (S)-Total			102.7		%		80-120	23-AUG-16
WG2373588-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	23-AUG-16
SO4-IC-N-WR	**Water**							
Batch R3532062								
WG2369969-2 LCS								
Sulfate (SO4)			101.4		%		90-110	17-AUG-16
WG2369969-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	17-AUG-16
TSS-MAN-WR	**Water**							
Batch R3531911								
WG2373087-2 LCS								
Total Suspended Solids			95.1		%		85-115	22-AUG-16
WG2373087-1 MB								
Total Suspended Solids			<3.0		mg/L		3	22-AUG-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	15-AUG-16 08:10	22-AUG-16 08:42	0.25	168	hours	EHTR-FM
	2	15-AUG-16 08:38	22-AUG-16 08:42	0.25	168	hours	EHTR-FM
	3	15-AUG-16 07:30	22-AUG-16 08:42	0.25	169	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1813894 were received on 16-AUG-16 10:05.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here
(lab use only)

COC Number: 2016-08-15 B

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 221837 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Tang **Sampler:** CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	E6	15-Aug-16	8:10	Water	R	R	R	R	R	R	R	R						6
	E3	15-Aug-16	8:38	Water	R	R	R	R	R	R	R	R						6
	C1	15-Aug-16	7:30	Water	R	R	R	R	R	R	R	R						6

Short Holding Time
Rush Processing

L1813894-COFC

Drinking Water (DW) Samples¹ (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special

p-down list below

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			-2.1	5	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Blurton	Date: 2016-08-15	Time: 12:30	Received by: Shayan	Date: Aug. 16	Time: 1005	Received by: JC	Date: AUG 1 7 2016	Time: 12:40

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 24-AUG-16
Report Date: 07-SEP-16 18:00 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1818233

Project P.O. #: 221837 (WUL)
Job Reference:
C of C Numbers: 2016-08-23 B
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1818233-1	L1818233-2	L1818233-3		
	Description	Water	Water	Water		
	Sampled Date	22-AUG-16	22-AUG-16	22-AUG-16		
	Sampled Time	07:50	08:25	08:50		
	Client ID	C1	E6	E3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	161	205	231		
	Hardness (as CaCO3) (mg/L)	77.0	94.1	111		
	pH (pH)	7.75	7.88	7.86		
	Total Suspended Solids (mg/L)	4.0	4.0	6.0		
	Total Dissolved Solids (mg/L)	88.3	116	136		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	75.7	89.2	95.5		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	75.7	89.2	95.5		
	Ammonia, Total (as N) (mg/L)	0.384	0.441	0.470		
	Chloride (Cl) (mg/L)	0.69	1.57	2.01		
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	0.769	1.31		
	Nitrate (as N) (mg/L)	<0.0050	0.761	1.29		
	Nitrite (as N) (mg/L)	<0.0010	0.0075	0.0136		
	Sulfate (SO4) (mg/L)	10.6	17.6	22.4		
	Anion Sum (meq/L)	1.75	2.25	2.52		
	Cation Sum (meq/L)	1.72	2.15	2.61		
	Cation - Anion Balance (%)	-0.8	-2.2	1.6		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0466	0.0499	0.0447		
	Antimony (Sb)-Total (mg/L)	0.00012	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00085	0.00078	0.00082		
	Barium (Ba)-Total (mg/L)	0.0407	0.0473	0.0482		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.014		
	Cadmium (Cd)-Total (mg/L)	0.0000127	0.0000105	0.0000115		
	Calcium (Ca)-Total (mg/L)	21.6	26.5	31.9		
	Chromium (Cr)-Total (mg/L)	0.00032	0.00023	0.00025		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00219	0.00541	0.00762		
	Iron (Fe)-Total (mg/L)	0.119	0.131	0.119		
	Lead (Pb)-Total (mg/L)	0.000111	0.000128	0.000126		
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Total (mg/L)	5.75	7.15	8.23		
	Manganese (Mn)-Total (mg/L)	0.00609	0.0121	0.0157		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00133	0.00183	0.00214		

ALS ENVIRONMENTAL ANALYTICAL REPORT

		Sample ID Description Sampled Date Sampled Time Client ID	L1818233-1 Water 22-AUG-16 07:50 C1	L1818233-2 Water 22-AUG-16 08:25 E6	L1818233-3 Water 22-AUG-16 08:50 E3		
Grouping	**Analyte**						
WATER							
Total Metals	Nickel (Ni)-Total (mg/L)		0.00065	0.00072	0.00061		
	Phosphorus (P)-Total (mg/L)		0.099	0.129	0.113		
	Potassium (K)-Total (mg/L)		0.89	1.27	1.60		
	Selenium (Se)-Total (mg/L)		0.000111	0.000357	0.000455		
	Silicon (Si)-Total (mg/L)		3.50	3.37	3.29		
	Silver (Ag)-Total (mg/L)		<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)		2.97	4.88	6.07		
	Strontium (Sr)-Total (mg/L)		0.135	0.209	0.257		
	Sulfur (S)-Total (mg/L)		3.65	6.06	7.63		
	Thallium (Tl)-Total (mg/L)		<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)		<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)		0.00148	0.00149	0.00135		
	Uranium (U)-Total (mg/L)		0.00103	0.00108	0.00107		
	Vanadium (V)-Total (mg/L)		0.00071	0.00071	0.00068		
	Zinc (Zn)-Total (mg/L)		0.0077	0.0119	0.0159		
	Zirconium (Zr)-Total (mg/L)		<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location		FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location		FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)		0.0111	0.0112	0.0096		
	Antimony (Sb)-Dissolved (mg/L)		<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)		0.00064	0.00063	0.00058		
	Barium (Ba)-Dissolved (mg/L)		0.0400	0.0441	0.0458		
	Beryllium (Be)-Dissolved (mg/L)		<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)		<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)		<0.010	<0.010	0.015		
	Cadmium (Cd)-Dissolved (mg/L)		0.0000083	0.0000066	0.0000074		
	Calcium (Ca)-Dissolved (mg/L)		21.5	26.1	31.5		
	Chromium (Cr)-Dissolved (mg/L)		0.00015	0.00011	0.00011		
	Cobalt (Co)-Dissolved (mg/L)		<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)		0.00127	0.00389	0.00554		
	Iron (Fe)-Dissolved (mg/L)		0.026	0.026	0.023		
	Lead (Pb)-Dissolved (mg/L)		<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)		<0.0010	<0.0010	0.0028		
	Magnesium (Mg)-Dissolved (mg/L)		5.69	7.03	7.93		
	Manganese (Mn)-Dissolved (mg/L)		0.00083	0.00147	0.00223		
	Mercury (Hg)-Dissolved (mg/L)		<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)		0.00124	0.00167	0.00192		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1818233-1	L1818233-2	L1818233-3
	Description	Water	Water	Water
	Sampled Date	22-AUG-16	22-AUG-16	22-AUG-16
	Sampled Time	07:50	08:25	08:50
	Client ID	C1	E6	E3
Grouping	**Analyte**			
WATER				
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00051	<0.00050	0.00054
	Phosphorus (P)-Dissolved (mg/L)	0.055	0.068	0.074
	Potassium (K)-Dissolved (mg/L)	0.84	1.26	1.51
	Selenium (Se)-Dissolved (mg/L)	0.000132	0.000347	0.000492
	Silicon (Si)-Dissolved (mg/L)	3.45	3.29	3.16
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	3.08	4.70	7.15
	Strontium (Sr)-Dissolved (mg/L)	0.132	0.202	0.263
	Sulfur (S)-Dissolved (mg/L)	3.61	6.00	7.60
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030
	Uranium (U)-Dissolved (mg/L)	0.000984	0.00101	0.00102
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0053	0.0085	0.0130
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1818233-1, -2, -3
Matrix Spike	Nitrate (as N)	MS-B	L1818233-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA	Water	Ion Balance Calculation	APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-LOW-ICP-VA Water Dissolved Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-TOT-LOW-ICP-VA Water Total Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

S-DIS-ICP-VA Water Dissolved Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

S-TOT-ICP-VA Water Total Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

SO4-IC-N-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

Reference Information

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-08-23 B

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1818233 Report Date: 20-DEC-17

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3
Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-VA	**Water**							
Batch R3537833								
WG2378617-18 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			100.5		%		85-115	31-AUG-16
WG2378617-23 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			100.1		%		85-115	31-AUG-16
WG2378617-25 DUP		**L1818233-1**						
Alkalinity, Total (as CaCO3)		75.7	75.7		mg/L	0.0	20	31-AUG-16
WG2378617-16 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	31-AUG-16
WG2378617-21 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	31-AUG-16
BE-D-L-CCMS-VA	**Water**							
Batch R3534863								
WG2375965-2 LCS								
Beryllium (Be)-Dissolved			104.4		%		80-120	26-AUG-16
WG2375965-1 MB		**NP**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	26-AUG-16
BE-T-L-CCMS-VA	**Water**							
Batch R3538728								
WG2379637-2 LCS								
Beryllium (Be)-Total			96.0		%		80-120	31-AUG-16
WG2379637-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	31-AUG-16
CL-IC-N-WR	**Water**							
Batch R3536516								
WG2375618-2 LCS								
Chloride (Cl)			104.5		%		90-110	25-AUG-16
WG2375618-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	25-AUG-16
EC-PCT-VA	**Water**							
Batch R3537833								
WG2378617-19 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			101.9		%		90-110	31-AUG-16
WG2378617-24 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			102.6		%		90-110	31-AUG-16
WG2378617-25 DUP		**L1818233-1**						
Conductivity		161	159		uS/cm	1.3	10	31-AUG-16
WG2378617-16 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-PCT-VA	**Water**							
Batch R3537833								
WG2378617-16 MB								
Conductivity			<2.0		uS/cm		2	31-AUG-16
WG2378617-21 MB								
Conductivity			<2.0		uS/cm		2	31-AUG-16
HG-D-CVAA-VA	**Water**							
Batch R3534718								
WG2375948-4 DUP		**L1818233-2**						
Mercury (Hg)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	26-AUG-16
Batch R3534765								
WG2375948-2 LCS								
Mercury (Hg)-Dissolved			101.5		%		80-120	26-AUG-16
Batch R3534939								
WG2375948-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	26-AUG-16
HG-T-CVAA-VA	**Water**							
Batch R3534596								
WG2376295-2 LCS								
Mercury (Hg)-Total			115.8		%		80-120	26-AUG-16
WG2376295-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	26-AUG-16
MET-D-CCMS-VA	**Water**							
Batch R3534863								
WG2375965-2 LCS								
Aluminum (Al)-Dissolved			105.2		%		80-120	26-AUG-16
Antimony (Sb)-Dissolved			98.1		%		80-120	26-AUG-16
Arsenic (As)-Dissolved			107.0		%		80-120	26-AUG-16
Barium (Ba)-Dissolved			107.1		%		80-120	26-AUG-16
Bismuth (Bi)-Dissolved			101.6		%		80-120	26-AUG-16
Boron (B)-Dissolved			97.1		%		80-120	26-AUG-16
Cadmium (Cd)-Dissolved			104.6		%		80-120	26-AUG-16
Chromium (Cr)-Dissolved			106.3		%		80-120	26-AUG-16
Cobalt (Co)-Dissolved			105.0		%		80-120	26-AUG-16
Copper (Cu)-Dissolved			103.8		%		80-120	26-AUG-16
Lead (Pb)-Dissolved			102.9		%		80-120	26-AUG-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3534863								
WG2375965-2 LCS								
Lithium (Li)-Dissolved			103.3		%		80-120	26-AUG-16
Manganese (Mn)-Dissolved			103.9		%		80-120	26-AUG-16
Molybdenum (Mo)-Dissolved			106.0		%		80-120	26-AUG-16
Nickel (Ni)-Dissolved			102.9		%		80-120	26-AUG-16
Selenium (Se)-Dissolved			98.7		%		80-120	26-AUG-16
Silver (Ag)-Dissolved			104.2		%		80-120	26-AUG-16
Sodium (Na)-Dissolved			104.7		%		80-120	26-AUG-16
Strontium (Sr)-Dissolved			100.7		%		80-120	26-AUG-16
Thallium (Tl)-Dissolved			103.9		%		80-120	26-AUG-16
Tin (Sn)-Dissolved			103.1		%		80-120	26-AUG-16
Titanium (Ti)-Dissolved			105.9		%		80-120	26-AUG-16
Uranium (U)-Dissolved			101.7		%		80-120	26-AUG-16
Vanadium (V)-Dissolved			106.9		%		80-120	26-AUG-16
Zinc (Zn)-Dissolved			95.8		%		80-120	26-AUG-16
Zirconium (Zr)-Dissolved			95.1		%		80-120	26-AUG-16
WG2375965-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	26-AUG-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	26-AUG-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	26-AUG-16
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	26-AUG-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	26-AUG-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	26-AUG-16
Cadmium (Cd)-Dissolved			<0.000005		mg/L		0.000005	26-AUG-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	26-AUG-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	26-AUG-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	26-AUG-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	26-AUG-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	26-AUG-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	26-AUG-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	26-AUG-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	26-AUG-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	26-AUG-16
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	26-AUG-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	26-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3534863								
WG2375965-1 MB		**NP**						
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	26-AUG-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	26-AUG-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	26-AUG-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	26-AUG-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	26-AUG-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	26-AUG-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	26-AUG-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	26-AUG-16
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3534745								
WG2375965-2 LCS								
Calcium (Ca)-Dissolved			101.9		%		80-120	26-AUG-16
Iron (Fe)-Dissolved			93.9		%		80-120	26-AUG-16
Magnesium (Mg)-Dissolved			99.2		%		80-120	26-AUG-16
Phosphorus (P)-Dissolved			101.5		%		80-120	26-AUG-16
Potassium (K)-Dissolved			97.1		%		80-120	26-AUG-16
Silicon (Si)-Dissolved			102.9		%		80-120	26-AUG-16
WG2375965-1 MB		**NP**						
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	26-AUG-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	26-AUG-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	26-AUG-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	26-AUG-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	26-AUG-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	26-AUG-16
MET-T-CCMS-VA	**Water**							
Batch R3538728								
WG2379637-2 LCS								
Aluminum (Al)-Total			96.3		%		80-120	31-AUG-16
Antimony (Sb)-Total			90.7		%		80-120	31-AUG-16
Arsenic (As)-Total			101.3		%		80-120	31-AUG-16
Barium (Ba)-Total			94.3		%		80-120	31-AUG-16
Bismuth (Bi)-Total			88.3		%		80-120	31-AUG-16
Boron (B)-Total			90.6		%		80-120	31-AUG-16
Cadmium (Cd)-Total			96.6		%		80-120	31-AUG-16
Chromium (Cr)-Total			97.2		%		80-120	31-AUG-16

Quality Control Report

Workorder: L1818233 Report Date: 20-DEC-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3538728								
WG2379637-2 LCS								
Cobalt (Co)-Total			98.1		%		80-120	31-AUG-16
Copper (Cu)-Total			99.8		%		80-120	31-AUG-16
Lead (Pb)-Total			91.1		%		80-120	31-AUG-16
Lithium (Li)-Total			104.3		%		80-120	31-AUG-16
Manganese (Mn)-Total			94.2		%		80-120	31-AUG-16
Molybdenum (Mo)-Total			93.9		%		80-120	31-AUG-16
Nickel (Ni)-Total			101.0		%		80-120	31-AUG-16
Selenium (Se)-Total			93.0		%		80-120	31-AUG-16
Silver (Ag)-Total			84.7		%		80-120	31-AUG-16
Sodium (Na)-Total			95.2		%		80-120	31-AUG-16
Strontium (Sr)-Total			88.1		%		80-120	31-AUG-16
Thallium (Tl)-Total			91.2		%		80-120	31-AUG-16
Tin (Sn)-Total			85.2		%		80-120	31-AUG-16
Titanium (Ti)-Total			87.5		%		80-120	31-AUG-16
Uranium (U)-Total			88.4		%		80-120	31-AUG-16
Vanadium (V)-Total			97.8		%		80-120	31-AUG-16
Zinc (Zn)-Total			89.4		%		80-120	31-AUG-16
Zirconium (Zr)-Total			84.4		%		80-120	31-AUG-16
WG2379637-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	31-AUG-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	31-AUG-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	31-AUG-16
Barium (Ba)-Total			<0.000050		mg/L		0.00005	31-AUG-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	31-AUG-16
Boron (B)-Total			<0.010		mg/L		0.01	31-AUG-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	31-AUG-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	31-AUG-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	31-AUG-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	31-AUG-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	31-AUG-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	31-AUG-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	31-AUG-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	31-AUG-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	31-AUG-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3538728								
WG2379637-1 MB								
Selenium (Se)-Total			<0.000050		mg/L		0.00005	31-AUG-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	31-AUG-16
Sodium (Na)-Total			<0.050		mg/L		0.05	31-AUG-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	31-AUG-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	31-AUG-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	31-AUG-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	31-AUG-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	31-AUG-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	31-AUG-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	31-AUG-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	31-AUG-16
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3538880								
WG2379637-2 LCS								
Calcium (Ca)-Total			103.2		%		80-120	31-AUG-16
Iron (Fe)-Total			98.8		%		80-120	31-AUG-16
Magnesium (Mg)-Total			102.6		%		80-120	31-AUG-16
Phosphorus (P)-Total			98.1		%		80-120	31-AUG-16
Potassium (K)-Total			106.4		%		80-120	31-AUG-16
Silicon (Si)-Total			107.4		%		80-120	31-AUG-16
WG2379637-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	31-AUG-16
Iron (Fe)-Total			<0.010		mg/L		0.01	31-AUG-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	31-AUG-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	31-AUG-16
Potassium (K)-Total			<0.10		mg/L		0.1	31-AUG-16
Silicon (Si)-Total			<0.050		mg/L		0.05	31-AUG-16
NH3-F-VA	**Water**							
Batch R3539519								
WG2380805-6 LCS								
Ammonia, Total (as N)			102.8		%		85-115	01-SEP-16
WG2380805-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	01-SEP-16
NO2-L-IC-N-WR	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WR	**Water**							
Batch R3536516								
WG2375618-2 LCS								
Nitrite (as N)			101.5		%		90-110	25-AUG-16
WG2375618-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	25-AUG-16
NO3-L-IC-N-WR	**Water**							
Batch R3536516								
WG2375618-2 LCS								
Nitrate (as N)			104.5		%		90-110	25-AUG-16
WG2375618-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	25-AUG-16
PH-PCT-VA	**Water**							
Batch R3537833								
WG2378617-17 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	31-AUG-16
WG2378617-22 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	31-AUG-16
WG2378617-25 DUP		**L1818233-1**						
pH		7.75	7.78	J	pH	0.03	0.3	31-AUG-16
S-DIS-ICP-VA	**Water**							
Batch R3534745								
WG2375965-2 LCS								
Sulfur (S)-Dissolved			100.0		%		80-120	26-AUG-16
WG2375965-1 MB		**NP**						
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	26-AUG-16
S-TOT-ICP-VA	**Water**							
Batch R3538880								
WG2379637-2 LCS								
Sulfur (S)-Total			106.4		%		80-120	31-AUG-16
WG2379637-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	31-AUG-16
SO4-IC-N-WR	**Water**							
Batch R3536516								
WG2375618-2 LCS								
Sulfate (SO4)			104.9		%		90-110	25-AUG-16
WG2375618-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	25-AUG-16
TSS-MAN-WR	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-MAN-WR	**Water**							
Batch R3536088								
WG2374852-2 LCS								
Total Suspended Solids			99.6		%		85-115	24-AUG-16
WG2374852-1 MB								
Total Suspended Solids			<3.0		mg/L		3	24-AUG-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	22-AUG-16 07:50	31-AUG-16 08:49	0.25	217	hours	EHTR-FM
	2	22-AUG-16 08:25	31-AUG-16 08:49	0.25	216	hours	EHTR-FM
	3	22-AUG-16 08:50	31-AUG-16 08:49	0.25	216	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1818233 were received on 24-AUG-16 10:25.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1818233-COFC

COC Number: 2016-08-23 B

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: 221837 (WUL)
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Tang

Sampler: CH

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	C1	22-Aug-16	7:50	Water	R	R	R	R	R	R	R	R						6
	E6	22-Aug-16	8:25	Water	R	R	R	R	R	R	R	R						6
	E3	22-Aug-16	8:50	Water	R	R	R	R	R	R	R	R						6

Short Holding Time

● *Rush Processing*

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☐ Ice Cubes ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4.0, 3.0			9	3	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Harry	Date: 2016-08-23 11:00	Time:	Received by: EHF	Date: 24Aug2016	Time: 10:25	Received by:	Date: Aug 25/16	Time: 1:15pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 31-AUG-16
Report Date: 19-SEP-16 16:58 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1822573

Project P.O. #: 220405 (MMER)
Job Reference:
C of C Numbers: 2016-08-31 E
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

	Sample ID	L1822573-1	L1822573-2	L1822573-3		
	Description	Water	Water	Water		
	Sampled Date	29-AUG-16	29-AUG-16	29-AUG-16		
	Sampled Time	09:20	09:15	09:10		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (umhos/cm)	160	205	245		
	Hardness (as CaCO3) (mg/L)	74.9	93.6	119		
	pH (pH units)	7.66	7.68	7.61		
	Total Suspended Solids (mg/L)	<3.0	6.7	8.7		
	TDS (Calculated) (mg/L)	85.4	114	143		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	73.4	84.8	95.7		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	73.4	84.8	95.7		
	Ammonia, Total (as N) (mg/L)	0.231	0.291	0.655		
	Chloride (Cl) (mg/L)	<0.50	1.25	2.19		
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	0.822	1.50		
	Nitrate (as N) (mg/L)	<0.0050	0.814	1.49		
	Nitrite (as N) (mg/L)	<0.0010	0.0077	0.0093		
	Sulfate (SO4) (mg/L)	10.6	18.3	25.0		
	Anion Sum (meq/L)	1.69	2.17	2.60		
	Cation Sum (meq/L)	1.68	2.15	2.77		
	Cation - Anion Balance (%)	-0.4	-0.4	3.2		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0910	0.108	0.101		
	Antimony (Sb)-Total (mg/L)	0.00015	0.00011	0.00010		
	Arsenic (As)-Total (mg/L)	0.00083	0.00088	0.00076		
	Barium (Ba)-Total (mg/L)	0.0429	0.0482	0.0457		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	0.011	0.016		
	Cadmium (Cd)-Total (mg/L)	0.0000078	0.0000139	0.0000120		
	Calcium (Ca)-Total (mg/L)	20.6	26.2	31.5		
	Chromium (Cr)-Total (mg/L)	0.00038	0.00037	0.00033		
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00010	0.00011		
	Copper (Cu)-Total (mg/L)	0.00192	0.00547	0.00848		
	Iron (Fe)-Total (mg/L)	0.153	0.197	0.212		
	Lead (Pb)-Total (mg/L)	0.000188	0.000228	0.000264		
	Lithium (Li)-Total (mg/L)	0.0011	<0.0010	<0.0010		
	Magnesium (Mg)-Total (mg/L)	5.63	7.11	8.41		
	Manganese (Mn)-Total (mg/L)	0.00752	0.0168	0.0225		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00128	0.00178	0.00213		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1822573-1	L1822573-2	L1822573-3
	Description	Water	Water	Water
	Sampled Date	29-AUG-16	29-AUG-16	29-AUG-16
	Sampled Time	09:20	09:15	09:10
	Client ID	YRC	E6	E3
Grouping	**Analyte**			
WATER				
Total Metals	Nickel (Ni)-Total (mg/L)	0.00100	0.00117	0.00101
	Phosphorus (P)-Total (mg/L)	0.054	0.074	0.187
	Potassium (K)-Total (mg/L)	0.86	1.29	1.72
	Selenium (Se)-Total (mg/L)	0.000121	0.000370	0.000532
	Silicon (Si)-Total (mg/L)	3.70	3.56	3.41
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	3.42	5.36	6.34
	Strontium (Sr)-Total (mg/L)	0.139	0.221	0.278
	Sulfur (S)-Total (mg/L)	3.45	6.15	8.15
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	0.00326	0.00339	0.00365
	Uranium (U)-Total (mg/L)	0.00115	0.00119	0.00120
	Vanadium (V)-Total (mg/L)	0.00093	0.00093	0.00082
	Zinc (Zn)-Total (mg/L)	0.0061	0.0093	0.0124
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0153	0.0157	0.0144
	Antimony (Sb)-Dissolved (mg/L)	0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00057	0.00062	0.00058
	Barium (Ba)-Dissolved (mg/L)	0.0391	0.0477	0.0504
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.010	0.011	0.015
	Cadmium (Cd)-Dissolved (mg/L)	0.0000056	0.0000084	0.0000057
	Calcium (Ca)-Dissolved (mg/L)	20.7	25.8	33.8
	Chromium (Cr)-Dissolved (mg/L)	0.00013	0.00010	0.00016
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Dissolved (mg/L)	0.00135	0.00397	0.00657
	Iron (Fe)-Dissolved (mg/L)	0.030	0.025	0.028
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	5.61	7.10	8.35
	Manganese (Mn)-Dissolved (mg/L)	0.00116	0.00116	0.00251
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.00118	0.00158	0.00210

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1822573-1 Water 29-AUG-16 09:20 YRC	L1822573-2 Water 29-AUG-16 09:15 E6	L1822573-3 Water 29-AUG-16 09:10 E3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00070	0.00057	0.00069		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	<0.050	0.122		
	Potassium (K)-Dissolved (mg/L)	0.86	1.33	1.71		
	Selenium (Se)-Dissolved (mg/L)	0.000105	0.000336	0.000494		
	Silicon (Si)-Dissolved (mg/L)	3.49	3.28	3.13		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	3.17	5.17	7.02		
	Strontium (Sr)-Dissolved (mg/L)	0.135	0.211	0.288		
	Sulfur (S)-Dissolved (mg/L)	3.48	5.93	8.07		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	<0.00030	0.00031	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00108	0.00103	0.00113		
	Vanadium (V)-Dissolved (mg/L)	0.00056	0.00052	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0040	0.0084	0.0097		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1822573-1, -2, -3
Matrix Spike	Manganese (Mn)-Total	MS-B	L1822573-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1822573-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1822573-1, -2, -3
Matrix Spike	Nitrate (as N)	MS-B	L1822573-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-CO3-CALC-WP	Water	Alkalinity, Carbonate (as CaCO3)	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by carbonate is calculated and reported as mg/L CaCO3.

ALK-HCO3-CALC-WP	Water	Alkalinity, Bicarbonate (as CaCO3)	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by bicarbonate is calculated and reported as mg/L CaCO3.

ALK-OH-CALC-WP	Water	Alkalinity, Hydroxide (as CaCO3)	CALCULATION

The Alkalinity of water is a measure of its acid neutralizing capacity.Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. The fraction of alkalinity contributed by hydroxide is calculated and reported as mg/L CaCO3.

ALK-TITR-WP	Water	Alkalinity, Total (as CaCO3)	APHA 2320B

The Alkalinity of water is a measure of its acid neutralizing capacity. Alkalinity is imparted by bicarbonate, carbonate and hydroxide components of water. Total alkalinity is determined by titration with a strong standard mineral acid to the successive HCO3- and H2CO3 endpoints indicated electrometrically.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

Reference Information

BE-D-L-CCMS-VA Water Diss. Be (low) in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA Water Total Be (Low) in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

CL-IC-N-WR Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-WP Water Conductivity APHA 2510B

Conductivity of an aqueous solution refers to its ability to carry an electric current. Conductance of a solution is measured between two spatially fixed and chemically inert electrodes.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-LOW-ICP-VA Water Dissolved Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-TOT-LOW-ICP-VA Water Total Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

NO3-L-IC-N-WR	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-WP	Water	pH	APHA 4500H

The pH of a sample is the determination of the activity of the hydrogen ions by potentiometric measurement using a standard hydrogen electrode and a reference electrode.

S-DIS-ICP-VA	Water	Dissolved Sulfur in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

S-TOT-ICP-VA	Water	Total Sulfur in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

SO4-IC-N-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-08-31 E

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1822573 Report Date: 20-DEC-17

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3
Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3547966								
WG2387735-4 LCS								
Alkalinity, Total (as CaCO3)			103.9		%		85-115	13-SEP-16
WG2387735-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	13-SEP-16
BE-D-L-CCMS-VA	**Water**							
Batch R3542125								
WG2381670-2 LCS								
Beryllium (Be)-Dissolved			98.2		%		80-120	03-SEP-16
WG2381670-1 MB		**NP**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	03-SEP-16
BE-T-L-CCMS-VA	**Water**							
Batch R3544850								
WG2384758-2 LCS								
Beryllium (Be)-Total			100.8		%		80-120	09-SEP-16
WG2384758-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	09-SEP-16
CL-IC-N-WR	**Water**							
Batch R3543987								
WG2384610-10 LCS								
Chloride (Cl)			102.3		%		90-110	01-SEP-16
WG2384610-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-SEP-16
EC-WP	**Water**							
Batch R3547966								
WG2387735-3 LCS								
Conductivity			99.2		%		90-110	13-SEP-16
WG2387735-1 MB								
Conductivity			<1.0		umhos/cm		1	13-SEP-16
HG-D-CVAA-VA	**Water**							
Batch R3540602								
WG2381669-2 LCS								
Mercury (Hg)-Dissolved			93.2		%		80-120	03-SEP-16
Batch R3541033								
WG2381669-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	03-SEP-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-T-CVAA-VA	**Water**							
Batch R3541477								
WG2382198-2 LCS								
Mercury (Hg)-Total			97.3		%		80-120	05-SEP-16
WG2382198-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	05-SEP-16
MET-D-CCMS-VA	**Water**							
Batch R3542125								
WG2381670-2 LCS								
Aluminum (Al)-Dissolved			97.4		%		80-120	03-SEP-16
Antimony (Sb)-Dissolved			90.0		%		80-120	03-SEP-16
Arsenic (As)-Dissolved			97.1		%		80-120	03-SEP-16
Barium (Ba)-Dissolved			97.1		%		80-120	03-SEP-16
Bismuth (Bi)-Dissolved			97.8		%		80-120	03-SEP-16
Boron (B)-Dissolved			93.6		%		80-120	03-SEP-16
Cadmium (Cd)-Dissolved			96.3		%		80-120	03-SEP-16
Chromium (Cr)-Dissolved			96.4		%		80-120	03-SEP-16
Cobalt (Co)-Dissolved			95.8		%		80-120	03-SEP-16
Copper (Cu)-Dissolved			94.8		%		80-120	03-SEP-16
Lead (Pb)-Dissolved			96.9		%		80-120	03-SEP-16
Lithium (Li)-Dissolved			98.0		%		80-120	03-SEP-16
Manganese (Mn)-Dissolved			97.8		%		80-120	03-SEP-16
Molybdenum (Mo)-Dissolved			98.0		%		80-120	03-SEP-16
Nickel (Ni)-Dissolved			94.5		%		80-120	03-SEP-16
Selenium (Se)-Dissolved			91.8		%		80-120	03-SEP-16
Silver (Ag)-Dissolved			95.5		%		80-120	03-SEP-16
Sodium (Na)-Dissolved			96.8		%		80-120	03-SEP-16
Strontium (Sr)-Dissolved			92.8		%		80-120	03-SEP-16
Thallium (Tl)-Dissolved			97.2		%		80-120	03-SEP-16
Tin (Sn)-Dissolved			94.5		%		80-120	03-SEP-16
Titanium (Ti)-Dissolved			90.9		%		80-120	03-SEP-16
Uranium (U)-Dissolved			97.5		%		80-120	03-SEP-16
Vanadium (V)-Dissolved			94.9		%		80-120	03-SEP-16
Zinc (Zn)-Dissolved			87.9		%		80-120	03-SEP-16
Zirconium (Zr)-Dissolved			91.0		%		80-120	03-SEP-16
WG2381670-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	03-SEP-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	03-SEP-16

Quality Control Report

Workorder: L1822573 Report Date: 20-DEC-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3542125								
WG2381670-1 MB		**NP**						
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	03-SEP-16
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	03-SEP-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	03-SEP-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	03-SEP-16
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	03-SEP-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	03-SEP-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	03-SEP-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	03-SEP-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	03-SEP-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	03-SEP-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	03-SEP-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	03-SEP-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	03-SEP-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	03-SEP-16
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	03-SEP-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	03-SEP-16
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	03-SEP-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	03-SEP-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	03-SEP-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	03-SEP-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	03-SEP-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	03-SEP-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	03-SEP-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	03-SEP-16
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3541275								
WG2381670-2 LCS								
Calcium (Ca)-Dissolved			101.5		%		80-120	03-SEP-16
Iron (Fe)-Dissolved			96.8		%		80-120	03-SEP-16
Magnesium (Mg)-Dissolved			98.6		%		80-120	03-SEP-16
Phosphorus (P)-Dissolved			99.1		%		80-120	03-SEP-16
Potassium (K)-Dissolved			98.5		%		80-120	03-SEP-16
Silicon (Si)-Dissolved			103.9		%		80-120	03-SEP-16
WG2381670-1 MB		**NP**						

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3541275								
WG2381670-1 MB		**NP**						
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	03-SEP-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	03-SEP-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	03-SEP-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	03-SEP-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	03-SEP-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	03-SEP-16
MET-T-CCMS-VA	**Water**							
Batch R3544850								
WG2384758-2 LCS								
Aluminum (Al)-Total			100.8		%		80-120	09-SEP-16
Antimony (Sb)-Total			101.7		%		80-120	09-SEP-16
Arsenic (As)-Total			100.4		%		80-120	09-SEP-16
Barium (Ba)-Total			102.1		%		80-120	09-SEP-16
Bismuth (Bi)-Total			100.8		%		80-120	09-SEP-16
Boron (B)-Total			96.3		%		80-120	09-SEP-16
Cadmium (Cd)-Total			101.9		%		80-120	09-SEP-16
Chromium (Cr)-Total			101.7		%		80-120	09-SEP-16
Cobalt (Co)-Total			100.4		%		80-120	09-SEP-16
Copper (Cu)-Total			97.3		%		80-120	09-SEP-16
Lead (Pb)-Total			99.1		%		80-120	09-SEP-16
Lithium (Li)-Total			102.0		%		80-120	09-SEP-16
Manganese (Mn)-Total			102.3		%		80-120	09-SEP-16
Molybdenum (Mo)-Total			104.4		%		80-120	09-SEP-16
Nickel (Ni)-Total			98.1		%		80-120	09-SEP-16
Selenium (Se)-Total			100.4		%		80-120	09-SEP-16
Silver (Ag)-Total			102.4		%		80-120	09-SEP-16
Sodium (Na)-Total			104.6		%		80-120	09-SEP-16
Strontium (Sr)-Total			100.5		%		80-120	09-SEP-16
Thallium (Tl)-Total			99.6		%		80-120	09-SEP-16
Tin (Sn)-Total			99.2		%		80-120	09-SEP-16
Titanium (Ti)-Total			93.1		%		80-120	09-SEP-16
Uranium (U)-Total			101.7		%		80-120	09-SEP-16
Vanadium (V)-Total			100.9		%		80-120	09-SEP-16
Zinc (Zn)-Total			93.9		%		80-120	09-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3544850								
WG2384758-2 LCS								
Zirconium (Zr)-Total			91.0		%		80-120	09-SEP-16
WG2384758-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	09-SEP-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	09-SEP-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	09-SEP-16
Barium (Ba)-Total			<0.000050		mg/L		0.00005	09-SEP-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	09-SEP-16
Boron (B)-Total			<0.010		mg/L		0.01	09-SEP-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	09-SEP-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	09-SEP-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	09-SEP-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	09-SEP-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	09-SEP-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	09-SEP-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	09-SEP-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	09-SEP-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	09-SEP-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	09-SEP-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	09-SEP-16
Sodium (Na)-Total			<0.050		mg/L		0.05	09-SEP-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	09-SEP-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	09-SEP-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	09-SEP-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	09-SEP-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	09-SEP-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	09-SEP-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	09-SEP-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	09-SEP-16
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3544841								
WG2384758-2 LCS								
Calcium (Ca)-Total			102.6		%		80-120	09-SEP-16
Iron (Fe)-Total			101.4		%		80-120	09-SEP-16
Magnesium (Mg)-Total			101.6		%		80-120	09-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3544841								
WG2384758-2 LCS								
Phosphorus (P)-Total			97.6		%		80-120	09-SEP-16
Potassium (K)-Total			99.1		%		80-120	09-SEP-16
Silicon (Si)-Total			110.5		%		80-120	09-SEP-16
WG2384758-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	09-SEP-16
Iron (Fe)-Total			<0.010		mg/L		0.01	09-SEP-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	09-SEP-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	09-SEP-16
Potassium (K)-Total			<0.10		mg/L		0.1	09-SEP-16
Silicon (Si)-Total			<0.050		mg/L		0.05	09-SEP-16
NH3-F-VA	**Water**							
Batch R3546678								
WG2386655-2 LCS								
Ammonia, Total (as N)			101.3		%		85-115	12-SEP-16
WG2386655-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	12-SEP-16
Batch R3549646								
WG2389835-10 LCS								
Ammonia, Total (as N)			95.1		%		85-115	16-SEP-16
WG2389835-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	16-SEP-16
NO2-L-IC-N-WR	**Water**							
Batch R3543987								
WG2384610-10 LCS								
Nitrite (as N)			101.2		%		90-110	01-SEP-16
WG2384610-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-SEP-16
NO3-L-IC-N-WR	**Water**							
Batch R3543987								
WG2384610-10 LCS								
Nitrate (as N)			102.6		%		90-110	01-SEP-16
WG2384610-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-SEP-16
PH-WP	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-WP	**Water**							
Batch R3547966								
WG2387735-2 LCS								
pH			7.41		pH units		7.3-7.5	13-SEP-16
S-DIS-ICP-VA	**Water**							
Batch R3541275								
WG2381670-2 LCS								
Sulfur (S)-Dissolved			101.7		%		80-120	03-SEP-16
WG2381670-1 MB		**NP**						
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	03-SEP-16
S-TOT-ICP-VA	**Water**							
Batch R3544841								
WG2384758-2 LCS								
Sulfur (S)-Total			105.4		%		80-120	09-SEP-16
WG2384758-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	09-SEP-16
SO4-IC-N-WR	**Water**							
Batch R3543987								
WG2384610-10 LCS								
Sulfate (SO4)			102.7		%		90-110	01-SEP-16
WG2384610-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	01-SEP-16
TSS-MAN-WR	**Water**							
Batch R3546087								
WG2381455-2 LCS								
Total Suspended Solids			109.3		%		85-115	02-SEP-16
WG2381455-1 MB								
Total Suspended Solids			<3.0		mg/L		3	02-SEP-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	29-AUG-16 09:20	13-SEP-16 12:45	0.25	363	hours	EHTR-FM
	2	29-AUG-16 09:15	13-SEP-16 12:45	0.25	364	hours	EHTR-FM
	3	29-AUG-16 09:10	13-SEP-16 12:45	0.25	364	hours	EHTR-FM
Anions and Nutrients							
Alkalinity, Total (as CaCO3)							
	1	29-AUG-16 09:20	13-SEP-16 12:45	14	15	days	EHT
	2	29-AUG-16 09:15	13-SEP-16 12:45	14	15	days	EHT
	3	29-AUG-16 09:10	13-SEP-16 12:45	14	15	days	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1822573 were received on 31-AUG-16 16:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1822573-COFC

COC Number: 2016-08-31 E

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
Company address below will appear on the final report		
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)	**4 day [P4]**	☐	EMERGENCY	**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 220405 (MMER)

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Ariel Tang **Sampler:** SB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	YRC ✓	29-Aug-16	9:20	Water	R	R	R	R	R	R	R	R						6
	E6 ✓	29-Aug-16	9:15	Water	R	R	R	R	R	R	R	R						6
	E3 ✓	29-Aug-16	9:10	Water	R	R	R	R	R	R	R	R						6

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☑	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☑						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
6.2, 7.4	4.6	6.4			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Shaun Roberts	Date: 31-Aug-2016	Time: 11:00	Received by:	Date: 31-Aug-16	Time: 4:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 07-SEP-16
Report Date: 19-SEP-16 17:22 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1825883

Project P.O. #: 220405 (MMER)
Job Reference:
C of C Numbers: 2016-09-07 B
Legal Site Desc:

Ariel McDonnell

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1825883-1	L1825883-2	L1825883-3		
	Description	Water	Water	Water		
	Sampled Date	05-SEP-16	05-SEP-16	05-SEP-16		
	Sampled Time	07:40	07:55	08:10		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	160	214	236		
	Hardness (as CaCO3) (mg/L)	78.2	103	115		
	pH (pH)	7.90	7.89	7.92		
	Total Suspended Solids (mg/L)	<3.0	3.6	<3.0		
	TDS (Calculated) (mg/L)	88.3	122	139		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	75.5	88.5	95.9		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	75.5	88.5	95.9		
	Ammonia, Total (as N) (mg/L)	0.394	0.323	0.599		
	Chloride (Cl) (mg/L)	<0.50	1.36	1.79		
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	0.955	1.38		
	Nitrate (as N) (mg/L)	<0.0050	0.951	1.37		
	Nitrite (as N) (mg/L)	<0.0010	0.0039	0.0095		
	Sulfate (SO4) (mg/L)	10.9	20.2	24.3		
	Anion Sum (meq/L)	1.73	2.30	2.57		
	Cation Sum (meq/L)	1.76	2.36	2.67		
	Cation - Anion Balance (%)	0.7	1.3	1.8		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0704	0.0611	0.0534		
	Antimony (Sb)-Total (mg/L)	0.00011	0.00010	0.00010		
	Arsenic (As)-Total (mg/L)	0.00091	0.00080	0.00076		
	Barium (Ba)-Total (mg/L)	0.0429	0.0485	0.0497		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	0.010	0.014		
	Cadmium (Cd)-Total (mg/L)	0.0000056	0.0000083	0.0000108		
	Calcium (Ca)-Total (mg/L)	20.3	28.2	30.8		
	Chromium (Cr)-Total (mg/L)	0.00030	0.00027	0.00875		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00194	0.00565	0.00732		
	Iron (Fe)-Total (mg/L)	0.135	0.126	0.148		
	Lead (Pb)-Total (mg/L)	0.000089	0.000082	0.000070		
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Total (mg/L)	5.75	7.78	8.63		
	Manganese (Mn)-Total (mg/L)	0.00704	0.0112	0.0113		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00124	0.00180	0.00211		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1825883-1	L1825883-2	L1825883-3		
	Description	Water	Water	Water		
	Sampled Date	05-SEP-16	05-SEP-16	05-SEP-16		
	Sampled Time	07:40	07:55	08:10		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Total Metals	Nickel (Ni)-Total (mg/L)	0.00069	0.00071	0.00155		
	Phosphorus (P)-Total (mg/L)	0.082	0.067	0.139		
	Potassium (K)-Total (mg/L)	0.82	1.39	1.63		
	Selenium (Se)-Total (mg/L)	0.000129	0.000376	0.000492		
	Silicon (Si)-Total (mg/L)	3.75	3.64	3.53		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	3.28	5.37	6.38		
	Strontium (Sr)-Total (mg/L)	0.141	0.233	0.277		
	Sulfur (S)-Total (mg/L)	3.93	7.53	9.04		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00276	0.00218	0.00203		
	Uranium (U)-Total (mg/L)	0.00104	0.00109	0.00111		
	Vanadium (V)-Total (mg/L)	0.00084	0.00080	0.00080		
	Zinc (Zn)-Total (mg/L)	0.0044	0.0069	0.0089		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0163	0.0233	0.0171		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00066	0.00061	0.00056		
	Barium (Ba)-Dissolved (mg/L)	0.0427	0.0471	0.0496		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.014		
	Cadmium (Cd)-Dissolved (mg/L)	0.0000056	0.0000072	0.0000057		
	Calcium (Ca)-Dissolved (mg/L)	21.4	28.4	32.1		
	Chromium (Cr)-Dissolved (mg/L)	0.00015	0.00018	0.00014		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00137	0.00641	0.00586		
	Iron (Fe)-Dissolved (mg/L)	0.036	0.048	0.035		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	6.00	7.88	8.56		
	Manganese (Mn)-Dissolved (mg/L)	0.00239	0.0126	0.00178		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00144	0.00172	DTC 0.00288		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1825883-1 Water 05-SEP-16 07:40 YRC	L1825883-2 Water 05-SEP-16 07:55 E6	L1825883-3 Water 05-SEP-16 08:10 E3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00059	0.00058	0.00060		
	Phosphorus (P)-Dissolved (mg/L)	0.066	<0.050	0.107		
	Potassium (K)-Dissolved (mg/L)	0.80	1.31	1.56		
	Selenium (Se)-Dissolved (mg/L)	0.000107	0.000376	0.000467		
	Silicon (Si)-Dissolved (mg/L)	3.89	3.65	3.48		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	3.33	5.25	6.28		
	Strontium (Sr)-Dissolved (mg/L)	0.145	0.227	0.266		
	Sulfur (S)-Dissolved (mg/L)	3.83	6.79	8.10		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	0.00041	0.00083	0.00039		
	Uranium (U)-Dissolved (mg/L)	0.00107	0.00103	0.00104		
	Vanadium (V)-Dissolved (mg/L)	0.00054	0.00052	0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0031	0.0046	0.0074		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Boron (B)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Cobalt (Co)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Nickel (Ni)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1825883-1, -2, -3
Matrix Spike	Sulfate (SO4)	MS-B	L1825883-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-WR	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Reference Information

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-LOW-ICP-VA Water Dissolved Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-TOT-LOW-ICP-VA Water Total Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

S-DIS-ICP-VA Water Dissolved Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

S-TOT-ICP-VA Water Total Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

Reference Information

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

SO4-IC-N-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA	Water	TDS (Calculated)	APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-09-07 B

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1825883 Report Date: 20-DEC-17

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-VA	**Water**							
Batch R3551617								
WG2390178-13 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			101.6		%		85-115	18-SEP-16
WG2390178-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	18-SEP-16
BE-D-L-CCMS-VA	**Water**							
Batch R3544850								
WG2384851-2 LCS								
Beryllium (Be)-Dissolved			101.5		%		80-120	09-SEP-16
WG2384851-1 MB		**NP**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	09-SEP-16
Batch R3548122								
WG2384851-8 MS		**L1825883-3**						
Beryllium (Be)-Dissolved			98.9		%		70-130	13-SEP-16
BE-T-L-CCMS-VA	**Water**							
Batch R3547388								
WG2386385-2 LCS								
Beryllium (Be)-Total			102.2		%		80-120	13-SEP-16
WG2386385-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	13-SEP-16
CL-IC-N-WR	**Water**							
Batch R3547911								
WG2385261-2 LCS								
Chloride (Cl)			101.9		%		90-110	07-SEP-16
WG2385261-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	07-SEP-16
EC-PCT-VA	**Water**							
Batch R3551617								
WG2390178-14 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			101.4		%		90-110	18-SEP-16
WG2390178-11 MB								
Conductivity			<2.0		uS/cm		2	18-SEP-16
HG-D-CVAA-VA	**Water**							
Batch R3544761								
WG2384866-2 LCS								
Mercury (Hg)-Dissolved			99.7		%		80-120	09-SEP-16
WG2384866-1 MB		**NP**						

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-CVAA-VA	**Water**							
Batch R3544761								
WG2384866-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.000005		mg/L		0.000005	09-SEP-16
HG-T-CVAA-VA	**Water**							
Batch R3544214								
WG2384928-2 LCS								
Mercury (Hg)-Total			107.3		%		80-120	08-SEP-16
WG2384928-1 MB								
Mercury (Hg)-Total			<0.000005		mg/L		0.000005	08-SEP-16
MET-D-CCMS-VA	**Water**							
Batch R3544850								
WG2384851-2 LCS								
Aluminum (Al)-Dissolved			104.0		%		80-120	09-SEP-16
Antimony (Sb)-Dissolved			95.1		%		80-120	09-SEP-16
Arsenic (As)-Dissolved			100.1		%		80-120	09-SEP-16
Barium (Ba)-Dissolved			100.5		%		80-120	09-SEP-16
Bismuth (Bi)-Dissolved			99.0		%		80-120	09-SEP-16
Boron (B)-Dissolved			96.6		%		80-120	09-SEP-16
Cadmium (Cd)-Dissolved			92.0		%		80-120	09-SEP-16
Chromium (Cr)-Dissolved			100.1		%		80-120	09-SEP-16
Cobalt (Co)-Dissolved			99.6		%		80-120	09-SEP-16
Copper (Cu)-Dissolved			95.8		%		80-120	09-SEP-16
Lead (Pb)-Dissolved			98.1		%		80-120	09-SEP-16
Lithium (Li)-Dissolved			103.1		%		80-120	09-SEP-16
Manganese (Mn)-Dissolved			100.3		%		80-120	09-SEP-16
Molybdenum (Mo)-Dissolved			103.5		%		80-120	09-SEP-16
Nickel (Ni)-Dissolved			96.4		%		80-120	09-SEP-16
Selenium (Se)-Dissolved			96.7		%		80-120	09-SEP-16
Silver (Ag)-Dissolved			101.6		%		80-120	09-SEP-16
Sodium (Na)-Dissolved			103.8		%		80-120	09-SEP-16
Strontium (Sr)-Dissolved			97.3		%		80-120	09-SEP-16
Thallium (Tl)-Dissolved			98.2		%		80-120	09-SEP-16
Tin (Sn)-Dissolved			98.0		%		80-120	09-SEP-16
Titanium (Ti)-Dissolved			97.9		%		80-120	09-SEP-16
Uranium (U)-Dissolved			101.7		%		80-120	09-SEP-16
Vanadium (V)-Dissolved			100.4		%		80-120	09-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3544850								
WG2384851-2 LCS								
Zinc (Zn)-Dissolved			92.6		%		80-120	09-SEP-16
Zirconium (Zr)-Dissolved			90.9		%		80-120	09-SEP-16
WG2384851-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	09-SEP-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	09-SEP-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	09-SEP-16
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	09-SEP-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	09-SEP-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	09-SEP-16
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	09-SEP-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	09-SEP-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	09-SEP-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	09-SEP-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	09-SEP-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	09-SEP-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	09-SEP-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	09-SEP-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	09-SEP-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	09-SEP-16
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	09-SEP-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	09-SEP-16
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	09-SEP-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	09-SEP-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	09-SEP-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	09-SEP-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	09-SEP-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	09-SEP-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	09-SEP-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	09-SEP-16
Batch R3548122								
WG2384851-8 MS		**L1825883-3**						
Aluminum (Al)-Dissolved			96.4		%		70-130	13-SEP-16
Antimony (Sb)-Dissolved			95.7		%		70-130	13-SEP-16
Arsenic (As)-Dissolved			99.4		%		70-130	13-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3548122								
WG2384851-8 MS		**L1825883-3**						
Barium (Ba)-Dissolved			N/A	MS-B	%		-	13-SEP-16
Bismuth (Bi)-Dissolved			81.1		%		70-130	13-SEP-16
Boron (B)-Dissolved			92.9		%		70-130	13-SEP-16
Cadmium (Cd)-Dissolved			96.5		%		70-130	13-SEP-16
Chromium (Cr)-Dissolved			93.4		%		70-130	13-SEP-16
Cobalt (Co)-Dissolved			95.5		%		70-130	13-SEP-16
Copper (Cu)-Dissolved			92.1		%		70-130	13-SEP-16
Lead (Pb)-Dissolved			91.7		%		70-130	13-SEP-16
Lithium (Li)-Dissolved			90.6		%		70-130	13-SEP-16
Manganese (Mn)-Dissolved			93.9		%		70-130	13-SEP-16
Molybdenum (Mo)-Dissolved			96.6		%		70-130	13-SEP-16
Nickel (Ni)-Dissolved			93.5		%		70-130	13-SEP-16
Selenium (Se)-Dissolved			98.4		%		70-130	13-SEP-16
Silver (Ag)-Dissolved			94.4		%		70-130	13-SEP-16
Sodium (Na)-Dissolved			N/A	MS-B	%		-	13-SEP-16
Strontium (Sr)-Dissolved			N/A	MS-B	%		-	13-SEP-16
Thallium (Tl)-Dissolved			88.7		%		70-130	13-SEP-16
Tin (Sn)-Dissolved			97.7		%		70-130	13-SEP-16
Titanium (Ti)-Dissolved			97.7		%		70-130	13-SEP-16
Uranium (U)-Dissolved			89.3		%		70-130	13-SEP-16
Vanadium (V)-Dissolved			100.2		%		70-130	13-SEP-16
Zinc (Zn)-Dissolved			90.8		%		70-130	13-SEP-16
Zirconium (Zr)-Dissolved			95.9		%		70-130	13-SEP-16
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3544841								
WG2384851-2 LCS								
Calcium (Ca)-Dissolved			101.9		%		80-120	09-SEP-16
Iron (Fe)-Dissolved			100.3		%		80-120	09-SEP-16
Magnesium (Mg)-Dissolved			101.0		%		80-120	09-SEP-16
Phosphorus (P)-Dissolved			98.6		%		80-120	09-SEP-16
Potassium (K)-Dissolved			98.6		%		80-120	09-SEP-16
Silicon (Si)-Dissolved			109.4		%		80-120	09-SEP-16
WG2384851-1 MB		**NP**						
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	09-SEP-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3544841								
WG2384851-1 MB		**NP**						
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	09-SEP-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	09-SEP-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	09-SEP-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	09-SEP-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	09-SEP-16
Batch R3545181								
WG2384851-8 MS		**L1825883-3**						
Calcium (Ca)-Dissolved			99.4		%		70-130	09-SEP-16
Iron (Fe)-Dissolved			95.8		%		70-130	09-SEP-16
Magnesium (Mg)-Dissolved			99.5		%		70-130	09-SEP-16
Phosphorus (P)-Dissolved			102.4		%		70-130	09-SEP-16
Potassium (K)-Dissolved			102.1		%		70-130	09-SEP-16
Silicon (Si)-Dissolved			N/A	MS-B	%		-	09-SEP-16
MET-T-CCMS-VA	**Water**							
Batch R3547388								
WG2386385-2 LCS								
Aluminum (Al)-Total			103.8		%		80-120	13-SEP-16
Antimony (Sb)-Total			103.3		%		80-120	13-SEP-16
Arsenic (As)-Total			100.3		%		80-120	13-SEP-16
Barium (Ba)-Total			100.5		%		80-120	13-SEP-16
Bismuth (Bi)-Total			99.2		%		80-120	13-SEP-16
Boron (B)-Total			97.1		%		80-120	13-SEP-16
Cadmium (Cd)-Total			92.5		%		80-120	13-SEP-16
Chromium (Cr)-Total			99.1		%		80-120	13-SEP-16
Cobalt (Co)-Total			97.9		%		80-120	13-SEP-16
Copper (Cu)-Total			96.8		%		80-120	13-SEP-16
Lead (Pb)-Total			96.5		%		80-120	13-SEP-16
Lithium (Li)-Total			106.5		%		80-120	13-SEP-16
Manganese (Mn)-Total			101.0		%		80-120	13-SEP-16
Molybdenum (Mo)-Total			104.1		%		80-120	13-SEP-16
Nickel (Ni)-Total			100.5		%		80-120	13-SEP-16
Selenium (Se)-Total			95.8		%		80-120	13-SEP-16
Silver (Ag)-Total			97.7		%		80-120	13-SEP-16
Sodium (Na)-Total			104.4		%		80-120	13-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3547388								
WG2386385-2 LCS								
Strontium (Sr)-Total			98.6		%		80-120	13-SEP-16
Thallium (Tl)-Total			101.5		%		80-120	13-SEP-16
Tin (Sn)-Total			95.2		%		80-120	13-SEP-16
Titanium (Ti)-Total			98.1		%		80-120	13-SEP-16
Uranium (U)-Total			93.3		%		80-120	13-SEP-16
Vanadium (V)-Total			103.3		%		80-120	13-SEP-16
Zinc (Zn)-Total			95.6		%		80-120	13-SEP-16
Zirconium (Zr)-Total			93.9		%		80-120	13-SEP-16
WG2386385-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	13-SEP-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	13-SEP-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	13-SEP-16
Barium (Ba)-Total			<0.000050		mg/L		0.00005	13-SEP-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	13-SEP-16
Boron (B)-Total			<0.010		mg/L		0.01	13-SEP-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	13-SEP-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	13-SEP-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	13-SEP-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	13-SEP-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	13-SEP-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	13-SEP-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	13-SEP-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	13-SEP-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	13-SEP-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	13-SEP-16
Sodium (Na)-Total			<0.050		mg/L		0.05	13-SEP-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	13-SEP-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	13-SEP-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	13-SEP-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	13-SEP-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	13-SEP-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	13-SEP-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	13-SEP-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	13-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3548231								
WG2386385-1 MB								
Silver (Ag)-Total			<0.000010		mg/L		0.00001	13-SEP-16
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3547156								
WG2386385-2 LCS								
Calcium (Ca)-Total			99.5		%		80-120	12-SEP-16
Iron (Fe)-Total			96.8		%		80-120	12-SEP-16
Magnesium (Mg)-Total			96.8		%		80-120	12-SEP-16
Phosphorus (P)-Total			97.9		%		80-120	12-SEP-16
Potassium (K)-Total			103.2		%		80-120	12-SEP-16
Silicon (Si)-Total			104.6		%		80-120	12-SEP-16
WG2386385-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	12-SEP-16
Iron (Fe)-Total			<0.010		mg/L		0.01	12-SEP-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	12-SEP-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	12-SEP-16
Potassium (K)-Total			<0.10		mg/L		0.1	12-SEP-16
Silicon (Si)-Total			<0.050		mg/L		0.05	12-SEP-16
NH3-F-VA	**Water**							
Batch R3549358								
WG2389354-2 LCS								
Ammonia, Total (as N)			98.8		%		85-115	16-SEP-16
WG2389354-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	16-SEP-16
Batch R3549646								
WG2389835-10 LCS								
Ammonia, Total (as N)			95.1		%		85-115	16-SEP-16
WG2389835-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	16-SEP-16
NO2-L-IC-N-WR	**Water**							
Batch R3547911								
WG2385261-2 LCS								
Nitrite (as N)			99.3		%		90-110	07-SEP-16
WG2385261-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	07-SEP-16
NO3-L-IC-N-WR	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WR	**Water**							
Batch R3547911								
WG2385261-2 LCS								
Nitrate (as N)			102.0		%		90-110	07-SEP-16
WG2385261-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	07-SEP-16
PH-PCT-VA	**Water**							
Batch R3551617								
WG2390178-12 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	18-SEP-16
S-DIS-ICP-VA	**Water**							
Batch R3544841								
WG2384851-2 LCS								
Sulfur (S)-Dissolved			105.7		%		80-120	09-SEP-16
WG2384851-1 MB		**NP**						
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	09-SEP-16
Batch R3545181								
WG2384851-8 MS		**L1825883-3**						
Sulfur (S)-Dissolved			99.6		%		70-130	09-SEP-16
S-TOT-ICP-VA	**Water**							
Batch R3547156								
WG2386385-2 LCS								
Sulfur (S)-Total			100.9		%		80-120	12-SEP-16
WG2386385-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	12-SEP-16
SO4-IC-N-WR	**Water**							
Batch R3547911								
WG2385261-2 LCS								
Sulfate (SO4)			102.2		%		90-110	07-SEP-16
WG2385261-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	07-SEP-16
TSS-VA	**Water**							
Batch R3544569								
WG2384823-5 LCS								
Total Suspended Solids			89.9		%		85-115	08-SEP-16
WG2384823-4 MB								
Total Suspended Solids			<3.0		mg/L		3	08-SEP-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	05-SEP-16 07:40	18-SEP-16 10:25	0.25	315	hours	EHTR-FM
	2	05-SEP-16 07:55	18-SEP-16 10:25	0.25	314	hours	EHTR-FM
	3	05-SEP-16 08:10	18-SEP-16 10:25	0.25	314	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1825883 were received on 07-SEP-16 15:20.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Short Holding Time ● Rush Processing

Chain of Custody (COC) / Analytical Request Form

Toll Free: 1 800 668 9878

L1825883-COFC

COC Number: 2016-09-07 B

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
Company address below will appear on the final report		
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4] ☐		**1 Business day [E1]** ☐	
3 day [P3] ☐		**Same Day, Weekend or Statutory holiday [E0]** ☐	
2 day [P2] ☐			

[redacted] **Date and Time Required for all E&P TATs:**

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 220405 (MMER)

LSD:

ALS Lab Work Order # (lab use only) L1825883

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Contact: Ariel Tang

Sampler: SB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)	Dissolved Organic Carbon (DOC)					Number of Containers
								P	F/P	P	F/P	P	F/P					
	YRC ✓	5-Sep-16	7:40	Water	R	R	R	R	R	R	R	R						6
	E6 ✓	5-Sep-16	7:55	Water	R	R	R	R	R	R	R	R						6
	E3 ✓	5-Sep-16	8:10	Water	R	R	R	R	R	R	R	R						6

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
0.2°C ✓			1,5,3,4	4,9	1

SHIPMENT RELEASE (client use)

Released by: Shaun Roberts | Date: 2016-09-07 | Time: 10:30

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: | Date: Sept-7-16 | Time: 3:20

FINAL SHIPMENT RECEPTION (lab use only)

Received by: | Date: SEP 8 2016 JC bby | Time: 12:40

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 15-SEP-16
Report Date: 27-SEP-16 16:49 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1829581
Project P.O. #: 220405 (MMER)
Job Reference:
C of C Numbers: 2016-09-13 C
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1829581-1	L1829581-2	L1829581-3		
	Description	Water	Water	Water		
	Sampled Date	12-SEP-16	12-SEP-16	12-SEP-16		
	Sampled Time	08:30	08:46	09:15		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	162	209	241		
	Hardness (as CaCO3) (mg/L)	79.3	102	118		
	pH (pH)	7.95	7.96	7.96		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	TDS (Calculated) (mg/L)	89.9	119	141		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	77.8	88.9	98.9		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	77.8	88.9	98.9		
	Ammonia, Total (as N) (mg/L)	0.414	0.406	0.612		
	Chloride (Cl) (mg/L)	<0.50	1.22	1.77		
	Nitrate and Nitrite (as N) (mg/L)	<0.0051	0.781	1.34		
	Nitrate (as N) (mg/L)	<0.0050	0.776	1.33		
	Nitrite (as N) (mg/L)	<0.0010	0.0048	0.0081		
	Sulfate (SO4) (mg/L)	10.9	18.6	24.0		
	Anion Sum (meq/L)	1.78	2.25	2.62		
	Cation Sum (meq/L)	1.77	2.30	2.68		
	Cation - Anion Balance (%)	-0.3	1.0	1.2		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0586	0.0559	0.0557		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Total (mg/L)	0.00074	0.00065	0.00071		
	Barium (Ba)-Total (mg/L)	0.0421	0.0460	0.0506		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.014		
	Cadmium (Cd)-Total (mg/L)	0.0000076	<0.0000050	0.0000105		
	Calcium (Ca)-Total (mg/L)	21.8	26.8	32.2		
	Chromium (Cr)-Total (mg/L)	0.00024	0.00025	0.00026		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00179	0.00414	0.00648		
	Iron (Fe)-Total (mg/L)	0.097	0.093	0.103		
	Lead (Pb)-Total (mg/L)	0.000110	0.000137	0.000124		
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Total (mg/L)	5.85	7.39	8.69		
	Manganese (Mn)-Total (mg/L)	0.00594	0.00841	0.0114		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00135	0.00171	0.00201		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1829581-1	L1829581-2	L1829581-3		
	Description	Water	Water	Water		
	Sampled Date	12-SEP-16	12-SEP-16	12-SEP-16		
	Sampled Time	08:30	08:46	09:15		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Total Metals	Nickel (Ni)-Total (mg/L)	0.00070	0.00067	0.00077		
	Phosphorus (P)-Total (mg/L)	0.067	0.090	0.119		
	Potassium (K)-Total (mg/L)	0.75	1.17	1.46		
	Selenium (Se)-Total (mg/L)	0.000177	0.000330	0.000306		
	Silicon (Si)-Total (mg/L)	3.79	3.54	3.52		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	3.21	4.83	6.17		
	Strontium (Sr)-Total (mg/L)	0.140	0.210	0.258		
	Sulfur (S)-Total (mg/L)	4.06	6.79	8.60		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00201	0.00175	0.00187		
	Uranium (U)-Total (mg/L)	0.00116	0.00113	0.00116		
	Vanadium (V)-Total (mg/L)	0.00069	0.00071	0.00069		
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0041	0.0070		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0130	0.0119	0.0109		
	Antimony (Sb)-Dissolved (mg/L)	0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00061	0.00056	0.00053		
	Barium (Ba)-Dissolved (mg/L)	0.0425	0.0455	0.0489		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.012		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	0.0000059	0.0000067		
	Calcium (Ca)-Dissolved (mg/L)	21.8	28.3	32.8		
	Chromium (Cr)-Dissolved (mg/L)	0.00014	0.00014	<0.00010		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00122	0.00349	0.00542		
	Iron (Fe)-Dissolved (mg/L)	0.027	0.028	0.028		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010		
	Magnesium (Mg)-Dissolved (mg/L)	6.05	7.55	8.64		
	Manganese (Mn)-Dissolved (mg/L)	0.00218	0.00112	0.00129		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00124	0.00165	0.00192		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1829581-1	L1829581-2	L1829581-3		
	Description	Water	Water	Water		
	Sampled Date	12-SEP-16	12-SEP-16	12-SEP-16		
	Sampled Time	08:30	08:46	09:15		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00056	0.00057	0.00057		
	Phosphorus (P)-Dissolved (mg/L)	<0.050	0.064	0.091		
	Potassium (K)-Dissolved (mg/L)	0.83	1.22	1.51		
	Selenium (Se)-Dissolved (mg/L)	0.000120	0.000301	DTC 0.000534		
	Silicon (Si)-Dissolved (mg/L)	3.67	3.47	3.39		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	3.05	4.64	5.74		
	Strontium (Sr)-Dissolved (mg/L)	0.143	0.220	0.272		
	Sulfur (S)-Dissolved (mg/L)	3.97	6.59	8.58		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	0.00035	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00107	0.00107	0.00108		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0033	0.0034	0.0058		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Alkalinity, Total (as CaCO3)	B	L1829581-1, -2, -3
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Boron (B)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1829581-1, -2, -3
Matrix Spike	Barium (Ba)-Total	MS-B	L1829581-1, -2, -3
Matrix Spike	Sodium (Na)-Total	MS-B	L1829581-1, -2, -3
Matrix Spike	Strontium (Sr)-Total	MS-B	L1829581-1, -2, -3
Matrix Spike	Silicon (Si)-Total	MS-B	L1829581-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1829581-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-N+N-CALC-VA	Water	Nitrite & Nitrate in Water (Calculation)	EPA 300.0

Nitrate and Nitrite (as N) is a calculated parameter. Nitrate and Nitrite (as N) = Nitrite (as N) + Nitrate (as N).

ALS Test Code	Matrix	Test Description	Method Reference**
BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

Reference Information

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-LOW-ICP-VA Water Dissolved Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-TOT-LOW-ICP-VA Water Total Metals in Water by ICPOES EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-VA Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-VA Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

S-DIS-ICP-VA Water Dissolved Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Reference Information

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

S-TOT-ICP-VA Water Total Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

SO4-IC-N-VA Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-09-13 C

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3
Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-VA	**Water**							
Batch R3557052								
WG2395728-28 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			100.6		%		85-115	24-SEP-16
WG2395728-26 MB								
Alkalinity, Total (as CaCO3)			1.2	B	mg/L		1	24-SEP-16
BE-D-L-CCMS-VA	**Water**							
Batch R3549964								
WG2389895-2 LCS								
Beryllium (Be)-Dissolved			102.5		%		80-120	16-SEP-16
WG2389895-1 MB		**NP**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	16-SEP-16
BE-T-L-CCMS-VA	**Water**							
Batch R3552865								
WG2392133-2 LCS								
Beryllium (Be)-Total			101.4		%		80-120	20-SEP-16
WG2392133-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	20-SEP-16
Batch R3553921								
WG2392133-3 DUP		**L1829581-1**						
Beryllium (Be)-Total		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	20-SEP-16
WG2392133-4 MS		**L1829581-3**						
Beryllium (Be)-Total			101.4		%		70-130	20-SEP-16
CL-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-12 DUP		**L1829581-3**						
Chloride (Cl)		1.77	1.77		mg/L	0.1	20	19-SEP-16
WG2391409-15 LCS								
Chloride (Cl)			100.2		%		90-110	19-SEP-16
WG2391409-2 LCS								
Chloride (Cl)			100.2		%		90-110	19-SEP-16
WG2391409-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-SEP-16
WG2391409-10 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-SEP-16
WG2391409-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-SEP-16
WG2391409-4 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-SEP-16
WG2391409-7 MB								

Quality Control Report

Workorder: L1829581 Report Date: 20-DEC-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-7 MB								
Chloride (Cl)			<0.50		mg/L		0.5	19-SEP-16
WG2391409-14 MS		**L1829581-1**						
Chloride (Cl)			98.4		%		75-125	19-SEP-16
EC-PCT-VA	**Water**							
Batch R3557052								
WG2395728-29 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			101.8		%		90-110	24-SEP-16
WG2395728-26 MB								
Conductivity			<2.0		uS/cm		2	24-SEP-16
HG-D-CVAA-VA	**Water**							
Batch R3549956								
WG2389897-6 DUP		**L1829581-1**						
Mercury (Hg)-Dissolved		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	16-SEP-16
WG2389897-2 LCS								
Mercury (Hg)-Dissolved			93.9		%		80-120	16-SEP-16
WG2389897-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	16-SEP-16
WG2389897-11 MS		**L1829581-3**						
Mercury (Hg)-Dissolved			88.7		%		70-130	16-SEP-16
HG-T-CVAA-VA	**Water**							
Batch R3549956								
WG2390517-2 LCS								
Mercury (Hg)-Total			94.7		%		80-120	16-SEP-16
WG2390517-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	16-SEP-16
MET-D-CCMS-VA	**Water**							
Batch R3549964								
WG2389895-2 LCS								
Aluminum (Al)-Dissolved			106.5		%		80-120	16-SEP-16
Antimony (Sb)-Dissolved			98.9		%		80-120	16-SEP-16
Arsenic (As)-Dissolved			101.1		%		80-120	16-SEP-16
Barium (Ba)-Dissolved			101.6		%		80-120	16-SEP-16
Bismuth (Bi)-Dissolved			99.9		%		80-120	16-SEP-16
Boron (B)-Dissolved			98.8		%		80-120	16-SEP-16
Cadmium (Cd)-Dissolved			97.6		%		80-120	16-SEP-16
Chromium (Cr)-Dissolved			100.4		%		80-120	16-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3549964								
WG2389895-2 LCS								
Cobalt (Co)-Dissolved			99.1		%		80-120	16-SEP-16
Copper (Cu)-Dissolved			97.0		%		80-120	16-SEP-16
Lead (Pb)-Dissolved			101.6		%		80-120	16-SEP-16
Lithium (Li)-Dissolved			102.2		%		80-120	16-SEP-16
Manganese (Mn)-Dissolved			99.4		%		80-120	16-SEP-16
Molybdenum (Mo)-Dissolved			106.6		%		80-120	16-SEP-16
Nickel (Ni)-Dissolved			97.8		%		80-120	16-SEP-16
Selenium (Se)-Dissolved			93.2		%		80-120	16-SEP-16
Silver (Ag)-Dissolved			103.2		%		80-120	16-SEP-16
Sodium (Na)-Dissolved			102.6		%		80-120	16-SEP-16
Strontium (Sr)-Dissolved			99.8		%		80-120	16-SEP-16
Thallium (Tl)-Dissolved			101.9		%		80-120	16-SEP-16
Tin (Sn)-Dissolved			98.1		%		80-120	16-SEP-16
Titanium (Ti)-Dissolved			99.2		%		80-120	16-SEP-16
Uranium (U)-Dissolved			102.6		%		80-120	16-SEP-16
Vanadium (V)-Dissolved			102.0		%		80-120	16-SEP-16
Zinc (Zn)-Dissolved			95.0		%		80-120	16-SEP-16
Zirconium (Zr)-Dissolved			93.9		%		80-120	16-SEP-16
WG2389895-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	16-SEP-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	16-SEP-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	16-SEP-16
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	16-SEP-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	16-SEP-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	16-SEP-16
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	16-SEP-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	16-SEP-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	16-SEP-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	16-SEP-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	16-SEP-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	16-SEP-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	16-SEP-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	16-SEP-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	16-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3549964								
WG2389895-1 MB		**NP**						
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	16-SEP-16
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	16-SEP-16
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	16-SEP-16
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	16-SEP-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	16-SEP-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	16-SEP-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	16-SEP-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	16-SEP-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	16-SEP-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	16-SEP-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	16-SEP-16
MET-DIS-LOW-ICP-VA	**Water**							
Batch R3549928								
WG2389895-2 LCS								
Calcium (Ca)-Dissolved			100.9		%		80-120	16-SEP-16
Iron (Fe)-Dissolved			98.3		%		80-120	16-SEP-16
Magnesium (Mg)-Dissolved			100.9		%		80-120	16-SEP-16
Phosphorus (P)-Dissolved			101.8		%		80-120	16-SEP-16
Potassium (K)-Dissolved			98.3		%		80-120	16-SEP-16
Silicon (Si)-Dissolved			106.9		%		80-120	16-SEP-16
WG2389895-1 MB		**NP**						
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	16-SEP-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	16-SEP-16
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	16-SEP-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	16-SEP-16
Potassium (K)-Dissolved			<0.10		mg/L		0.1	16-SEP-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	16-SEP-16
MET-T-CCMS-VA	**Water**							
Batch R3552865								
WG2392133-2 LCS								
Aluminum (Al)-Total			101.3		%		80-120	20-SEP-16
Antimony (Sb)-Total			103.9		%		80-120	20-SEP-16
Arsenic (As)-Total			102.3		%		80-120	20-SEP-16
Barium (Ba)-Total			101.8		%		80-120	20-SEP-16
Bismuth (Bi)-Total			101.9		%		80-120	20-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3552865								
WG2392133-2 LCS								
Boron (B)-Total			99.7		%		80-120	20-SEP-16
Cadmium (Cd)-Total			100.5		%		80-120	20-SEP-16
Chromium (Cr)-Total			98.4		%		80-120	20-SEP-16
Cobalt (Co)-Total			99.99		%		80-120	20-SEP-16
Copper (Cu)-Total			105.9		%		80-120	20-SEP-16
Lead (Pb)-Total			102.1		%		80-120	20-SEP-16
Lithium (Li)-Total			104.0		%		80-120	20-SEP-16
Manganese (Mn)-Total			101.9		%		80-120	20-SEP-16
Molybdenum (Mo)-Total			106.5		%		80-120	20-SEP-16
Nickel (Ni)-Total			98.2		%		80-120	20-SEP-16
Selenium (Se)-Total			98.4		%		80-120	20-SEP-16
Silver (Ag)-Total			104.2		%		80-120	20-SEP-16
Sodium (Na)-Total			101.7		%		80-120	20-SEP-16
Strontium (Sr)-Total			101.3		%		80-120	20-SEP-16
Thallium (Tl)-Total			102.2		%		80-120	20-SEP-16
Tin (Sn)-Total			100.3		%		80-120	20-SEP-16
Titanium (Ti)-Total			91.9		%		80-120	20-SEP-16
Uranium (U)-Total			105.6		%		80-120	20-SEP-16
Vanadium (V)-Total			101.9		%		80-120	20-SEP-16
Zinc (Zn)-Total			94.9		%		80-120	20-SEP-16
Zirconium (Zr)-Total			97.4		%		80-120	20-SEP-16
WG2392133-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	20-SEP-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	20-SEP-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	20-SEP-16
Barium (Ba)-Total			<0.000050		mg/L		0.00005	20-SEP-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	20-SEP-16
Boron (B)-Total			<0.010		mg/L		0.01	20-SEP-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	20-SEP-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	20-SEP-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	20-SEP-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	20-SEP-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	20-SEP-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	20-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3552865								
WG2392133-1 MB								
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	20-SEP-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	20-SEP-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	20-SEP-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	20-SEP-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	20-SEP-16
Sodium (Na)-Total			<0.050		mg/L		0.05	20-SEP-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	20-SEP-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	20-SEP-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	20-SEP-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	20-SEP-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	20-SEP-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	20-SEP-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	20-SEP-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	20-SEP-16
Batch R3553921								
WG2392133-3 DUP		**L1829581-1**						
Aluminum (Al)-Total		0.0586	0.0571		mg/L	2.5	20	20-SEP-16
Antimony (Sb)-Total		<0.00010	0.00011	RPD-NA	mg/L	N/A	20	20-SEP-16
Arsenic (As)-Total		0.00074	0.00073		mg/L	1.9	20	20-SEP-16
Barium (Ba)-Total		0.0421	0.0419		mg/L	0.7	20	20-SEP-16
Bismuth (Bi)-Total		<0.000050	<0.000050	RPD-NA	mg/L	N/A	20	20-SEP-16
Boron (B)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	20-SEP-16
Cadmium (Cd)-Total		0.0000076	0.0000075		mg/L	0.9	20	20-SEP-16
Chromium (Cr)-Total		0.00024	0.00024		mg/L	0.0	20	20-SEP-16
Cobalt (Co)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-SEP-16
Copper (Cu)-Total		0.00179	0.00169		mg/L	6.3	20	20-SEP-16
Lead (Pb)-Total		0.000110	0.000105		mg/L	4.0	20	20-SEP-16
Lithium (Li)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	20-SEP-16
Manganese (Mn)-Total		0.00594	0.00612		mg/L	2.9	20	20-SEP-16
Molybdenum (Mo)-Total		0.00135	0.00132		mg/L	2.4	20	20-SEP-16
Nickel (Ni)-Total		0.00070	0.00069		mg/L	0.7	20	20-SEP-16
Selenium (Se)-Total		0.000177	0.000142	J	mg/L	0.000035	0.0001	20-SEP-16
Silver (Ag)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	20-SEP-16
Sodium (Na)-Total		3.21	3.20		mg/L	0.4	20	20-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3553921								
WG2392133-3 DUP		**L1829581-1**						
Strontium (Sr)-Total		0.140	0.138		mg/L	1.3	20	20-SEP-16
Thallium (Tl)-Total		<0.000010	<0.000010	RPD-NA	mg/L	N/A	20	20-SEP-16
Tin (Sn)-Total		<0.00010	<0.00010	RPD-NA	mg/L	N/A	20	20-SEP-16
Titanium (Ti)-Total		0.00201	0.00173		mg/L	15	20	20-SEP-16
Uranium (U)-Total		0.00116	0.00114		mg/L	2.0	20	20-SEP-16
Vanadium (V)-Total		0.00069	0.00070		mg/L	1.6	20	20-SEP-16
Zinc (Zn)-Total		<0.0030	0.0032	RPD-NA	mg/L	N/A	20	20-SEP-16
Zirconium (Zr)-Total		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	20-SEP-16
WG2392133-4 MS		**L1829581-3**						
Aluminum (Al)-Total			102.4		%		70-130	20-SEP-16
Antimony (Sb)-Total			101.1		%		70-130	20-SEP-16
Arsenic (As)-Total			103.8		%		70-130	20-SEP-16
Barium (Ba)-Total			N/A	MS-B	%		-	20-SEP-16
Bismuth (Bi)-Total			98.5		%		70-130	20-SEP-16
Boron (B)-Total			102.6		%		70-130	20-SEP-16
Cadmium (Cd)-Total			98.9		%		70-130	20-SEP-16
Chromium (Cr)-Total			101.4		%		70-130	20-SEP-16
Cobalt (Co)-Total			102.1		%		70-130	20-SEP-16
Copper (Cu)-Total			98.0		%		70-130	20-SEP-16
Lead (Pb)-Total			97.3		%		70-130	20-SEP-16
Lithium (Li)-Total			104.9		%		70-130	20-SEP-16
Manganese (Mn)-Total			104.8		%		70-130	20-SEP-16
Molybdenum (Mo)-Total			101.7		%		70-130	20-SEP-16
Nickel (Ni)-Total			101.4		%		70-130	20-SEP-16
Selenium (Se)-Total			103.9		%		70-130	20-SEP-16
Silver (Ag)-Total			101.0		%		70-130	20-SEP-16
Sodium (Na)-Total			N/A	MS-B	%		-	20-SEP-16
Strontium (Sr)-Total			N/A	MS-B	%		-	20-SEP-16
Thallium (Tl)-Total			95.7		%		70-130	20-SEP-16
Tin (Sn)-Total			99.8		%		70-130	20-SEP-16
Titanium (Ti)-Total			107.7		%		70-130	20-SEP-16
Uranium (U)-Total			98.9		%		70-130	20-SEP-16
Vanadium (V)-Total			104.2		%		70-130	20-SEP-16
Zinc (Zn)-Total			94.1		%		70-130	20-SEP-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3553921								
WG2392133-4 MS		**L1829581-3**						
Zirconium (Zr)-Total			100.6		%		70-130	20-SEP-16
MET-TOT-LOW-ICP-VA	**Water**							
Batch R3552886								
WG2392133-2 LCS								
Calcium (Ca)-Total			101.4		%		80-120	20-SEP-16
Iron (Fe)-Total			96.1		%		80-120	20-SEP-16
Magnesium (Mg)-Total			99.5		%		80-120	20-SEP-16
Phosphorus (P)-Total			99.6		%		80-120	20-SEP-16
Potassium (K)-Total			104.2		%		80-120	20-SEP-16
Silicon (Si)-Total			116.5		%		80-120	20-SEP-16
WG2392133-1 MB								
Calcium (Ca)-Total			<0.050		mg/L		0.05	20-SEP-16
Iron (Fe)-Total			<0.010		mg/L		0.01	20-SEP-16
Magnesium (Mg)-Total			<0.050		mg/L		0.05	20-SEP-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	20-SEP-16
Potassium (K)-Total			<0.10		mg/L		0.1	20-SEP-16
Silicon (Si)-Total			<0.050		mg/L		0.05	20-SEP-16
Batch R3553912								
WG2392133-3 DUP		**L1829581-1**						
Calcium (Ca)-Total		21.8	21.8		mg/L	0.1	20	21-SEP-16
Iron (Fe)-Total		0.097	0.097		mg/L	0.7	20	21-SEP-16
Magnesium (Mg)-Total		5.85	5.94		mg/L	1.5	20	21-SEP-16
Phosphorus (P)-Total		0.067	0.058		mg/L	14	20	21-SEP-16
Potassium (K)-Total		0.75	0.78		mg/L	4.1	20	21-SEP-16
Silicon (Si)-Total		3.79	3.78		mg/L	0.2	20	21-SEP-16
WG2392133-4 MS		**L1829581-3**						
Calcium (Ca)-Total			95.4		%		70-130	21-SEP-16
Iron (Fe)-Total			97.1		%		70-130	21-SEP-16
Magnesium (Mg)-Total			97.4		%		70-130	21-SEP-16
Phosphorus (P)-Total			98.2		%		70-130	21-SEP-16
Potassium (K)-Total			95.0		%		70-130	21-SEP-16
Silicon (Si)-Total			N/A	MS-B	%		-	21-SEP-16
NH3-F-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH3-F-VA	**Water**							
Batch R3556361								
WG2395963-2 LCS								
Ammonia, Total (as N)			103.9		%		85-115	24-SEP-16
WG2395963-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	24-SEP-16
NO2-L-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-12 DUP		**L1829581-3**						
Nitrite (as N)		0.0081	0.0082		mg/L	1.2	20	19-SEP-16
WG2391409-15 LCS								
Nitrite (as N)			101.6		%		90-110	19-SEP-16
WG2391409-2 LCS								
Nitrite (as N)			101.9		%		90-110	19-SEP-16
WG2391409-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-SEP-16
WG2391409-10 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-SEP-16
WG2391409-13 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-SEP-16
WG2391409-4 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-SEP-16
WG2391409-7 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	19-SEP-16
WG2391409-14 MS		**L1829581-1**						
Nitrite (as N)			96.3		%		75-125	19-SEP-16
NO3-L-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-12 DUP		**L1829581-3**						
Nitrate (as N)		1.33	1.33		mg/L	0.1	20	19-SEP-16
WG2391409-15 LCS								
Nitrate (as N)			100.7		%		90-110	19-SEP-16
WG2391409-2 LCS								
Nitrate (as N)			100.8		%		90-110	19-SEP-16
WG2391409-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-SEP-16
WG2391409-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-SEP-16
WG2391409-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-SEP-16
WG2391409-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	19-SEP-16
WG2391409-14 MS		**L1829581-1**						
Nitrate (as N)			98.8		%		75-125	19-SEP-16
PH-PCT-VA	**Water**							
Batch R3557052								
WG2395728-27 CRM		**VA-PH7-BUF**						
pH			7.00		pH		6.9-7.1	24-SEP-16
S-DIS-ICP-VA	**Water**							
Batch R3549928								
WG2389895-2 LCS								
Sulfur (S)-Dissolved			101.8		%		80-120	16-SEP-16
WG2389895-1 MB		**NP**						
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	16-SEP-16
S-TOT-ICP-VA	**Water**							
Batch R3552886								
WG2392133-2 LCS								
Sulfur (S)-Total			99.0		%		80-120	20-SEP-16
WG2392133-1 MB								
Sulfur (S)-Total			<0.50		mg/L		0.5	20-SEP-16
Batch R3553912								
WG2392133-3 DUP		**L1829581-1**						
Sulfur (S)-Total		4.06	4.03		mg/L	0.9	20	21-SEP-16
WG2392133-4 MS		**L1829581-3**						
Sulfur (S)-Total			103.4		%		65-135	21-SEP-16
SO4-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-12 DUP		**L1829581-3**						
Sulfate (SO4)		24.0	24.0		mg/L	0.2	20	19-SEP-16
WG2391409-15 LCS								
Sulfate (SO4)			100.9		%		90-110	19-SEP-16
WG2391409-2 LCS								
Sulfate (SO4)			100.8		%		90-110	19-SEP-16
WG2391409-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-VA	**Water**							
Batch R3553819								
WG2391409-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-SEP-16
WG2391409-10 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-SEP-16
WG2391409-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-SEP-16
WG2391409-4 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-SEP-16
WG2391409-7 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	19-SEP-16
WG2391409-14 MS		**L1829581-1**						
Sulfate (SO4)			97.7		%		75-125	19-SEP-16
TSS-VA	**Water**							
Batch R3551905								
WG2389862-8 LCS								
Total Suspended Solids			98.5		%		85-115	16-SEP-16
WG2389862-7 MB								
Total Suspended Solids			<3.0		mg/L		3	16-SEP-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
B	Method Blank exceeds ALS DQO. Associated sample results which are < Limit of Reporting or > 5 times blank level are considered reliable.
J	Duplicate results and limits are expressed in terms of absolute difference.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	12-SEP-16 08:30	24-SEP-16 08:20	0.25	288	hours	EHTR-FM
	2	12-SEP-16 08:46	24-SEP-16 08:20	0.25	288	hours	EHTR-FM
	3	12-SEP-16 09:15	24-SEP-16 08:20	0.25	287	hours	EHTR-FM
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	12-SEP-16 08:30	19-SEP-16 07:13	3	7	days	EHTR
	2	12-SEP-16 08:46	19-SEP-16 07:13	3	7	days	EHTR
	3	12-SEP-16 09:15	19-SEP-16 07:13	3	7	days	EHTR
Nitrite in Water by IC (Low Level)							
	1	12-SEP-16 08:30	19-SEP-16 07:13	3	7	days	EHTR
	2	12-SEP-16 08:46	19-SEP-16 07:13	3	7	days	EHTR
	3	12-SEP-16 09:15	19-SEP-16 07:13	3	7	days	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1829581 were received on 15-SEP-16 12:45.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1829581-COFC

COC Number: 2016-09-13 C

Page of

Report To	Contact and company name below will appear on the final report	**Report Format / Distribution**	
Company:	Minto Explorations Ltd.	Select Report Format:	☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report	☑ YES ☐ NO
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	220405 (MMER)	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Ariel Tang	**Sampler:** CB

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved)	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)						Number of Containers
								P	F/P	P	F/P	P	F/P					
	YRC	12-Sep-16	8:30	Water	R	R	R	R	R	R	R	R						6
	E6	12-Sep-16	8:46	Water	R	R	R	R	R	R	R	R						6
	E3	12-Sep-16	9:15	Water	R	R	R	R	R	R	R	R						6

Short Holding Time

Rush Processing

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0,6.0,5.0			4	4	3

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Colin Prentice	Date: 2016-09-13	Time:	Received by: EHF	Date: 14 Sep 2016	Time: 13:19	Received by: JC	Date: SEP 15 2016	Time: 12:45

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 20-SEP-16
Report Date: 03-OCT-16 14:54 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1831166

Project P.O. #: 220405 (MMER)
Job Reference:
C of C Numbers: 2016-09-14 D
Legal Site Desc:

Ariel McDonnell, B.Sc.
Account Manager

	Sample ID	L1831166-1	L1831166-2	L1831166-3		
	Description	Water	Water	Water		
	Sampled Date	19-SEP-16	19-SEP-16	19-SEP-16		
	Sampled Time	08:15	08:25	08:40		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	158	201	237		
	Hardness (as CaCO3) (mg/L)	76.3	98.3	112		
	pH (pH)	7.68	7.81	7.81		
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0		
	TDS (Calculated) (mg/L)	86.1	117	137		
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	72.9	86.3	95.5		
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0		
	Alkalinity, Total (as CaCO3) (mg/L)	72.9	86.3	95.5		
	Ammonia, Total (as N) (mg/L)	0.411	0.320	0.576		
	Chloride (Cl) (mg/L)	<0.50	1.18	1.76		
	Nitrate and Nitrite (as N) (mg/L)	0.0068	0.816	1.36		
	Nitrate (as N) (mg/L)	0.0068	0.813	1.35		
	Nitrite (as N) (mg/L)	<0.0010	0.0031	0.0102		
	Sulfate (SO4) (mg/L)	11.1	19.1	24.4		
	Anion Sum (meq/L)	1.69	2.21	2.56		
	Cation Sum (meq/L)	1.71	2.24	2.60		
	Cation - Anion Balance (%)	0.8	0.6	0.7		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0622	0.0665	0.0623		
	Antimony (Sb)-Total (mg/L)	0.00011	0.00010	0.00010		
	Arsenic (As)-Total (mg/L)	0.00063	0.00060	0.00060		
	Barium (Ba)-Total (mg/L)	0.0431	0.0487	0.0506		
	Beryllium (Be)-Total (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Total (mg/L)	<0.010	<0.010	0.013		
	Cadmium (Cd)-Total (mg/L)	0.0000051	0.0000101	0.0000064		
	Calcium (Ca)-Total (mg/L)	21.1	27.7	30.9		
	Chromium (Cr)-Total (mg/L)	0.00023	0.00024	0.00025		
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00188	0.00552	0.00743		
	Iron (Fe)-Total (mg/L)	0.109	0.127	0.128		
	Lead (Pb)-Total (mg/L)	0.000067	0.000062	0.000092		
	Lithium (Li)-Total (mg/L)	0.0011	0.0011	0.0011		
	Magnesium (Mg)-Total (mg/L)	5.97	7.81	8.54		
	Manganese (Mn)-Total (mg/L)	0.00713	0.0118	0.0140		
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Total (mg/L)	0.00135	0.00181	0.00206		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1831166-1 Water 19-SEP-16 08:15 YRC	L1831166-2 Water 19-SEP-16 08:25 E6	L1831166-3 Water 19-SEP-16 08:40 E3		
Grouping	**Analyte**					
WATER						
Total Metals	Nickel (Ni)-Total (mg/L)	0.00057	0.00062	0.00064		
	Phosphorus (P)-Total (mg/L)	0.060	0.083	0.112		
	Potassium (K)-Total (mg/L)	0.82	1.25	1.47		
	Selenium (Se)-Total (mg/L)	0.000196	0.000374	0.000455		
	Silicon (Si)-Total (mg/L)	3.51	3.63	3.32		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	3.14	5.13	6.12		
	Strontium (Sr)-Total (mg/L)	0.132	0.218	0.267		
	Sulfur (S)-Total (mg/L)	4.48	7.59	8.80		
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	0.00231	0.00233	0.00226		
	Uranium (U)-Total (mg/L)	0.00112	0.00118	0.00116		
	Vanadium (V)-Total (mg/L)	0.00069	0.00065	0.00064		
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0065	0.0062		
	Zirconium (Zr)-Total (mg/L)	<0.00030	<0.00030	<0.00030		
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD		
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD		
	Aluminum (Al)-Dissolved (mg/L)	0.0140	0.0135	0.0115		
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Arsenic (As)-Dissolved (mg/L)	0.00057	0.00050	0.00053		
	Barium (Ba)-Dissolved (mg/L)	0.0431	0.0476	0.0516		
	Beryllium (Be)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020		
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	0.012		
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Calcium (Ca)-Dissolved (mg/L)	20.8	26.8	30.4		
	Chromium (Cr)-Dissolved (mg/L)	0.00013	<0.00010	0.00012		
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Copper (Cu)-Dissolved (mg/L)	0.00112	0.00394	0.00573		
	Iron (Fe)-Dissolved (mg/L)	0.029	0.027	0.027		
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Dissolved (mg/L)	0.0010	0.0010	0.0011		
	Magnesium (Mg)-Dissolved (mg/L)	5.91	7.62	8.76		
	Manganese (Mn)-Dissolved (mg/L)	0.00352	0.00132	0.00151		
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050		
	Molybdenum (Mo)-Dissolved (mg/L)	0.00125	0.00162	0.00187		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1831166-1	L1831166-2	L1831166-3		
	Description	Water	Water	Water		
	Sampled Date	19-SEP-16	19-SEP-16	19-SEP-16		
	Sampled Time	08:15	08:25	08:40		
	Client ID	YRC	E6	E3		
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00051	0.00055		
	Phosphorus (P)-Dissolved (mg/L)	0.050	<0.050	0.098		
	Potassium (K)-Dissolved (mg/L)	0.83	1.26	1.53		
	Selenium (Se)-Dissolved (mg/L)	0.000174	0.000388	0.000482		
	Silicon (Si)-Dissolved (mg/L)	3.32	3.36	3.27		
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Dissolved (mg/L)	3.11	5.08	6.34		
	Strontium (Sr)-Dissolved (mg/L)	0.130	0.210	0.259		
	Sulfur (S)-Dissolved (mg/L)	3.75	6.95	8.83		
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010		
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Dissolved (mg/L)	0.00030	<0.00030	<0.00030		
	Uranium (U)-Dissolved (mg/L)	0.00107	0.00108	0.00109		
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050		
	Zinc (Zn)-Dissolved (mg/L)	0.0021	0.0029	0.0055		
	Zirconium (Zr)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Aluminum (Al)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Arsenic (As)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Arsenic (As)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Molybdenum (Mo)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1831166-1, -2, -3
Matrix Spike	Sulfur (S)-Dissolved	MS-B	L1831166-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-N+N-CALC-WR	Water	Nitrite & Nitrate Nitrogen	EPA 300.1

Nitrate and Nitrite Nitrogen is determined by calculation from the individual Nitrate and Nitrite Nitrogen analyses by Ion Chromatography with UV absorbance.

BE-D-L-CCMS-VA	Water	Diss. Be (low) in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

BE-T-L-CCMS-VA	Water	Total Be (Low) in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Reference Information

CL-IC-N-WR Water Chloride in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA Water Diss. Mercury in Water by CVAAS or CVAFS APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA Water Total Mercury in Water by CVAAS or CVAFS EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

Ion Balance (%) = [Cation Sum-Anion Sum] / [Cation Sum+Anion Sum]

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-N-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".
The Total Dissolved Solids result is calculated from measured concentrations of anions and cations in the sample.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

2016-09-14 D

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1831166 Report Date: 20-DEC-17

Client: Minto Explorations Ltd.
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3
Contact: Minto Environment - Coordinator

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-VA	**Water**							
Batch R3560694								
WG2400029-8 CRM		**VA-ALK-TITR-CONTROL**						
Alkalinity, Total (as CaCO3)			98.6		%		85-115	30-SEP-16
WG2400029-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	30-SEP-16
BE-D-L-CCMS-VA	**Water**							
Batch R3554686								
WG2394160-1 MB		**NP**						
Beryllium (Be)-Dissolved			<0.000020		mg/L		0.00002	22-SEP-16
Batch R3555590								
WG2394160-2 LCS								
Beryllium (Be)-Dissolved			97.3		%		80-120	22-SEP-16
BE-T-L-CCMS-VA	**Water**							
Batch R3557341								
WG2396138-2 LCS								
Beryllium (Be)-Total			103.9		%		80-120	25-SEP-16
WG2396138-1 MB								
Beryllium (Be)-Total			<0.000020		mg/L		0.00002	25-SEP-16
CL-IC-N-WR	**Water**							
Batch R3559896								
WG2392673-2 LCS								
Chloride (Cl)			99.7		%		90-110	20-SEP-16
WG2392673-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	20-SEP-16
EC-PCT-VA	**Water**							
Batch R3560694								
WG2400029-37 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			103.0		%		90-110	30-SEP-16
WG2400029-9 CRM		**VA-EC-PCT-CONTROL**						
Conductivity			100.5		%		90-110	30-SEP-16
WG2400029-6 MB								
Conductivity			<2.0		uS/cm		2	30-SEP-16
HG-D-CVAA-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-D-CVAA-VA	**Water**							
Batch R3554683								
WG2394220-2 LCS								
Mercury (Hg)-Dissolved			99.2		%		80-120	22-SEP-16
WG2394220-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.0000050		mg/L		0.000005	22-SEP-16
HG-T-CVAA-VA	**Water**							
Batch R3554120								
WG2394237-2 LCS								
Mercury (Hg)-Total			98.5		%		80-120	21-SEP-16
WG2394237-1 MB								
Mercury (Hg)-Total			<0.0000050		mg/L		0.000005	21-SEP-16
MET-D-CCMS-VA	**Water**							
Batch R3554686								
WG2394160-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	22-SEP-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	22-SEP-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	22-SEP-16
Barium (Ba)-Dissolved			<0.000050		mg/L		0.00005	22-SEP-16
Bismuth (Bi)-Dissolved			<0.000050		mg/L		0.00005	22-SEP-16
Boron (B)-Dissolved			<0.010		mg/L		0.01	22-SEP-16
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	22-SEP-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	22-SEP-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	22-SEP-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	22-SEP-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	22-SEP-16
Iron (Fe)-Dissolved			<0.010		mg/L		0.01	22-SEP-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	22-SEP-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	22-SEP-16
Magnesium (Mg)-Dissolved			<0.0050		mg/L		0.005	22-SEP-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	22-SEP-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	22-SEP-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	22-SEP-16
Phosphorus (P)-Dissolved			<0.050		mg/L		0.05	22-SEP-16
Potassium (K)-Dissolved			<0.050		mg/L		0.05	22-SEP-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	22-SEP-16
Silicon (Si)-Dissolved			<0.050		mg/L		0.05	22-SEP-16
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	22-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3554686								
WG2394160-1 MB		**NP**						
Sodium (Na)-Dissolved			<0.050		mg/L		0.05	22-SEP-16
Strontium (Sr)-Dissolved			<0.00020		mg/L		0.0002	22-SEP-16
Sulfur (S)-Dissolved			<0.50		mg/L		0.5	22-SEP-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	22-SEP-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	22-SEP-16
Titanium (Ti)-Dissolved			<0.00030		mg/L		0.0003	22-SEP-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	22-SEP-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	22-SEP-16
Zinc (Zn)-Dissolved			<0.0010		mg/L		0.001	22-SEP-16
Zirconium (Zr)-Dissolved			<0.00030		mg/L		0.0003	22-SEP-16
Batch R3555590								
WG2394160-2 LCS								
Aluminum (Al)-Dissolved			96.8		%		80-120	22-SEP-16
Antimony (Sb)-Dissolved			92.7		%		80-120	22-SEP-16
Arsenic (As)-Dissolved			99.6		%		80-120	22-SEP-16
Barium (Ba)-Dissolved			99.99		%		80-120	22-SEP-16
Bismuth (Bi)-Dissolved			97.6		%		80-120	22-SEP-16
Boron (B)-Dissolved			94.7		%		80-120	22-SEP-16
Cadmium (Cd)-Dissolved			93.3		%		80-120	22-SEP-16
Calcium (Ca)-Dissolved			98.9		%		80-120	22-SEP-16
Chromium (Cr)-Dissolved			97.0		%		80-120	22-SEP-16
Cobalt (Co)-Dissolved			95.8		%		80-120	22-SEP-16
Copper (Cu)-Dissolved			95.8		%		80-120	22-SEP-16
Iron (Fe)-Dissolved			92.9		%		80-120	22-SEP-16
Lead (Pb)-Dissolved			99.6		%		80-120	22-SEP-16
Lithium (Li)-Dissolved			97.2		%		80-120	22-SEP-16
Magnesium (Mg)-Dissolved			99.0		%		80-120	22-SEP-16
Manganese (Mn)-Dissolved			97.7		%		80-120	22-SEP-16
Molybdenum (Mo)-Dissolved			102.5		%		80-120	22-SEP-16
Nickel (Ni)-Dissolved			95.9		%		80-120	22-SEP-16
Phosphorus (P)-Dissolved			97.5		%		80-120	22-SEP-16
Potassium (K)-Dissolved			96.3		%		80-120	22-SEP-16
Selenium (Se)-Dissolved			101.8		%		80-120	22-SEP-16
Silicon (Si)-Dissolved			104.4		%		80-120	22-SEP-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3555590								
WG2394160-2 LCS								
Silver (Ag)-Dissolved			99.4		%		80-120	22-SEP-16
Sodium (Na)-Dissolved			101.7		%		80-120	22-SEP-16
Strontium (Sr)-Dissolved			96.9		%		80-120	22-SEP-16
Sulfur (S)-Dissolved			94.8		%		80-120	22-SEP-16
Thallium (Tl)-Dissolved			100.8		%		80-120	22-SEP-16
Tin (Sn)-Dissolved			98.0		%		80-120	22-SEP-16
Titanium (Ti)-Dissolved			94.1		%		80-120	22-SEP-16
Uranium (U)-Dissolved			100.1		%		80-120	22-SEP-16
Vanadium (V)-Dissolved			99.2		%		80-120	22-SEP-16
Zinc (Zn)-Dissolved			90.7		%		80-120	22-SEP-16
Zirconium (Zr)-Dissolved			92.9		%		80-120	22-SEP-16
MET-T-CCMS-VA	**Water**							
Batch R3557341								
WG2396138-2 LCS								
Aluminum (Al)-Total			104.5		%		80-120	25-SEP-16
Antimony (Sb)-Total			111.9		%		80-120	25-SEP-16
Arsenic (As)-Total			106.9		%		80-120	25-SEP-16
Barium (Ba)-Total			106.7		%		80-120	25-SEP-16
Bismuth (Bi)-Total			110.7		%		80-120	25-SEP-16
Boron (B)-Total			99.9		%		80-120	25-SEP-16
Cadmium (Cd)-Total			102.1		%		80-120	25-SEP-16
Calcium (Ca)-Total			105.3		%		80-120	25-SEP-16
Chromium (Cr)-Total			101.9		%		80-120	25-SEP-16
Cobalt (Co)-Total			104.6		%		80-120	25-SEP-16
Copper (Cu)-Total			104.0		%		80-120	25-SEP-16
Iron (Fe)-Total			100.5		%		80-120	25-SEP-16
Lead (Pb)-Total			107.2		%		80-120	25-SEP-16
Lithium (Li)-Total			110.9		%		80-120	25-SEP-16
Magnesium (Mg)-Total			100.5		%		80-120	25-SEP-16
Manganese (Mn)-Total			105.2		%		80-120	25-SEP-16
Molybdenum (Mo)-Total			107.0		%		80-120	25-SEP-16
Nickel (Ni)-Total			105.8		%		80-120	25-SEP-16
Phosphorus (P)-Total			99.3		%		80-120	25-SEP-16
Potassium (K)-Total			109.1		%		80-120	25-SEP-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3557341								
WG2396138-2 LCS								
Selenium (Se)-Total			103.6		%		80-120	25-SEP-16
Silicon (Si)-Total			120.0		%		80-120	25-SEP-16
Silver (Ag)-Total			97.1		%		80-120	25-SEP-16
Sodium (Na)-Total			101.7		%		80-120	25-SEP-16
Strontium (Sr)-Total			103.2		%		80-120	25-SEP-16
Sulfur (S)-Total			92.2		%		80-120	25-SEP-16
Thallium (Tl)-Total			112.4		%		80-120	25-SEP-16
Tin (Sn)-Total			103.5		%		80-120	25-SEP-16
Titanium (Ti)-Total			105.0		%		80-120	25-SEP-16
Uranium (U)-Total			102.1		%		80-120	25-SEP-16
Vanadium (V)-Total			102.2		%		80-120	25-SEP-16
Zinc (Zn)-Total			97.2		%		80-120	25-SEP-16
Zirconium (Zr)-Total			98.0		%		80-120	25-SEP-16
WG2396138-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	25-SEP-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	25-SEP-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	25-SEP-16
Barium (Ba)-Total			<0.000050		mg/L		0.00005	25-SEP-16
Bismuth (Bi)-Total			<0.000050		mg/L		0.00005	25-SEP-16
Boron (B)-Total			<0.010		mg/L		0.01	25-SEP-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	25-SEP-16
Calcium (Ca)-Total			<0.050		mg/L		0.05	25-SEP-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	25-SEP-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	25-SEP-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	25-SEP-16
Iron (Fe)-Total			<0.010		mg/L		0.01	25-SEP-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	25-SEP-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	25-SEP-16
Magnesium (Mg)-Total			<0.0050		mg/L		0.005	25-SEP-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	25-SEP-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	25-SEP-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	25-SEP-16
Phosphorus (P)-Total			<0.050		mg/L		0.05	25-SEP-16
Potassium (K)-Total			<0.050		mg/L		0.05	25-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3557341								
WG2396138-1 MB								
Selenium (Se)-Total			<0.000050		mg/L		0.00005	25-SEP-16
Silicon (Si)-Total			<0.050		mg/L		0.05	25-SEP-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	25-SEP-16
Sodium (Na)-Total			<0.050		mg/L		0.05	25-SEP-16
Strontium (Sr)-Total			<0.00020		mg/L		0.0002	25-SEP-16
Sulfur (S)-Total			<0.50		mg/L		0.5	25-SEP-16
Thallium (Tl)-Total			<0.000010		mg/L		0.00001	25-SEP-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	25-SEP-16
Titanium (Ti)-Total			<0.00030		mg/L		0.0003	25-SEP-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	25-SEP-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	25-SEP-16
Zinc (Zn)-Total			<0.0030		mg/L		0.003	25-SEP-16
Zirconium (Zr)-Total			<0.00030		mg/L		0.0003	25-SEP-16
NH3-F-VA	**Water**							
Batch R3559701								
WG2399175-10 LCS								
Ammonia, Total (as N)			97.0		%		85-115	29-SEP-16
WG2399175-9 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	29-SEP-16
NO2-L-IC-N-WR	**Water**							
Batch R3559896								
WG2392673-2 LCS								
Nitrite (as N)			101.8		%		90-110	20-SEP-16
WG2392673-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	20-SEP-16
NO3-L-IC-N-WR	**Water**							
Batch R3559896								
WG2392673-2 LCS								
Nitrate (as N)			99.3		%		90-110	20-SEP-16
WG2392673-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	20-SEP-16
PH-PCT-VA	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH-PCT-VA	**Water**							
Batch R3560694								
WG2400029-7 CRM		**VA-PH7-BUF**						
pH			7.01		pH		6.9-7.1	30-SEP-16
SO4-IC-N-WR	**Water**							
Batch R3559896								
WG2392673-2 LCS								
Sulfate (SO4)			99.7		%		90-110	20-SEP-16
WG2392673-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	20-SEP-16
TSS-MAN-WR	**Water**							
Batch R3558852								
WG2394835-2 LCS								
Total Suspended Solids			95.1		%		85-115	22-SEP-16
WG2394835-1 MB								
Total Suspended Solids			<3.0		mg/L		3	22-SEP-16

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH by Meter (Automated)							
	1	19-SEP-16 08:15	30-SEP-16 06:50	0.25	263	hours	EHTR-FM
	2	19-SEP-16 08:25	30-SEP-16 06:50	0.25	262	hours	EHTR-FM
	3	19-SEP-16 08:40	30-SEP-16 06:50	0.25	262	hours	EHTR-FM

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1831166 were received on 20-SEP-16 09:00.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1831166-COFC

COC Number: 2016-09-14 D

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: 220405 (MMER)

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	
ALS Contact: **Ariel Tang**	**Sampler:** CB

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH / Conductivity / Alkalinity / Anions	Total Suspended Solids (TSS)	Total Disolved Solids (TDS)	Total Metals (TM), Hardness	Dissolved Metals (DM)(filtered and preserved	Total Mercury, Hardness	Dissolved Mercury [1] (Filtered + preserved)	Total Nutrients (Ammonia)						Number of Containers
								P	F/P	P	F/P	P	F/P					
	YRC	19-Sep-16	8:15	Water	R	R	R	R	R	R	R	R						6
	E6	19-Sep-16	8:25	Water	R	R	R	R	R	R	R	R						6
	E3	19-Sep-16	8:40	Water	R	R	R	R	R	R	R	R						6

Short Holding Time

- *Rush Processing*

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0			4	5	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chris Blurton	Date: 2016-09-19	Time: 11:00	Received by: EHF	Date: 20 Sep 2016	Time: 09:00	Received by: JC	Date: 21/9/16	Time: 14:30

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2016 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

MINNOW ENVIRONMENTAL INC.
ATTN: Pierre Stecko
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 26-SEP-16
Report Date: 06-OCT-16 16:40 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1834209

Project P.O. #: NOT SUBMITTED
Job Reference: 15-87
C of C Numbers: 1, 2
Legal Site Desc:

Selam Worku
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1834209-1	L1834209-2	L1834209-3	L1834209-4	L1834209-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	22-SEP-16	22-SEP-16	22-SEP-16	25-SEP-16	24-SEP-16
	Sampled Time					
	Client ID	UMC-1	UMC-2	UMC-3	REF-1	REF-2
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	119	124	122	64.2	58.2
	Total Suspended Solids (mg/L)	6.3	8.7	4.1	<3.0	3.9
	Total Dissolved Solids (mg/L)	196	188	188	125	122
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	105	105	105	65	76
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0051	<0.0050	0.0051	0.0060
	Nitrate (as N) (mg/L)	1.88	1.90	1.88	0.0404	0.0213
	Total Kjeldahl Nitrogen (mg/L)	0.814	2.17	0.275	0.366	0.406
	Phosphorus (P)-Total (mg/L)	0.0132	0.0485	0.0158	0.0156	0.0115
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	5.51	5.36	5.48	15.4	14.6
	Total Organic Carbon (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)	0.0930	0.320	0.0848	0.0503	0.0627
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Total (mg/L)	<0.00050	<0.00050	<0.00050	0.00055	<0.00050
	Barium (Ba)-Total (mg/L)	0.048	0.053	0.048	0.033	<0.020
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000071	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	30.8	31.2	30.7	19.1	13.4
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Total (mg/L)	0.0057	0.0068	0.0057	0.0015	0.0013
	Iron (Fe)-Total (mg/L)	0.150	0.465	0.176	0.476	0.454
	Lead (Pb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Total (mg/L)	11.1	11.4	11.2	5.67	7.45
	Manganese (Mn)-Total (mg/L)	0.0250	0.0479	0.0236	0.0295	0.0320
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	0.0023	0.0023	0.0024	<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)	<0.0010	0.0012	<0.0010	0.0012	<0.0010
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)	0.000514	0.000498	0.000500	0.000264	0.000119
	Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Total (mg/L)	11.5	11.9	11.9	4.2	9.7
	Thallium (Tl)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Total (mg/L)	<0.010	0.021	<0.010	<0.010	<0.010

	Sample ID	L1834209-6	L1834209-7	L1834209-8	L1834209-9	L1834209-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-SEP-16	24-SEP-16	23-SEP-16	24-SEP-16	24-SEP-16
	Sampled Time					
	Client ID	REF-3	REF-4	REF-5	REF-6	REF-7
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	105	51.5	115	125	213
	Total Suspended Solids (mg/L)	21.4	21.4	<3.0	<3.0	<3.0
	Total Dissolved Solids (mg/L)	175	101	171	202	299
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	100	42.9	81	145	165
	Ammonia, Total (as N) (mg/L)	<0.0050	0.0189	<0.0050	0.0054	<0.0050
	Nitrate (as N) (mg/L)	0.0718	0.0844	0.0781	0.0819	0.0323
	Total Kjeldahl Nitrogen (mg/L)	0.420	0.480	0.189	0.433	0.412
	Phosphorus (P)-Total (mg/L)	0.0111	0.0398	0.0073	0.0241	0.0106
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	14.6	13.4	6.58	14.0	14.7
	Total Organic Carbon (mg/L)					
Total Metals	Aluminum (Al)-Total (mg/L)	0.0916	0.522	0.0223	0.0289	0.0468
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Total (mg/L)	0.00058	0.00070	<0.00050	0.00066	<0.00050
	Barium (Ba)-Total (mg/L)	0.070	0.057	0.051	0.039	0.056
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	0.0000057	0.0000154	0.0000074	<0.0000050	0.0000062
	Calcium (Ca)-Total (mg/L)	29.3	14.3	28.8	28.9	53.3
	Chromium (Cr)-Total (mg/L)	<0.0010	0.0012	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Total (mg/L)	<0.00030	0.00083	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Total (mg/L)	0.0018	0.0035	<0.0010	0.0012	0.0014
	Iron (Fe)-Total (mg/L)	0.275	1.67	0.133	0.194	0.236
	Lead (Pb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Total (mg/L)	<0.0010	<0.0010	0.0052	<0.0010	0.0013
	Magnesium (Mg)-Total (mg/L)	7.14	5.20	10.7	12.8	19.9
	Manganese (Mn)-Total (mg/L)	0.0360	0.128	0.0269	0.0169	0.0281
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	0.0016
	Nickel (Ni)-Total (mg/L)	0.0014	0.0015	<0.0010	0.0018	0.0032
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	3.1
	Selenium (Se)-Total (mg/L)	0.000079	0.000107	0.000511	0.000409	0.000146
	Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Total (mg/L)	6.5	4.1	4.8	17.7	4.9
	Thallium (Tl)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Total (mg/L)	<0.010	0.032	<0.010	<0.010	<0.010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1834209-11	L1834209-12	L1834209-13	L1834209-14	L1834209-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-SEP-16	23-SEP-16	23-SEP-16	23-SEP-16	
	Sampled Time					
	Client ID	REF-8	REF-9	REF-10	REF-9X	TRAVEL BLANK
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	116	154	32.9	157	<0.50 HTC
	Total Suspended Solids (mg/L)	4.1	<3.0	<3.0	<3.0	<3.0
	Total Dissolved Solids (mg/L)	170	181	75	214	<10
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	72	129	37.0	127	<2.0
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Nitrate (as N) (mg/L)	0.300	0.166	0.0423	0.165	<0.0050
	Total Kjeldahl Nitrogen (mg/L)	0.224	0.159	0.126	0.146	<0.050
	Phosphorus (P)-Total (mg/L)	0.0101	0.0076	0.0073	0.0034	<0.0020
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	6.62	4.25	4.23	4.34	
	Total Organic Carbon (mg/L)					<0.50
Total Metals	Aluminum (Al)-Total (mg/L)	0.117	0.0212	0.0656	0.0246	<0.0050
	Antimony (Sb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Total (mg/L)	<0.00050	0.00099	<0.00050	0.00102	<0.00050
	Barium (Ba)-Total (mg/L)	0.079	0.058	0.033	0.059	<0.020
	Beryllium (Be)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Total (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Total (mg/L)	30.3	33.3	9.85	33.8	<0.10
	Chromium (Cr)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Total (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Total (mg/L)	0.0016	<0.0010	<0.0010	<0.0010	<0.0010
	Iron (Fe)-Total (mg/L)	0.164	0.092	0.203	0.092	<0.030
	Lead (Pb)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Total (mg/L)	<0.0010	0.0012	<0.0010	0.0011	<0.0010
	Magnesium (Mg)-Total (mg/L)	8.11	16.7	2.47	16.9	<0.10
	Manganese (Mn)-Total (mg/L)	0.0193	0.0360	0.00325	0.0370	<0.00030
	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Nickel (Ni)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Potassium (K)-Total (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Total (mg/L)	0.000150	0.000249	0.000063	0.000268	<0.000050
	Silver (Ag)-Total (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Total (mg/L)	3.8	<2.0	3.0	<2.0	<2.0
	Thallium (Tl)-Total (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1834209-1	L1834209-2	L1834209-3	L1834209-4	L1834209-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	22-SEP-16	22-SEP-16	22-SEP-16	25-SEP-16	24-SEP-16
	Sampled Time					
	Client ID	UMC-1	UMC-2	UMC-3	REF-1	REF-2
Grouping	**Analyte**					
WATER						
Total Metals	Uranium (U)-Total (mg/L)	0.00069	0.00070	0.00068	0.00033	0.00036
	Vanadium (V)-Total (mg/L)	0.00079	0.00134	0.00067	0.00073	0.00247
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	0.0312	0.0338
	Antimony (Sb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00051	<0.00050
	Barium (Ba)-Dissolved (mg/L)	0.042	0.044	0.044	0.029	<0.020
	Beryllium (Be)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Calcium (Ca)-Dissolved (mg/L)	31.7	32.6	32.2	17.4	12.3
	Chromium (Cr)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Dissolved (mg/L)	0.0046	0.0047	0.0046	0.0016	0.0011
	Iron (Fe)-Dissolved (mg/L)	<0.030	<0.030	<0.030	0.332	0.331
	Lead (Pb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Magnesium (Mg)-Dissolved (mg/L)	9.74	10.2	10.1	5.04	6.67
	Manganese (Mn)-Dissolved (mg/L)	0.0121	0.0125	0.0125	0.0263	0.0289
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	0.0022	0.0022	0.0022	<0.0010	<0.0010
	Nickel (Ni)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	0.0010	<0.0010
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Selenium (Se)-Dissolved (mg/L)	0.000486	0.000516	0.000518	0.000260	0.000117
	Silver (Ag)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Dissolved (mg/L)	11.0	11.8	11.6	4.1	9.5
	Thallium (Tl)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)	0.00064	0.00063	0.00064	0.00031	0.00033
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00051	0.00193
	Zinc (Zn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1834209-6	L1834209-7	L1834209-8	L1834209-9	L1834209-10
	Description	Water	Water	Water	Water	Water
	Sampled Date	24-SEP-16	24-SEP-16	23-SEP-16	24-SEP-16	24-SEP-16
	Sampled Time					
	Client ID	REF-3	REF-4	REF-5	REF-6	REF-7
Grouping	**Analyte**					
WATER						
Total Metals	Uranium (U)-Total (mg/L)	0.00039	<0.00020	0.00085	0.00082	0.00059
	Vanadium (V)-Total (mg/L)	0.00114	0.00274	<0.00050	0.00136	0.00064
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0201	0.0523	0.0090	0.0117	0.0177
	Antimony (Sb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Arsenic (As)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	0.00064	<0.00050
	Barium (Ba)-Dissolved (mg/L)	0.063	0.043	0.046	0.035	0.052
	Beryllium (Be)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	<0.10
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	0.0000056	<0.0000050	0.0000053
	Calcium (Ca)-Dissolved (mg/L)	31.5	13.2	30.2	31.3	55.9
	Chromium (Cr)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Cobalt (Co)-Dissolved (mg/L)	<0.00030	0.00048	<0.00030	<0.00030	<0.00030
	Copper (Cu)-Dissolved (mg/L)	0.0014	0.0021	<0.0010	0.0011	0.0013
	Iron (Fe)-Dissolved (mg/L)	0.141	0.565	0.082	0.148	0.152
	Lead (Pb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Lithium (Li)-Dissolved (mg/L)	<0.0010	<0.0010	0.0051	<0.0010	0.0015
	Magnesium (Mg)-Dissolved (mg/L)	6.46	4.50	9.59	11.5	17.9
	Manganese (Mn)-Dissolved (mg/L)	0.0245	0.108	0.0239	0.0138	0.0225
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Molybdenum (Mo)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	0.0016
	Nickel (Ni)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	0.0013	0.0028
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	2.9
	Selenium (Se)-Dissolved (mg/L)	0.000077	0.000087	0.000457	0.000394	0.000141
	Silver (Ag)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
	Sodium (Na)-Dissolved (mg/L)	6.3	3.9	4.6	17.0	4.7
	Thallium (Tl)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
	Tin (Sn)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)	0.00036	<0.00020	0.00079	0.00081	0.00057
	Vanadium (V)-Dissolved (mg/L)	0.00067	0.00087	<0.00050	0.00116	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1834209-11	L1834209-12	L1834209-13	L1834209-14	L1834209-15
	Description	Water	Water	Water	Water	Water
	Sampled Date	25-SEP-16	23-SEP-16	23-SEP-16	23-SEP-16	
	Sampled Time					
	Client ID	REF-8	REF-9	REF-10	REF-9X	TRAVEL BLANK
Grouping	**Analyte**					
WATER						
Total Metals	Uranium (U)-Total (mg/L)	0.00070	0.00090	0.00030	0.00091	<0.00020
	Vanadium (V)-Total (mg/L)	0.00070	<0.00050	<0.00050	<0.00050	<0.00050
	Zinc (Zn)-Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0206	0.0094	0.0228	0.0091	
	Antimony (Sb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Arsenic (As)-Dissolved (mg/L)	<0.00050	0.00098	<0.00050	0.00093	
	Barium (Ba)-Dissolved (mg/L)	0.075	0.055	0.029	0.057	
	Beryllium (Be)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Boron (B)-Dissolved (mg/L)	<0.10	<0.10	<0.10	<0.10	
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Calcium (Ca)-Dissolved (mg/L)	34.0	36.5	9.45	36.9	
	Chromium (Cr)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Cobalt (Co)-Dissolved (mg/L)	<0.00030	<0.00030	<0.00030	<0.00030	
	Copper (Cu)-Dissolved (mg/L)	0.0014	<0.0010	<0.0010	<0.0010	
	Iron (Fe)-Dissolved (mg/L)	<0.030	0.056	0.040	0.057	
	Lead (Pb)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0014	<0.0010	0.0013	
	Magnesium (Mg)-Dissolved (mg/L)	7.60	15.3	2.26	15.7	
	Manganese (Mn)-Dissolved (mg/L)	0.0128	0.0323	0.00209	0.0319	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Nickel (Ni)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Potassium (K)-Dissolved (mg/L)	<2.0	<2.0	<2.0	<2.0	
	Selenium (Se)-Dissolved (mg/L)	0.000115	0.000260	0.000060	0.000293	
	Silver (Ag)-Dissolved (mg/L)	<0.000020	<0.000020	<0.000020	<0.000020	
	Sodium (Na)-Dissolved (mg/L)	3.6	<2.0	2.8	<2.0	
	Thallium (Tl)-Dissolved (mg/L)	<0.00020	<0.00020	<0.00020	<0.00020	
	Tin (Sn)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Dissolved (mg/L)	0.00065	0.00088	0.00028	0.00089	
	Vanadium (V)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Zinc (Zn)-Dissolved (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Thallium (Tl)-Total	MB-LOR	L1834209-1, -10, -11, -12, -13, -14, -15, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1834209-1, -11, -12, -13, -14, -2, -3, -5, -7, -8, -9
Matrix Spike	Dissolved Organic Carbon	MS-B	L1834209-10, -4, -6
Matrix Spike	Arsenic (As)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Cobalt (Co)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Lead (Pb)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Nickel (Ni)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Nickel (Ni)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Uranium (U)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9

Reference Information

	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Zinc (Zn)-Dissolved	MS-B	L1834209-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Aluminum (Al)-Total	MS-B	L1834209-1, -10, -11, -12, -13, -14, -15, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Manganese (Mn)-Total	MS-B	L1834209-1, -10, -11, -12, -13, -14, -15, -2, -3, -4, -5, -6, -7, -8, -9
Matrix Spike	Phosphorus (P)-Total	MS-B	L1834209-15
Matrix Spike	Phosphorus (P)-Total	MS-B	L1834209-14

Qualifiers for Individual Parameters Listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-ICP-VA	Water	Dissolved Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

Reference Information

MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO3-L-IC-N-VA	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.
Samples with very high dissolved solids (i.e. seawaters, brackish waters) may produce a negative bias by this method. Alternate methods are available for these types of samples.

Arsenic (5+), at elevated levels, is a positive interference on colourimetric phosphate analysis.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TKN-F-VA	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1834209 Report Date: 20-DEC-17

Client: MINNOW ENVIRONMENTAL INC.
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2
Contact: Pierre Stecko

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-COL-VA	**Water**							
Batch R3563877								
WG2403733-5 DUP		**L1834209-11**						
Alkalinity, Total (as CaCO3)		72	72		mg/L	0.0	20	04-OCT-16
WG2403733-2 LCS								
Alkalinity, Total (as CaCO3)			105.2		%		85-115	04-OCT-16
WG2403733-1 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-OCT-16
WG2403733-4 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-OCT-16
WG2403733-6 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-OCT-16
WG2403733-8 MB								
Alkalinity, Total (as CaCO3)			<2.0		mg/L		2	04-OCT-16
CARBONS-DOC-VA	**Water**							
Batch R3561181								
WG2399600-12 LCS								
Dissolved Organic Carbon			100.4		%		80-120	29-SEP-16
WG2399600-16 LCS								
Dissolved Organic Carbon			100.6		%		80-120	29-SEP-16
WG2399600-4 LCS								
Dissolved Organic Carbon			97.4		%		80-120	29-SEP-16
WG2399600-8 LCS								
Dissolved Organic Carbon			99.9		%		80-120	29-SEP-16
WG2399600-11 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
WG2399600-15 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
WG2399600-3 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
WG2399600-7 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
WG2399600-10 MS		**L1834209-1**						
Dissolved Organic Carbon			N/A	MS-B	%		-	29-SEP-16
Batch R3562668								
WG2401835-4 LCS								
Dissolved Organic Carbon			99.6		%		80-120	02-OCT-16
WG2401835-8 LCS								
Dissolved Organic Carbon			97.8		%		80-120	02-OCT-16
WG2401835-3 MB								

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CARBONS-DOC-VA	**Water**							
Batch R3562668								
WG2401835-3 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	02-OCT-16
WG2401835-7 MB								
Dissolved Organic Carbon			<0.50		mg/L		0.5	02-OCT-16
CARBONS-TOC-VA	**Water**							
Batch R3561180								
WG2399598-1 LCS								
Total Organic Carbon			99.7		%		80-120	29-SEP-16
WG2399598-13 LCS								
Total Organic Carbon			103.0		%		80-120	29-SEP-16
WG2399598-5 LCS								
Total Organic Carbon			99.6		%		80-120	29-SEP-16
WG2399598-9 LCS								
Total Organic Carbon			102.8		%		80-120	29-SEP-16
WG2399598-12 MB								
Total Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
WG2399598-4 MB								
Total Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
WG2399598-8 MB								
Total Organic Carbon			<0.50		mg/L		0.5	29-SEP-16
HG-D-CVAA-VA	**Water**							
Batch R3559239								
WG2398449-5 DUP		**L1834209-6**						
Mercury (Hg)-Dissolved		<0.0000050	<0.000005	RPD-NA	mg/L	N/A	20	28-SEP-16
WG2398449-2 LCS								
Mercury (Hg)-Dissolved			97.9		%		80-120	28-SEP-16
WG2398449-1 MB		**NP**						
Mercury (Hg)-Dissolved			<0.000005		mg/L		0.000005	28-SEP-16
WG2398449-8 MS		**L1834209-13**						
Mercury (Hg)-Dissolved			92.9		%		70-130	28-SEP-16
HG-T-CVAA-VA	**Water**							
Batch R3558480								
WG2398404-2 LCS								
Mercury (Hg)-Total			93.9		%		80-120	27-SEP-16
WG2398404-1 MB								
Mercury (Hg)-Total			<0.000005		mg/L		0.000005	27-SEP-16
WG2398404-6 MS		**L1834209-5**						
Mercury (Hg)-Total			84.5		%		70-130	27-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3558938								
WG2398468-2 LCS								
Aluminum (Al)-Dissolved			102.0		%		80-120	28-SEP-16
Antimony (Sb)-Dissolved			96.4		%		80-120	28-SEP-16
Arsenic (As)-Dissolved			99.7		%		80-120	28-SEP-16
Beryllium (Be)-Dissolved			103.3		%		80-120	28-SEP-16
Cadmium (Cd)-Dissolved			99.6		%		80-120	28-SEP-16
Chromium (Cr)-Dissolved			99.4		%		80-120	28-SEP-16
Cobalt (Co)-Dissolved			100.6		%		80-120	28-SEP-16
Copper (Cu)-Dissolved			97.0		%		80-120	28-SEP-16
Lead (Pb)-Dissolved			99.99		%		80-120	28-SEP-16
Lithium (Li)-Dissolved			101.3		%		80-120	28-SEP-16
Manganese (Mn)-Dissolved			101.9		%		80-120	28-SEP-16
Molybdenum (Mo)-Dissolved			103.8		%		80-120	28-SEP-16
Nickel (Ni)-Dissolved			99.9		%		80-120	28-SEP-16
Selenium (Se)-Dissolved			98.4		%		80-120	28-SEP-16
Silver (Ag)-Dissolved			92.8		%		80-120	28-SEP-16
Thallium (Tl)-Dissolved			105.5		%		80-120	28-SEP-16
Tin (Sn)-Dissolved			90.8		%		80-120	28-SEP-16
Uranium (U)-Dissolved			98.2		%		80-120	28-SEP-16
Vanadium (V)-Dissolved			100.1		%		80-120	28-SEP-16
WG2398468-1 MB		**NP**						
Aluminum (Al)-Dissolved			<0.0010		mg/L		0.001	28-SEP-16
Antimony (Sb)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Arsenic (As)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Beryllium (Be)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Cadmium (Cd)-Dissolved			<0.0000050		mg/L		0.000005	28-SEP-16
Chromium (Cr)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Cobalt (Co)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	28-SEP-16
Lead (Pb)-Dissolved			<0.000050		mg/L		0.00005	28-SEP-16
Lithium (Li)-Dissolved			<0.0010		mg/L		0.001	28-SEP-16
Manganese (Mn)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Molybdenum (Mo)-Dissolved			<0.000050		mg/L		0.00005	28-SEP-16
Nickel (Ni)-Dissolved			<0.00050		mg/L		0.0005	28-SEP-16
Selenium (Se)-Dissolved			<0.000050		mg/L		0.00005	28-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3558938								
WG2398468-1 MB		**NP**						
Silver (Ag)-Dissolved			<0.000010		mg/L		0.00001	28-SEP-16
Thallium (Tl)-Dissolved			<0.000010		mg/L		0.00001	28-SEP-16
Tin (Sn)-Dissolved			<0.00010		mg/L		0.0001	28-SEP-16
Uranium (U)-Dissolved			<0.000010		mg/L		0.00001	28-SEP-16
Vanadium (V)-Dissolved			<0.00050		mg/L		0.0005	28-SEP-16
Batch R3562796								
WG2398468-7 DUP		**L1834209-8**						
Aluminum (Al)-Dissolved		0.0090	0.0081		mg/L	9.6	20	01-OCT-16
Antimony (Sb)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Arsenic (As)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Beryllium (Be)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Cadmium (Cd)-Dissolved		0.0000056	<0.000005	RPD-NA	mg/L	N/A	20	01-OCT-16
Chromium (Cr)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Cobalt (Co)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	01-OCT-16
Copper (Cu)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Lead (Pb)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Lithium (Li)-Dissolved		0.0051	0.0053		mg/L	3.0	20	01-OCT-16
Manganese (Mn)-Dissolved		0.0239	0.0235		mg/L	1.5	20	01-OCT-16
Molybdenum (Mo)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Nickel (Ni)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Selenium (Se)-Dissolved		0.000457	0.000452		mg/L	1.2	20	01-OCT-16
Silver (Ag)-Dissolved		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	01-OCT-16
Thallium (Tl)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	01-OCT-16
Tin (Sn)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Uranium (U)-Dissolved		0.00079	0.00079		mg/L	0.5	20	01-OCT-16
Vanadium (V)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
WG2398468-8 DUP		**L1834209-4**						
Aluminum (Al)-Dissolved		0.0312	0.0291		mg/L	7.0	20	01-OCT-16
Antimony (Sb)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Arsenic (As)-Dissolved		0.00051	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Beryllium (Be)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Cadmium (Cd)-Dissolved		<0.0000050	0.0000086	RPD-NA	mg/L	N/A	20	01-OCT-16
Chromium (Cr)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Cobalt (Co)-Dissolved		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	01-OCT-16
Copper (Cu)-Dissolved		0.0016	0.0015		mg/L	3.1	20	01-OCT-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-VA	**Water**							
Batch R3562796								
WG2398468-8 DUP		**L1834209-4**						
Lead (Pb)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Lithium (Li)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Manganese (Mn)-Dissolved		0.0263	0.0260		mg/L	1.3	20	01-OCT-16
Molybdenum (Mo)-Dissolved		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Nickel (Ni)-Dissolved		0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Selenium (Se)-Dissolved		0.000260	0.000218		mg/L	17	20	01-OCT-16
Silver (Ag)-Dissolved		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	01-OCT-16
Thallium (Tl)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	01-OCT-16
Tin (Sn)-Dissolved		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Uranium (U)-Dissolved		0.00031	0.00031		mg/L	0.3	20	01-OCT-16
Vanadium (V)-Dissolved		0.00051	0.00050		mg/L	1.0	20	01-OCT-16
MET-DIS-ICP-VA	**Water**							
Batch R3559265								
WG2398468-7 DUP		**L1834209-8**						
Barium (Ba)-Dissolved		0.046	0.046		mg/L	1.7	20	28-SEP-16
Boron (B)-Dissolved		<0.10	<0.10	RPD-NA	mg/L	N/A	20	28-SEP-16
Calcium (Ca)-Dissolved		30.2	30.3		mg/L	0.4	20	28-SEP-16
Iron (Fe)-Dissolved		0.082	0.083		mg/L	0.9	20	28-SEP-16
Magnesium (Mg)-Dissolved		9.59	9.57		mg/L	0.2	20	28-SEP-16
Potassium (K)-Dissolved		<2.0	<2.0	RPD-NA	mg/L	N/A	20	28-SEP-16
Sodium (Na)-Dissolved		4.6	4.5		mg/L	2.0	20	28-SEP-16
Titanium (Ti)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	28-SEP-16
Zinc (Zn)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	28-SEP-16
WG2398468-8 DUP		**L1834209-4**						
Barium (Ba)-Dissolved		0.029	0.029		mg/L	0.2	20	28-SEP-16
Boron (B)-Dissolved		<0.10	<0.10	RPD-NA	mg/L	N/A	20	28-SEP-16
Calcium (Ca)-Dissolved		17.4	17.7		mg/L	1.5	20	28-SEP-16
Iron (Fe)-Dissolved		0.332	0.335		mg/L	0.8	20	28-SEP-16
Magnesium (Mg)-Dissolved		5.04	5.06		mg/L	0.4	20	28-SEP-16
Potassium (K)-Dissolved		<2.0	<2.0	RPD-NA	mg/L	N/A	20	28-SEP-16
Sodium (Na)-Dissolved		4.1	4.1		mg/L	0.3	20	28-SEP-16
Titanium (Ti)-Dissolved		<0.010	<0.010	RPD-NA	mg/L	N/A	20	28-SEP-16
Zinc (Zn)-Dissolved		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	28-SEP-16
WG2398468-2 LCS								
Barium (Ba)-Dissolved			100.2		%		80-120	28-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-VA	**Water**							
Batch R3559265								
WG2398468-2 LCS								
Boron (B)-Dissolved			94.9		%		80-120	28-SEP-16
Calcium (Ca)-Dissolved			102.7		%		80-120	28-SEP-16
Iron (Fe)-Dissolved			95.2		%		80-120	28-SEP-16
Magnesium (Mg)-Dissolved			97.9		%		80-120	28-SEP-16
Potassium (K)-Dissolved			104.2		%		80-120	28-SEP-16
Sodium (Na)-Dissolved			97.2		%		80-120	28-SEP-16
Titanium (Ti)-Dissolved			101.9		%		80-120	28-SEP-16
Zinc (Zn)-Dissolved			94.3		%		80-120	28-SEP-16
WG2398468-1 MB		**NP**						
Barium (Ba)-Dissolved			<0.010		mg/L		0.01	28-SEP-16
Boron (B)-Dissolved			<0.10		mg/L		0.1	28-SEP-16
Calcium (Ca)-Dissolved			<0.050		mg/L		0.05	28-SEP-16
Iron (Fe)-Dissolved			<0.030		mg/L		0.03	28-SEP-16
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	28-SEP-16
Potassium (K)-Dissolved			<2.0		mg/L		2	28-SEP-16
Sodium (Na)-Dissolved			<2.0		mg/L		2	28-SEP-16
Titanium (Ti)-Dissolved			<0.010		mg/L		0.01	28-SEP-16
Zinc (Zn)-Dissolved			<0.0050		mg/L		0.005	28-SEP-16
MET-T-CCMS-VA	**Water**							
Batch R3562782								
WG2400648-2 LCS								
Aluminum (Al)-Total			116.0		%		80-120	30-SEP-16
Antimony (Sb)-Total			110.6		%		80-120	30-SEP-16
Arsenic (As)-Total			111.3		%		80-120	30-SEP-16
Beryllium (Be)-Total			109.1		%		80-120	30-SEP-16
Cadmium (Cd)-Total			107.7		%		80-120	30-SEP-16
Chromium (Cr)-Total			111.8		%		80-120	30-SEP-16
Cobalt (Co)-Total			108.5		%		80-120	30-SEP-16
Copper (Cu)-Total			108.1		%		80-120	30-SEP-16
Lead (Pb)-Total			111.0		%		80-120	30-SEP-16
Lithium (Li)-Total			110.6		%		80-120	30-SEP-16
Molybdenum (Mo)-Total			112.4		%		80-120	30-SEP-16
Nickel (Ni)-Total			109.1		%		80-120	30-SEP-16
Selenium (Se)-Total			108.3		%		80-120	30-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3562782								
WG2400648-2 LCS								
Silver (Ag)-Total			111.3		%		80-120	30-SEP-16
Thallium (Tl)-Total			110.2		%		80-120	30-SEP-16
Tin (Sn)-Total			109.7		%		80-120	30-SEP-16
Uranium (U)-Total			113.6		%		80-120	30-SEP-16
Vanadium (V)-Total			111.3		%		80-120	30-SEP-16
WG2400648-1 MB								
Aluminum (Al)-Total			<0.0030		mg/L		0.003	30-SEP-16
Antimony (Sb)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Arsenic (As)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Beryllium (Be)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Cadmium (Cd)-Total			<0.0000050		mg/L		0.000005	30-SEP-16
Chromium (Cr)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Cobalt (Co)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Copper (Cu)-Total			<0.00050		mg/L		0.0005	30-SEP-16
Lead (Pb)-Total			<0.000050		mg/L		0.00005	30-SEP-16
Lithium (Li)-Total			<0.0010		mg/L		0.001	30-SEP-16
Manganese (Mn)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Molybdenum (Mo)-Total			<0.000050		mg/L		0.00005	30-SEP-16
Nickel (Ni)-Total			<0.00050		mg/L		0.0005	30-SEP-16
Selenium (Se)-Total			<0.000050		mg/L		0.00005	30-SEP-16
Silver (Ag)-Total			<0.000010		mg/L		0.00001	30-SEP-16
Tin (Sn)-Total			<0.00010		mg/L		0.0001	30-SEP-16
Uranium (U)-Total			<0.000010		mg/L		0.00001	30-SEP-16
Vanadium (V)-Total			<0.00050		mg/L		0.0005	30-SEP-16
Batch R3562796								
WG2400648-3 DUP		**L1834209-1**						
Aluminum (Al)-Total		0.0930	0.0931		mg/L	0.1	20	01-OCT-16
Antimony (Sb)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Arsenic (As)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Beryllium (Be)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Cadmium (Cd)-Total		<0.0000050	<0.0000050	RPD-NA	mg/L	N/A	20	01-OCT-16
Chromium (Cr)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Cobalt (Co)-Total		<0.00030	<0.00030	RPD-NA	mg/L	N/A	20	01-OCT-16
Copper (Cu)-Total		0.0057	0.0059		mg/L	3.0	20	01-OCT-16
Lead (Pb)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-VA	**Water**							
Batch R3562796								
WG2400648-3 DUP		**L1834209-1**						
Lithium (Li)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Manganese (Mn)-Total		0.0250	0.0248		mg/L	0.7	20	01-OCT-16
Molybdenum (Mo)-Total		0.0023	0.0024		mg/L	2.3	20	01-OCT-16
Nickel (Ni)-Total		<0.0010	<0.0010	RPD-NA	mg/L	N/A	20	01-OCT-16
Selenium (Se)-Total		0.000514	0.000484		mg/L	5.9	20	01-OCT-16
Silver (Ag)-Total		<0.000020	<0.000020	RPD-NA	mg/L	N/A	20	01-OCT-16
Thallium (Tl)-Total		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	01-OCT-16
Tin (Sn)-Total		<0.00050	<0.00050	RPD-NA	mg/L	N/A	20	01-OCT-16
Uranium (U)-Total		0.00069	0.00069		mg/L	0.8	20	01-OCT-16
Vanadium (V)-Total		0.00079	0.00075		mg/L	4.2	20	01-OCT-16
WG2400648-4 MS		**L1834209-2**						
Aluminum (Al)-Total			N/A	MS-B	%		-	01-OCT-16
Antimony (Sb)-Total			101.4		%		70-130	01-OCT-16
Arsenic (As)-Total			101.9		%		70-130	01-OCT-16
Beryllium (Be)-Total			97.8		%		70-130	01-OCT-16
Cadmium (Cd)-Total			95.2		%		70-130	01-OCT-16
Chromium (Cr)-Total			100.5		%		70-130	01-OCT-16
Cobalt (Co)-Total			101.7		%		70-130	01-OCT-16
Copper (Cu)-Total			97.3		%		70-130	01-OCT-16
Lead (Pb)-Total			94.9		%		70-130	01-OCT-16
Lithium (Li)-Total			102.7		%		70-130	01-OCT-16
Manganese (Mn)-Total			N/A	MS-B	%		-	01-OCT-16
Molybdenum (Mo)-Total			100.5		%		70-130	01-OCT-16
Nickel (Ni)-Total			104.7		%		70-130	01-OCT-16
Selenium (Se)-Total			99.6		%		70-130	01-OCT-16
Silver (Ag)-Total			100.7		%		70-130	01-OCT-16
Thallium (Tl)-Total			94.1		%		70-130	01-OCT-16
Tin (Sn)-Total			96.4		%		70-130	01-OCT-16
Uranium (U)-Total			94.4		%		70-130	01-OCT-16
Vanadium (V)-Total			102.4		%		70-130	01-OCT-16
Batch R3563808								
WG2400648-2 LCS								
Manganese (Mn)-Total			105.4		%		80-120	03-OCT-16
WG2400648-1 MB								
Thallium (Tl)-Total			0.000029	MB-LOR	mg/L		0.00001	03-OCT-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TOT-ICP-VA	**Water**							
Batch R3561082								
WG2400648-2 LCS								
Barium (Ba)-Total			101.7		%		80-120	30-SEP-16
Boron (B)-Total			96.9		%		80-120	30-SEP-16
Calcium (Ca)-Total			98.3		%		80-120	30-SEP-16
Iron (Fe)-Total			96.4		%		80-120	30-SEP-16
Magnesium (Mg)-Total			98.6		%		80-120	30-SEP-16
Potassium (K)-Total			101.6		%		80-120	30-SEP-16
Sodium (Na)-Total			100.4		%		80-120	30-SEP-16
Titanium (Ti)-Total			100.5		%		80-120	30-SEP-16
Zinc (Zn)-Total			94.2		%		80-120	30-SEP-16
WG2400648-1 MB								
Barium (Ba)-Total			<0.010		mg/L		0.01	30-SEP-16
Boron (B)-Total			<0.10		mg/L		0.1	30-SEP-16
Calcium (Ca)-Total			<0.050		mg/L		0.05	30-SEP-16
Iron (Fe)-Total			<0.030		mg/L		0.03	30-SEP-16
Magnesium (Mg)-Total			<0.10		mg/L		0.1	30-SEP-16
Potassium (K)-Total			<2.0		mg/L		2	30-SEP-16
Sodium (Na)-Total			<2.0		mg/L		2	30-SEP-16
Titanium (Ti)-Total			<0.010		mg/L		0.01	30-SEP-16
Zinc (Zn)-Total			<0.0050		mg/L		0.005	30-SEP-16
Batch R3561135								
WG2400648-3 DUP		**L1834209-1**						
Barium (Ba)-Total		0.048	0.049		mg/L	2.2	20	30-SEP-16
Boron (B)-Total		<0.10	<0.10	RPD-NA	mg/L	N/A	20	30-SEP-16
Calcium (Ca)-Total		30.8	30.9		mg/L	0.3	20	30-SEP-16
Iron (Fe)-Total		0.150	0.176		mg/L	16	20	30-SEP-16
Magnesium (Mg)-Total		11.1	11.2		mg/L	1.4	20	30-SEP-16
Potassium (K)-Total		<2.0	<2.0	RPD-NA	mg/L	N/A	20	30-SEP-16
Sodium (Na)-Total		11.5	11.7		mg/L	2.1	20	30-SEP-16
Titanium (Ti)-Total		<0.010	<0.010	RPD-NA	mg/L	N/A	20	30-SEP-16
Zinc (Zn)-Total		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	30-SEP-16
WG2400648-4 MS		**L1834209-2**						
Barium (Ba)-Total			98.2		%		70-130	30-SEP-16
Boron (B)-Total			97.9		%		70-130	30-SEP-16
Calcium (Ca)-Total			88.3		%		70-130	30-SEP-16
Iron (Fe)-Total			80.6		%		70-130	30-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TOT-ICP-VA	**Water**							
Batch R3561135								
WG2400648-4 MS		**L1834209-2**						
Magnesium (Mg)-Total			98.4		%		70-130	30-SEP-16
Potassium (K)-Total			103.5		%		70-130	30-SEP-16
Sodium (Na)-Total			102.9		%		70-130	30-SEP-16
Titanium (Ti)-Total			93.2		%		70-130	30-SEP-16
Zinc (Zn)-Total			93.5		%		70-130	30-SEP-16
NH3-F-VA	**Water**							
Batch R3564905								
WG2403831-7 DUP		**L1834209-12**						
Ammonia, Total (as N)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	20	05-OCT-16
WG2403831-2 LCS								
Ammonia, Total (as N)			97.9		%		85-115	05-OCT-16
WG2403831-6 LCS								
Ammonia, Total (as N)			95.4		%		85-115	05-OCT-16
WG2403831-1 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	05-OCT-16
WG2403831-5 MB								
Ammonia, Total (as N)			<0.0050		mg/L		0.005	05-OCT-16
WG2403831-8 MS		**L1834209-12**						
Ammonia, Total (as N)			88.0		%		75-125	05-OCT-16
NO3-L-IC-N-VA	**Water**							
Batch R3560087								
WG2398050-18 LCS								
Nitrate (as N)			100.5		%		90-110	27-SEP-16
WG2398050-2 LCS								
Nitrate (as N)			100.5		%		90-110	27-SEP-16
WG2398050-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-SEP-16
WG2398050-10 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-SEP-16
WG2398050-13 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-SEP-16
WG2398050-16 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-SEP-16
WG2398050-4 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-SEP-16
WG2398050-7 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	27-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WR	**Water**							
Batch R3558094								
WG2397916-17 DUP		**L1834209-2**						
Nitrate (as N)		1.90	1.86		mg/L	1.9	20	26-SEP-16
WG2397916-18 DUP		**L1834209-14**						
Nitrate (as N)		0.165	0.170		mg/L	3.5	20	26-SEP-16
WG2397916-29 LCS								
Nitrate (as N)			97.5		%		90-110	26-SEP-16
WG2397916-31 LCS								
Nitrate (as N)			98.3		%		90-110	26-SEP-16
WG2397916-33 LCS								
Nitrate (as N)			98.6		%		90-110	26-SEP-16
WG2397916-28 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-SEP-16
WG2397916-30 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-SEP-16
WG2397916-32 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	26-SEP-16
WG2397916-22 MS		**L1834209-1**						
Nitrate (as N)			79.0		%		75-125	26-SEP-16
WG2397916-25 MS		**L1834209-13**						
Nitrate (as N)			94.7		%		75-125	26-SEP-16
P-T-PRES-COL-VA	**Water**							
Batch R3559549								
WG2398740-6 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			101.1		%		80-120	29-SEP-16
WG2398740-7 DUP		**L1834209-1**						
Phosphorus (P)-Total		0.0132	0.0121		mg/L	9.1	20	29-SEP-16
WG2398740-5 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-16
WG2398740-8 MS		**L1834209-2**						
Phosphorus (P)-Total			84.3		%		70-130	29-SEP-16
Batch R3559703								
WG2398969-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			99.4		%		80-120	29-SEP-16
WG2398969-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	29-SEP-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
P-T-PRES-COL-VA	**Water**							
Batch R3560884								
WG2399594-2 CRM		**VA-ERA-PO4**						
Phosphorus (P)-Total			101.1		%		80-120	30-SEP-16
WG2399594-1 MB								
Phosphorus (P)-Total			<0.0020		mg/L		0.002	30-SEP-16
TDS-VA	**Water**							
Batch R3560530								
WG2399452-2 LCS								
Total Dissolved Solids			100.2		%		85-115	29-SEP-16
WG2399452-5 LCS								
Total Dissolved Solids			97.4		%		85-115	29-SEP-16
WG2399452-1 MB								
Total Dissolved Solids			<10		mg/L		10	29-SEP-16
WG2399452-4 MB								
Total Dissolved Solids			<10		mg/L		10	29-SEP-16
TKN-F-VA	**Water**							
Batch R3564606								
WG2403538-3 DUP		**L1834209-5**						
Total Kjeldahl Nitrogen		0.406	0.389		mg/L	4.2	20	05-OCT-16
WG2403538-2 LCS								
Total Kjeldahl Nitrogen			102.6		%		75-125	05-OCT-16
WG2403538-1 MB								
Total Kjeldahl Nitrogen			<0.050		mg/L		0.05	05-OCT-16
WG2403538-4 MS		**L1834209-7**						
Total Kjeldahl Nitrogen			97.6		%		70-130	05-OCT-16
TSS-VA	**Water**							
Batch R3560719								
WG2399553-5 LCS								
Total Suspended Solids			108.3		%		85-115	29-SEP-16
WG2399553-4 MB								
Total Suspended Solids			<3.0		mg/L		3	29-SEP-16
Batch R3561167								
WG2400526-2 LCS								
Total Suspended Solids			98.2		%		85-115	30-SEP-16
WG2400526-5 LCS								
Total Suspended Solids			92.3		%		85-115	30-SEP-16
WG2400526-1 MB								
Total Suspended Solids			<3.0		mg/L		3	30-SEP-16
WG2400526-4 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TSS-VA	**Water**							
Batch R3561167								
WG2400526-4 MB								
Total Suspended Solids			<3.0		mg/L		3	30-SEP-16

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Anions and Nutrients							
Nitrate in Water by IC (Low Level)							
	1	22-SEP-16	26-SEP-16 14:02	3	4	days	EHTR
	2	22-SEP-16	26-SEP-16 14:02	3	4	days	EHTR
	3	22-SEP-16	26-SEP-16 14:02	3	4	days	EHTR

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1834209 were received on 26-SEP-16 09:55.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1834209-COFC

COC Number: 14 -

Page 1 of 2

Report To

Company: Minnow Environmental Inc.

Contact: Pierre Stecko

Address: 101 - 1025 Hillside Ave.
Victoria, BC, V8T 2A2

Phone: (250) 595-1627 x24
(250) 709-5533

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ Yes ☐ No

☐ Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax pstecko@minnow.ca

Email 2 RyanH@mintomine.com

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

R ☑ Regular (Standard TAT if received by 3 pm - business days)

P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT

E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT

E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Invoice To Same as Report To ☐ Yes ☑ No

Copy of Invoice with Report ☐ Yes ☑ No

Company: Capstone - Minto Mine

Contact: Ryan Herbert

Invoice Distribution

Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax RyanH@mintomine.com

Email 2

Project Information

ALS Quote #: Q58355

Job #: 15-87

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

Approver ID:

Cost Center:

GL Account:

Routing Code:

Activity Code:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Selam Worku

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ALK-COL-VA	TDS-VA	TSS-VA	NO3-L-IC-N-VA	TKN-F-VA	NH3-F-VA	P-T-PRES-COL-VA	CARBONS-DOC-VA	MET-DIS-CCME-VA	MET-TOT-CCME-VA				Number of Containers
						F		P	P	P	P	F/P	F/P	P				
	UMC-1	22-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	UMC-2	22-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	UMC-3	22-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-1	25-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-2	24-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-3	24-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-4	24-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-5	23-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-6	24-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-7	24-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-8	25-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-9	23-09-16		Water	R	R	R	R	R	R	R	R	R	R				7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☑ No

Are samples for human drinking water use?
☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐

SIF Observations Yes ☐ No ☐

Ice packs Yes ☑ No ☐

Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
08.09	1.2	0.6			

SHIPMENT RELEASE (client use)

Released by:

Date: Sept26

Time: 10:00

INITIAL SHIPMENT RECEPTION (lab use only)

Received by:

Date: 26-SEP-16

Time: 9:55

FINAL SHIPMENT RECEPTION (lab use only)

Received by:

Date:

Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an **Authorized DW COC form**.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1834209-COFC

COC Number: 14 -

Page 2 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Pierre Stecko
Address:	101 - 1025 Hillside Ave. Victoria, BC, V8T 2A2
Phone:	(250) 595-1627 x24 (250) 709-5533
Invoice To	Same as Report To ☐ Yes ☑ No
	Copy of Invoice with Report ☐ Yes ☑ No
Company:	Capstone - Minto Mine
Contact:	Ryan Herbert

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ Yes ☐ No

☐ Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax pstecko@minnow.ca

Email 2 RyanH@mintomine.com

Invoice Distribution

Select Invoice Distribution: ☐ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax RyanH@mintomine.com

Email 2

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

R ☑ Regular (Standard TAT if received by 3 pm - business days)

P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT

E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT

E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Project Information

ALS Quote #:	Q58355
Job #:	15-87
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: Selam Worku

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	ALK-COL-VA	TDS-VA	TSS-VA	NO3-L-IC-N-VA	TKN-F-VA	NH3-F-VA	P-T-PRES-COL-VA	CARBONS-DOC-VA	MET-DIS-CCME-VA	MET-TOT-CCME-VA				Number of Containers
						F		P	P	P	P	F/P	F/P	P				
	REF-10	23-09-16		Water	R	R	R	R	R	R	R	R	R	R				7
	REF-9x	23-09-16		Water	R	R	R	R	R	R	R	R	R	R				7

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☑ No

Are samples for human drinking water use?
☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice packs Yes ☑ No ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
0.8,0.9	1.2	0.6			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: Sept 26	Time: 10:00	Received by:	Date: 26-SEP-16	Time: 9:55	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326a v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

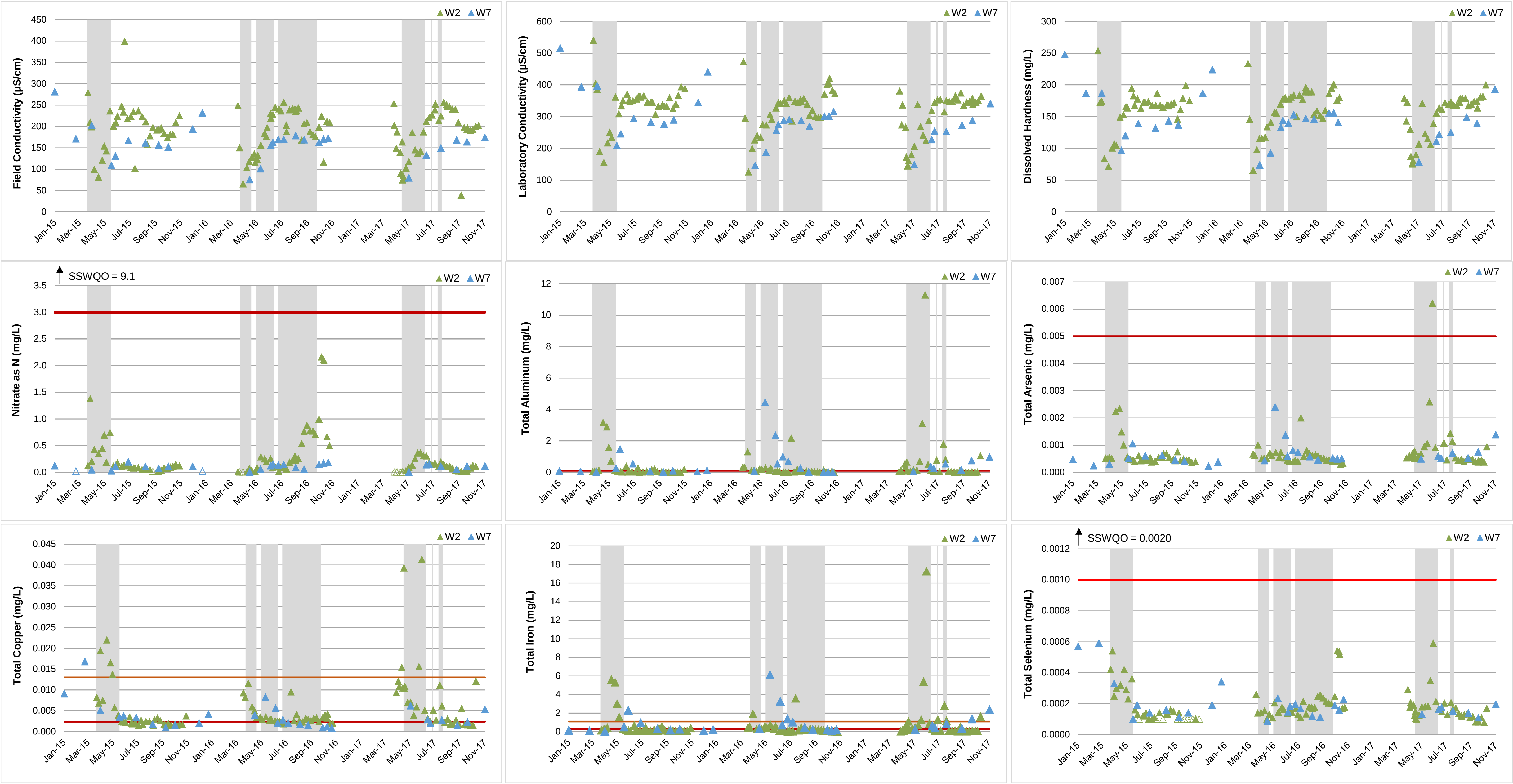


Figure C.1: **Concentrations of Key Analytes of Routine Water Quality Monitoring under MMER at Lower Minto Creek (Station W2) and the Reference Tributary (Station W7), 2015 - 2017**

Notes: Grey shading indicates periods of Water Storage Pond discharge.
Symbols that are unfilled are less than method detection limits.
Red line represents water quality (WQ) guidelines (CCME 1999 with updates). For total aluminum and arsenic, this line represents both WQ guidelines and site-specific water quality objectives (SSWQO).
Orange line represents SSWQO for Station W2 per the Minto Mine Water Use Licence. The SSWQO are applicable on a dissolved basis only for metals

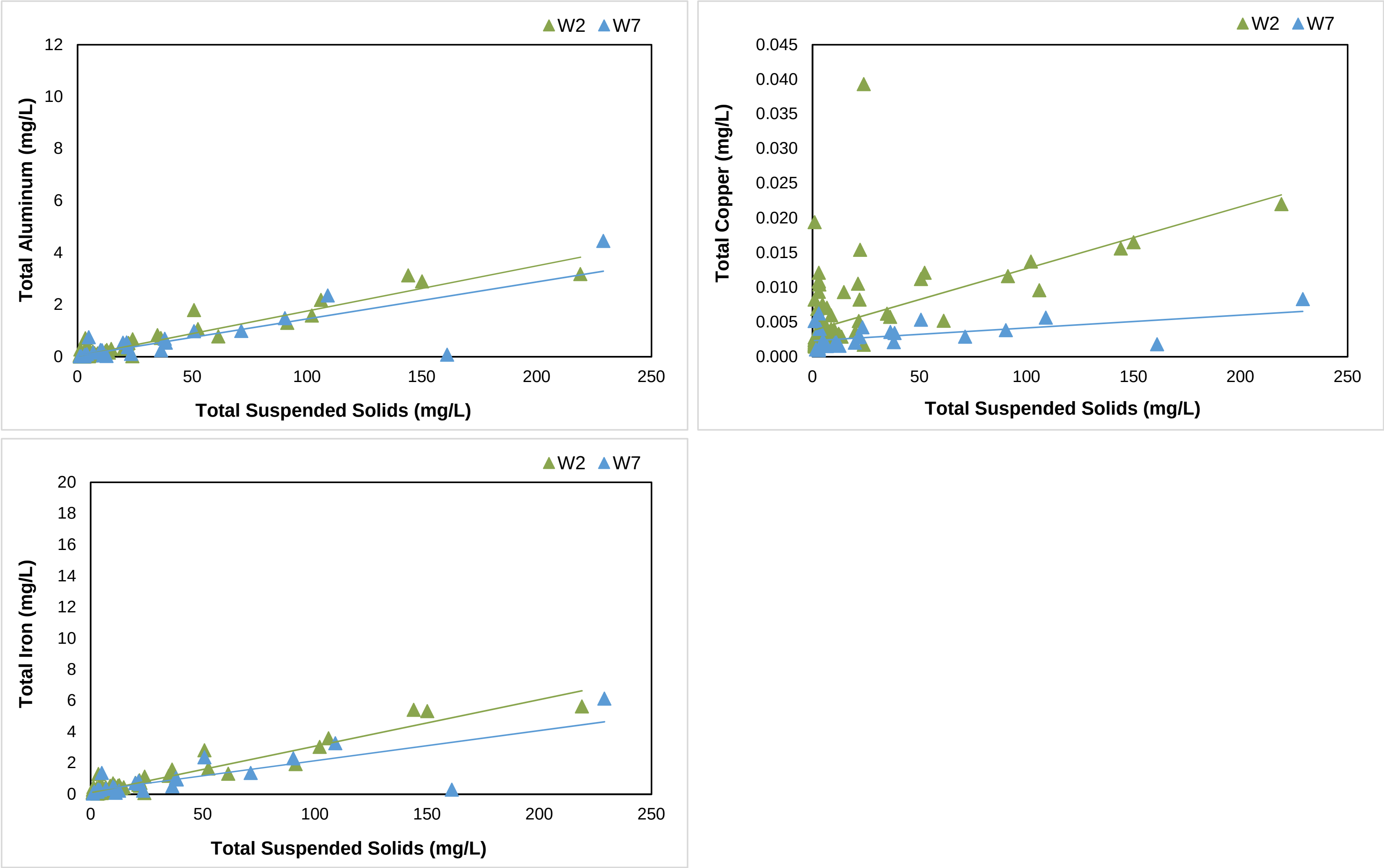


Figure C.2: **Regression of Total Metal Concentrations (mg/L) relative to Total Suspended Solids (mg/L) in Routine Water Quality Monitoring Samples under MMER at Lower Minto Creek (Station W2) and the Reference Tributary (Station W7), 2015-2017**

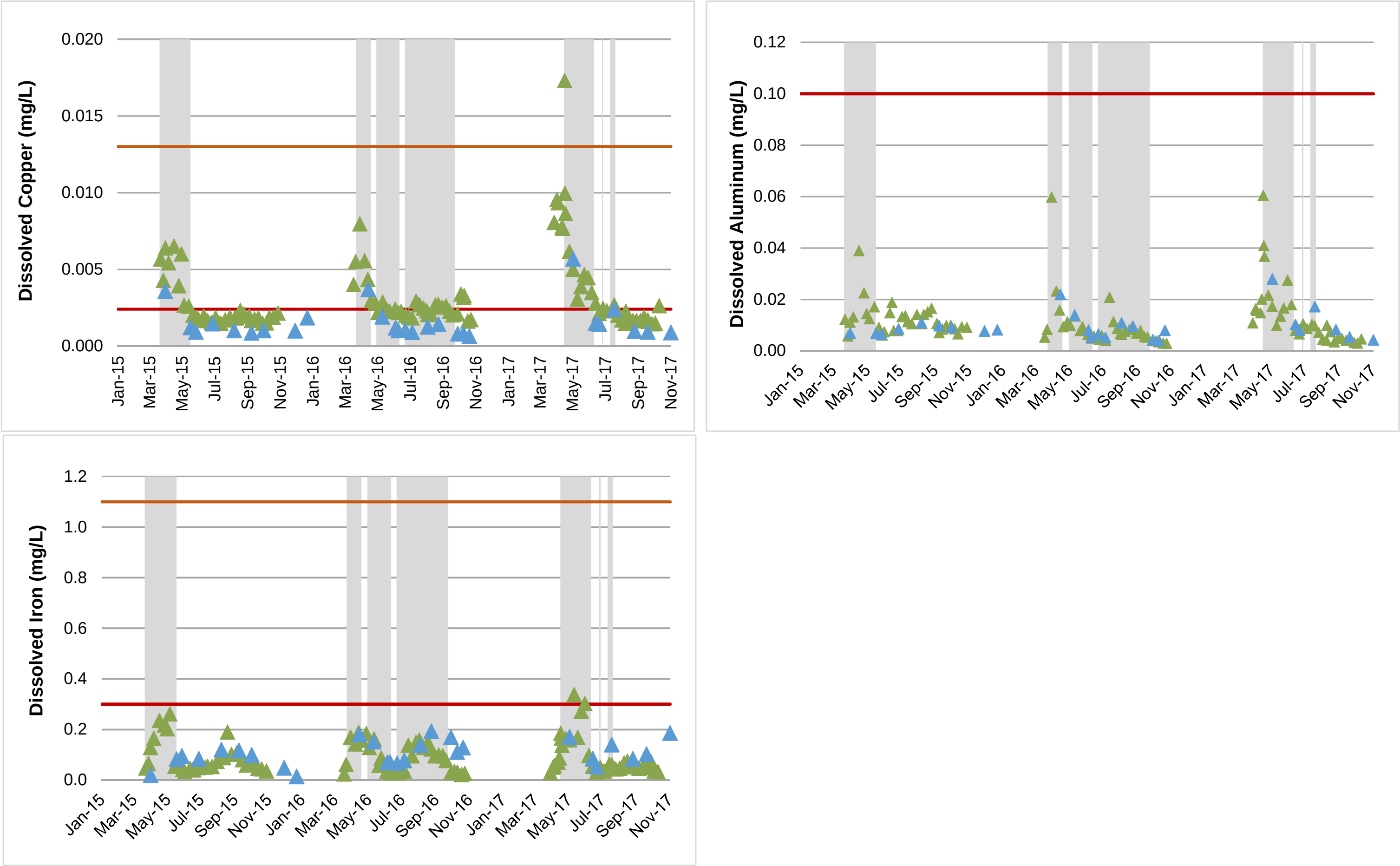


Figure C.3: **Concentrations of Dissolved Metals of Routine Water Quality Monitoring under MMER at Lower Minto Creek (Station W2) and the Reference Tributary (Station W7), 2015 - 2017**

Notes: Grey shading indicates periods of Water Storage Pond discharge.

Symbols that are unfilled are less than method detection limits.

Red line represents water quality (WQ) guidelines (CCME 1999 with updates). For dissolved aluminum, this line represents both WQ guidelines and site-specific water quality objectives (SSWQO). WQ guidelines are applicable on a total basis only for metals.

Orange line represents SSWQO for Station W2 per the Minto Mine Water Use Licence.

Table C.1: Minto Mine Routine EEM Water Quality Monitoring Data, 2014-2017

Analytes		Station W7 (Reference)									
		2014					2015				
		5-May-14	30-Jun-14	9-Aug-14	31-Oct-14	2014 MEAN	31-May-15	11-Jul-15	21-Aug-15	15-Oct-15	2015 MEAN
Water Temperature	°C	-0.1	2.5	2.3	-1.6	0.8	0	1.2	3.0	0	1.1
Field Conductivity	µS/cm	59	171	186	199	153	109	167	161	152	147
Laboratory Conductivity	µS/cm	105	278	291	304	245	209	294	283	290	269
Dissolved Oxygen	mg/L	14.4	12.1	12.9	13.4	13.2	13.3	10.7	11.8	12.3	12.0
pH	pH units	8.19	8.11	7.92	7.29	7.88	7.51	7.67	7.85	7.53	7.64
Total Hardness	mg/L	52	135	143	164	124	104	145	164	154	142
Dissolved Hardness	mg/L	53	129	133	159	119	97	139	132	137	126
Total Alkalinity	mg/L	48	130	142	150	118	100	143	140	138	130
Total Ammonia	mg/L	0.014	0.025	0.025	0.022	0.022	0.014	0.039	0.043	0.038	0.034
Nitrate	mg/L	<0.02	0.20	0.16	0.20	0.15	0.0290	0.20	0.11	0.11	0.11
TSS	mg/L	3.5	4.5	2.9	2.6	3.4	36.4	38.4	161	4.1	60.0
Total Aluminum	mg/L	0.12	0.10	0.032	0.010	0.065	0.25	0.53	0.074	0.097	0.24
Total Arsenic	mg/L	0.00049	0.00040	0.00049	0.00044	0.00046	0.00051	0.00061	0.00062	0.00041	0.00054
Total Cadmium	mg/L	0.000026	0.000012	<0.000010	<0.000010	0.000015	<0.00001	0.000011	<0.00001	<0.00001	0.000010
Total Copper	mg/L	0.0062	0.0021	0.0012	0.00098	0.0026	0.0035	0.0034	0.0018	0.0016	0.0026
Total Iron	mg/L	0.40	0.18	0.18	0.15	0.23	0.50	0.95	0.29	0.27	0.50
Total Lead	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.0002	<0.0002	0.00027	<0.0002	<0.0002	0.00022
Total Mercury	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Total Molybdenum	mg/L	<0.0010	0.0015	0.0016	0.0015	0.0014	0.0013	0.0015	0.0019	0.0014	0.0015
Total Nickel	mg/L	0.0019	<0.0010	<0.0010	<0.0010	0.0012	0.0014	0.0023	0.0014	0.0010	0.0015
Total Selenium	mg/L	0.00011	0.00018	0.00030	0.00016	0.00019	0.00010	0.00014	0.00016	0.00014	0.00014
Total Zinc	mg/L	0.0059	<0.0050	<0.0050	<0.0050	0.0052	<0.005	<0.005	<0.005	<0.005	<0.005

Analytes		Station W2 (Effluent-Exposed)									
		2014					2015				
		5-May-14	30-Jun-14	7-Aug-14	31-Oct-14	2014 MEAN	9-May-15	15-Jun-15	13-Aug-15	5-Oct-15	2015 MEAN
Water Temperature	°C	0.3	8.7	6.6	-1.4	3.6	2.5	6.5	6.7	0	3.9
Field Conductivity	µS/cm	77	239	237	188	185	121	224	223	184	188
Laboratory Conductivity	µS/cm	77	239	237	188	185	217	351	346	360	319
Dissolved Oxygen	mg/L	14.4	11.0	13.7	14.3	13.4	14.3	10.8	11.6	14.5	12.8
pH	pH units	8.22	8.30	8.08	7.69	8.07	7.60	7.87	8.09	7.92	7.87
Total Hardness	mg/L	69	167	180	176	148	115	172	176	178	160
Dissolved Hardness	mg/L	66	158	164	204	148	101	164	168	172	151
Total Alkalinity	mg/L	61	151	154	181	137	85	154	164	165	142
Total Ammonia	mg/L	0.021	0.040	0.014	0.0091	0.021	0.028	0.030	0.039	0.013	0.028
Nitrate	mg/L	0.0540	0.0490	0.12	0.18	0.10	0.45	0.18	0.0520	0.0860	0.19
TSS	mg/L	54.4	<1.0	4.2	<1.0	15.2	150	1.3	2.6	<1.0	38.7
Total Aluminum	mg/L	0.90	0.051	0.16	0.014	0.28	2.9	0.020	0.058	0.007	0.74
Total Arsenic	mg/L	0.00096	0.00052	0.00072	0.00032	0.00063	0.0023	0.00039	0.00055	0.00043	0.00093
Total Cadmium	mg/L	0.000028	0.000020	<0.000010	<0.000010	0.000017	0.000054	<0.00001	<0.00001	<0.00001	0.000021
Total Copper	mg/L	0.0070	0.0034	0.0022	0.0016	0.0036	0.017	0.0022	0.0024	0.0015	0.0057
Total Iron	mg/L	1.7	0.12	0.49	0.083	0.60	5.3	0.069	0.21	0.065	1.4
Total Lead	mg/L	0.00049	<0.00020	<0.00020	<0.00020	0.00027	0.00154	<0.0002	<0.0002	<0.0002	0.00054
Total Mercury	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001
Total Molybdenum	mg/L	<0.0010	0.0016	0.0015	0.0012	0.0013	0.0015	0.0015	0.0016	0.0014	0.0015
Total Nickel	mg/L	0.0032	0.0011	0.0013	0.0011	0.0017	0.0069	<0.001	0.0010	<0.001	0.0025
Total Selenium	mg/L	0.00014	0.00013	0.00010	<0.00010	0.00012	0.00042	<0.0001	<0.0001	<0.0001	0.00018
Total Zinc	mg/L	0.0060	0.0053	<0.0050	<0.0050	0.0053	0.013	<0.005	<0.005	<0.005	0.0071

[1] If greater than 50% of samples were less than method detection limit, the mean was presented with a less than symbol (<)

Note: Only water quality data presented for 2015 to 2017 pertain to the Phase 4 EEM. Water quality data from 2014 collected following the completion of the Phase 3 EEM are included herein for informational purposes only.

Table C.1: Minto Mine Routine EEM Water Quality Monitoring Data, 2014-2017

Analytes		Station W7 (Reference)												
		2016					2017					2015 to 2017		
		28-Apr-16	23-Jun-16	17-Aug-16	23-Oct-16	2016 MEAN	16-May-17	27-Jun-17	1-Aug-17	3-Oct-17	2017 MEAN	MEAN	5th Percentile	95th Percentile
Water Temperature	°C	0.1	3.1	4.5	-0.1	1.9	-0.1	2.3	4.0	0.8	1.8	1.6	-0.10	4.5
Field Conductivity	µS/cm	76	163	178	170	147	80	133	149	164	132	142	76	178
Laboratory Conductivity	µS/cm	146	275	288	302	253	149	228	253	288	230	250	146	302
Dissolved Oxygen	mg/L	15.4	11.4	11.8	12.0	12.7	15.0	12.5	11.9	13.7	13.3	12.6	10.7	15.4
pH	pH units	7.72	7.62	7.81	7.68	7.71	7.58	8.13	7.58	7.50	7.70	7.68	7.50	8.13
Total Hardness	mg/L	-	-	-	-	-	-	-	-	-	-	142	-	-
Dissolved Hardness	mg/L	74	144	147	156	130	78	111	125	139	113	123	74	156
Total Alkalinity	mg/L	70	134	157	164	131	76	118	127	150	118	126	70	164
Total Ammonia	mg/L	0.0069	0.015	0.016	0.027	0.016	0.0070	0.011	0.014	0.015	0.012	0.020	0.0069	0.043
Nitrate	mg/L	0.0063	0.15	0.0883	0.17	0.10	0.0050	0.14	0.12	0.12	0.10	0.10	0.0050	0.20
TSS	mg/L	3.3	19.8	10.0	<3.0	9.0	<3.0	22.0	21.4	4.9	12.8	27.3	<3.0	161
Total Aluminum	mg/L	0.073	0.54	0.26	0.014	0.22	0.041	0.37	0.54	0.74	0.42	0.29	0.014	0.74
Total Arsenic	mg/L	0.00043	0.00059	0.00057	0.00049	0.00052	0.00049	0.00059	0.00071	0.00075	0.00064	0.00056	0.00041	0.00075
Total Cadmium	mg/L	0.0000091	0.0000058	<0.000005	<0.000005	0.0000062	0.0000082	0.000010	0.000011	0.000014	0.000011	0.0000083	<0.000005	0.000014
Total Copper	mg/L	0.0040	0.0020	0.0018	0.0012	0.0022	0.0062	0.0029	0.0028	0.0023	0.0035	0.0028	0.0012	0.0062
Total Iron	mg/L	0.31	0.70	0.47	0.15	0.41	0.23	0.66	0.85	1.4	0.77	0.56	0.15	1.4
Total Lead	mg/L	<0.000050	0.00026	0.00014	<0.000050	0.00013	<0.00005	0.00019	0.00021	0.00039	0.00021	0.00016	<0.00005	0.00039
Total Mercury	mg/L	0.000012	<0.000005	<0.000005	<0.000005	0.0000068	<0.000005	<0.000005	<0.000005	<0.0000050	<0.000005	0.0000056	<0.000005	0.000012
Total Molybdenum	mg/L	0.00073	0.0016	0.0016	0.0013	0.0013	0.00081	0.0016	0.0014	0.0013	0.0013	0.0014	0.00073	0.0019
Total Nickel	mg/L	0.0015	0.0018	0.0017	0.00088	0.0015	0.0018	0.0020	0.0021	0.0028	0.0022	0.0017	0.00088	0.0028
Total Selenium	mg/L	0.000087	0.00018	0.00012	0.00016	0.00014	0.00013	0.00016	0.00015	0.00011	0.00014	0.00014	0.000087	0.00018
Total Zinc	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.003	<0.003	<0.003	0.0032	0.0055	0.0037	0.0032	<0.003	0.0055

Analytes		Station W7 (Reference)									
		2016					2017				
		27-Apr-16	23-Jun-16	17-Aug-16	23-Oct-16	2016 MEAN	16-May-17	27-Jun-17	1-Aug-17	3-Oct-17	2017 MEAN
Water Temperature	°C	0.2	6.8	7.0	0	3.5	1.5	6.0	6.7	0.8	3.8
Field Conductivity	µS/cm	118	227	235	117	174	118	212	224	193	187
Laboratory Conductivity	µS/cm	227	344	349	404	331	207	319	350	358	309
Dissolved Oxygen	mg/L	14.4	10.8	11.9	13.1	12.6	14.6	10.9	11.8	14.4	12.9
pH	pH units	7.95	7.81	8.06	7.87	7.92	7.69	7.96	7.81	7.47	7.73
Total Hardness	mg/L	-	-	-	-	-	-	-	-	-	-
Dissolved Hardness	mg/L	115	178	196	201	173	107	156	173	174	153
Total Alkalinity	mg/L	95	158	176	176	151	99	150	168	174	148
Total Ammonia	mg/L	<0.005	<0.005	0.0061	0.0055	0.0054	0.0062	0.013	0.0061	<0.005	0.0077
Nitrate	mg/L	0.0717	0.10	0.22	2.11	0.63	0.0935	0.31	0.20	0.0162	0.15
TSS	mg/L	4.0	8.0	<3.0	<3.0	4.5	6.7	7.4	34.8	23.9	18.2
Total Aluminum	mg/L	0.10	0.071	0.041	0.029	0.061	0.16	0.14	0.82	0.010	0.28
Total Arsenic	mg/L	0.00053	0.00045	0.00058	0.00045	0.00050	0.00068	0.00061	0.0011	0.00038	0.00070
Total Cadmium	mg/L	0.0000091	<0.0000050	<0.0000050	<0.0000050	0.0000060	0.000016	<0.000005	0.000015	0.0000068	0.000011
Total Copper	mg/L	0.0050	0.0025	0.0023	0.0032	0.0033	0.0071	0.0032	0.0062	0.0017	0.0045
Total Iron	mg/L	0.35	0.14	0.23	0.081	0.20	0.44	0.28	1.2	0.078	0.49
Total Lead	mg/L	0.000065	<0.000050	<0.000050	<0.000050	0.000054	0.000083	0.000077	0.00032	<0.000050	0.00013
Total Mercury	mg/L	0.000010	<0.000005	<0.000005	<0.000005	0.0000063	<0.000005	<0.000005	<0.000005	<0.0000050	<0.000005
Total Molybdenum	mg/L	0.0012	0.0014	0.0017	0.0022	0.0016	0.0011	0.0019	0.0018	0.0014	0.0015
Total Nickel	mg/L	0.0015	0.0012	0.0012	0.00084	0.0012	0.0018	0.0014	0.0028	0.0010	0.0018
Total Selenium	mg/L	0.00010	0.00014	0.00017	0.00054	0.00024	0.00018	0.00017	0.00016	0.000085	0.00015
Total Zinc	mg/L	<0.0030	<0.0030	<0.0030	<0.0030	<0.003	0.0056	<0.003	0.0042	<0.0030	0.0040

[1] If greater than 50% of samples were less than method detection limit, the mean was presented with a less than symbol (<)

Note: Only water quality data presented for 2015 to 2017 pertain to the Phase 4 EEM. Water quality data from 2014 collected following the completion of the Phase 3 EEM are included herein for informational purposes only.

Table C.2: *In-situ* Water Quality and Physical Measures at Benthic Community Sites, Minto Mine Phase 4 EEM, September 2016

Area	Station	Temperature (°C)	Specific Conductance (µs/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH (pH units)	Water Velocity (m/s)	Mean Depth (m)	Median Intermediate Axis (cm)
Water Quality Guidelines		**-**	**-**	**6.5**	**-**	**6.5 - 9.0**	**-**	**-**	**-**
Reference Creeks	REF-1	0.0	131.6	12.86	88.1	7.74	0.48	0.11	4.2
	REF-2	0.8	137.2	13.45	93.9	8.07	0.56	0.15	4.2
	REF-3	0.5	209.2	13.65	94.7	7.94	0.65	0.09	4.9
	REF-4	1.3	110.7	13.44	95.3	7.69	0.42	0.22	3.5
	REF-5	0.9	232.1	13.32	93.5	7.91	0.68	0.13	4.5
	REF-6	0.1	265.1	13.63	93.6	8.05	0.37	0.22	3.1
	REF-7	2.0	389.1	13.50	97.6	8.32	0.57	0.10	4.8
	REF-8	0.0	221.2	13.66	93.4	7.97	0.52	0.15	4.5
	REF-9	3.0	275.1	13.01	96.7	8.26	0.55	0.11	5.5
	REF-10	1.3	73.9	13.67	96.2	7.66	0.63	0.12	4.2
	n	10	10	10	10	10	10	10	10
	mean	0.99	205	13.4	94.3	7.96	0.54	0.14	4.3
	median	0.85	215	13.5	94.3	7.96	0.56	0.13	4.4
	minimum	0.00	74	12.9	88.1	7.66	0.37	0.09	3.1
	maximum	3.00	389	13.7	97.6	8.32	0.68	0.22	5.5
	standard deviation	0.96	94	0.28	2.6	0.22	0.10	0.05	0.7
	standard error	0.30	30	0.09	0.83	0.07	0.03	0.01	0.2
Upper Minto Creek (Exposure)	UMC-1	9.0	267.9	10.07	87.1	7.91	0.60	0.12	4.7
	UMC-2	8.9	268.1	10.20	88.1	7.92	0.61	0.12	3.5
	UMC-3	8.9	264.4	10.27	88.7	7.81	0.56	0.11	3.5
	UMC-4	7.1	273.0	11.08	91.5	7.98	0.58	0.13	4.1
	UMC-5	9.1	267.7	10.14	88.0	7.96	0.65	0.09	3.8
	n	5	5	5	5	5	5	5	5
	mean	8.60	268	10.4	88.7	7.92	0.60	0.11	3.9
	median	8.90	268	10.2	88.1	7.92	0.60	0.12	3.8
	minimum	7.10	264	10.1	87.1	7.81	0.56	0.09	3.5
	maximum	9.10	273	11.1	91.5	7.98	0.65	0.13	4.7
	standard deviation	0.84	3.08	0.41	1.7	0.07	0.03	0.02	0.5
	standard error	0.38	1.38	0.18	0.7	0.03	0.02	0.01	0.2

Table C.3: Intermediate Axis Length and Embeddedness of 100 Cobble Washed during Surber Sampling at Benthic Invertebrate Stations, Minto Mine Phase 4 EEM, 2016

Cobble Number	Ref-1		Ref-2		Ref-3		Ref-4		Ref-5	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	6.3	-	3.4	-	3.4	-	5.0	-	8.7	-
2	4.6	-	4.3	-	8.4	-	2.7	-	10.6	-
3	4.0	-	7.4	-	10.5	-	3.5	-	3.2	-
4	7.0	-	5.7	-	9.0	-	3.0	-	9.1	-
5	7.8	-	7.7	-	8.9	-	5.4	-	4.5	-
6	7.6	-	5.7	-	6.8	-	2.8	-	6.3	-
7	5.0	-	5.6	-	4.9	-	3.3	-	5.7	-
8	3.3	-	3.4	-	5.3	-	4.8	-	6.5	-
9	4.6	-	6.7	-	4.0	-	2.7	-	7.5	-
10	4.0	25	5.5	50	3.5	75	3.3	50	6.0	50
11	4.5	-	6.6	-	3.8	-	3.4	-	3.4	-
12	6.7	-	8.5	-	3.8	-	5.6	-	3.4	-
13	4.5	-	6.5	-	2.5	-	2.8	-	5.1	-
14	5.5	-	7.9	-	7.0	-	4.7	-	3.3	-
15	4.4	-	6.2	-	6.0	-	3.3	-	11.6	-
16	3.3	-	5.5	-	3.8	-	3.5	-	5.2	-
17	3.3	-	4.6	-	2.0	-	3.0	-	3.1	-
18	5.4	-	3.2	-	3.0	-	2.7	-	3.1	-
19	10.2	-	9.0	-	3.5	-	5.4	-	2.1	-
20	3.5	25	3.3	0	4.7	25	2.2	0	2.7	0
21	4.5	-	2.6	-	5.4	-	4.0	-	3.6	-
22	3.0	-	12.5	-	8.8	-	3.5	-	2.7	-
23	3.0	-	5.0	-	6.7	-	2.8	-	3.4	-
24	3.0	-	3.8	-	5.8	-	4.6	-	1.8	-
25	4.6	-	4.9	-	7.8	-	3.0	-	6.8	-
26	4.9	-	6.5	-	4.9	-	5.2	-	5.6	-
27	7.4	-	3.2	-	14.0	-	4.6	-	9.4	-
28	3.3	-	6.1	-	5.3	-	2.5	-	4.0	-
29	5.6	-	3.9	-	7.1	-	3.4	-	11.7	-
30	6.3	50	4.9	75	7.8	50	3.4	0	2.1	0
31	4.5	-	5.3	-	3.8	-	3.0	-	11.1	-
32	6.3	-	7.2	-	3.2	-	3.2	-	7.4	-
33	2.4	-	6.4	-	2.9	-	2.3	-	6.3	-
34	2.2	-	5.5	-	9.5	-	4.1	-	7.2	-
35	2.2	-	7.0	-	3.9	-	4.9	-	5.5	-
36	2.6	-	5.5	-	13.5	-	2.9	-	4.6	-
37	4.6	-	3.0	-	5.7	-	3.1	-	3.7	-
38	3.1	-	6.9	-	9.0	-	5.0	-	4.0	-
39	3.4	-	2.6	-	6.4	-	4.1	-	4.6	-
40	4.3	50	8.4	0	5.4	75	3.5	0	4.5	-
41	4.0	-	5.4	-	5.7	-	2.8	-	3.3	-
42	3.6	-	6.6	-	4.9	-	2.4	-	4.1	-
43	3.0	-	3.1	-	10.5	-	3.6	-	2.4	-
44	3.3	-	5.4	-	3.3	-	3.9	-	3.5	-
45	3.8	-	9.7	-	5.2	-	4.7	-	2.6	-
46	2.5	-	4.0	-	5.3	-	3.0	-	4.7	-
47	3.6	-	5.1	-	3.6	-	4.5	-	8.9	-
48	2.3	-	9.0	-	3.4	-	3.5	-	3.8	-
49	2.4	-	3.9	-	4.3	-	6.2	-	9.6	-
50	3.0	25	4.6	75	4.6	25	3.8	0	6.2	-
51	6.0	-	4.2	-	2.8	-	2.5	-	3.1	-
52	4.3	-	6.2	-	2.5	-	3.0	-	3.7	-
53	6.1	-	3.1	-	3.4	-	4.7	-	4.0	-
54	4.5	-	4.6	-	3.5	-	3.2	-	2.9	-
55	4.3	-	4.3	-	3.9	-	3.5	-	4.5	-
56	8.3	-	2.9	-	2.9	-	3.0	-	5.0	-
57	3.7	-	3.6	-	7.6	-	3.5	-	4.3	-
58	4.4	-	3.2	-	3.3	-	2.5	-	6.7	-
59	9.0	-	2.8	-	4.8	-	4.0	-	9.0	-
60	5.5	0	2.4	75	7.5	0	3.5	25	5.2	75
61	6.2	-	3.4	-	7.3	-	2.7	-	7.8	-
62	3.9	-	3.1	-	6.3	-	2.8	-	3.0	-
63	3.3	-	3.3	-	6.5	-	7.5	-	5.1	-
64	3.4	-	3.1	-	3.5	-	2.0	-	2.4	-
65	4.5	-	4.1	-	3.3	-	3.8	-	4.4	-
66	3.8	-	2.9	-	4.1	-	2.5	-	4.1	-
67	4.4	-	2.7	-	2.9	-	6.7	-	4.0	-
68	4.0	-	4.0	-	5.0	-	2.6	-	2.9	-
69	4.8	-	3.3	-	7.2	-	5.2	-	3.2	-
70	3.7	50	2.9	0	13.5	25	3.4	25	3.4	0
71	2.8	-	4.0	-	3.7	-	3.8	-	3.4	-
72	3.6	-	9.1	-	3.1	-	4.9	-	2.5	-
73	4.5	-	3.7	-	2.0	-	5.0	-	2.5	-
74	2.8	-	2.5	-	1.9	-	3.5	-	4.5	-
75	3.0	-	5.2	-	4.4	-	4.0	-	11.5	-
76	5.2	-	3.3	-	2.2	-	3.4	-	4.4	-
77	3.6	-	5.9	-	1.8	-	4.3	-	4.0	-
78	3.5	-	2.5	-	4.8	-	3.3	-	7.5	-
79	10.7	-	3.7	-	4.9	-	7.2	-	3.6	-
80	2.8	25	2.7	25	4.1	0	6.3	0	11.0	0
81	5.7	-	4.5	-	4.7	-	4.3	-	4.1	-
82	3.1	-	2.8	-	6.0	-	5.1	-	5.4	-
83	4.2	-	2.9	-	4.0	-	3.0	-	3.5	-
84	5.4	-	2.9	-	8.8	-	3.1	-	6.0	-
85	6.3	-	4.0	-	4.9	-	3.8	-	3.8	-
86	6.5	-	4.4	-	13.6	-	3.9	-	2.0	-
87	3.6	-	2.7	-	9.0	-	4.0	-	6.6	-
88	3.2	-	2.8	-	5.1	-	3.4	-	7.5	-
89	5.8	-	2.5	-	5.5	-	3.0	-	7.7	-
90	3.4	0	1.8	25	4.9	50	3.9	75	3.2	50
91	4.0	-	2.3	-	11.6	-	5.3	-	11.5	-
92	4.2	-	2.0	-	7.5	-	3.8	-	5.1	-
93	3.7	-	7.0	-	4.1	-	3.3	-	2.1	-
94	4.2	-	5.6	-	10.3	-	4.0	-	17.0	-
95	3.7	-	3.2	-	5.9	-	2.8	-	11.1	-
96	4.3	-	4.2	-	4.7	-	3.4	-	10.5	-
97	3.0	-	3.4	-	6.2	-	2.6	-	10.5	-
98	3.1	-	4.0	-	4.0	-	1.9	-	4.1	-
99	4.5	-	8.7	-	3.5	-	2.5	-	15.2	-
100	4.2	0	3.9	0	3.5	75	3.5	0	2.0	50
Minimum	**2.2**	**-**	**1.8**	**-**	**1.8**	**-**	**1.9**	**-**	**1.8**	**-**
Maximum	**10.7**	**-**	**12.5**	**-**	**14.0**	**-**	**7.5**	**-**	**17.0**	**-**
Mean	**4.4**	**-**	**4.7**	**-**	**5.6**	**-**	**3.7**	**-**	**5.5**	**-**
Geometric mean	**4.2**	**-**	**4.4**	**-**	**5.0**	**-**	**3.6**	**-**	**4.8**	**-**
Median	**4.2**	**25.0**	**4.2**	**25.0**	**4.9**	**37.5**	**3.5**	**0.0**	**4.5**	**25.0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table C.3: Intermediate Axis Length and Embeddedness of 100 Cobble Washed during Surber Sampling at Benthic Invertebrate Stations, Minto Mine Phase 4 EEM, 2016

Cobble Number	Ref-6		Ref-7		Ref-8		Ref-9		Ref-10	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	7.1	-	5.9	-	6.5	-	15.3	-	7.2	-
2	6.6	-	7.3	-	3.4	-	7.5	-	9.8	-
3	2.8	-	6.6	-	3.0	-	5.4	-	2.8	-
4	6.1	-	12.5	-	3.2	-	4.4	-	3.3	-
5	4.0	-	5.0	-	2.7	-	2.9	-	2.9	-
6	3.5	-	5.1	-	3.5	-	3.2	-	5.5	-
7	2.8	-	5.1	-	3.8	-	5.0	-	4.4	-
8	4.0	-	5.5	-	4.4	-	2.3	-	2.5	-
9	3.3	-	5.0	-	8.2	-	4.5	-	4.2	-
10	2.5	0	2.8	0	8.2	75	5.2	25	4.8	0
11	2.4	-	5.0	-	5.0	-	3.3	-	5.5	-
12	3.0	-	5.9	-	4.2	-	3.7	-	2.5	-
13	3.2	-	5.8	-	3.8	-	3.1	-	10.9	-
14	3.8	-	6.0	-	3.1	-	3.9	-	3.4	-
15	3.1	-	4.7	-	5.2	-	4.4	-	5.6	-
16	5.7	-	6.1	-	6.4	-	2.8	-	4.4	-
17	1.7	-	4.8	-	4.8	-	3.4	-	3.1	-
18	8.7	-	10.2	-	4.9	-	2.3	-	4.3	-
19	3.3	-	3.8	-	4.6	-	8.0	-	7.3	-
20	5.5	50	6.4	50	4.5	0	13.2	0	6.8	0
21	3.3	-	10.8	-	4.4	-	8.7	-	5.4	-
22	3.0	-	5.3	-	9.5	-	13.6	-	5.8	-
23	5.0	-	6.6	-	2.0	-	7.3	-	2.6	-
24	2.3	-	3.9	-	5.5	-	8.5	-	3.5	-
25	2.6	-	4.7	-	5.2	-	11.0	-	7.5	-
26	2.8	-	3.3	-	3.4	-	10.7	-	2.4	-
27	3.9	-	3.7	-	5.5	-	7.7	-	2.4	-
28	3.3	-	3.1	-	3.7	-	8.6	-	6.5	-
29	2.4	-	3.3	-	3.4	-	4.0	-	3.0	-
30	5.0	0	3.6	75	4.3	75	3.0	25	8.0	75
31	3.2	-	5.1	-	2.7	-	3.3	-	2.0	-
32	3.3	-	6.6	-	3.7	-	2.6	-	8.5	-
33	3.0	-	7.0	-	5.5	-	6.3	-	5.8	-
34	2.2	-	7.5	-	3.5	-	5.9	-	4.3	-
35	2.4	-	2.9	-	4.2	-	5.7	-	2.7	-
36	3.0	-	7.2	-	4.5	-	2.8	-	10.1	-
37	2.3	-	3.1	-	3.1	-	3.3	-	7.7	-
38	2.7	-	11.5	-	2.9	-	5.7	-	4.8	-
39	2.2	-	12.3	-	3.9	-	8.5	-	4.5	-
40	2.5	0	6.0	25	2.8	75	2.4	0	3.2	25
41	2.0	-	4.8	-	2.7	-	11.9	-	3.8	-
42	2.1	-	5.8	-	2.7	-	5.4	-	2.5	-
43	2.3	-	3.3	-	3.1	-	8.9	-	3.8	-
44	2.2	-	4.8	-	3.3	-	2.9	-	15.0	-
45	4.2	-	3.7	-	2.5	-	3.1	-	8.7	-
46	4.0	-	5.3	-	6.8	-	3.2	-	3.6	-
47	3.2	-	2.8	-	4.2	-	5.3	-	5.0	-
48	6.2	-	2.7	-	7.1	-	4.3	-	4.5	-
49	2.7	-	2.7	-	5.7	-	5.2	-	3.2	-
50	6.2	25	9.3	50	3.7	0	9.5	25	3.3	0
51	2.3	-	6.5	-	4.4	-	3.9	-	10.4	-
52	7.0	-	8.4	-	7.4	-	3.1	-	2.7	-
53	6.5	-	7.1	-	9.5	-	6.8	-	4.9	-
54	5.5	-	9.4	-	7.6	-	4.3	-	4.2	-
55	3.7	-	6.3	-	15.5	-	3.4	-	1.9	-
56	4.8	-	3.7	-	9.5	-	5.5	-	12.2	-
57	5.9	-	4.2	-	3.8	-	4.8	-	5.1	-
58	4.0	-	5.1	-	4.7	-	1.7	-	4.6	-
59	4.1	-	4.2	-	4.2	-	9.6	-	6.8	-
60	3.1	25	5.0	25	5.5	0	9.2	25	6.5	0
61	4.5	-	4.4	-	4.6	-	3.1	-	4.8	-
62	4.3	-	3.9	-	2.9	-	4.7	-	4.9	-
63	2.5	-	3.4	-	3.0	-	8.5	-	2.7	-
64	3.0	-	3.7	-	2.3	-	12.5	-	8.6	-
65	1.9	-	2.2	-	2.6	-	2.5	-	12.0	-
66	4.9	-	3.8	-	2.4	-	11.0	-	7.5	-
67	3.0	-	2.3	-	6.1	-	5.2	-	4.5	-
68	6.1	-	2.1	-	11.3	-	5.5	-	2.8	-
69	3.1	-	2.2	-	9.8	-	5.3	-	5.5	-
70	5.7	25	2.1	75	4.3	0	12.0	75	4.5	0
71	4.9	-	6.0	-	6.3	-	13.4	-	2.4	-
72	4.0	-	5.1	-	5.0	-	8.8	-	3.5	-
73	2.9	-	7.0	-	6.1	-	15.0	-	4.4	-
74	4.4	-	10.5	-	5.5	-	5.0	-	4.0	-
75	3.8	-	2.7	-	6.2	-	9.8	-	16.7	-
76	3.4	-	4.9	-	2.4	-	2.3	-	4.8	-
77	3.5	-	4.0	-	4.7	-	3.4	-	2.3	-
78	3.1	-	5.0	-	5.4	-	8.5	-	2.2	-
79	2.9	-	4.4	-	10.1	-	4.2	-	2.6	-
80	3.6	50	4.7	50	4.7	25	6.0	0	2.3	50
81	1.6	-	4.2	-	7.4	-	5.5	-	3.1	-
82	2.3	-	4.1	-	2.9	-	7.0	-	3.0	-
83	2.9	-	3.5	-	4.8	-	4.4	-	2.5	-
84	2.6	-	3.9	-	3.9	-	3.4	-	2.8	-
85	2.9	-	3.1	-	5.1	-	8.4	-	3.8	-
86	3.2	-	12.3	-	4.9	-	11.8	-	2.0	-
87	2.9	-	5.5	-	3.1	-	3.2	-	2.0	-
88	2.9	-	5.6	-	3.6	-	9.7	-	3.0	-
89	2.3	-	3.7	-	1.9	-	6.4	-	2.7	-
90	2.0	50	3.2	0	2.9	50	5.8	0	2.3	0
91	2.4	-	3.3	-	4.9	-	8.1	-	1.7	-
92	2.3	-	3.4	-	9.8	-	10.2	-	1.1	-
93	1.4	-	3.1	-	6.5	-	15.9	-	2.8	-
94	2.5	-	4.4	-	4.2	-	8.1	-	1.6	-
95	2.5	-	3.9	-	5.5	-	4.6	-	1.6	-
96	2.8	-	4.0	-	4.5	-	6.0	-	1.6	-
97	2.5	-	2.8	-	5.2	-	7.4	-	6.4	-
98	3.3	-	4.7	-	5.5	-	8.0	-	4.5	-
99	2.7	-	5.1	-	3.4	-	8.6	-	5.5	-
100	2.6	50	5.7	25	3.3	25	10.5	50	3.7	0
Minimum	**1.4**	**-**	**2.1**	**-**	**1.9**	**-**	**1.7**	**-**	**1.1**	**-**
Maximum	**8.7**	**-**	**12.5**	**-**	**15.5**	**-**	**15.9**	**-**	**16.7**	**-**
Mean	**3.5**	**-**	**5.2**	**-**	**4.9**	**-**	**6.5**	**-**	**4.8**	**-**
Geometric mean	**3.3**	**-**	**4.7**	**-**	**4.5**	**-**	**5.6**	**-**	**4.1**	**-**
Median	**3.1**	**25.0**	**4.8**	**37.5**	**4.5**	**25.0**	**5.5**	**25.0**	**4.2**	**0.0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table C.3: Intermediate Axis Length and Embeddedness of 100 Cobble Washed during Surber Sampling at Benthic Invertebrate Stations, Minto Mine Phase 4 EEM, 2016

Cobble Number	UMC-1		UMC-2		UMC-3		UMC-4		UMC-5	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	8.2	-	5.4	-	3.5	-	7.7	-	4.9	-
2	4.5	-	8.3	-	5.2	-	9.5	-	3.2	-
3	3.3	-	4.3	-	3.9	-	4.7	-	4.1	-
4	3.8	-	5.2	-	2.2	-	3.3	-	2.6	-
5	4.9	-	3.0	-	4.0	-	4.8	-	4.6	-
6	3.1	-	8.0	-	2.0	-	5.5	-	2.1	-
7	3.7	-	4.2	-	4.5	-	3.5	-	4.7	-
8	5.5	-	2.4	-	2.8	-	5.2	-	3.9	-
9	2.2	-	5.2	-	3.0	-	2.5	-	3.4	-
10	7.6	0	3.6	0	5.5	25	6.6	25	5.5	75
11	3.8	-	3.5	-	2.3	-	3.1	-	2.2	-
12	3.7	-	2.7	-	2.5	-	4.1	-	3.8	-
13	4.7	-	2.7	-	4.3	-	3.4	-	5.0	-
14	3.7	-	1.5	-	5.1	-	4.4	-	3.4	-
15	4.2	-	7.3	-	3.5	-	3.2	-	4.4	-
16	2.7	-	3.4	-	4.5	-	2.5	-	3.4	-
17	8.5	-	3.2	-	4.0	-	3.4	-	3.5	-
18	9.8	-	3.7	-	3.3	-	7.0	-	3.4	-
19	4.6	-	2.5	-	2.0	-	4.4	-	3.8	-
20	9.1	25	2.5	0	3.3	25	3.7	0	2.1	50
21	3.3	-	3.8	-	4.1	-	3.4	-	2.4	-
22	8.2	-	1.9	-	1.3	-	4.1	-	3.7	-
23	7.4	-	6.8	-	2.6	-	3.0	-	3.4	-
24	2.6	-	4.1	-	2.8	-	6.5	-	4.2	-
25	10.3	-	3.0	-	3.0	-	3.7	-	2.7	-
26	3.7	-	4.5	-	2.1	-	4.1	-	4.1	-
27	2.4	-	6.8	-	3.7	-	3.0	-	2.8	-
28	7.3	-	3.4	-	3.5	-	2.2	-	3.4	-
29	5.6	-	5.0	-	6.5	-	2.4	-	5.1	-
30	8.1	25	3.4	50	5.5	0	2.2	50	3.2	0
31	5.0	-	2.8	-	5.5	-	3.0	-	4.4	-
32	6.6	-	1.8	-	6.7	-	2.5	-	3.6	-
33	4.7	-	1.8	-	2.7	-	2.2	-	3.7	-
34	7.1	-	2.8	-	2.0	-	2.7	-	4.7	-
35	7.5	-	2.6	-	2.4	-	2.4	-	5.4	-
36	4.1	-	2.6	-	3.2	-	2.2	-	5.8	-
37	5.7	-	2.1	-	2.2	-	2.8	-	3.6	-
38	6.5	-	2.5	-	5.6	-	2.1	-	3.0	-
39	3.9	-	3.3	-	2.5	-	2.2	-	2.9	-
40	7.2	75	3.0	25	7.5	50	10.3	0	3.2	0
41	3.7	-	3.3	-	3.0	-	6.3	-	5.5	-
42	4.4	-	2.5	-	2.0	-	3.8	-	2.5	-
43	3.6	-	3.1	-	4.7	-	4.8	-	1.9	-
44	3.8	-	1.0	-	2.0	-	1.9	-	2.8	-
45	4.3	-	1.2	-	3.4	-	3.8	-	2.0	-
46	2.6	-	7.5	-	3.4	-	5.2	-	4.0	-
47	2.6	-	10.0	-	2.6	-	12.4	-	3.5	-
48	2.9	-	7.5	-	3.6	-	7.9	-	1.5	-
49	3.3	-	3.8	-	7.9	-	7.5	-	1.4	-
50	2.7	75	3.3	0	3.7	0	8.1	25	1.5	25
51	2.9	-	3.4	-	5.0	-	7.2	-	1.1	-
52	2.7	-	4.8	-	6.0	-	6.2	-	1.5	-
53	2.7	-	3.8	-	2.7	-	5.6	-	6.2	-
54	2.6	-	3.0	-	2.9	-	4.7	-	4.4	-
55	1.7	-	6.5	-	5.3	-	3.1	-	5.2	-
56	2.2	-	3.7	-	2.0	-	4.6	-	4.0	-
57	8.8	-	8.1	-	3.0	-	3.3	-	2.6	-
58	7.7	-	3.8	-	4.3	-	2.6	-	4.5	-
59	6.0	-	3.2	-	5.6	-	3.8	-	5.0	-
60	6.8	50	4.6	25	2.6	0	2.9	0	3.3	25
61	6.5	-	4.3	-	7.3	-	6.1	-	4.1	-
62	5.3	-	9.3	-	3.0	-	6.9	-	5.8	-
63	9.0	-	4.1	-	8.0	-	4.6	-	4.7	-
64	8.4	-	3.8	-	4.3	-	3.7	-	4.8	-
65	6.5	-	5.1	-	2.5	-	3.0	-	3.5	-
66	6.5	-	5.7	-	4.1	-	2.5	-	5.0	-
67	4.0	-	7.0	-	2.7	-	2.1	-	3.7	-
68	4.4	-	3.7	-	5.7	-	3.4	-	3.2	-
69	3.5	-	3.0	-	5.5	-	6.9	-	4.0	-
70	6.5	0	3.5	0	3.0	50	4.3	25	3.0	0
71	5.9	-	3.3	-	2.9	-	6.7	-	3.3	-
72	5.0	-	11.0	-	7.4	-	8.3	-	5.6	-
73	7.5	-	5.2	-	2.1	-	3.8	-	3.4	-
74	7.8	-	2.6	-	6.0	-	5.1	-	6.0	-
75	2.9	-	6.5	-	2.6	-	7.8	-	8.4	-
76	4.1	-	3.4	-	2.7	-	3.0	-	8.2	-
77	4.0	-	3.8	-	3.3	-	2.7	-	4.8	-
78	2.9	-	4.7	-	4.3	-	3.8	-	3.9	-
79	4.0	-	8.7	-	4.9	-	3.1	-	3.5	-
80	2.3	50	2.8	0	3.9	25	4.2	50	5.3	0
81	4.9	-	3.1	-	6.5	-	7.9	-	5.5	-
82	3.7	-	10.2	-	4.3	-	5.7	-	11.3	-
83	2.8	-	5.8	-	2.3	-	5.5	-	6.3	-
84	5.1	-	7.0	-	3.3	-	8.4	-	7.0	-
85	5.4	-	3.6	-	3.1	-	10.2	-	5.1	-
86	9.2	-	2.2	-	5.3	-	9.4	-	3.1	-
87	6.3	-	3.4	-	2.9	-	6.3	-	3.3	-
88	7.1	-	5.7	-	4.2	-	7.9	-	5.4	-
89	4.7	-	4.0	-	5.0	-	9.7	-	3.3	-
90	3.6	25	2.2	50	6.2	25	8.3	50	5.4	25
91	3.2	-	2.9	-	3.9	-	6.1	-	3.4	-
92	4.1	-	2.8	-	2.6	-	7.8	-	3.1	-
93	3.2	-	2.9	-	4.6	-	2.5	-	3.0	-
94	11.5	-	5.0	-	2.5	-	3.0	-	6.3	-
95	12.0	-	4.8	-	3.1	-	7.4	-	7.3	-
96	7.4	-	3.5	-	3.5	-	4.5	-	5.9	-
97	10.6	-	2.5	-	3.0	-	4.1	-	4.8	-
98	7.5	-	3.4	-	2.6	-	2.7	-	4.8	-
99	8.3	-	1.9	-	4.6	-	3.4	-	5.2	-
100	4.0	50	2.0	25	4.4	25	2.5	25	3.4	0
Minimum	**1.7**	**-**	**1.0**	**-**	**1.3**	**-**	**1.9**	**-**	**1.1**	**-**
Maximum	**12.0**	**-**	**11.0**	**-**	**8.0**	**-**	**12.4**	**-**	**11.3**	**-**
Mean	**5.3**	**-**	**4.2**	**-**	**3.9**	**-**	**4.8**	**-**	**4.1**	**-**
Geometric mean	**4.8**	**-**	**3.8**	**-**	**3.6**	**-**	**4.3**	**-**	**3.8**	**-**
Median	**4.7**	**37.5**	**3.5**	**12.5**	**3.5**	**25.0**	**4.1**	**25.0**	**3.8**	**12.5**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table C.4: Raw In situ Water Quality Measures for the Fish Exposure Study, August to September, 2016

Date	Control						E6						E3					
	Temperature (°C)	pH	Dissolved Oxygen		Specific Conductivity (µS/cm)	Ammonia (mg/L)	Temperature (°C)	pH	Dissolved Oxygen		Specific Conductivity (µS/cm)	Ammonia (mg/L)	Temperature (°C)	pH	Dissolved Oxygen		Specific Conductivity (µS/cm)	Ammonia (mg/L)
			%	mg/L					%	mg/L					%	mg/L		
7-Aug-16	15.0	8.00	73.2	7.75	292.3	-	14.9	7.94	76.2	7.76	326.2	-	15.5	7.84	78.1	7.41	321.0	-
	-	-	-	-	-	-	14.9	-	-	7.92	-	-	15.4	7.82	-	-	-	-
8-Aug-16	14.3	8.11	68.1	6.97	281.7	-	14.1	8.00	64.2	6.60	324.1	-	13.8	8.01	66.3	6.81	328.2	-
	14.5	7.85	80.4	8.11	286.9	0.06	14.3	7.71	72.7	7.41	331.9	0.09	14.2	7.73	73.0	7.45	334.0	0.11
	15.6	7.48	64.4	6.44	290.1	-	15.2	7.58	71.9	7.08	335.5	-	15.1	7.65	75.3	7.54	336.9	-
9-Aug-16	13.8	7.47	66.6	6.89	288.9	0.16	13.8	7.54	74.9	7.73	332.2	0.17	13.7	7.63	72.6	7.51	334.3	0.19
	14.0	7.75	64.4	6.66	225.2	-	13.9	7.70	69.1	7.13	273.3	-	13.8	7.74	58.2	6.02	287.6	-
10-Aug-16	12.7	7.84	73.6	7.77	216.6	0.10	12.5	7.80	71.1	7.55	262.2	0.11	12.6	7.81	66.5	7.03	276.9	0.18
	14.3	7.82	100.2	10.28	195.7	-	14.1	7.65	110.7	11.24	234.5	-	14.2	7.69	108.9	10.72	257.7	-
	13.9	7.41	80.8	8.36	187.4	-	13.9	7.50	98.0	10.11	239.9	-	13.9	7.60	73.6	7.60	253.8	-
11-Aug-16	11.2	7.33	81.9	8.84	180.4	0.29	11.3	7.49	103.9	11.36	227.8	0.34	10.6	7.71	81.9	9.10	239.1	0.49
	12.8	7.70	87.3	9.25	178.5	-	12.4	7.54	72.7	7.76	226.6	-	12.3	7.58	79.7	8.52	240.2	-
12-Aug-16	11.5	7.38	108.1	11.86	177.1	0.35	11.4	7.43	135.2	13.79	228.8	0.46	11.2	7.52	103.2	11.40	239.7	0.57
	11.4	7.47	88.0	9.58	179.5	-	11.5	7.53	98.3	10.71	226.5	-	11.4	7.58	82.3	9.00	238.9	-
	12.3	7.41	76.3	8.23	178.8	-	12.5	7.48	88.3	9.34	222.4	-	12.6	7.54	83.2	8.91	239.4	-
13-Aug-16	11.7	7.54	62.2	6.73	178.1	0.48	11.8	7.23	66.3	7.18	226.6	0.46	11.6	7.43	64.2	6.95	240.5	0.65
	12.7	7.65	71.2	7.55	178.5	-	12.7	7.43	70.7	6.98	217.0	-	12.9	7.55	75.1	7.92	237.7	-
14-Aug-16	11.7	7.63	63.5	6.91	169.1	0.51	11.5	7.34	62.9	6.85	214.5	0.47	11.4	7.37	69.0	7.51	240.2	0.55
	12.9	7.23	89.5	9.52	171.1	-	12.6	7.38	59.0	6.27	213.9	-	12.8	7.38	96.9	10.25	238.4	-
15-Aug-16	11.7	7.26	83.1	9.04	170.9	0.45	11.5	7.39	106.7	11.66	211.1	0.56	11.2	7.44	71.1	7.87	237.7	0.61
	12.7	7.12	79.1	8.39	170.0	-	12.6	7.42	89.1	9.48	210.3	-	12.8	7.38	96.9	10.25	238.4	-
16-Aug-16	11.4	7.05	81.9	8.95	170.3	0.49	11.3	7.33	97.7	10.70	211.3	0.60	11.0	7.44	97.4	10.72	234.1	0.43
	12.5	7.22	83.1	8.83	167.2	-	12.4	7.46	69.1	7.37	205.8	-	12.8	7.42	84.4	8.95	235.1	-
17-Aug-16	11.3	7.11	66.4	7.27	167.5	0.43	11.3	7.23	99.5	10.90	205.0	0.55	10.9	7.28	72.1	7.96	235.5	0.56
	12.4	7.08	68.9	7.35	166.4	-	12.3	7.32	85.7	9.17	205.4	-	12.2	7.31	76.6	8.31	236.1	-
18-Aug-16	11.7	7.03	66.5	7.22	165.5	0.46	11.6	7.20	83.0	9.02	205.4	0.52	11.4	7.35	75.5	8.24	234.4	0.61
	11.4	7.18	68.2	7.44	170.8	-	11.3	7.29	76.3	8.36	206.4	-	11.2	7.35	76.8	8.41	236.0	-
19-Aug-16	10.4	7.06	78.1	8.73	165.1	0.53	10.3	7.26	89.5	10.03	205.9	0.59	10.2	7.29	83.0	9.33	235.5	0.58
	11.8	7.08	75.5	8.17	165.7	-	11.8	7.31	88.5	9.55	206.4	-	11.9	7.33	80.7	8.71	236.0	-
20-Aug-16	10.5	7.01	72.9	8.11	164.1	0.38	10.3	7.13	76.3	8.51	208.5	0.63	10.1	7.27	72.6	8.17	236.6	0.58
	11.8	7.07	72.4	7.84	165.6	-	11.8	7.24	75.9	8.20	208.1	-	11.8	7.26	69.9	7.74	237.0	-
21-Aug-16	10.4	7.03	90.5	10.15	165.4	0.51	10.3	7.21	88.6	9.91	207.9	0.56	10.1	7.27	82.7	9.31	236.7	0.61
	12.0	7.08	82.8	8.91	165.5	-	11.8	7.23	90.9	8.74	208.3	-	11.9	7.24	81.1	8.75	236.8	-
22-Aug-16	11.0	7.13	80.7	8.85	165.4	0.47	10.9	7.20	80.3	8.86	207.8	0.55	10.9	7.19	71.0	7.85	237.8	0.55
	12.0	7.01	80.1	8.63	165.0	-	11.9	7.27	78.2	8.43	208.3	-	11.9	7.22	74.7	8.06	237.1	-
23-Aug-16	11.5	7.20	74.2	8.08	163.9	0.42	11.3	7.30	82.3	9.01	204.7	0.48	11.1	7.26	72.9	8.03	237.1	0.54
	12.1	7.06	74.2	7.99	165.5	-	11.8	7.21	80.1	8.64	214.5	-	11.9	7.19	72.2	7.78	237.9	-
24-Aug-16	10.8	7.01	75.8	8.39	165.9	0.50	10.7	7.17	84.3	9.33	215.0	0.65	10.6	7.27	65.7	7.29	236.0	0.60
	11.7	8.02	89.1	9.57	172.8	-	11.9	7.38	79.9	8.65	216.5	-	11.7	7.27	77.8	8.35	235.8	-
25-Aug-16	11.5	7.36	78.1	8.38	172.9	0.61	11.3	7.08	72.9	7.95	215.5	0.64	11.3	7.14	63.9	7.03	237.3	0.54
	12.0	7.70	73.0	7.87	174.5	-	11.8	7.20	78.2	8.46	215.1	-	11.8	7.17	70.8	7.72	237.2	-
26-Aug-16	11.0	7.32	74.4	8.09	168.3	0.48	10.9	6.87	76.2	8.42	212.9	0.64	10.7	6.90	66.7	7.39	241.1	0.60
	11.8	7.62	71.5	7.74	169.5	-	11.5	7.70	76.3	8.31	213.2	-	12.0	7.58	59.5	6.39	243.8	-
27-Aug-16	10.4	7.52	80.7	9.00	212.8	0.52	10.4	7.52	80.7	9.00	212.8	0.63	10.3	-	-	-	-	0.61
	11.5	6.92	83.8	9.13	210.7	-	11.5	6.92	83.8	9.13	210.7	-	11.7	7.14	59.6	6.47	248.1	-
28-Aug-16	12.1	7.05	80.2	9.02	216.4	0.52	12.1	7.05	80.2	9.02	216.4	0.66	9.9	7.15	53.2	6.74	246.6	0.35
	10.9	8.03	86.0	9.37	212.4	-	10.9	8.03	86.0	9.37	212.4	-	10.9	7.76	102.5	11.26	252.7	-
29-Aug-16	9.3	7.88	87.3	10.02	210.8	0.30	9.3	7.88	87.3	10.02	210.8	0.47	9.1	7.55	112.2	12.90	252.0	1.02
	10.1	7.28	88.9	10.00	218.0	-	10.1	7.28	88.9	10.00	218.0	-	10.1	7.19	122.3	13.76	250.8	-
30-Aug-16	8.8	7.89	85.3	9.88	216.4	0.58	8.8	7.89	85.3	9.88	216.4	0.70	8.7	7.66	112.1	13.00	251.9	0.80
	10.2	6.80	77.3	8.68	216.2	-	10.2	6.80	77.3	8.68	216.2	-	10.2	6.88	64.0	7.15	249.5	-
31-Aug-16	9.3	7.66	76.9	8.80	218.9	0.74	9.3	7.66	76.9	8.80	218.9	0.87	9.2	7.60	120.5	13.76	248.1	0.80
	10.9	6.83	78.5	8.69	217.8	-	10.9	6.83	78.5	8.69	217.8	-	10.7	6.89	131.7	14.61	253.6	-
1-Sep-16	9.8	7.70	80.1	9.12	217.9	0.61	9.8	7.70	80.1	9.12	217.9	0.55	9.4	7.17	124.6	14.32	247.3	0.68
	10.3	7.69	80.8	9.05	217.9	-	10.3	7.69	80.8	9.05	217.9	-	9.9	7.64	125.5	14.00	248.7	-
2-Sep-16	9.4	7.47	78.4	8.97	218.3	0.44	9.4	7.47	78.4	8.97	218.3	0.60	9.0	7.51	117.7	13.54	242.5	0.82
	10.5	7.69	82.4	9.18	217.6	-	10.5	7.69	82.4	9.18	217.6	-	10.6	7.56	116.6	12.96	247.1	-
3-Sep-16	9.2	7.80	79.8	9.07	169.1	0.41	9.1	7.24	78.5	9.05	216.1	0.38	9.0	7.25	122.6	14.12	244.9	0.60
	11.0	7.88	67.8	7.43	169.8	-	10.9	7.67	73.2	8.08	217.8	-	11.0	7.55	101.9	11.23	247.0	-
4-Sep-16	8.7	7.73	68.2	7.93	181.1	0.66	8.6	7.34	82.9	9.69	222.2	0.72	8.3	7.20	111.7	13.11	244.8	1.01
	11.0	7.71	65.4	7.23	177.1	-	11.1	7.21	77.3	8.50	222.3	-	11.3	7.21	105.4	11.51	249.4	-
5-Sep-16	9.8	7.98	67.9	7.67	168.1	0.52	9.8	7.50	68.3	7.75	217.0	0.51	9.7	7.53	101.3	11.47	246.4	0.87
	10.1	7.41	54.1	6.09	172.5	-	10.3	7.60	74.1	8.32	228.5	-	10.4	7.45	95.9	10.71	246.4	-
6-Sep-16	9.6	7.98	69.8	7.76	167.9	0.44	9.6	7.64	62.7	7.13	224.7	0.59	9.4	7.57	106.1	12.11	260.0	0.33
	10.6	7.43	68.0	7.57	180.2	-	10.6	7.16	78.8	8.76	217.1	-	10.6	7.17	113.8	12.66	241.5	-
7-Sep-16	9.4	8.27	78.4	8.92	172.7	0.61	9.2	7.83	67.3	7.74	218.5	0.72	9.1	7.66	108.2	12.46	255.8	1.00
	9.2	6.78	70.6	8.14	167.7	-	9.4	7.27	84.9	9.71	213.7	-	9.5	7.22	111.6	12.76	249.0	-
8-Sep-16	8.9	6.72	82.0	9.46	165.9	<0.010	9.0	6.99	84.2	9.66	213.9	<0.010	8.9	7.11	134.1	15.56	251.3	-
	10.0	6.70	77.5	8.67	168.1	-	10.2	7.00	86.9	9.77	214.4	-	10.2	7.15	72.2	8.07	-	-
9-Sep-16	8.4	6.79	70.8	8.43	165.0	<0.010	8.6	6.90	74.4	8.70	214.5	<0.010	8.4	7.10	92.6	10.85	246.4	-
	9.1	6.98	62.2	7.17	169.1	0.69	9.2	7.04	92.6	10.57	214.2	-	9.3	7.15	83.5	9.53	245.3	0.51
10-Sep-16	8.7	7.14	66.4	7.75	163.7	0.22	8.5	7.14	69.2	8.08	216.6	0.47	8.3	7.10	70.7	8.30	247.1	0.81
	9.9	7.02	61.3	6.91	167.0	-	9.8	6.94	77.5	8.82	212.2	0.46	9.9	6.91	69.7	7.75	246.8	-
11-Sep-16	8.5	6.89	81.7	9.53	165.0	0.40	8.4	6.99	68.1	7.95	212.7	0.53	8.4	7.01	61.3	7.17	246.2	0.69
	9.6	7.03	73.2	8.33	169.9	-	9.5	6.94	80.5	9.19	213.4	-	9.7	6.81	71.2	8.09	246.3	-
12-Sep-16	9.7	6.50	71.4	8.17	166.2	0.49	9.6	7.09	62.2	7.08	212.5	0.50	9.7	7.09	67.7	7.08	244.9	0.70
	9.9	6.67	82.4	9.32	165.3	-	9.9	6.90	75.3	8.52	212.4	-	10.0	6.84	69.1	7.83	248.3	-
13-Sep-16	9.6	6.45	76.4	8.69	164.9	0.45	9.6	6.63	57.5	6.55	212.9	0.55	9.6	6.86	61.1	6.96	252.6	0.80
	10.1	7.62	89.7	10.02	156.3	-	10.1	7.71	72.1	8.13	207.4	-	10.1	7.57	84.0	9.42	240.7	-
14-Sep-16	9.0	7.85	87.1	10.12	160.5	0.41	9.0	7.75	74.5	8.66	204.5	0.40	8.9	7.62	81.8	9.54	240.4	0.65
	9.9	7.63	86.7	9.80	159.7	-	9.8	7.66	78.0	8.85	205.7	-	9.9	7.60	82.1	9.25	240.3	-
15-Sep-16	8.7	7.42	69.0	8.08	160.1	0.48	8.6	7.39	64.1	7.47	205.5	0.42	8.6	7.40	67.9	7.95	240.1	0.67
	9.7	7.72	74.6	8.48	159.5	-	9.7	7.70	75.4	8.69	205.5	-	9.9	7.63	77.5	8.78	239.0	-
16-Sep-16	9.8	7.55	61.9	7.02	158.1	0.33	9.9	7.46	56.3	6.38	205.2	0.33	9.9	7.40	57.6	6.51	232.5	0.67
	10.6	7.60	70.6	7.79	162.5	-	10.4	7.69	71.8	8.00	211.6	-	10.6	7.70	75.3	8.38	236.0	-
17-Sep-16	9.3	6.60	79.3	9.08	163.7	0.37	9.5	6.80	69.1	7.90	213.3	0.33	9.3	6.91	65.5	7.51	244.1	0.57
	10.2	7.08	78.3	8.79	165.0	-	10.2	6.93	73.4	8.23	214.7	-	10.2	6.86	72.3	8.11	241.1	-
18-Sep-16	9.3	7.61	70.3	8.04	160.0	0.57	9.3	7.44	60.1	6.90	207.4	0.50	9.2	7.40	57.3	6.57	240.9	0.83
	9.9	7.74	77.7	8.84	158.4	-	9.8	7.68	71.5	8.12	206.7	-	9.8	7.62	75.4	8.53	239.1	-
19-Sep-16	8.4	7.59	74.3	8.71	164.2	-	9.5	7.45	60.7	7.10	206.2	-	8.3	7.41	63.1	7.41	240.3	-
	9.1	7.26	75.5	8.71	164.2	-	9.3	7.31	76.5	8.76	213.4	-	9.4	7.32	67.7	7.73	248.3	-
20-Sep-16	8.0	6.81	66.6	7.90	163.7	0.57	7.9	6.88	66.9	7.94	214.6	0.46	7.7	6.94	63.5	6.38	248.9	0.93
	8.7	7.57	77.2	8.95	162.2	-	8.6	7.66	76.0	8.95	211.3	-	8.6	7.64	64.7	7.55	240.9	-
21-Sep-16	8.2	6.89	64.5	7.61	161.6	0.26	8.2	6.83	56.6	6.67	210.5	0.36	8.1	6.71	50.3	5.94	250.0	0.69
	9.0	8.29	105.6	12.20	158.6	-	8.8	8.05	87.6	10.15	201.9	-	9.0	7.91	82.1	9.47	239.1	-

Table C.5: Raw Supporting Water Quality Results for Laboratory Fish Exposure Study, Minto Mine Phase 4 EEM, 2016

Analyte	Units	Guideline [a]	SSWQO	Control							
				8-Aug-16	15-Aug-16	22-Aug-16	29-Aug-16	5-Sep-16	12-Sep-16	19-Sep-16	MEAN
Physical											
Water Temperature	°C	-	-	14.5	11.7	11.0	9.40	9.80	9.70	8.40	10.6
Specific Conductance	µS/cm	-	-	287	171	165	166	118	166	164	177
Field Conductance	µS/cm	-	-	230	127	122	-	-	-	-	159
Laboratory Conductance	µS/cm	-	-	273	169	161	160	160	162	158	178
Dissolved Oxygen	mg/L	> 6.5	-	8.11	9.04	8.85	9.44	7.67	8.17	8.71	8.57
Dissolved Oxygen	%	-	-	80.4	83.1	80.7	85.1	67.9	71.4	74.3	77.6
Field pH	pH units	6.5 - 9.0	6.0 - 9.0	7.85	7.26	7.13	8.28	7.98	6.50	7.59	7.51
Laboratory pH	pH units			8.07	7.76	7.75	7.66	7.90	7.95	7.68	7.82
Cation - Anion Balance	%			0.30	-0.50	-0.80	-0.40	0.70	-0.30	0.80	<0.44
Anion Sum	meq/L			2.83	1.80	1.75	1.69	1.73	1.78	1.69	1.90
Cation Sum	meq/L			2.85	1.78	1.72	1.68	1.76	1.77	1.71	1.90
Ions, Nutrients and Solids											
Hardness (as $CaCO_3$)	mg/L	-	-	119	78.6	77.0	74.9	78.2	79.3	76.3	83.3
Alkalinity, Total (as $CaCO_3$)	mg/L	-	-	95.0	76.2	75.7	73.4	75.5	77.8	72.9	78.1
Alkalinity, Bicarbonate (as $CaCO_3$)	mg/L	-	-	95.0	76.2	75.7	73.4	75.5	77.8	72.9	78.1
Alkalinity, Carbonate (as $CaCO_3$)	mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Alkalinity, Hydroxide (as $CaCO_3$)	mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Sulfate (SO_4)	mg/L	309 [b]	-	11.1	10.4	10.6	10.6	10.9	10.9	11.1	10.8
Chloride (Cl)	mg/L	120	-	23.8	1.92	0.69	<0.50	<0.50	<0.50	<0.50	<4.06
Total Ammonia (as N)	mg/L	0.20 to 26.6	0.25	0.049	**0.40**	**0.38**	0.23	**0.39**	**0.41**	**0.41**	**0.33**
Nitrite (as N)	mg/L	0.060	0.060	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.001
Nitrate (as N)	mg/L	3.00	9.10	0.40	0.028	<0.0050	<0.0050	<0.0050	<0.0050	0.0068	<0.065
Nitrate and Nitrite (as N)	mg/L			0.40	0.028	<0.0051	<0.0051	<0.0051	<0.0051	0.0068	<0.065
Total Suspended Solids	mg/L	narrative [d]	-	<3.0	3.30	4.00	<3.0	<3.0	<3.0	<3.0	<3.19
Total Dissolved Solids	mg/L	-	-	148	91.0	88.3	85.4	88.3	89.9	86.1	96.7
Total Metals											
Aluminum (Al)	mg/L	0.10 [e]	-	0.081	0.054	0.047	0.091	0.070	0.059	0.062	0.066
Antimony (Sb)	mg/L	0.0090	-	<0.00010	0.00010	0.00012	0.00015	0.00011	<0.00010	0.00011	0.00011
Arsenic (As)	mg/L	0.0050	-	0.00052	0.00087	0.00085	0.00083	0.00091	0.00074	0.00063	0.00076
Barium (Ba)	mg/L	-	-	0.045	0.041	0.041	0.043	0.043	0.042	0.043	0.042
Beryllium (Be)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Boron (B)	mg/L	1.50	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01
Cadmium (Cd)	mg/L	0.00016 [b]	-	0.0000086	0.000011	0.000013	0.0000078	0.0000056	0.0000076	0.0000051	0.0000084
Calcium (Ca)	mg/L	-	-	36.2	22.8	21.6	20.6	20.3	21.8	21.1	23.5
Chromium (Cr)	mg/L	0.0010 / 0.0090 [f]	-	0.00022	0.00027	0.00032	0.00038	0.00030	0.00024	0.00023	0.00028
Cobalt (Co)	mg/L	0.0040	-	0.00016	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00011
Copper (Cu)	mg/L	0.0024 [b]	-	0.0028	0.0020	0.0022	0.0019	0.0019	0.0018	0.0019	0.0021
Iron (Fe)	mg/L	0.30	-	0.15	0.12	0.12	0.15	0.14	0.10	0.11	0.13
Lead (Pb)	mg/L	0.0032 [b]	-	0.00020	0.00013	0.00011	0.00019	0.000089	0.00011	0.000067	0.00013
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0010	0.0011	<0.0010	<0.0010	0.0011	<0.0010
Magnesium (Mg)	mg/L	-	-	6.99	5.92	5.75	5.63	5.75	5.85	5.97	5.98
Manganese (Mn)	mg/L	1.00	-	0.0073	0.0059	0.0061	0.0075	0.0070	0.0059	0.0071	0.0067
Mercury (Hg)	mg/L	0.000026	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000005
Molybdenum (Mo)	mg/L	0.073	-	0.0019	0.0013	0.0013	0.0013	0.0012	0.0014	0.0014	0.0014
Nickel (Ni)	mg/L	0.096 [b]	-	0.00074	0.00074	0.00065	0.0010	0.00069	0.00070	0.00057	0.00073
Phosphorus (P)	mg/L	-	-	<0.050	0.11	0.10	0.054	0.082	0.067	0.060	0.074
Potassium (K)	mg/L	-	-	1.92	0.98	0.89	0.86	0.82	0.75	0.82	1.01
Selenium (Se)	mg/L	0.0010	-	0.00015	0.00014	0.00011	0.00012	0.00013	0.00018	0.00020	0.00015
Silicon (Si)	mg/L	-	-	4.41	3.88	3.50	3.70	3.75	3.79	3.51	3.79
Silver (Ag)	mg/L	0.00025	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Sodium (Na)	mg/L	-	-	9.56	3.59	2.97	3.42	3.28	3.21	3.14	4.17
Strontium (Sr)	mg/L	-	-	0.23	0.14	0.14	0.14	0.14	0.14	0.13	0.15
Sulphur (S)	mg/L	-	-	4.01	3.90	3.65	3.45	3.93	4.06	4.48	3.93
Thallium (Tl)	mg/L	0.00080	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Tin (Sn)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Titanium (Ti)	mg/L	-	-	0.0024	0.0017	0.0015	0.0033	0.0028	0.0020	0.0023	0.0023
Uranium (U)	mg/L	0.015	-	0.0014	0.0011	0.0010	0.0012	0.0010	0.0012	0.0011	0.0011
Vanadium (V)	mg/L	-	-	0.00070	0.00075	0.00071	0.00093	0.00084	0.00069	0.00069	0.00076
Zinc (Zn)	mg/L	0.030	-	0.009	0.010	0.0077	0.0061	0.0044	<0.0030	<0.0030	0.0061
Zirconium (Zr)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0003
Dissolved Metals											
Aluminum (Al)	mg/L	-	0.10	0.017	0.013	0.011	0.015	0.016	0.013	0.014	0.014
Antimony (Sb)	mg/L	-	-	<0.00010	<0.00010	<0.00010	0.00010	<0.00010	0.00010	<0.00010	<0.0001
Arsenic (As)	mg/L	-	0.0050	0.00045	0.00066	0.00064	0.00057	0.00066	0.00061	0.00057	0.00059
Barium (Ba)	mg/L	-	-	0.044	0.038	0.040	0.039	0.043	0.043	0.043	0.041
Beryllium (Be)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Boron (B)	mg/L	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.01
Cadmium (Cd)	mg/L	-	0.00021	<0.0000050	0.0000073	0.0000083	0.0000056	0.0000056	<0.0000050	<0.0000050	0.0000060
Calcium (Ca)	mg/L	-	-	36.4	22.1	21.5	20.7	21.4	21.8	20.8	23.5
Chromium (Cr)	mg/L	-	0.0010	<0.00010	0.00015	0.00015	0.00013	0.00015	0.00014	0.00013	0.00014
Cobalt (Co)	mg/L	-	-	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)	mg/L	-	0.013 / 0.02 [h]	0.0014	0.0014	0.0013	0.0014	0.0014	0.0012	0.0011	0.0013
Iron (Fe)	mg/L	-	1.10	0.027	0.031	0.026	0.030	0.036	0.027	0.029	0.029
Lead (Pb)	mg/L	-	0.0040	0.000062	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000052
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	<0.001
Magnesium (Mg)	mg/L	-	-	6.84	5.70	5.69	5.61	6.00	6.05	5.91	5.97
Manganese (Mn)	mg/L	-	-	0.0031	0.0013	0.00083	0.0012	0.0024	0.0022	0.0035	0.0021
Mercury (Hg)	mg/L	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Molybdenum (Mo)	mg/L	-	0.073	0.0018	0.0012	0.0012	0.0012	0.0014	0.0012	0.0013	0.0013
Nickel (Ni)	mg/L	-	0.11	0.00059	0.00060	0.00051	0.00070	0.00059	0.00056	<0.00050	0.00058
Phosphorus (P)	mg/L	-	-	<0.050	0.068	0.055	<0.050	0.066	<0.050	0.050	0.056
Potassium (K)	mg/L	-	-	1.85	0.93	0.84	0.86	0.80	0.83	0.83	0.99
Selenium (Se)	mg/L	-	0.0020	0.00016	0.00014	0.00013	0.00011	0.00011	0.00012	0.00017	0.00013
Silicon (Si)	mg/L	-	-	4.37	3.73	3.45	3.49	3.89	3.67	3.32	3.70
Silver (Ag)	mg/L	-	0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Sodium (Na)	mg/L	-	-	9.49	3.49	3.08	3.17	3.33	3.05	3.11	4.10
Strontium (Sr)	mg/L	-	-	0.22	0.14	0.13	0.14	0.15	0.14	0.13	0.15
Sulphur (S)	mg/L	-	-	3.95	3.61	3.61	3.48	3.83	3.97	3.75	3.74
Thallium (Tl)	mg/L	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Tin (Sn)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Titanium (Ti)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	0.00041	0.00035	0.00030	<0.00032
Uranium (U)	mg/L	-	-	0.0013	0.0010	0.00098	0.0011	0.0011	0.0011	0.0011	0.0011
Vanadium (V)	mg/L	-	-	<0.00050	0.00056	<0.00050	0.00056	0.00054	<0.00050	<0.00050	<0.00052
Zinc (Zn)	mg/L	-	0.030	0.009	0.0076	0.0053	0.0040	0.0031	0.0033	0.0021	0.0050
Zirconium (Zr)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0003

Notes: Means are represented with a "<" symbol if greater than 50% of data used in their calculation were below the Method Detection Limit (MDL).

▨ Concentration greater than the lowest guideline or SSWQO (lower in the case of dissolved oxygen, or outside the guideline or SSWQO range in the case of pH). For total ammonia, shading indicates exceedance of the guideline only (not the SSWQO).

Bold font: Total ammonia concentration greater than the SSWQO.

[a] Water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2017); blue text are BC Water Quality Guidelines (BCMOE 2017a,b). Guideline for dissolved oxygen is for "Other life stages" of coldwater biota.

[b] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[c] Guideline calculated for each individual sample based on measured pH and temperature; the range of these individual guideline values is shown. Guideline for mean total ammonia concentrations calculated at temperature 15°C and pH 8.5; values that are inclusive of all *in situ* temperature and pH data associated with these water samples (maximum temperature = 15.6°C, maximum pH = 8.29; see

[d] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[e] At pH 8.5 (slightly conservative conditions).

[f] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[g] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

Table C.5: Raw Supporting Water Quality Results for Laboratory Fish Exposure Study, Minto Mine Phase 4 EEM, 2016

Analyte	Units	Guideline [a]	SSWQO	E6							
				8-Aug-16	15-Aug-16	22-Aug-16	29-Aug-16	5-Sep-16	12-Sep-16	19-Sep-16	MEAN
Physical											
Water Temperature	°C	-	-	14.3	11.5	10.9	9.30	9.80	9.60	9.50	10.7
Specific Conductance	µS/cm	-	-	332	211	208	211	217	213	206	228
Field Conductance	µS/cm	-	-	264	157	153	-	-	-	-	191
Laboratory Conductance	µS/cm	-	-	322	209	205	205	214	209	201	224
Dissolved Oxygen	mg/L	> 6.5	-	7.41	11.7	8.86	10.0	7.75	7.08	7.10	8.55
Dissolved Oxygen	%	-	-	72.7	107	80.3	87.3	68.3	62.2	60.7	76.9
Field pH	pH units	6.5 - 9.0	6.0 - 9.0	7.71	7.39	7.20	7.88	7.50	7.09	7.45	7.46
Laboratory pH	pH units			8.10	7.82	7.88	7.68	7.89	7.96	7.81	7.88
Cation - Anion Balance	%			-0.60	-1.2	-2.2	-0.40	1.30	1.00	0.60	0.72
Anion Sum	meq/L			3.32	2.24	2.25	2.17	2.30	2.25	2.21	2.39
Cation Sum	meq/L			3.28	2.19	2.15	2.15	2.36	2.30	2.24	2.38
Ions, Nutrients and Solids											
Hardness (as $CaCO_3$)	mg/L	-	-	136	95.3	94.1	93.6	103	102	98.3	103
Alkalinity, Total (as $CaCO_3$)	mg/L	-	-	107	87.4	89.2	84.8	88.5	88.9	86.3	90.3
Alkalinity, Bicarbonate (as $CaCO_3$)	mg/L	-	-	107	87.4	89.2	84.8	88.5	88.9	86.3	90.3
Alkalinity, Carbonate (as $CaCO_3$)	mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Alkalinity, Hydroxide (as $CaCO_3$)	mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Sulfate (SO_4)	mg/L	309 [b]	-	16.6	17.0	17.6	18.3	20.2	18.6	19.1	18.2
Chloride (Cl)	mg/L	120	-	26.9	3.09	1.57	1.25	1.36	1.22	1.18	5.22
Total Ammonia (as N)	mg/L	0.20 to 26.6	0.25	0.071	**0.46**	**0.44**	**0.29**	**0.32**	**0.41**	**0.32**	**0.33**
Nitrite (as N)	mg/L	0.060	0.060	0.0043	0.0070	0.0075	0.0077	0.0039	0.0048	0.0031	0.0055
Nitrate (as N)	mg/L	3.00	9.10	1.05	0.76	0.76	0.81	0.95	0.78	0.81	0.85
Nitrate and Nitrite (as N)	mg/L			1.06	0.77	0.77	0.82	0.96	0.78	0.82	0.85
Total Suspended Solids	mg/L	narrative [d]	-	<3.0	4.00	4.00	6.70	3.60	<3.0	<3.0	3.90
Total Dissolved Solids	mg/L	-	-	176	117	116	114	122	119	117	126
Total Metals											
Aluminum (Al)	mg/L	0.10 [e]	-	0.069	0.061	0.050	0.11	0.061	0.056	0.067	0.067
Antimony (Sb)	mg/L	0.0090	-	<0.00010	0.00010	<0.00010	0.00011	0.00010	<0.00010	0.00010	0.00010
Arsenic (As)	mg/L	0.0050	-	0.00048	0.00086	0.00078	0.00088	0.00080	0.00065	0.00060	0.00072
Barium (Ba)	mg/L	-	-	0.050	0.043	0.047	0.048	0.049	0.046	0.049	0.047
Beryllium (Be)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Boron (B)	mg/L	1.50	-	0.011	0.011	<0.010	0.011	0.010	<0.010	<0.010	0.010
Cadmium (Cd)	mg/L	0.00016 [b]	-	0.0000091	0.0000091	0.000011	0.000014	0.0000083	<0.0000050	0.000010	0.0000094
Calcium (Ca)	mg/L	-	-	42.2	28.8	26.5	26.2	28.2	26.8	27.7	29.5
Chromium (Cr)	mg/L	0.0010 / 0.0090 [f]	-	0.00020	0.00026	0.00023	0.00037	0.00027	0.00025	0.00024	0.00026
Cobalt (Co)	mg/L	0.0040	-	0.00018	<0.00010	<0.00010	0.00010	<0.00010	<0.00010	<0.00010	<0.00011
Copper (Cu)	mg/L	0.0024 [b]	-	0.0055	0.0054	0.0054	0.0055	0.0057	0.0041	0.0055	0.0053
Iron (Fe)	mg/L	0.30	-	0.15	0.16	0.13	0.20	0.13	0.093	0.13	0.14
Lead (Pb)	mg/L	0.0032 [b]	-	0.00034	0.00017	0.00013	0.00023	0.000082	0.00014	0.000062	0.00016
Lithium (Li)	mg/L	-	-	<0.0010	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	<0.0010
Magnesium (Mg)	mg/L	-	-	8.31	7.19	7.15	7.11	7.78	7.39	7.81	7.53
Manganese (Mn)	mg/L	1.00	-	0.020	0.015	0.012	0.017	0.011	0.0084	0.012	0.014
Mercury (Hg)	mg/L	0.000026	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000005
Molybdenum (Mo)	mg/L	0.073	-	0.0024	0.0018	0.0018	0.0018	0.0018	0.0017	0.0018	0.0019
Nickel (Ni)	mg/L	0.096 [b]	-	0.00074	0.00074	0.00072	0.0012	0.00071	0.00067	0.00062	0.00077
Phosphorus (P)	mg/L	-	-	<0.050	0.12	0.13	0.074	0.067	0.090	0.083	0.088
Potassium (K)	mg/L	-	-	2.43	1.42	1.27	1.29	1.39	1.17	1.25	1.46
Selenium (Se)	mg/L	0.0010	-	0.00033	0.00033	0.00036	0.00037	0.00038	0.00033	0.00037	0.00035
Silicon (Si)	mg/L	-	-	4.39	3.73	3.37	3.56	3.64	3.54	3.63	3.69
Silver (Ag)	mg/L	0.00025	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Sodium (Na)	mg/L	-	-	12.0	5.32	4.88	5.36	5.37	4.83	5.13	6.13
Strontium (Sr)	mg/L	-	-	0.30	0.21	0.21	0.22	0.23	0.21	0.22	0.23
Sulphur (S)	mg/L	-	-	6.15	6.28	6.06	6.15	7.53	6.79	7.59	6.65
Thallium (Tl)	mg/L	0.00080	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Tin (Sn)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Titanium (Ti)	mg/L	-	-	0.0020	0.0020	0.0015	0.0034	0.0022	0.0018	0.0023	0.0022
Uranium (U)	mg/L	0.015	-	0.0014	0.0011	0.0011	0.0012	0.0011	0.0011	0.0012	0.0012
Vanadium (V)	mg/L	-	-	0.00072	0.00070	0.00071	0.00093	0.00080	0.00071	0.00065	0.00075
Zinc (Zn)	mg/L	0.030	-	0.020	0.014	0.012	0.009	0.0069	0.0041	0.0065	0.010
Zirconium (Zr)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0003
Dissolved Metals											
Aluminum (Al)	mg/L	-	0.10	0.020	0.014	0.011	0.016	0.023	0.012	0.014	0.016
Antimony (Sb)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Arsenic (As)	mg/L	-	0.0050	0.00043	0.00060	0.00063	0.00062	0.00061	0.00056	0.00050	0.00056
Barium (Ba)	mg/L	-	-	0.049	0.040	0.044	0.048	0.047	0.046	0.048	0.046
Beryllium (Be)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Boron (B)	mg/L	-	-	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	<0.010
Cadmium (Cd)	mg/L	-	0.00021	0.0000057	0.0000054	0.0000066	0.0000084	0.0000072	0.0000059	<0.0000050	0.0000063
Calcium (Ca)	mg/L	-	-	41.3	26.7	26.1	25.8	28.4	28.3	26.8	29.1
Chromium (Cr)	mg/L	-	0.0010	<0.00010	0.00013	0.00011	0.00010	0.00018	0.00014	<0.00010	0.00012
Cobalt (Co)	mg/L	-	-	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)	mg/L	-	0.013 / 0.02 [h]	0.0037	0.0039	0.0039	0.0040	0.0064	0.0035	0.0039	0.0042
Iron (Fe)	mg/L	-	1.10	0.028	0.034	0.026	0.025	0.048	0.028	0.027	0.031
Lead (Pb)	mg/L	-	0.0040	0.000069	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000053
Lithium (Li)	mg/L	-	-	0.0012	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010	<0.0010
Magnesium (Mg)	mg/L	-	-	7.99	6.96	7.03	7.10	7.88	7.55	7.62	7.45
Manganese (Mn)	mg/L	-	-	0.013	0.0022	0.0015	0.0012	0.013	0.0011	0.0013	0.0047
Mercury (Hg)	mg/L	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000005
Molybdenum (Mo)	mg/L	-	0.073	0.0022	0.0016	0.0017	0.0016	0.0017	0.0017	0.0016	0.0017
Nickel (Ni)	mg/L	-	0.11	0.00058	0.00057	<0.00050	0.00057	0.00058	0.00057	0.00051	0.00055
Phosphorus (P)	mg/L	-	-	<0.050	0.062	0.068	<0.050	<0.050	0.064	<0.050	<0.056
Potassium (K)	mg/L	-	-	2.30	1.33	1.26	1.33	1.31	1.22	1.26	1.43
Selenium (Se)	mg/L	-	0.0020	0.00030	0.00031	0.00035	0.00034	0.00038	0.00030	0.00039	0.00034
Silicon (Si)	mg/L	-	-	4.24	3.55	3.29	3.28	3.65	3.47	3.36	3.55
Silver (Ag)	mg/L	-	0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Sodium (Na)	mg/L	-	-	11.3	4.98	4.70	5.17	5.25	4.64	5.08	5.87
Strontium (Sr)	mg/L	-	-	0.29	0.21	0.20	0.21	0.23	0.22	0.21	0.22
Sulphur (S)	mg/L	-	-	5.83	5.91	6.00	5.93	6.79	6.59	6.95	6.29
Thallium (Tl)	mg/L	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Tin (Sn)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Titanium (Ti)	mg/L	-	-	<0.00030	0.00033	<0.00030	0.00031	0.00083	<0.00030	<0.00030	<0.00038
Uranium (U)	mg/L	-	-	0.0013	0.0010	0.0010	0.0010	0.0010	0.0011	0.0011	0.0011
Vanadium (V)	mg/L	-	-	<0.00050	<0.00050	<0.00050	0.00052	0.00052	<0.00050	<0.00050	<0.00051
Zinc (Zn)	mg/L	-	0.030	0.019	0.011	0.0085	0.0084	0.0046	0.0034	0.0029	0.0082
Zirconium (Zr)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0003

Notes: Means are represented with a "<" symbol if greater than 50% of data used in their calculation were below the Method Detection Limit (MDL).

▨ Concentration greater than the lowest guideline or SSWQO (lower in the case of dissolved oxygen, or outside the guideline or SSWQO range in the case of pH). For total ammonia, shading indicates exceedance of the guideline only (not the SSWQO).

Bold font: Total ammonia concentration greater than the SSWQO.

[a] Water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2017); blue text are BC Water Quality Guidelines (BCMOE 2017a,b). Guideline for dissolved oxygen is for "Other life stages" of coldwater biota.

[b] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[c] Guideline calculated for each individual sample based on measured pH and temperature; the range of these individual guideline values is shown. Guideline for mean total ammonia concentrations calculated at temperature 15°C and pH 8.5; values that are inclusive of all *in situ* temperature and pH data associated with these water samples (maximum temperature = 15.6°C, maximum pH = 8.29; see

[d] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[e] At pH 8.5 (slightly conservative conditions).

[f] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[g] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

Table C.5: Raw Supporting Water Quality Results for Laboratory Fish Exposure Study, Minto Mine Phase 4 EEM, 2016

Analyte	Units	Guideline [a]	SSWQO	E3							
				8-Aug-16	15-Aug-16	22-Aug-16	29-Aug-16	5-Sep-16	12-Sep-16	19-Sep-16	MEAN
Physical											
Water Temperature	°C	-	-	14.2	11.2	10.9	10.1	9.70	9.70	8.30	10.6
Specific Conductance	µS/cm	-	-	334	238	238	251	246	245	240	256
Field Conductance	µS/cm	-	-	266	175	174	-	-	-	-	205
Laboratory Conductance	µS/cm	-	-	324	236	231	245	236	241	237	250
Dissolved Oxygen	mg/L	> 6.5	-	7.45	7.87	7.85	13.8	11.5	7.08	7.41	8.98
Dissolved Oxygen	%	-	-	73.0	71.1	71.0	122	101	67.7	63.1	81.4
Field pH	pH units	6.5 - 9.0	6.0 - 9.0	7.73	7.44	7.19	7.19	7.53	7.09	7.41	7.37
Laboratory pH	pH units			8.05	7.82	7.86	7.61	7.92	7.96	7.81	7.86
Cation - Anion Balance	%			-0.60	0.20	1.60	3.20	1.80	1.20	0.70	1.27
Anion Sum	meq/L			3.37	2.55	2.52	2.60	2.57	2.62	2.56	2.68
Cation Sum	meq/L			3.33	2.56	2.61	2.77	2.67	2.68	2.60	2.75
Ions, Nutrients and Solids											
Hardness (as $CaCO_3$)	mg/L	-	-	139	110	111	119	115	118	112	118
Alkalinity, Total (as $CaCO_3$)	mg/L	-	-	110	95.4	95.5	95.7	95.9	98.9	95.5	98.1
Alkalinity, Bicarbonate (as $CaCO_3$)	mg/L	-	-	110	95.4	95.5	95.7	95.9	98.9	95.5	98.1
Alkalinity, Carbonate (as $CaCO_3$)	mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Alkalinity, Hydroxide (as $CaCO_3$)	mg/L	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Sulfate (SO_4)	mg/L	309 [b]	-	21.6	22.1	22.4	25.0	24.3	24.0	24.4	23.4
Chloride (Cl)	mg/L	120	-	22.0	3.04	2.01	2.19	1.79	1.77	1.76	4.94
Total Ammonia (as N)	mg/L	0.20 to 26.6	0.25	0.089	**0.48**	**0.47**	**0.66**	**0.60**	**0.61**	**0.58**	**0.50**
Nitrite (as N)	mg/L	0.060	0.060	0.014	0.013	0.014	0.009	0.010	0.0081	0.010	0.011
Nitrate (as N)	mg/L	3.00	9.10	1.53	1.32	1.29	1.49	1.37	1.33	1.35	1.38
Nitrate and Nitrite (as N)	mg/L			1.55	1.33	1.31	1.50	1.38	1.34	1.36	1.40
Total Suspended Solids	mg/L	narrative [d]	-	<3.0	5.30	6.00	8.70	<3.0	<3.0	<3.0	<4.6
Total Dissolved Solids	mg/L	-	-	180	136	136	143	139	141	137	145
Total Metals											
Aluminum (Al)	mg/L	0.10 [e]	-	0.072	0.084	0.045	0.10	0.053	0.056	0.062	0.068
Antimony (Sb)	mg/L	0.0090	-	<0.00010	0.00010	<0.00010	0.00010	0.00010	<0.00010	0.00010	0.00010
Arsenic (As)	mg/L	0.0050	-	0.00053	0.00097	0.00082	0.00076	0.00076	0.00071	0.00060	0.00074
Barium (Ba)	mg/L	-	-	0.049	0.049	0.048	0.046	0.050	0.051	0.051	0.049
Beryllium (Be)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Boron (B)	mg/L	1.50	-	0.016	0.016	0.014	0.016	0.014	0.014	0.013	0.015
Cadmium (Cd)	mg/L	0.00016 [b]	-	0.000011	0.000013	0.000012	0.000012	0.000011	0.000011	0.0000064	0.000011
Calcium (Ca)	mg/L	-	-	42.2	31.9	31.9	31.5	30.8	32.2	30.9	33.1
Chromium (Cr)	mg/L	0.0010 / 0.0090 [f]	-	0.00020	0.00030	0.00025	0.00033	0.0088	0.00026	0.00025	0.0015
Cobalt (Co)	mg/L	0.0040	-	0.00017	<0.00010	<0.00010	0.00011	<0.00010	<0.00010	<0.00010	<0.00011
Copper (Cu)	mg/L	0.0024 [b]	-	0.0086	0.0079	0.0076	0.0085	0.0073	0.0065	0.0074	0.0077
Iron (Fe)	mg/L	0.30	-	0.17	0.18	0.12	0.21	0.15	0.10	0.13	0.15
Lead (Pb)	mg/L	0.0032 [b]	-	0.00020	<0.00030	0.00013	0.00026	0.000070	0.00012	0.000092	0.00015
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0011	<0.0010
Magnesium (Mg)	mg/L	-	-	9.07	8.12	8.23	8.41	8.63	8.69	8.54	8.53
Manganese (Mn)	mg/L	1.00	-	0.033	0.028	0.016	0.023	0.011	0.011	0.014	0.019
Mercury (Hg)	mg/L	0.000026	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000005
Molybdenum (Mo)	mg/L	0.073	-	0.0026	0.0022	0.0021	0.0021	0.0021	0.0020	0.0021	0.0022
Nickel (Ni)	mg/L	0.096 [b]	-	0.00080	0.00083	0.00061	0.0010	0.0016	0.00077	0.00064	0.00089
Phosphorus (P)	mg/L	-	-	0.052	0.12	0.11	0.19	0.14	0.12	0.11	0.12
Potassium (K)	mg/L	-	-	2.54	1.73	1.60	1.72	1.63	1.46	1.47	1.74
Selenium (Se)	mg/L	0.0010	-	0.00049	0.00048	0.00046	0.00053	0.00049	0.00031	0.00046	0.00046
Silicon (Si)	mg/L	-	-	4.03	3.61	3.29	3.41	3.53	3.52	3.32	3.53
Silver (Ag)	mg/L	0.00025	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Sodium (Na)	mg/L	-	-	12.2	6.77	6.07	6.34	6.38	6.17	6.12	7.15
Strontium (Sr)	mg/L	-	-	0.33	0.26	0.26	0.28	0.28	0.26	0.27	0.27
Sulphur (S)	mg/L	-	-	7.92	8.01	7.63	8.15	9.04	8.60	8.80	8.31
Thallium (Tl)	mg/L	0.00080	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Tin (Sn)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Titanium (Ti)	mg/L	-	-	0.0023	0.0026	0.0014	0.0037	0.0020	0.0019	0.0023	0.0023
Uranium (U)	mg/L	0.015	-	0.0014	0.0011	0.0011	0.0012	0.0011	0.0012	0.0012	0.0012
Vanadium (V)	mg/L	-	-	0.00071	0.00077	0.00068	0.00082	0.00080	0.00069	0.00064	0.00073
Zinc (Zn)	mg/L	0.030	-	0.021	0.018	0.016	0.012	0.0089	0.0070	0.0062	0.013
Zirconium (Zr)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0003
Dissolved Metals											
Aluminum (Al)	mg/L	-	0.10	0.020	0.014	0.010	0.014	0.017	0.011	0.012	0.014
Antimony (Sb)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Arsenic (As)	mg/L	-	0.0050	0.00043	0.00060	0.00058	0.00058	0.00056	0.00053	0.00053	0.00054
Barium (Ba)	mg/L	-	-	0.052	0.044	0.046	0.050	0.050	0.049	0.052	0.049
Beryllium (Be)	mg/L	-	-	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.00002
Bismuth (Bi)	mg/L	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Boron (B)	mg/L	-	-	0.015	0.015	0.015	0.015	0.014	0.012	0.012	0.014
Cadmium (Cd)	mg/L	-	0.00021	0.0000084	0.0000064	0.0000074	0.0000057	0.0000057	0.0000067	<0.0000050	0.0000065
Calcium (Ca)	mg/L	-	-	41.4	31.3	31.5	33.8	32.1	32.8	30.4	33.3
Chromium (Cr)	mg/L	-	0.0010	<0.00010	0.00015	0.00011	0.00016	0.00014	<0.00010	0.00012	0.00013
Cobalt (Co)	mg/L	-	-	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Copper (Cu)	mg/L	-	0.013 / 0.02 [h]	0.0064	0.0061	0.0055	0.0066	0.0059	0.0054	0.0057	0.0059
Iron (Fe)	mg/L	-	1.10	0.034	0.033	0.023	0.028	0.035	0.028	0.027	0.030
Lead (Pb)	mg/L	-	0.0040	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.00005
Lithium (Li)	mg/L	-	-	<0.0010	<0.0010	0.0028	<0.0010	<0.0010	<0.0010	0.0011	<0.0013
Magnesium (Mg)	mg/L	-	-	8.65	7.84	7.93	8.35	8.56	8.64	8.76	8.39
Manganese (Mn)	mg/L	-	-	0.024	0.0025	0.0022	0.0025	0.0018	0.0013	0.0015	0.0051
Mercury (Hg)	mg/L	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000005
Molybdenum (Mo)	mg/L	-	0.073	0.0024	0.0019	0.0019	0.0021	0.0029	0.0019	0.0019	0.0021
Nickel (Ni)	mg/L	-	0.11	0.00064	0.00066	0.00054	0.00069	0.00060	0.00057	0.00055	0.00061
Phosphorus (P)	mg/L	-	-	<0.050	0.081	0.074	0.12	0.11	0.091	0.10	0.089
Potassium (K)	mg/L	-	-	2.41	1.62	1.51	1.71	1.56	1.51	1.53	1.69
Selenium (Se)	mg/L	-	0.0020	0.00046	0.00049	0.00049	0.00049	0.00047	0.00053	0.00048	0.00049
Silicon (Si)	mg/L	-	-	3.91	3.37	3.16	3.13	3.48	3.39	3.27	3.39
Silver (Ag)	mg/L	-	0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Sodium (Na)	mg/L	-	-	11.1	6.28	7.15	7.02	6.28	5.74	6.34	7.13
Strontium (Sr)	mg/L	-	-	0.34	0.25	0.26	0.29	0.27	0.27	0.26	0.28
Sulphur (S)	mg/L	-	-	7.55	7.66	7.60	8.07	8.10	8.58	8.83	8.06
Thallium (Tl)	mg/L	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00001
Tin (Sn)	mg/L	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.0001
Titanium (Ti)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	0.00039	<0.00030	<0.00030	<0.00031
Uranium (U)	mg/L	-	-	0.0012	0.0011	0.0010	0.0011	0.0010	0.0011	0.0011	0.0011
Vanadium (V)	mg/L	-	-	<0.00050	<0.00050	<0.00050	<0.00050	0.00050	<0.00050	<0.00050	<0.0005
Zinc (Zn)	mg/L	-	0.030	0.021	0.014	0.013	0.010	0.0074	0.0058	0.0055	0.011
Zirconium (Zr)	mg/L	-	-	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.0003

Notes: Means are represented with a "<" symbol if greater than 50% of data used in their calculation were below the Method Detection Limit (MDL).

▨ Concentration greater than the lowest guideline or SSWQO (lower in the case of dissolved oxygen, or outside the guideline or SSWQO range in the case of pH). For total ammonia, shading indicates exceedance of the guideline only (not the SSWQO).

Bold font: Total ammonia concentration greater than the SSWQO.

[a] Water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2017); blue text are BC Water Quality Guidelines (BCMOE 2017a,b). Guideline for dissolved oxygen is for "Other life stages" of coldwater biota.

[b] At hardness of 100 mg/L (conservative conditions for Minto Creek).

[c] Guideline calculated for each individual sample based on measured pH and temperature; the range of these individual guideline values is shown. Guideline for mean total ammonia concentrations calculated at temperature 15°C and pH 8.5; values that are inclusive of all *in situ* temperature and pH data associated with these water samples (maximum temperature = 15.6°C, maximum pH = 8.29; see

[d] Maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures.

[e] At pH 8.5 (slightly conservative conditions).

[f] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII).

[g] 0.013 mg/L copper at a dissolved organic carbon (DOC) concentration ≤10 mg/L and 0.02 mg/L copper at a DOC concentrarion >10 mg/L.

APPENDIX D

BENTHIC INVERTEBRATE COMMUNITY DATA

Methods and QC Report 2016

Project ID: Minto Mine EEM Monitoring 2016 (157202-0087); PO: 223066
Client: Minnow Environmental c/o Minto Explorations Ltd.

Prepared by:
Cordillera Consulting Inc.
Summerland, BC

Unit 1, 13216 Henry Ave B1202
Summerland, BC, V0H 1Z0
www.cordilleraconsulting.ca

P:250.494.7553
F: 250.494.7562

Table of Contents

Sample Reception

On October 8, 2016, Cordillera Consulting received 15 benthic samples from Minnow Environmental on behalf of Minto Mines, Minto Explorations Ltd. When samples arrived to Cordillera Consulting, exterior packaging was initially inspected for damage or wet spots that would have indicated damage to the interior containers.

Next, samples were logged into a proprietary software database (INSTAR1) where the clients assigned sample name was recorded along with a Cordillera Consulting (CC) number for cross-reference. Each sample was checked to ensure that all sites and replicates recorded on field sheets or packing lists were delivered intact and with adequate preservative. Any missing, mislabelled or extra samples were reported to the client immediately to confirm the total numbers and correct names on the sample jars. The client representative was notified of the arrival of the shipment and provided a sample inventory once intake was completed.
See table below for sample inventory:

Table 1: Summary of sample information including Cordillera Consulting (CC) number

Sample	CC#	Date	Size	# of Jars
UMC-1	CC171138	9/25/2016	500µM	1
UMC-2	CC171139	9/22/2016	500µM	1
UMC-3	CC171140	9/22/2016	500µM	1
UMC-4	CC171141	9/25/2016	500µM	1
UMC-5	CC171142	9/22/2016	500µM	1
REF-1	CC171143	9/25/2016	500µM	1
REF-2	CC171144	9/24/2016	500µM	1
REF-3	CC171145	9/24/2016	500µM	2
REF-4	CC171146	9/24/2016	500µM	1
REF-5	CC171147	9/23/2016	500µM	1
REF-6	CC171148	9/24/2016	500µM	1
REF-7	CC171149	9/24/2016	500µM	1
REF-8	CC171150	9/25/2016	500µM	1

REF-9	CC171151	9/23/2016	500µM	1
REF-10	CC171152	9/23/2016	500µM	1

Sample Sorting

- Using a gridded Petri dish, fine forceps and a low power stereo-microscope (Olympus, Nikon, Leica) the sorting technicians removed the invertebrates and sorted them into family/orders.
- The sorting technician kept a running tally of total numbers excluding organisms from Porifera, Nemata, Platyhelminthes, Ostracoda, Copepoda, Cladocera and terrestrial drop-ins such as aphids. These organisms were marked for their presence (value of 1) and left in the sample. They were not included towards the 300-organism subsample count.
- Where specimens are broken or damaged, only heads were counted.
- Subsampling was conducted with the use of a Marchant Box.
- Cells were extracted at the same time in the order indicated by a random number table.
- If the 300th organism was found part way into sorting a cell then the balance of that cell was sorted. If the organism count had not reached 300 by the 50th cell then the entire sample was sorted.
- The total number of cells sorted and the number of organisms removed were recorded manually on a bench sheet and then recorded into INSTAR1
- Organisms were stored in vials containing 80% ethanol and an interior label indicating the site names, date of sampling, site code numbers and portion subsampled. This information was also recorded on the laboratory bench sheet and on INSTAR1.
- The sorted portion of the debris was preserved and labeled separately from the unsorted portion and was tested for sorting efficiency (Sorting Quality Control – Sorting Efficiency). The unsorted portion was also labeled and preserved in separate jars.

Percent sub-sampled and total countable invertebrates pulled from the samples were summarized in the table below.

Table 2: Percent sub-sample and invertebrate count for each sample

Sample	**Date**	**CC#**	**500 micron fraction**	
			% Sampled	**# Invertebrates**
UMC-1	25-Sep-16	CC171138	100%	301
UMC-2	22-Sep-16	CC171139	100%	180
UMC-3	22-Sep-16	CC171140	100%	264
UMC-4	25-Sep-16	CC171141	100%	435
UMC-5	22-Sep-16	CC171142	100%	267
REF-1	25-Sep-16	CC171143	75%	370
REF-2	24-Sep-16	CC171144	25%	332
REF-3	24-Sep-16	CC171145	50%	351
REF-4	24-Sep-16	CC171146	100%	145

REF-5	23-Sep-16	CC171147	50%	381
REF-6	24-Sep-16	CC171148	100%	354
REF-7	24-Sep-16	CC171149	100%	357
REF-8	25-Sep-16	CC171150	50%	328
REF-9	23-Sep-16	CC171151	6%	324
REF-10	23-Sep-16	CC171152	25%	597

Sorting Quality Control - Sorting Efficiency

As a part of Cordillera's laboratory policy, all projects undergo sorting efficiency checks.

- As sorting progresses, 10% of samples were randomly chosen by senior members of the sorting team for resorting.
- All sorters working on a project had at least 1 sample resorted by another sorter.
- An efficiency of 90 % was expected (95% for CABIN samples).
- If 90/95% efficiency was not met, samples from that sorter were resorted.
- To calculated sorting efficiency the following formula was used:

$$\frac{\#OrganismsMissed}{TotalOrganismsFound} * 100 = \%OM$$

Table 3: Summary of sorting efficiency

CC #	Number of Organisms Recovered (initial sort)	Number of Organisms in Re-sort	Percent Recovery
CC171139	180	4	98%
CC171140	264	6	98%
		Average Recovery	98%

Sorting Quality Control - Sub-Sampling QC

Certain Provincial and Mining projects require additional sorting checks in the form of sub-sampling QC, (Environmental Effects Monitoring (EEM) protocol). This ensured that any fraction of the total sample that was examined was actually an accurate representation of the number of total organisms. Organisms from the additional sub-samples were not identified; rather total organism count only was compared.

Sub-Sampling efficiency was measured on 10% of the number of sub-sampled samples in the project. Ex. In a project where 50 of 100 total samples were processed through subsampling using a Marchant box, then 10% of 50; or 5 samples were used for sub sampling efficiency.

Sub-Sampling efficiency was performed by fractioning the entire sample into sub-sample percentages. On each sub-sampled portion, a total organism count was recorded and compared to the rest of the sub-samples. In order to pass, all fractions were required to be within 20% of total organism count.

Example: If 300 organisms are found in 10% of the sample, the sorter will continue to sample in 10% fractions until the entire sample is separated. They will then count the total number of organisms in each of the 10 fractions of 10% and compare the organism count.

When divergence is >20% the sorting manager examines for the source of the problem and takes steps to correct it. With the Marchant box, the problem typically rested with how the box is flipped back to the upright position. For this reason subsampling was performed by experienced employees only. Another common source of area would be the type of debris in the sample. Samples with algae or heavy with periphyton have a higher incident of failure due to clumping than clear samples.

NOTE: A single member of our staff sorted this entire project. This experienced staff member upon conducting sub-sampling QC failed the first 2 QC samples that were examined. We recognized a problem with the sub-sampling device, and repeated all of the sub-sampled samples from this project. The results below are from the repeated QAQC after fixing our equipment.

Table 4: Summary of Sub Sample efficiency

Station ID		**Organisms in Subsample**																				Actual Total	Precision Error		Accuracy Error	
CC#	**Sample Name**	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		Min (%)	Max (%)	Min (%)	Max (%)
171150	REF-8	326	341																			667	4.40	4.40	2.25	2.25

Taxonomic Effort

The next procedure was the identification to genus-species level where possible of all the organisms in the sample.

- Identifications were made at the genus/species level for all insect organisms found including Chironomidae (Based on CABIN protocol).
- Non-insect organisms (except those not included in CABIN count) were identified to genus/species where possible and to a minimum of family level with intact and mature specimens.
- The Standard Taxonomic Effort lists compiled by the CABIN manual[1], SAFIT[2] , and PNAMP[3] were used as a guide line for what level of identification to achieve where the condition and maturity of the organism enabled.
- Organisms from the same families/order were kept in separate vials with 80% ethanol and an interior label of printed laser paper.
- Chironomidae was identified to genus/species level where possible and was aided by slide mounts. CMC-10 was used to clear and mount the slide.
- Oligochaetes was identified to family/genus level with the aid of slide mounts. CMC-10 was used to clear and mount the slide.
- Other Annelida (leeches, polychaetes) were identified to the family/genus/species level with undamaged, mature specimens.
- Mollusca was identified to family and genus/species where possible
- Decapoda, Amphipoda and Isopoda were identified at family/genus/species level where possible.
- Bryozoans and Nemata remained at the phylum level
- Hydrachnidae and Cnidaria were identified at the family/genus level where possible.
- When requested, reference collections were made containing at least one individual from each taxa listed. Organisms represented will have been identified to the lowest practical level.
- Reference collection specimens were stored in 55 mm glass vials with screw-cap lids with polyseal inserts (museum quality). They were labeled with taxa name, site code, date identified and taxonomist name. The same information was applied to labels on the slide mounts.

Taxonomy Staff

The taxonomists for this project were certified by the Society of Freshwater Science (SFS) Taxonomic Certification Program at level 2 which is the required certification for CABIN projects:

Sue Salter: Group 1 General Arthropods (West); Group 2 EPT (East/West); Group 3 Chironomidae (East/West); Group 4 Oligochaeta

Scott Finlayson: Group 1 General Arthropods (East/West); Group 2 EPT (East/West); Group 3 Chironomidae (East/West); Group 4 Oligochaeta

Adam Bliss: Group 1 General Arthropods (East/West); Group 2 EPT (East/West); Group 3 Chironomidae
Rita Avery: Group 1 General Arthropods (East/West); Group 2 EPT (East/West)
Qi Liu: Group 3 Chironomid (East/West)

References

[1] McDermott, H., Paull, T., Strachan, S. (May 2014). Laboratory Methods: Processing, Taxonomy, and Quality Control of Benthic Macroinvertebrate Samples, Environment Canada. ISBN: 978-1-100-25417-3

[2] Southwest Association of Freshwater Invertebrate Taxonomists. (2015). www.safit.org

[3] Pacific Northwest Aquatic Monitoring Partnership (Accessed 2015). www.pnamp.org

Taxonomic Keys

Below is a reference list of taxonomic keys utilized by taxonomists at Cordillera Consulting. Cordillera taxonomists routinely seek out new literature to ensure the most accurate identification keys are being utilized. This is not reflective of the exhaustive list of resources that we use for identification. A more complete list of taxonomic resources can be found at Southwest Association of Freshwater Invertebrate Taxonomists. (2015). http://www.safit.org/Docs/SAFIT_Taxonomic_Literature_Database_1_March_2011.enl

Brook, Arthur R. and Leonard A. Kelton. 1967. Aquatic and semiaquatic Heteroptera of Alberta, Saskatchewan and Manitoba (Hemiptera) Memoirs of the Entomological Society of Canada. No. 51.

Brown HP & White DS (1978) Notes on Seperation and Identification of North American Riffle Beetles (Coleoptera: Dryopidea: Elmidae).Entomological News 89 (1&2): 1-13

Clifford, Hugh F. 1991. Aquatic Invertebrates of Alberta. University of Alberta Press Edmonton, Alberta.

Epler, John. 2001 The Larval Chironomids of North and South Carolina. http://home.earthlink.net/~johnepler/

Epler, John. Identification Manual for the Water Beetles of Florida. http://home.earthlink.net/~johnepler/

Epler, John. Identification Manual for the Aquatic and Semi-aquatic Heteroptera of Florida. http://home.earthlink.net/~johnepler/

Trond Andersen, Peter S. Cranston & John H. Epler (Eds) (2013) Chironomidae of the Holarctic Region: Keys and DIagnoses. Part 1. Larvae. *Insect Systematics and Evolution Supplements* 66: 1-571.

Jacobus, Luke and Pat Randolph. 2005. Northwest Ephemeroptera Nymphs. Manual from Northwest Biological Assessment Working Group. Moscow Idaho 2005. Not Published.

Jacobus LM, McCafferty WP (2004) Revisionary Contributions to the Genus Drunella (Ephemeroptera : Ephemerellidae). Journal of the New York Entomological Society 112: 127-147

Jacobus LM, McCafferty WP (2003) Revisionary Contributions to North American Ephemerella and Serratella (Ephemeroptera : Ephemerellidae). Journal of the New York Entomological Society 111 (4): 174-193.

Kathman,R.D., R.O. Brinkhurst. 1999. Guide to the Freshwater Oligochaetes of North America. Aquatic Resources Center, College Grove, Tennessee.

Larson, D.J., Y. Alarie, R.E. Roughly.2005. Predaceous Diving Beetles (Coleoptera: Dytiscidae) of the Neararctic Region. NRC-CNRC Research Press. Ottawa.

Merritt, R.W., K.W. Cummins, M. B. Berg. (eds.). 2007. An introduction to the aquatic insects of North America, 4th. Kendall/Hunt, Dubuque, IA

Morihara DK, McCafferty WP (1979) The Baetis Larvae of North American (Ephemeroptera: Baetidae). Transactions of the American Entomological Society 105: 139-221.

Needham, James, M. May, M. Westfall Jr. 2000. Dragonflies of North America. Scientific Publishers. Gainsville FL.

Prescott David, R.C.and Medea M. Curteanu.2004. Survey of Aquatic Gastropods of Alberta. Species at Risk Report No. 104. ISSN: 1496-7146 (Online Edition)

Needham, K. 1996. An Identification Guide to the Nymphal Mayflies of British Columbia. Publication #046 Resource Inventory Committee, Government of British Columbia.

Oliver, Donald R. and Mary E. Roussel. 1983. The Insects and Arachnids of Canada Part 11. The Genera of larval midges of Canada. Biosystematics Research Institute. Ottawa, Ontario. Research Branch, Agriculture Canada. Publication 1746.

Proctor, H. The ‘Top 18’ Water Mite Families in Alberta. Zoology 351. University of Alberta, Edmonton, Alberta.

Rogers, D.C. and M. Hill, 2008. Key to the Freshwater Malacostraca (Crustacea) of the mid-Atlantic Region. EPA-230-R-08-017. US Environmental Protection Agency, Office of Environmental Information, Washington, DC.

Stewart, Kenneth W. and Bill Stark. 2002. The Nymphs of North American Stonefly Genera (Plecoptera). The Caddis Press. Columbus Ohio.

Stewart, Kenneth W. and Mark W. Oswood. 2006 The Stoneflies (Plecoptera) of Alaska and Western Canada. The Caddis Press.

Stonedahl, Gary and John D. Lattin. 1986. The Corixidae of Oregon and Washington (Hemiptera: Heteroptera). Technical Bulletin 150. Oregon State University, Corvalis Oregon.

Thorpe, J. H. and A. P. Covich [Eds.] 1991. Ecology and classification of North American freshwater invertebrates. Academic Press, San Diego.

Tinerella, Paul P. and Ralph W. Gunderson.2005. The Waterboatmen (Insecta: Heteroptera: Corixidae) of Minisota. Publication No.23 Dept. Of Entomology, North Dakota State University, Fargo, North Dakota, USA.

Weiderholm, Torgny (Ed.) 1983. The larvae of Chironomidae (Diptera) of the Holartic region. Entomologica Scaninavica. Supplement No. 19.

Westfall, Minter J. Jr. and May, Michael L. 1996. Damselflies of North America. Scientific Publishers, Gainesville, FL.

Wiggins, Glenn B. 1998. Larvae of the North American Caddisfly Genera (Tricoptera) 2nd ed. University of Toronto Press. Toronto Ontario.

Cordillera Consulting

Project: Minto EEM Monitoring 2016 (157202.0087)
Minnow (Victoria), Pierre Stecko
Taxonomist: Sue Salter
suesalter@cordilleraconsulting.ca
250-494-7553

Site:	UMC	UMC	UMC	UMC	UMC	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Sample:	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
Sample Collection Date:	25-Sep-16	22-Sep-16	22-Sep-16	25-Sep-16	22-Sep-16	25-Sep-16	24-Sep-16	24-Sep-16	24-Sep-16	23-Sep-16	24-Sep-16	24-Sep-16	25-Sep-16	23-Sep-16	23-Sep-16
CC#:	CC171138	CC171139	CC171140	CC171141	CC171142	CC171143	CC171144	CC171145	CC171146	CC171147	CC171148	CC171149	CC171150	CC171151	CC171152
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	2	0	3	14	0	1	4	2	1	0	2	0	0	0	12
| Family: Onychiuridae	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	16	10	5	21	7	101	12	0	0	32	184	13	20	0	96
| Family: Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis	3	2	2	6	5	1	0	0	1	16	2	3	0	133	16
Baetis tricaudatus group	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Baetis bicaudatus	16	5	12	10	9	1	0	0	0	0	6	32	0	867	204
| Family: Ephemerellidae	0	0	1	0	1	0	0	0	0	0	0	0	0	117	0
Drunella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drunella grandis group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Drunella doddsii	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
| Family: Heptageniidae	1	0	0	1	0	0	68	0	0	0	1	1	44	0	0
Cinygmula	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	11	7	13	14	8	23	28	90	1	24	4	8	22	33	48
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	0	2	0	0	0	0	8
Haploperla	0	0	1	0	0	0	0	0	0	8	0	5	0	0	12
Sweltsa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
| Family: Leuctridae	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0
| Family: Nemouridae	11	3	5	3	10	128	284	40	71	0	12	13	12	67	0
Nemoura	4	5	9	8	4	0	76	0	2	0	0	0	0	0	0
Ostrocerca	0	0	0	0	0	5	200	0	2	0	3	0	2	0	0
Podmosta	0	0	0	0	0	0	0	16	2	0	0	0	2	0	0
Zapada	0	0	0	0	0	0	0	0	0	16	0	3	0	317	56
Zapada oregonensis group	0	0	0	0	0	0	0	0	0	74	0	16	0	17	0
Zapada cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	67	64
Zapada columbiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104
| Family: Perlodidae	0	0	0	0	0	0	8	0	0	2	0	0	0	0	0
Skwala	0	0	0	0	0	0	0	0	0	0	0	6	4	0	0
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	2	0	4	0	67	0
| Order: Trichoptera	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0
| Family: Limnephilidae	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0
Chyrandra centralis	8	1	2	2	1	35	0	0	0	12	3	0	6	0	0
Clostoeca disjuncta	0	2	3	1	0	0	0	0	0	0	0	0	0	0	0
Ecclisomyia	6	6	8	11	9	0	0	0	0	64	1	0	4	0	12
| Family: Rhyacophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Rhyacophila vofixa group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
| Family: Uenoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neothremma	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0

Site:	UMC	UMC	UMC	UMC	UMC	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Sample:	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
Sample Collection Date:	25-Sep-16	22-Sep-16	22-Sep-16	25-Sep-16	22-Sep-16	25-Sep-16	24-Sep-16	24-Sep-16	24-Sep-16	23-Sep-16	24-Sep-16	24-Sep-16	25-Sep-16	23-Sep-16	23-Sep-16
CC#:	CC171138	CC171139	CC171140	CC171141	CC171142	CC171143	CC171144	CC171145	CC171146	CC171147	CC171148	CC171149	CC171150	CC171151	CC171152
| Order: Coleoptera	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Carabidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraena	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
| Family: Staphylinidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0
| Family: Chironomidae	3	5	0	6	0	0	0	2	0	14	1	0	12	50	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stictochironomus	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	39	8	41	31	20	11	0	0	1	0	0	0	0	83	0
Paratanytarsus	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudokiefferiella	0	0	0	0	0	0	32	26	1	0	0	0	12	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diamesa	0	0	3	3	4	3	0	38	0	202	1	6	224	50	172
Pagastia	0	0	0	2	1	0	0	0	0	2	0	3	46	117	1028
Pseudodiamesa	14	2	10	15	12	25	60	4	1	32	42	5	52	33	8
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brillia	4	1	10	4	0	0	0	0	0	0	0	0	0	0	0
Chaetocladius	0	0	0	0	0	0	44	106	1	0	1	0	6	0	0
Corynoneura	2	0	1	4	0	0	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	7	1	3	22	2	4	0	0	6	2	1	0	0	33	0
Eukiefferiella	22	33	24	58	21	16	228	288	5	2	21	177	50	50	60
Hydrobaenus	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Krenosmittia	0	0	0	0	0	0	4	0	1	0	0	0	0	0	0
Limnophyes	0	0	1	0	0	1	0	0	1	0	0	2	0	0	0
Metriocnemus	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0
Orthocladius complex	39	60	36	101	40	37	112	16	4	4	0	0	4	600	0
Orthocladius lignicola	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
Paraphaenocladius	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Parorthocladius	0	0	1	0	0	0	0	0	0	0	3	1	0	0	0
Psectrocladius	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Rheocricotopus	1	0	0	0	0	0	0	0	0	0	0	0	0	33	0
Tvetenia	0	0	0	0	0	0	0	0	1	0	0	1	0	2167	36
| Subfamily: Podonominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichotanypus	1	1	5	0	2	12	100	2	9	6	2	0	0	0	0
| Family: Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	13	1	2	6	2	0	0	0	0	10	0	0	0	117	0
Clinocera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Clinocerinae Unknown Genus A	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0
Neoplasta	0	0	0	0	0	0	0	0	0	2	0	0	0	67	0
Oreogeton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28
| Family: Muscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophora	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
| Family: Psychodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	3	5	10	26	14	1	0	0	0	18	33	8	10	183	44
| Family: Simuliidae	0	0	0	0	0	0	12	0	0	2	0	4	0	17	0
Gymnopais	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Prosimulium	0	0	0	0	0	3	0	0	1	174	1	3	2	0	260
Simulium	0	0	0	0	0	1	0	2	0	0	0	2	0	0	4
| Family: Syrphidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Dicranota	14	6	16	14	13	29	16	28	24	18	12	5	8	50	8

Site:	UMC	UMC	UMC	UMC	UMC	REF	REF	REF	REF	REF	REF	REF	REF	REF	REF
Sample:	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
Sample Collection Date:	25-Sep-16	22-Sep-16	22-Sep-16	25-Sep-16	22-Sep-16	25-Sep-16	24-Sep-16	24-Sep-16	24-Sep-16	23-Sep-16	24-Sep-16	24-Sep-16	25-Sep-16	23-Sep-16	23-Sep-16
CC#:	CC171138	CC171139	CC171140	CC171141	CC171142	CC171143	CC171144	CC171145	CC171146	CC171147	CC171148	CC171149	CC171150	CC171151	CC171152
| Order: Lepidoptera	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	1	0	0	0	0	0	0	0	0	0	0	0	0	0	20
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	0	0	0	1	0	0	0	52
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Oribatida	0	0	1	0	1	0	0	2	0	0	0	0	0	0	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corophiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Americorophium	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	53	11	27	38	77	28	28	16	2	2	13	3	114	33	4
Rhynchelmis	0	0	0	0	0	0	4	2	0	0	1	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubifex	0	3	2	1	0	0	0	10	2	10	0	10	0	0	0
| Subfamily: Tubificinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirosperma	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals:	**299**	**178**	**262**	**432**	**266**	**487**	**1324**	**698**	**145**	**758**	**352**	**356**	**656**	**5385**	**2384**

Taxa present but not included:

Terrestrials	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	1	1	0	1	0	0	0	0	0	2	0	0	0	0	0
| Class: Maxillipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0
Phylum: Nemata	0	0	0	1	0	1	4	2	0	2	0	0	0	17	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	1	1	0	0	1	0	0	2	0	0	1	1	0	0	4
Totals:	**2**	**2**	**2**	**3**	**1**	**2**	**4**	**4**	**0**	**4**	**2**	**1**	**0**	**17**	**4**

Table D.1: Benthic Invertebrate Community (Organisms/m^2) at the Lowest Practical Level of Taxonomic Resolution, Minto Mine, Phase 4, 2016

Invertebrates	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	7.2	0	11	50	0	3.6	14	7.2	3.6	0	7.2	0	0	0	43
| Family: Onychiuridae	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	57	36	18	75	25	362	43	0	0	115	660	47	72	0	344
| Family: Baetidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baetis	11	7.2	7.2	22	18	3.6	0	0	3.6	57	7.2	11	0	477	57
Baetis tricaudatus group	0	0	0	0	0	0	0	0	3.6	0	0	0	0	0	0
Baetis bicaudatus	57	18	43	36	32	3.6	0	0	0	0	22	115	0	3,111	732
| Family: Ephemerellidae	0	0	3.6	0	3.6	0	0	0	0	0	0	0	0	420	0
Drunella grandis group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Drunella doddsii	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0	0
| Family: Heptageniidae	3.6	0	0	3.6	0	0	244	0	0	0	3.6	3.6	158	0	0
Cinygmula	0	0	0	0	0	0	0	0	0	7.2	0	0	0	0	0
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	39	25	47	50	29	83	100	323	3.6	86	14	29	79	118	172
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	0	7.2	0	0	0	0	29
Haploperla	0	0	3.6	0	0	0	0	0	0	29	0	18	0	0	43
Sweltsa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
| Family: Leuctridae	0	0	0	0	0	0	0	0	3.6	0	0	3.6	0	0	0
| Family: Nemouridae	39	11	18	11	36	459	1,019	144	255	0	43	47	43	240	0
Nemoura	14	18	32	29	14	0	273	0	7.2	0	0	0	0	0	0
Ostrocerca	0	0	0	0	0	18	718	0	7.2	0	11	0	7.2	0	0
Podmosta	0	0	0	0	0	0	0	57	7.2	0	0	0	7.2	0	0
Zapada	0	0	0	0	0	0	0	0	0	57	0	11	0	1,137	201
Zapada oregonensis group	0	0	0	0	0	0	0	0	0	266	0	57	0	61	0
Zapada cinctipes	0	0	0	0	0	0	0	0	0	0	0	0	0	240	230
Zapada columbiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	373
| Family: Perlodidae	0	0	0	0	0	0	29	0	0	7.2	0	0	0	0	0
Skwala	0	0	0	0	0	0	0	0	0	0	0	22	14	0	0
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	7.2	0	14	0	240	0
| Order: Trichoptera	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0
| Family: Limnephilidae	0	0	0	0	0	61	0	0	0	0	0	0	0	0	0
Chyrandra centralis	29	3.6	7.2	7.2	3.6	126	0	0	0	43	11	0	22	0	0
Clostoeca disjuncta	0	7.2	11	3.6	0	0	0	0	0	0	0	0	0	0	0
Ecclisomyia	22	22	29	39	32	0	0	0	0	230	3.6	0	14	0	43
| Family: Rhyacophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophila	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Rhyacophila vofixa group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	43
| Family: Uenoidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Neothremma	0	0	0	0	0	0	0	0	0	7.2	0	0	0	0	0

Notes: Samples processed in the lab using a 500 µm sieve. The numbers provided at higher levels of taxonomy (order, class, sub-phylum, or phylum) do not represent totals for that level of taxonomy. Rather, if a number other than zero is provided at a higher level of taxonomy, it represents any organism(s) within that taxonomic group that could not be assigned to a lower level of taxonomy.

Table D.1: Benthic Invertebrate Community (Organisms/m^2) at the Lowest Practical Level of Taxonomic Resolution, Minto Mine, Phase 4, 2016

Invertebrates	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
| **Order: Coleoptera**	0	0	3.6	0	0	0	0	7.2	0	0	0	0	0	0	0
| **Family: Carabidae**	0	0	3.6	0	0	0	0	0	0	0	0	0	0	0	0
| **Family: Hydraenidae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydraena	0	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0
| **Family: Staphylinidae**	0	0	0	3.6	0	0	0	0	0	0	0	0	0	0	0
| **Order: Diptera**	0	0	0	0	0	0	0	7.2	0	0	0	3.6	0	0	0
| **Family: Chironomidae**	11	18	0	22	0	0	0	7.2	0	50	3.6	0	43	179	0
| **Subfamily: Chironominae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Tribe: Chironomini**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stictochironomus	0	0	3.6	0	0	0	0	0	0	0	0	0	0	0	0
| **Tribe: Tanytarsini**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	140	29	147	111	72	39	0	0	3.6	0	0	0	0	298	0
Paratanytarsus	3.6	0	0	3.6	7.2	0	0	0	0	0	0	0	0	0	0
Rheotanytarsus	0	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0
| **Subfamily: Diamesinae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudokiefferiella	0	0	0	0	0	0	115	93	3.6	0	0	0	43	0	0
| **Tribe: Diamesini**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diamesa	0	0	11	11	14	11	0	136	0	725	3.6	22	804	179	617
Pagastia	0	0	0	7.2	3.6	0	0	0	0	7.2	0	11	165	420	3,688
Pseudodiamesa	50	7.2	36	54	43	90	215	14	3.6	115	151	18	187	118	29
| **Subfamily: Orthocladiinae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brillia	14	3.6	36	14	0	0	0	0	0	0	0	0	0	0	0
Chaetocladius	0	0	0	0	0	0	158	380	3.6	0	3.6	0	22	0	0
Corynoneura	7.2	0	3.6	14	0	0	0	0	0	0	0	0	0	0	0
Diplocladius cultriger	25	3.6	11	79	7.2	14	0	0	22	7.2	3.6	0	0	118	0
Eukiefferiella	79	118	86	208	75	57	818	1,033	18	7.2	75	635	179	179	215
Hydrobaenus	0	0	0	7.2	0	0	0	0	0	0	0	0	0	0	0
Krenosmittia	0	0	0	0	0	0	14	0	3.6	0	0	0	0	0	0
Limnophyes	0	0	3.6	0	0	3.6	0	0	3.6	0	0	7.2	0	0	0
Metriocnemus	0	0	0	0	0	0	0	7.2	7.2	0	0	0	0	0	0
Orthocladius complex	140	215	129	362	144	133	402	57	14	14	0	0	14	2,153	0
Orthocladius lignicola	0	0	0	0	0	3.6	0	0	3.6	0	0	0	0	0	0
Paraphaenocladius	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0
Parorthocladius	0	0	3.6	0	0	0	0	0	0	0	11	3.6	0	0	0
Psectrocladius	0	0	3.6	0	0	0	0	0	0	0	0	0	0	0	0
Rheocricotopus	3.6	0	0	0	0	0	0	0	0	0	0	0	0	118	0
Tvetenia	0	0	0	0	0	0	0	0	3.6	0	0	3.6	0	7,775	129
| **Subfamily: Podonominae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trichotanypus	3.6	3.6	18	0	7.2	43	359	7.2	32	22	7.2	0	0	0	0
| **Family: Empididae**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	47	3.6	7.2	22	7.2	0	0	0	0	36	0	0	0	420	0
Clinocera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
Clinocerinae Unknown Genus A	0	0	0	0	0	0	0	0	0	0	0	43	0	0	0
Neoplasta	0	0	0	0	0	0	0	0	0	7.2	0	0	0	240	0
Oreogeton	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100

Notes: Samples processed in the lab using a 500 µm sieve. The numbers provided at higher levels of taxonomy (order, class, sub-phylum, or phylum) do not represent totals for that level of taxonomy. Rather, if a number other than zero is provided at a higher level of taxonomy, it represents any organism(s) within that taxonomic group that could not be assigned to a lower level of taxonomy.

Table D.1: Benthic Invertebrate Community (Organisms/m^2) at the Lowest Practical Level of Taxonomic Resolution, Minto Mine, Phase 4, 2016

Invertebrates	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
| Family: Muscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophora	0	0	0	0	0	0	0	7.2	0	0	0	0	0	0	0
| Family: Psychodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	11	18	36	93	50	3.6	0	0	0	65	118	29	36	657	158
| Family: Simuliidae	0	0	0	0	0	0	43	0	0	7.2	0	14	0	61	0
Gymnopais	0	0	0	0	0	7.2	0	0	0	0	0	0	0	0	0
Prosimulium	0	0	0	0	0	11	0	0	3.6	624	3.6	11	7.2	0	933
Simulium	0	0	0	0	0	3.6	0	7.2	0	0	0	7.2	0	0	14
| Family: Syrphidae	0	0	0	0	3.6	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	3.6	0	3.6	0	0	3.6	0	0	0	0	0	0	0	0	0
Dicranota	50	22	57	50	47	104	57	100	86	65	43	18	29	179	29
| Order: Lepidoptera	0	0	0	3.6	0	0	0	0	0	7.2	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	72
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0	187
| Order: Oribatida	0	0	3.6	0	3.6	0	0	7.2	0	0	0	0	0	0	0
| Class: Malacostraca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Amphipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Corophiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Americorophium	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	190	39	97	136	276	100	100	57	7.2	7.2	47	11	409	118	14
Rhynchelmis	0	0	0	0	0	0	14	7.2	0	0	3.6	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubifex	0	11	7.2	3.6	0	0	0	36	7.2	36	0	36	0	0	0
| Subfamily: Tubificinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirosperma	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Notes: Samples processed in the lab using a 500 µm sieve. The numbers provided at higher levels of taxonomy (order, class, sub-phylum, or phylum) do not represent totals for that level of taxonomy. Rather, if a number other than zero is provided at a higher level of taxonomy, it represents any organism(s) within that taxonomic group that could not be assigned to a lower level of taxonomy.

Table D.2: Benthic Invertebrate Community (Organisms/m^2) at the Family Level of Taxonomic Resolution, Minto Mine, Phase 4, 2016

Invertebrates	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	REF-1	REF-2	REF-3	REF-4	REF-5	REF-6	REF-7	REF-8	REF-9	REF-10
Phylum: Arthropoda															
| Order: Collembola	7.2	0	11	50	0	3.6	14	7.2	3.6	0	7.2	22	0	0	43
| Family: Onychiuridae															
Subphylum: Hexapoda															
| Class: Insecta															
| Order: Ephemeroptera															
Family Ameletidae	57	36	18	75	25	362	43	0	0	115	660	47	72	0	344
Family Baetidae	68	25	50	57	50	7.2	0	0	7.2	57	29	126	0	3,588	789
Family Ephemerellidae	0	0	3.6	0	3.6	0	0	0	0	0	3.6	0	0	420	14
Family Heptageniidae	3.6	0	0	3.6	0	0	244	0	0	7.2	3.6	3.6	158	0	0
| Order: Plecoptera															
Family Capniidae	39	25	47	50	29	83	100	323	3.6	86	14	29	79	118	172
Family Chloroperlidae	0	0	3.6	0	0	0	0	0	0	36	0	18	0	0	86
Family Leuctridae	0	0	0	0	0	0	0	0	3.6	0	0	3.6	0	0	0
Family Nemouridae	54	29	50	39	50	477	2,009	201	276	323	54	115	57	1,679	804
Family Perlodidae	0	0	0	0	0	0	29	0	0	7.2	0	22	14	0	0
Family Taeniopterygidae	0	0	0	0	0	0	0	0	0	7.2	0	14	0	240	0
| Order: Trichoptera	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0
Family Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	61	0
Family Limnephilidae	50	32	47	50	36	187	0	0	0	273	14	0	36	0	43
Family Rhyacophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57
Family Uenoidae	0	0	0	0	0	0	0	0	0	7.2	0	0	0	0	0
| Order: Coleoptera	0	0	3.6	0	0	0	0	7.2	0	0	0	0	0	0	0
Family Carabidae	0	0	3.6	0	0	0	0	0	0	0	0	0	0	0	0
Family Hydraenidae	0	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0
Family Staphylinidae	0	0	0	3.6	0	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	7.2	0	0	0	3.6	0	0	0
Family Chironomidae	477	398	492	911	373	395	2,081	1,737	122	947	258	703	1,457	11,539	4,679
Family Empididae	47	3.6	7.2	22	7.2	0	0	0	0	43	0	43	0	660	115
Family Muscidae	0	0	0	0	0	0	0	7.2	0	0	0	0	0	0	0
Family Psychodidae	11	18	36	93	50	3.6	0	0	0	65	118	29	36	657	158
Family Simuliidae	0	0	0	0	0	22	43	7.2	3.6	631	3.6	32	7.2	61	947
Family Syrphidae	0	0	0	0	3.6	0	0	0	0	0	0	0	0	0	0
Family Tipulidae	54	22	61	50	47	108	57	100	86	65	43	18	29	179	29
| Order: Lepidoptera	0	0	0	3.6	0	0	0	0	0	7.2	0	0	0	0	0
Subphylum: Chelicerata															
| Class: Arachnida															
| Order: Trombidiformes	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Family Lebertiidae	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	72
Family Sperchontidae	0	0	0	0	0	0	0	0	0	0	3.6	0	0	0	187
| Order: Oribatida	0	0	3.6	0	3.6	0	0	7.2	0	0	0	0	0	0	0
| Class: Malacostraca															
| Order: Amphipoda															
Family Corophiidae	3.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida															
Subphylum: Clitellata															
| Class: Oligochaeta															
| Order: Lumbriculida															
Family Lumbriculidae	190	39	97	136	276	100	115	65	7.2	7.2	50	11	409	118	14
| Order: Tubificida															
Family Naididae	3.6	11	7.2	3.6	0	0	0	36	7.2	36	0	36	0	0	0

Table D.3: Benthic Endpoints from Reference and Exposed Stations, Minto Mine, Phase 4, 2016

Area	Station ID	Density / Abundance	Lowest Practical Level			Family Level			EPT		Ephemeroptera		Plecoptera		Trichoptera		Chironomidae		Diptera (excluding Chironomidae)		Oligocheata	
			Richness	Evenness (Simpson's)	Bray Curtis Distance	Richness	Evenness (Simpson's)	Bray Curtis Distance	(%)	(org/m²)	(%)	(org/m²)	(%)	(org/m²)	(%)	(org/m²)	(%)	(org/m²)	(%)	(org/m²)	(%)	(org/m²)
Reference	REF-1	1,747	22	0.32	0.43	11	0.48	0.45	64	1,116	21	370	32	560	11	187	23	395	7.6	133	5.7	100
	REF-2	4,750	18	0.39	0.69	11	0.24	0.46	51	2,440	6.0	287	45	2,138	0.30	14	44	2,081	2.1	100	2.4	115
	REF-3	2,504	18	0.25	0.60	11	0.18	0.26	21	524	0	0	21	524	0	0	69	1,737	4.9	122	4.0	100
	REF-4	520	24	0.32	0.47	10	0.27	0.59	56	291	1.4	7.2	54	283	0	0	23	122	17	90	2.8	14
	REF-5	2,720	26	0.25	0.57	18	0.27	0.32	34	919	6.6	179	17	459	10	280	35	947	30	804	1.6	43
	REF-6	1,263	21	0.16	0.59	14	0.22	0.65	62	779	55	696	5.4	68	1.1	14	20	258	13	165	4.0	50
	REF-7	1,277	26	0.14	0.55	18	0.17	0.36	29	377	14	176	16	201	0	0	55	703	9.8	126	3.7	47
	REF-8	2,354	19	0.30	0.58	11	0.22	0.27	18	416	9.8	230	6.4	151	1.5	36	62	1,457	3.0	72	17	409
	REF-9	19,321	22	0.21	0.90	12	0.21	0.83	32	6,107	21	4,008	11	2,038	0.32	61	60	11,539	8.1	1,557	0.61	118
	REF-10	8,554	26	0.17	0.82	17	0.18	0.66	27	2,311	13	1,148	12	1,062	1.2	100	55	4,679	15	1,249	0.17	14
	Mean	**4,501**	**22**	**0.25**	**0.62**	**13**	**0.24**	**0.49**	**39**	**1,528**	**15**	**710**	**22**	**748**	**2.5**	**69**	**45**	**2,392**	**11**	**442**	**4.2**	**101**
	SD	5,698	3.2	0.081	0.15	3.2	0.091	0.19	17	1,783	16	1,209	17	760	4.2	95	18	3,479	8.2	556	4.9	115
Exposed	UMC-1	1,073	25	0.44	0.57	15	0.27	0.47	25	273	12	129	8.7	93	4.7	50	44	477	10	111	18	194
	UMC-2	639	19	0.31	0.60	11	0.22	0.53	23	147	9.6	61	8.4	54	5.1	32	62	398	6.7	43	7.9	50
	UMC-3	940	30	0.41	0.55	16	0.21	0.44	23	219	7.6	72	11	100	5.0	47	52	492	11	104	11	104
	UMC-4	1,550	28	0.35	0.55	15	0.18	0.28	18	276	8.8	136	5.8	90	3.2	50	59	911	11	165	9.0	140
	UMC-5	954	22	0.34	0.58	13	0.31	0.55	20	194	8.3	79	8.3	79	3.8	36	39	373	11	108	29	276

Table D.4: Summary Statistics for Benthic Invertebrate Community Endpoints for Reference (n = 10) and Exposed (n = 5) Sites, 2016

Site	Endpoint		Units	N	Mean	Standard Deviation	Standard Error	Minimum	Median	Maximum
Reference	Density		org/m²	10	4,501	5,698	1,802	520	2,429	19,321
	LPL	Richness	# taxa	10	22	3.2	1.0	18	22	26
		Evenness (Simpson's)	-	10	0.25	0.081	0.026	0.14	0.25	0.39
		Bray-Curtis Distance	-	10	0.62	0.15	0.047	0.43	0.58	0.90
	Family	Richness	# taxa	10	13	3.2	1.0	10	12	18
		Evenness (Simpson's)	-	10	0.24	0.091	0.029	0.17	0.22	0.48
		BC Distance	-	10	0.49	0.19	0.061	0.26	0.45	0.83
	Relative Density	EPT	%	10	39	17	5.4	18	33	64
		Ephemeroptera	%	10	15	16	5.0	0	12	55
		Plecoptera	%	10	22	17	5.3	5.4	16	54
		Trichoptera	%	10	2.5	4.2	1.3	0	0.73	11
		Chironomidae	%	10	45	18	5.7	20	49	69
		Diptera (excluding Chironomidae)	%	10	11	8.2	2.6	2.1	8.9	30
		Oligochaeta	%	10	4.2	4.9	1.6	0.17	3.2	17
	Density	EPT	org/m²	10	1,528	1,783	564	291	849	6,107
		Ephemeroptera	org/m²	10	710	1,209	382	0	258	4,008
		Plecoptera	org/m²	10	748	760	240	68	492	2,138
		Trichoptera	org/m²	10	69	95	30	0	25	280
		Chironomidae	org/m²	10	2,392	3,479	1,100	122	1,202	11,539
		Diptera (excluding Chironomidae)	org/m²	10	442	556	176	72	129	1,557
		Oligochaeta	org/m²	10	101	115	36	14	75	409
Exposed	Density		org/m²	5	1,031	331	148	639	954	1,550
	LPL	Richness	# taxa	5	25	4.4	2.0	19	25	30
		Evenness (Simpson's)	-	5	0.37	0.054	0.024	0.31	0.35	0.44
		Bray-Curtis Distance	-	5	0.57	0.021	0.010	0.55	0.57	0.60
	Family	Richness	# taxa	5	14	2.0	0.89	11	15	16
		Evenness (Simpson's)	-	5	0.24	0.050	0.022	0.18	0.22	0.31
		BC Distance	-	5	0.45	0.11	0.048	0.28	0.47	0.55
	Relative Density	EPT	%	5	22	2.9	1.3	18	23	25
		Ephemeroptera	%	5	9.3	1.7	0.76	7.6	8.8	12
		Plecoptera	%	5	8.4	1.7	0.78	5.8	8.4	11
		Trichoptera	%	5	4.3	0.80	0.36	3.2	4.7	5.1
		Chironomidae	%	5	51	10	4.3	39	52	62
		Diptera (excluding Chironomidae)	%	5	10	1.9	0.84	6.7	11	11
		Oligochaeta	%	5	15	8.7	3.9	7.9	11	29
	Density	EPT	org/m²	5	222	55	24	147	219	276
		Ephemeroptera	org/m²	5	95	35	16	61	79	136
		Plecoptera	org/m²	5	83	18	8.1	54	90	100
		Trichoptera	org/m²	5	43	8.4	3.8	32	47	50
		Chironomidae	org/m²	5	530	219	98	373	477	911
		Diptera (excluding Chironomidae)	org/m²	5	106	43	19	43	108	165
		Oligochaeta	org/m²	5	153	87	39	50	140	276

Table D.5: Upper Minto Creek Compared to the Upper and Lower 90% Confidence Limits on the 2.5th and 97.5th Percentiles of the Reference Area Distribution

Endpoint		Transformation	97.5th Percentile			50th Percentile			2.5th Percentile			Minto Creek				
			90% Upper CL	Value	90% Lower CL	90% Upper CL	Value	90% Lower CL	90% Upper CL	Value	90% Lower CL	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5
Density		Log	59,720	21,679	11,445	3.6	3.4	3.2	623	329	119	1,073	639	940	1,550	954
Lowest Practical Level	Richness	Fourth Root	34	29	27	2.2	2.2	2.1	18	16	14	25	19	30	28	22
	Simpson's Evenness	Log (x+1)	0.51	0.42	0.37	0.28	0.25	0.21	0.14	0.094	0.027	0.44	0.31	0.41	0.35	0.34
	Bray Curtis Distance	Log	1.2	0.96	0.84	0.67	0.61	0.55	0.44	0.38	0.30	0.57	0.60	0.55	0.55	0.58
Family Level	Richness	Log	26	21	18	14	13	12	9.4	8.1	6.5	15	11	16	15	13
	Simpson's Evenness	Log	0.58	0.43	0.36	0.27	0.23	0.20	0.15	0.12	0.092	0.27	0.22	0.21	0.18	0.31
	Bray-Curtis Distance	Fourth Root	1.3	0.97	0.78	0.55	0.46	0.38	0.25	0.18	0.11	0.47	0.53	0.44	0.28	0.55
EPT	(%)	Log	142	91	68	44	36	29	19	14	9.1	25	23	23	18	20
	(org/m^2)	Log	17,894	6,890	3,775	1,466	959	627	243	133	51	273	147	219	276	194
Ephemeroptera	(%)	Square Root	89	56	38	18	11	5.9	0.21	0 [a]	0 [a]	12	9.6	7.6	8.8	8.3
	(org/m^2)	Fourth Root	12,386	5,030	2,513	611	262	90	0.88	0 [a]	0 [a]	129	61	72	136	79
Plecoptera	(%)	Log	173	81	50	24	17	12	5.7	3.5	1.7	8.7	8.4	11	5.8	8.3
	(org/m^2)	Log	12,918	4,332	2,176	737	453	279	94	47	16	93	54	100	90	79
Tricoptera	(%)	Fourth Root	67	23	10	1.6	0.47	0.080	0.00026	0 [a]	0 [a]	4.7	5.1	5.0	3.2	3.8
	(org/m^2)	Square Root	570	328	209	77	38	13	4.4	1.0	1.0	50	32	47	50	36
Chironomidae	(%)	None	99	81	70	53	45	37	19	7.8	0 [a]	44	62	52	59	39
	(org/m^2)	Log	64,428	17,032	7,362	1,970	1,089	602	161	70	18	477	398	492	911	373
Diptera (excluding Chironomidae)	(%)	Fourth Root	58	35	24	13	9.1	6.3	2.5	1.2	0.25	10	6.7	11	11	11
	(org/m^2)	Log	7,501	2,392	1,164	375	225	136	44	21	6.8	111	43	104	165	108
Oligochaeta	(%)	Log (x+1)	39	18	11	4.5	2.9	1.8	0.34	0 [a]	0 [a]	18	7.9	11	9.0	29
	(org/m^2)	Log (x+1)	1,323	496	267	101	65	41	15	7.7	2.3	194	50	104	140	276

🟥 Value less than the lower 90% confidence limit on the 2.5th percentile or greater than the upper 90% confidence limit on the 97.5th percentile (i.e., out of reference condition).

🟩 Value greater than the upper 90% confidence limit on the 2.5th percentile or less than the lower 90% confidence limit on the 97.5th percentile (i.e., within reference condition).

⬜ Value within the 90% confidence limits on the 2.5th percentile or within the 90% confidence limits on the 97.5th percentile (i.e., inconclusive).

[a] Value was negative and truncated to zero.

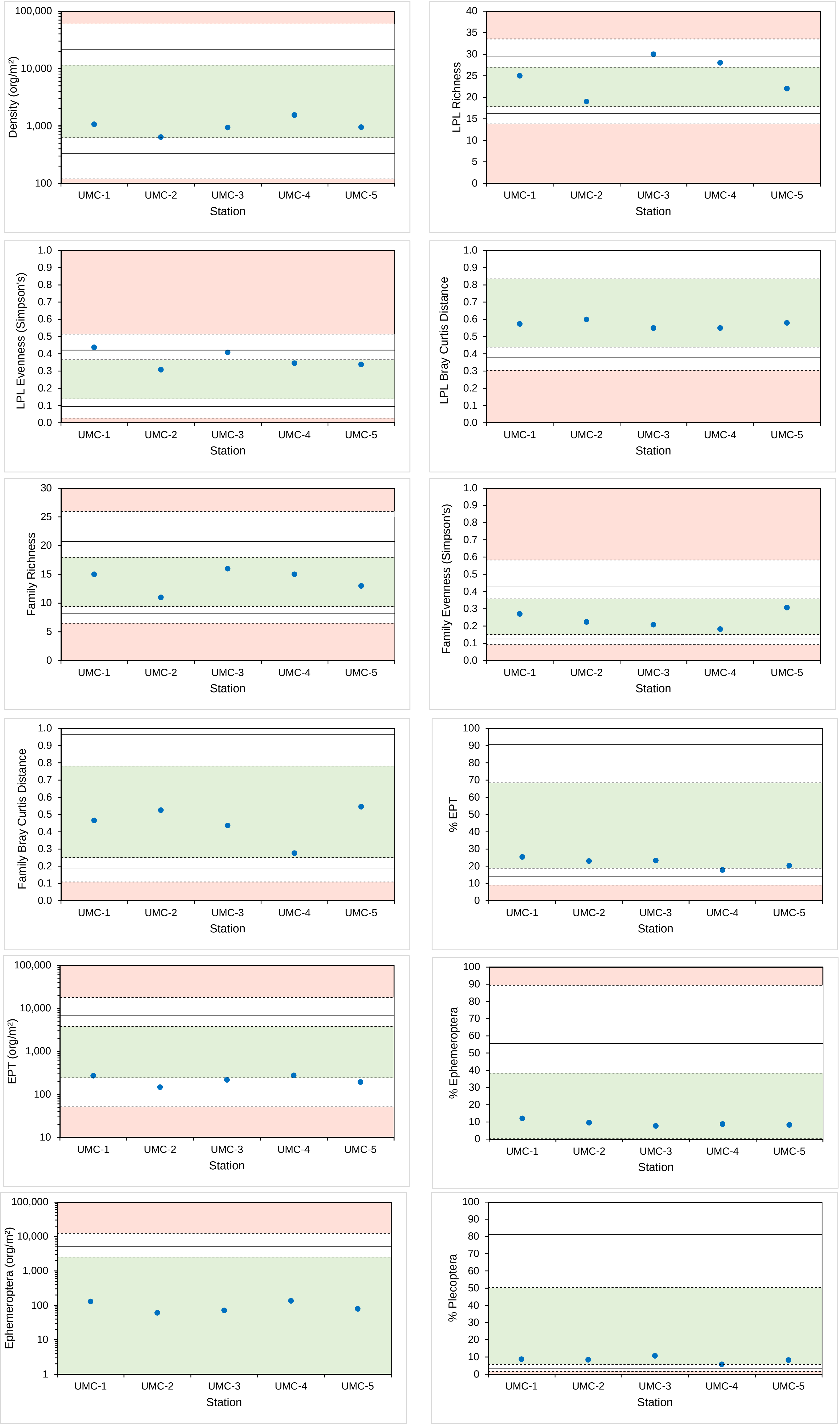


Figure D.1: **Individual Value Plot of Benthic Invertebrate Community Endpoints for Exposed Sites (n = 5), Relative to the Reference Condition (n = 10), 2017**

Notes: solid lines = 2.5th and 97.5th percentiles, dashed lines = 90% confidence limits on the percentiles.

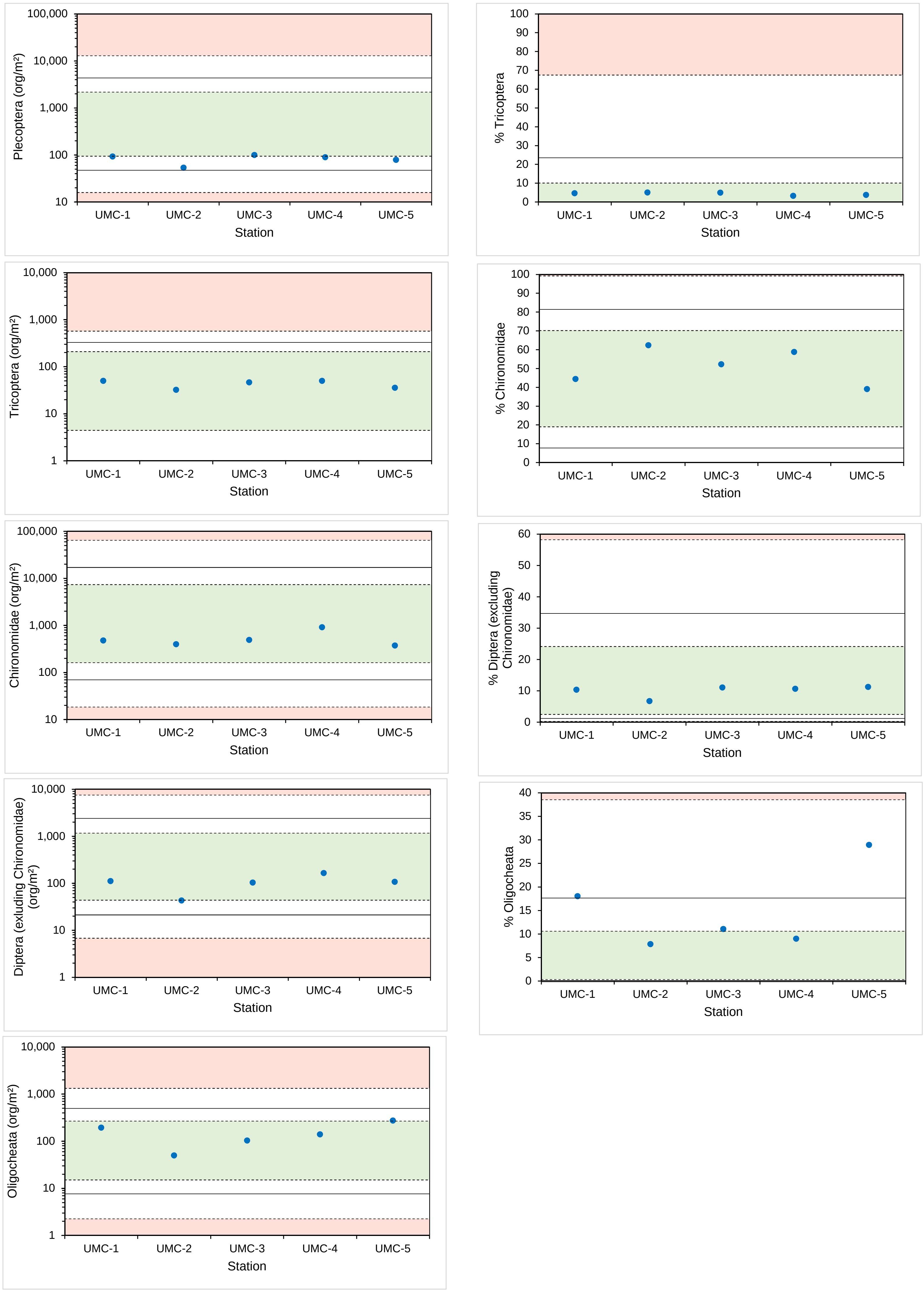


Figure D.1: **Individual Value Plot of Benthic Invertebrate Community Endpoints for Exposed Sites (n = 5), Relative to the Reference Condition (n = 10), 2017**

Notes: solid lines = 2.5th and 97.5th percentiles, dashed lines = 90% confidence limits on the percentiles.

Table D.6: Summary of Statistical Comparisons of Benthic Invertebrate Community Endpoints Between Reference (n = 10) and Exposed (n = 5) Sites, 2016

Endpoint		Data Transformation	Test	Test P-value	Mean or Median [a]		Observed ES [b] (Exposed - Reference)/SD
					Reference	Exposed	
Density		log	T	0.059	2,671	990	-1.2
Lowest Practical Level	Richness	none	T	0.215	22	25	0.74
	Evenness (Simpson's)	fourth root	T	0.016	0.24	0.37	1.6
	Bray-Curtis Distance	log	T	0.577	0.61	0.57	-0.32
Family Level	Richness	log	T	0.567	13	14	0.33
	Evenness (Simpson's)	log	T	0.955	0.23	0.23	0.033
	BC Distance	square root	T	0.795	0.47	0.44	-0.15
Relative Density	% EPT	fourth root	Tunequal	0.009	37	22	-1.3
	% Ephemeroptera	log(X+1)	T	0.942	9.8	10	0.042
	% Plecoptera	log	Tunequal	0.018	17	8.2	-1.2
	% Trichoptera	fourth root	Tunequal	0.019	0.47	4.3	1.1
	% Chironomidae	none	T	0.451	45	51	0.44
	% Diptera (excluding Chironomidae)	fourth root	Tunequal	0.746	9.1	9.9	0.14
	% Oligochaeta	fourth root	T	0.006	2.8	14	1.9
Density	EPT	log	T	0.006	959	3	-1.9
	Ephemeroptera	rank	MW	0.066	258	219	-
	Plecoptera	log	Tunequal	<0.001	453	81	-1.9
	Trichoptera	square root	Tunequal	0.854	38	43	0.075
	Chironomidae	log	Tunequal	0.117	1,089	502	-0.70
	Diptera (excluding Chironomidae)	log	T	0.153	225	98	-0.86
	Oligochaeta	log	T	0.178	64	131	0.81

▨ P-value < 0.1.

[a] For transformed data, the mean was calculated on the transformed scale, and back-transformed to original data units; the median is reported for the Mann-Whitney test.

[b] The observed effect size is calculated on the transformed scale when the data were transformed for analysis. An effect size is not reported when the data were analyzed using the Mann-Whitney test.

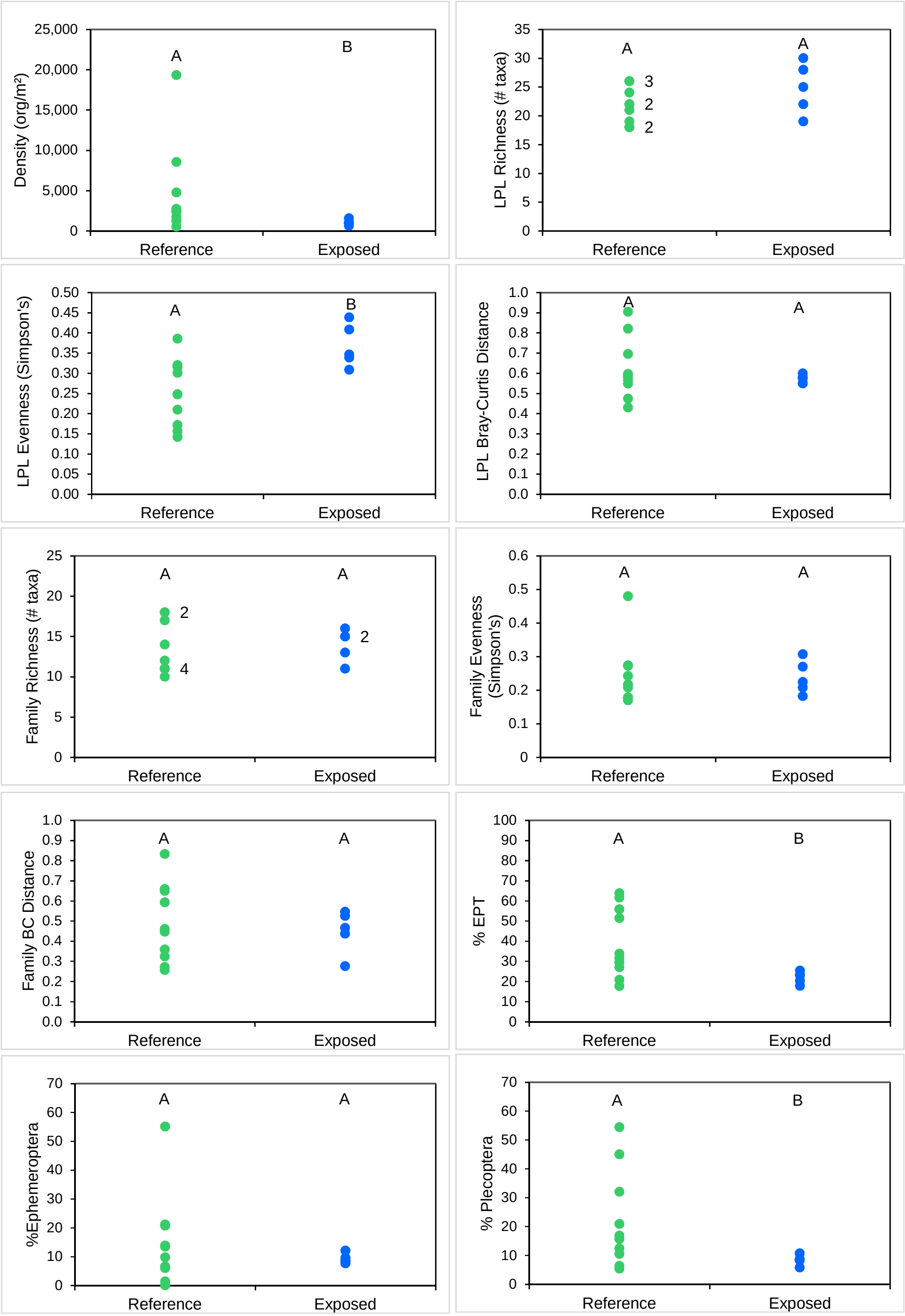


Figure D.2: **Individual Value Plot of Benthic Invertebrate Community Taxon Proportions for Reference (n = 10) and Exposed (n = 5) Sites, 2017**

Notes: The letter B above the exposed group indicates a significant difference relative to reference (A) α = 0.1. The letter A above the exposed group indicates no significant difference relative to reference (A) α = 0.1.
Numbers next to individual points represent the number of overlapping points at that value.

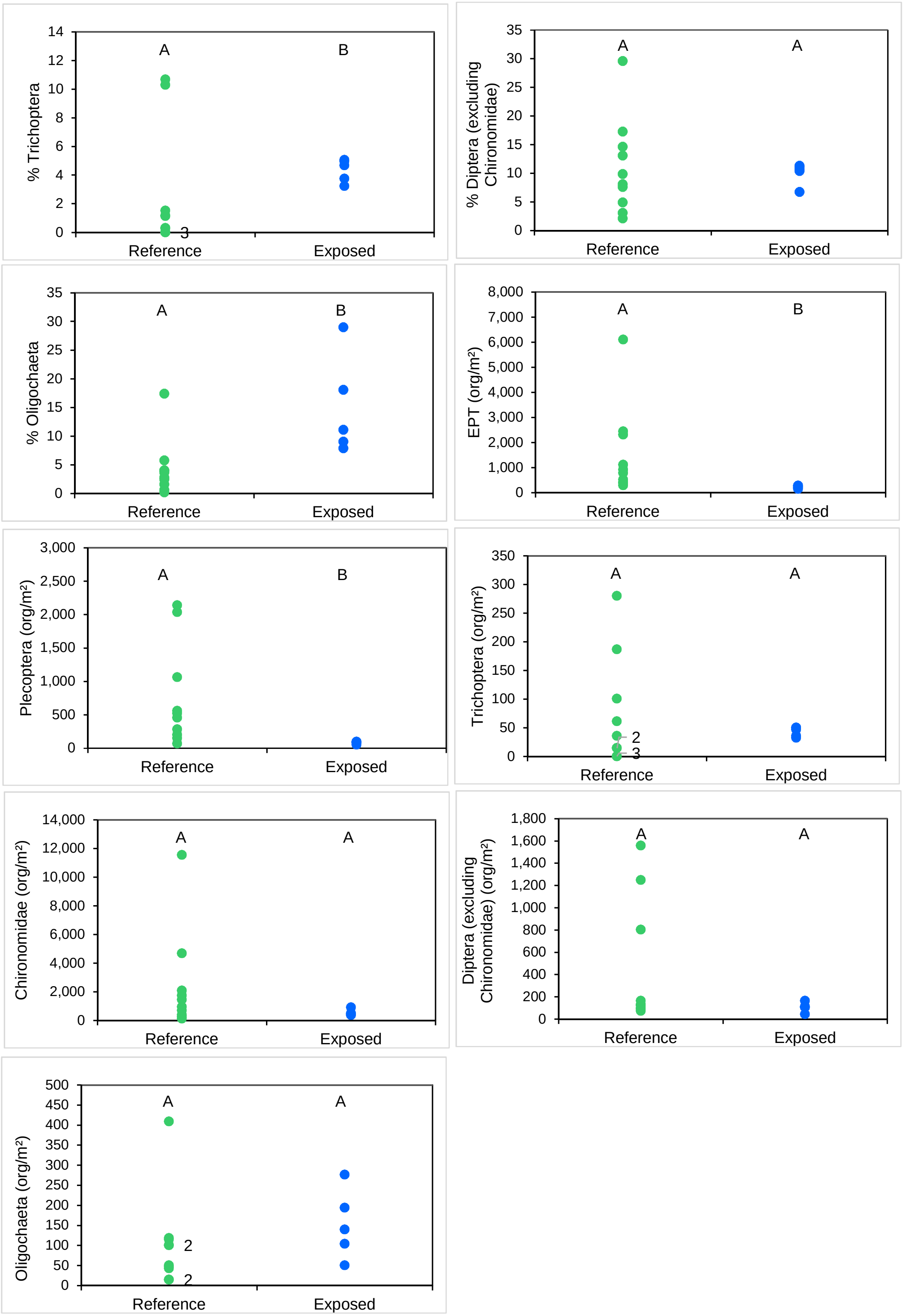


Figure D.2: **Individual Value Plot of Benthic Invertebrate Community Taxon Proportions for Reference (n = 10) and Exposed (n = 5) Sites, 2017**

Notes: The letter B above the exposed group indicates a significant difference relative to reference (A) α = 0.1. The letter A above the exposed group indicates no significant difference relative to reference (A) α = 0.1.
Numbers next to individual points represent the number of overlapping points at that value.

Table D.7: **Symmetric Component Coefficients for Each Taxa and Each Area for the First Two Components (C-1 and C-2) of a Correspondance Analysis for the Relative Abundance of 19 Taxa for Reference (n = 10) and Mine-exposed (n = 5) Areas, 2016**

Taxa	Symmetric Component Coefficients	
	C-1 (27.8%)	C-2 (23.3%)
Collembola	0.0105	0.2057
Ameletidae	1.7519	-0.1901
Baetidae	-0.2057	0.4646
Ephemerellidae	-0.1535	0.6471
Heptageniidae	-0.3724	-0.1611
Capniidae	-0.1379	0.1818
Chloroperlidae	-0.3451	0.0938
Nemouridae	-0.2715	-1.0555
Perlodidae	-0.4424	0.0406
Taeniopterygidae	-0.4968	0.4901
Limnephilidae	0.2030	-0.0389
Chironomidae	-0.1790	0.2193
Empididae	-0.2718	0.5172
Psychodidae	0.6612	0.3922
Simuliidae	-0.2731	-0.2828
Tipulidae	-0.0391	-0.5681
Oribatida	-0.2579	0.6262
Lumbriculidae	0.0542	0.5117
Naididae	-0.3775	-0.0745

Area	Symmetric Component Coefficients	
	C-1 (27.8%)	C-2 (23.3%)
UMC-1	-0.0156	0.3336
UMC-2	-0.0305	0.2659
UMC-3	-0.1194	0.2703
UMC-4	0.0109	0.3741
UMC-5	-0.0010	0.4265
REF-1	0.5018	-0.5845
REF-2	-0.3916	-0.7394
REF-3	-0.3300	0.1723
REF-4	-0.3912	-1.2416
REF-5	-0.1440	-0.2193
REF-6	1.7766	-0.1002
REF-7	-0.2183	0.1950
REF-8	-0.1437	0.3892
REF-9	-0.3206	0.3664
REF-10	-0.1970	0.0962

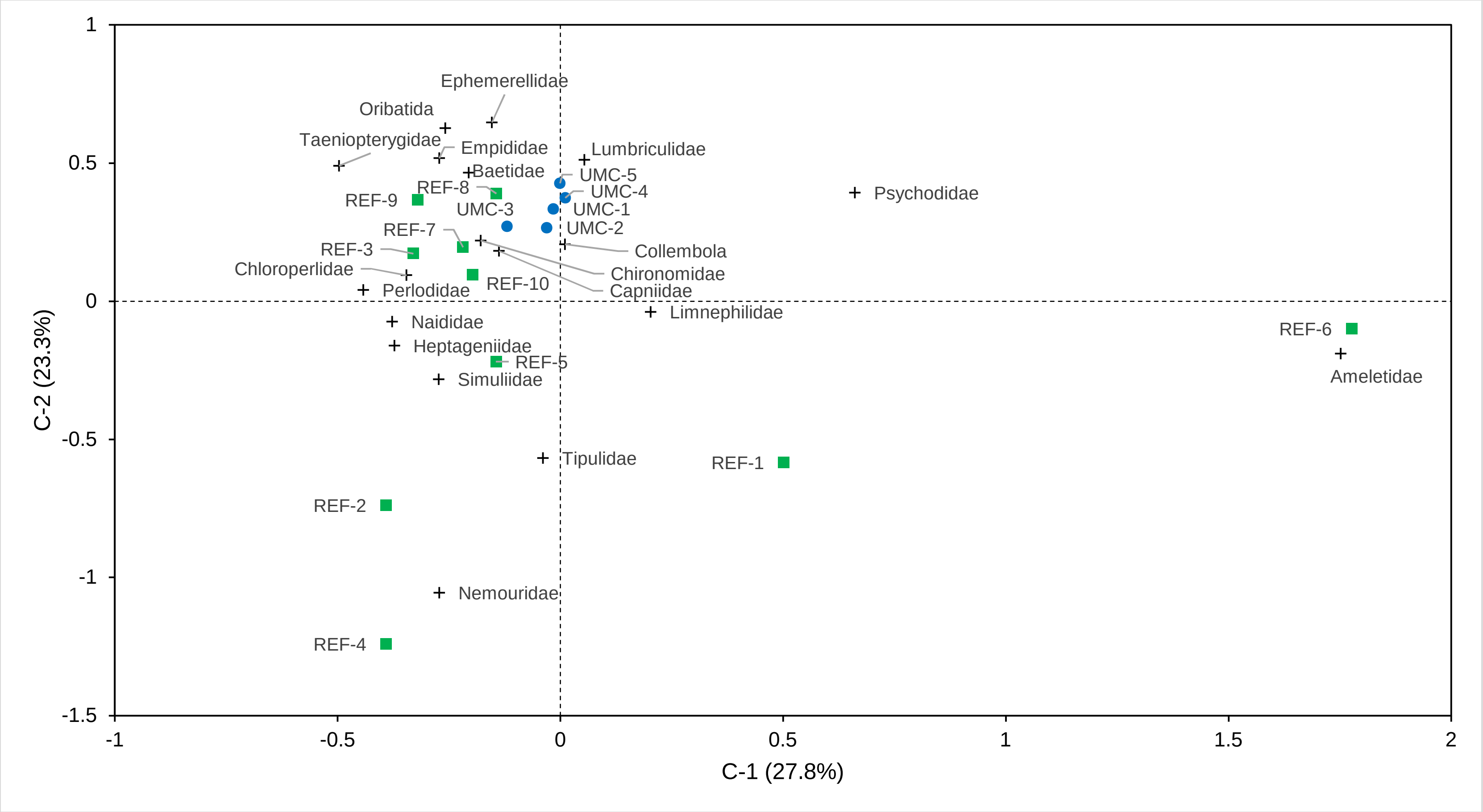


Figure D.3: Scatterplot of the Symmetric Representation of Component 2 (C-2) vs. C-1 from a Correspondence Analysis of Areas and Taxa

Table D.8: Coefficients for Water Quality Variables (Total Metals Only) for the First Two Principal Components (PC-1 and PC-2) and Spearman Rank Correlations for Water Quality Variables (Total Metals Only) with PC-1 and PC-2 for a Principal Component Analysis of Ranked Concentrations of Water Quality Variables for Reference (n = 10) and Mine-exposed (n = 3) Areas, 2016

Variable	Principal Component Coefficients		Spearman Rank Correlations			
			PC-1		PC-2	
	PC-1	PC-2	r	P-value	r	P-value
Hardness (as $CaCO_3$)	-0.224	0.254	-0.703	0.007	0.670	0.012
Total Suspended Solids	0.213	0.178	0.548	0.053	0.429	0.144
Total Dissolved Solids	-0.187	0.295	-0.580	0.038	0.801	0.001
Total Alkalinity (as $CaCO_3$)	-0.205	0.260	-0.619	0.024	0.685	0.010
Total Ammonia (as N)	0.242	0.042	0.672	0.012	-0.038	0.903
Nitrate (as N)	-0.021	0.230	-0.245	0.420	0.616	0.025
Total Kjeldahl Nitrogen	0.163	0.296	0.407	0.168	0.725	0.005
Total Phosphorus (P)	0.192	0.261	0.457	0.117	0.586	0.035
Dissolved Organic Carbon	0.088	0.006	0.371	0.212	-0.085	0.782
Total Aluminum	0.233	0.125	0.610	0.027	0.330	0.271
Total Arsenic	0.087	-0.002	0.144	0.639	-0.038	0.903
Total Barium	-0.013	0.113	-0.163	0.596	0.320	0.287
Total Cadmium	0.122	0.109	0.141	0.646	0.294	0.329
Total Calcium	-0.185	0.272	-0.610	0.027	0.742	0.004
Total Chromium	0.258	0.019	0.463	0.111	0.077	0.802
Total Cobalt	0.258	0.019	0.463	0.111	0.077	0.802
Total Copper	0.147	0.272	0.346	0.247	0.681	0.010
Total Iron	0.280	0.027	0.846	<0.001	-0.011	0.972
Total Lithium	-0.207	-0.026	-0.717	0.006	-0.015	0.962
Total Magnesium	-0.228	0.244	-0.714	0.006	0.632	0.021
Total Manganese	0.165	0.117	0.380	0.201	0.201	0.511
Total Molybdenum	-0.069	0.276	-0.296	0.326	0.777	0.002
Total Nickel	0.112	0.157	0.266	0.379	0.407	0.168
Total Potassium	-0.099	0.085	-0.309	0.305	0.309	0.305
Total Selenium	-0.148	0.192	-0.544	0.055	0.473	0.103
Total Sodium	0.001	0.260	0.052	0.865	0.602	0.029
Total Titanium	0.240	0.156	0.472	0.104	0.376	0.206
Total Uranium	-0.244	0.127	-0.737	0.004	0.292	0.334
Total Vanadium	0.256	0.148	0.757	0.003	0.254	0.402

▒	P-value < 0.05.
🟦	r > 0.6 or r < -0.6.

Table D.9: **The First Two Principal Components (PC-1 and PC-2) for a Principal Component Analysis of Ranked Concentrations of Water Quality Variables (Total Metals Only) for Reference (n = 10) and Mine-exposed (n = 3) Areas, 2016**

Area	PC-1 (30.0%)	PC-2 (23.7%)
REF-1	1.552	-2.078
REF-2	1.857	-2.116
REF-3	1.653	0.123
REF-4	7.471	0.446
REF-5	-2.888	-2.002
REF-6	-1.051	1.615
REF-7	-2.856	1.936
REF-8	-0.738	-1.067
REF-9	-4.030	-0.686
REF-10	0.037	-5.372
UMC-1	-1.064	2.543
UMC-2	1.529	4.737
UMC-3	-1.472	1.920

Note: PCA conducted on the correlation matrix with ranked concentrations (equivalent to the Spearman rank correlation matrix).

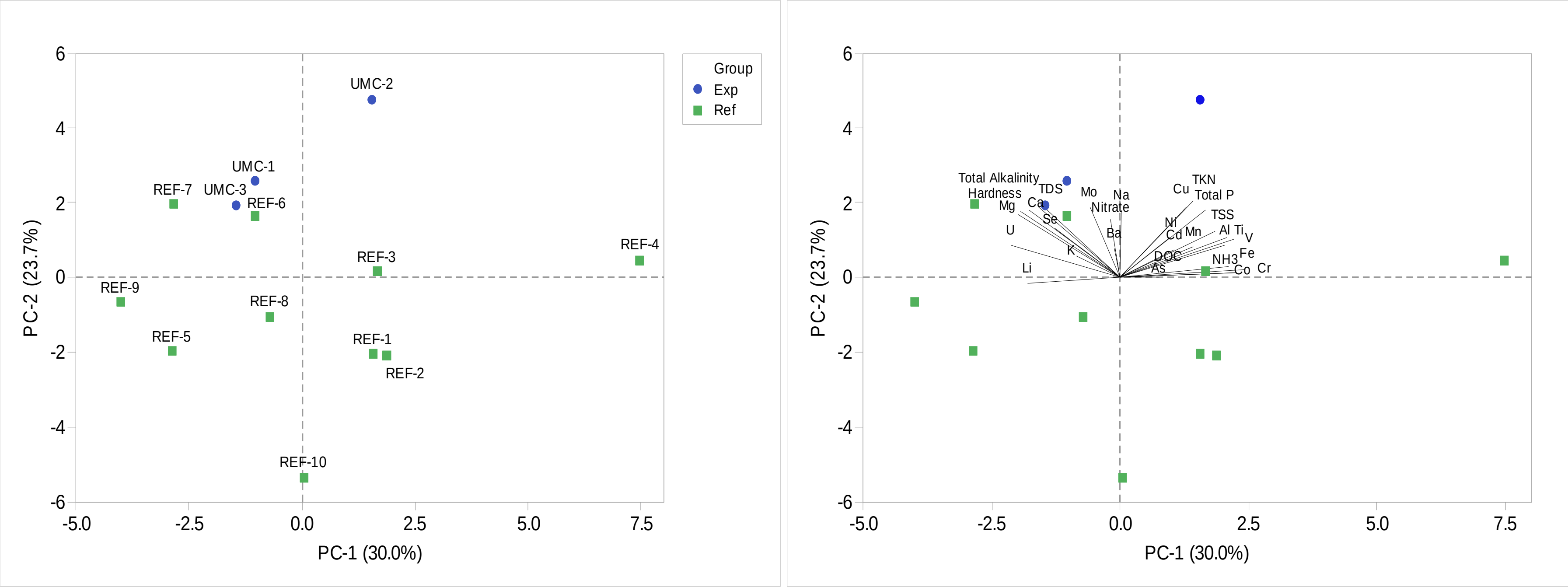


Figure D.4: **Scatterplot of Principal Component 2 (PC-2) vs. PC-1 for Reference (n = 10) and Mine-exposed (n = 3) Areas from a Principal Component Analysis of Ranks of Water Quality Variables (left) and the Loadings (Scaled Coefficients) of Each Variable to each Principal Component are Plotted on the Scatterplot (right)**

Note: Only total metals concentration data were included in the Principal Compnent Analysis; dissolved metals data were excluded.

Table D.10: Coefficients for Each Habitat Variable for the First Two Principal Components (PC-1 and PC-2) and Pearson Correlations for Each Habitat Variable with PC-1 and PC-2 for a Principal Component Analysis of Habitat Variables for Reference (n = 9) and Mine-exposed (n = 5) Areas, 2016

Variable	Principal Component Coefficients		Spearman Rank Correlations			
			PC-1		PC-2	
	PC-1	PC-2	r	P-value	r	P-value
Water Velocity	0.534	0.053	0.948	<0.001	0.074	0.802
Average Depth	-0.511	0.032	-0.906	<0.001	0.045	0.879
Median	0.372	-0.284	0.661	0.010	-0.398	0.159
Median	0.200	0.169	0.355	0.214	0.237	0.415
% cobble	-0.046	-0.708	-0.081	0.782	-0.990	<0.001
% gravel	-0.393	0.368	-0.697	0.006	0.515	0.059
% sand and finer	0.345	0.501	0.611	0.020	0.700	0.005

▨ P-value < 0.05.

🟦 r > 0.6 or r < -0.6.

Table D.11: **The First Two Principal Components (PC-1 and PC-2) for a Principal Component Analysis of Habitat Variables for Reference (n = 9) and Mine-exposed (n = 5) Areas, 2016**

Area	PC-1 (45.0%)	PC-2 (28.0%)
Ref-2	-0.327	-1.675
Ref-3	2.044	-0.495
Ref-4	-3.392	-0.466
Ref-5	2.195	2.190
Ref-6	-4.073	1.330
Ref-7	0.813	0.815
Ref-8	-0.407	-1.828
Ref-9	0.864	-2.290
Ref-10	0.319	-1.364
UMC-1	0.667	0.913
UMC-2	0.682	1.070
UMC-3	-0.307	1.200
UMC-4	-0.095	0.971
UMC-5	1.017	-0.371

Notes: no particle size data for Ref-1 were collected so this area was omitted from the analysis. PCA conducted on the correlation matrix.

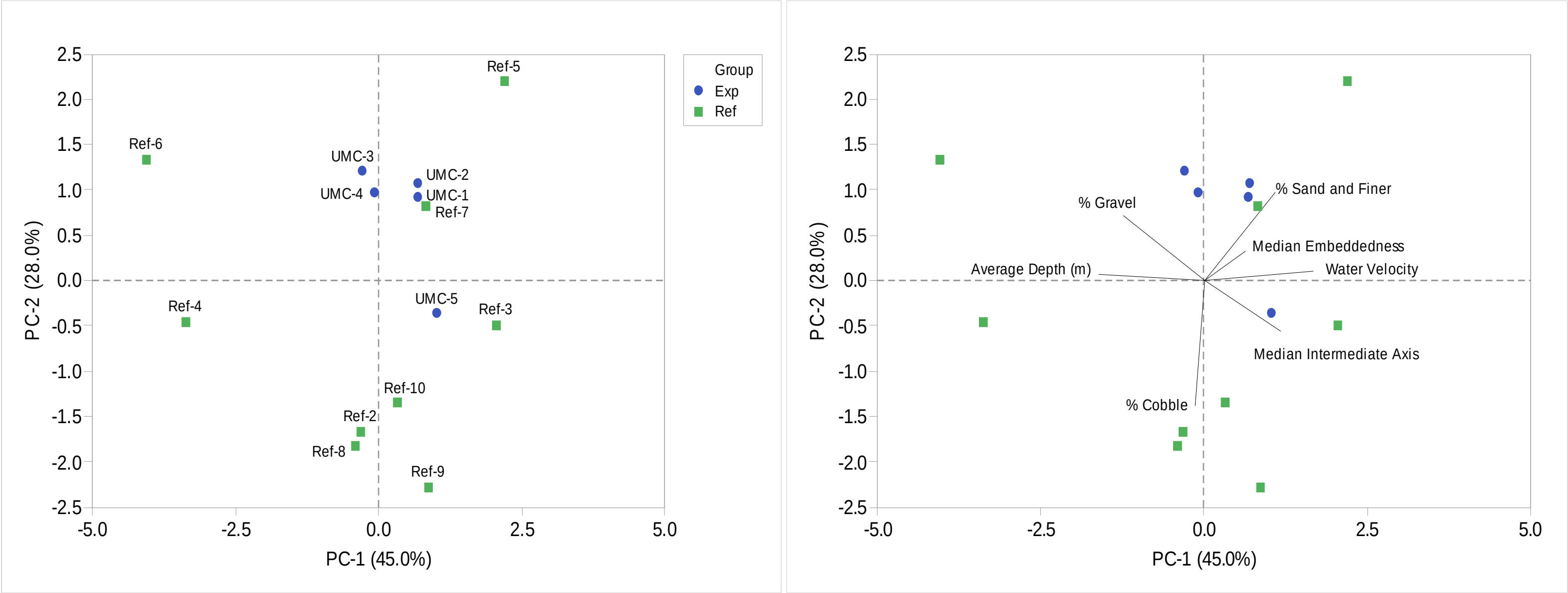


Figure D.5: **Scatterplot of Principal Component 2 (PC-2) vs. PC-1 for Reference (n = 9) and Mine-exposed (n = 5) Areas from a Principal Component Analysis of Habitat Variables (left) and the Loading (Scaled Coefficients) of Each Variable to each Principal Component are Plotted on the Scatterplot (right)**

Note: No particle size data for Ref-1 were collected so this area was omitted from the analysis.

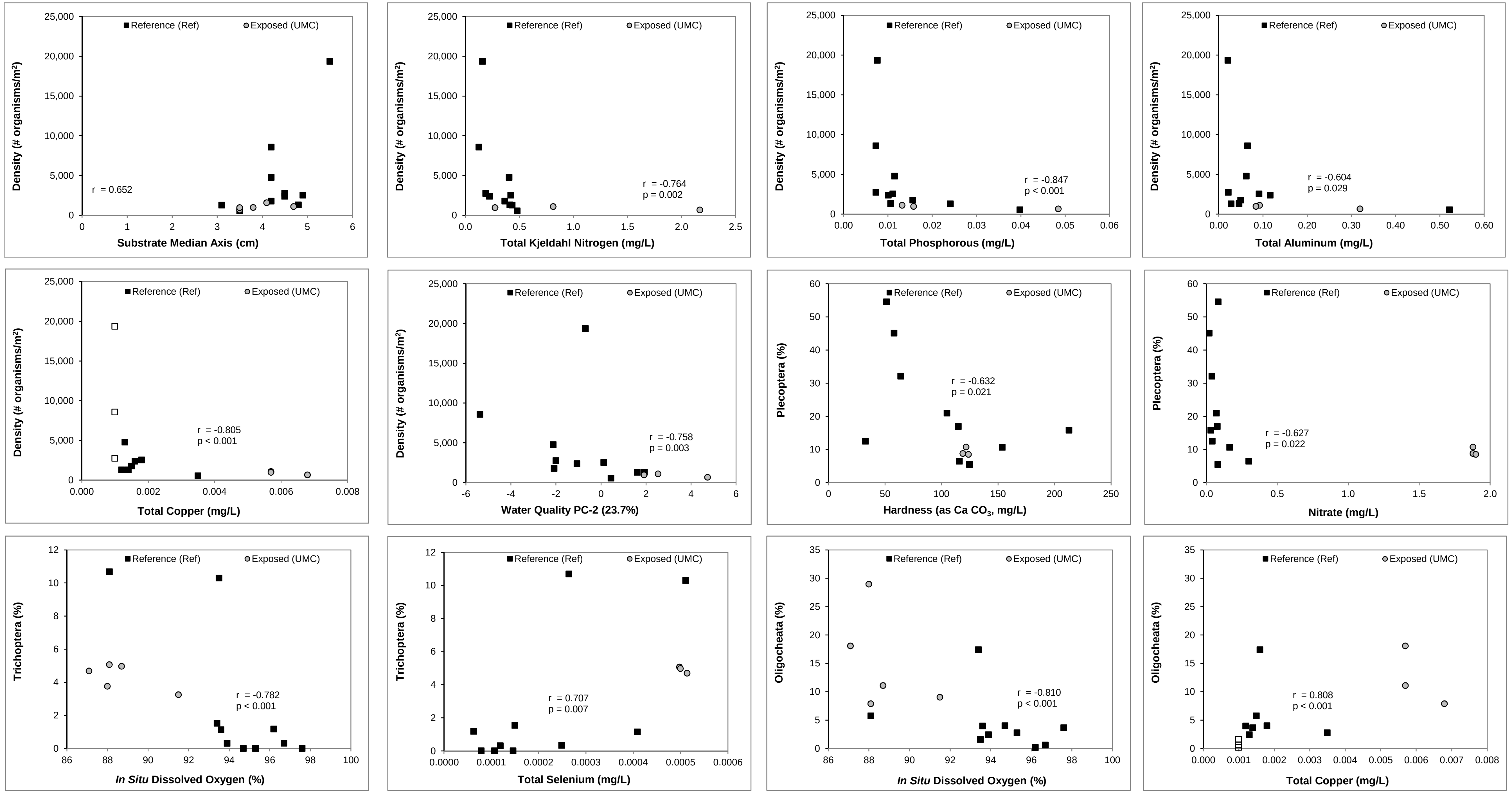


Figure D.6: Scatterplots of Significant Spearman's Rank Correlation Relationships between Benthic Invertebrate Community Metrics, and Water Quality, *In Situ*, and Principal Components Results, Minto Mine Cycle 4 EEM, 2016

Notes: Hollow symbols represent values below the Method Detection Limit (MDL). All correlations were calculated using data < MDL at the MDL value. N = 13 for all analyses of water quality (n = 10 for reference, n = 3 for exposed). N = 14 for all habitat analyses (n = 9 for reference due to exclusion of Ref-1, n = 5 for exposed). The Spearman's Rank Correlation coefficient is represented by "r" on the above plots.

Table D.12: Spearman Correlation of Benthic Invertebrate Endpoints vs. Principal Components Results, *In situ* Measures, and Water Quality Results, Minto Mine Phase 4 EEM, 2016

Endpoint		*In situ* Measures																Water Quality					
		Temperature (°C)		Specific Conductance (μs/cm)		Dissolved Oxygen (mg/L)		Dissolved Oxygen (%)		pH (pH units)		Water Velocity (m/s)		Mean Depth (m)		Substrate Median Intermediate Axis (cm)		Hardness (as CaCO3, mg/L)		Nitrate (as N, mg/L)		Total Kjeldahl Nitrogen (mg/L)	
		n=15		n=15		n=15		n=15		n=15		n=15		n=15		n=15		n=13		n=13		n=13	
		r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value
Density *		-0.453	0.090	-0.179	0.524	0.525	0.044	0.481	0.070	0.252	0.365	0.159	0.571	-0.052	0.853	0.652	0.008	-0.181	0.553	-0.514	0.072	-0.764	0.002
Lowest Practical Level	Richness	0.441	0.100	0.204	0.467	-0.259	0.350	-0.005	0.987	-0.296	0.284	0.143	0.612	-0.087	0.759	-0.090	0.750	0.103	0.739	0.081	0.794	-0.325	0.279
	Evenness (Simpson's)	0.428	0.112	-0.075	0.791	-0.679	0.005	-0.685	0.005	-0.277	0.318	0.030	0.914	0.083	0.769	-0.272	0.327	-0.330	0.271	0.371	0.212	0.297	0.325
	Bray Curtis Distance	0.054	0.849	0.021	0.940	0.236	0.398	0.234	0.401	0.263	0.344	0.254	0.361	-0.038	0.893	0.176	0.529	0.038	0.901	0.055	0.858	-0.242	0.426
Family Level	Richness	0.329	0.231	0.368	0.177	-0.046	0.872	0.084	0.766	0.057	0.841	0.412	0.127	-0.206	0.461	0.150	0.594	0.359	0.228	-0.111	0.719	-0.393	0.184
	Evenness (Simpson's)	-0.007	0.980	-0.286	0.302	-0.493	0.062	-0.593	0.020	-0.352	0.198	-0.134	0.634	0.215	0.442	-0.347	0.204	-0.363	0.223	0.107	0.727	0.313	0.297
	Bray Curtis Distance	0.267	0.336	-0.021	0.940	-0.111	0.694	0.155	0.580	-0.109	0.699	-0.254	0.361	0.137	0.626	-0.299	0.279	0.027	0.929	0.151	0.622	0.011	0.972
Relative Density	EPT (%) *	-0.397	0.142	-0.314	0.254	0.143	0.612	0.304	0.271	-0.118	0.675	-0.478	0.072	0.300	0.278	-0.122	0.664	-0.170	0.578	-0.492	0.087	-0.011	0.972
	Ephemeroptera (%)	-0.116	0.680	0.321	0.243	0.043	0.879	0.021	0.940	0.214	0.443	-0.403	0.137	-0.034	0.903	0.063	0.823	0.467	0.108	-0.052	0.865	-0.181	0.553
	Plecoptera (%) *	-0.288	0.297	-0.564	0.028	0.200	0.475	0.372	0.172	-0.341	0.213	0.007	0.980	-0.090	0.749	0.241	0.386	-0.632	0.021	-0.627	0.022	-0.060	0.845
	Trichoptera (%) *	0.199	0.476	0.043	0.879	-0.591	0.020	-0.782	<0.001	-0.425	0.114	0.223	0.425	-0.074	0.792	-0.249	0.370	0.000	1.000	0.357	0.231	-0.160	0.601
	Chironomidae (%)	0.174	0.536	0.339	0.216	0.125	0.657	0.168	0.549	0.270	0.331	0.347	0.205	-0.350	0.201	0.452	0.091	0.247	0.415	0.272	0.368	-0.060	0.845
	Diptera (%)	0.251	0.368	-0.100	0.723	-0.079	0.781	0.059	0.835	-0.434	0.106	0.127	0.652	0.193	0.490	-0.380	0.163	-0.077	0.803	0.096	0.754	-0.121	0.694
	Oligocheata (%) *	0.358	0.190	0.275	0.321	-0.554	0.032	-0.810	<0.001	-0.023	0.934	0.052	0.854	-0.213	0.446	-0.227	0.416	0.253	0.405	0.556	0.049	0.511	0.074
Density	EPT (org/m^2) *	-0.650	0.009	-0.368	0.177	0.600	0.018	0.599	0.018	0.159	0.571	-0.225	0.419	0.168	0.550	0.437	0.103	-0.275	0.364	-0.641	0.018	-0.654	0.015
	Ephemeroptera (org/m^2) *	-0.392	0.148	-0.043	0.879	0.357	0.191	0.309	0.262	0.259	0.351	-0.324	0.239	0.217	0.438	0.207	0.459	0.055	0.859	-0.322	0.284	-0.632	0.021
	Plecoptera (org/m^2) *	-0.440	0.100	-0.482	0.069	0.454	0.089	0.577	0.024	-0.055	0.845	-0.048	0.864	-0.078	0.783	0.560	0.030	-0.500	0.082	-0.680	0.011	-0.615	0.025
	Trichoptera (org/m^2)	0.050	0.859	-0.059	0.834	-0.255	0.360	-0.307	0.266	-0.361	0.186	0.197	0.482	-0.045	0.873	0.181	0.519	-0.133	0.665	0.114	0.712	-0.600	0.030
	Chironomidae (org/m^2)	-0.165	0.557	-0.025	0.930	0.429	0.111	0.477	0.072	0.265	0.341	0.306	0.268	-0.146	0.603	0.675	0.006	-0.077	0.803	-0.272	0.368	-0.687	0.010
	Diptera (org/m^2)	-0.120	0.670	0.121	0.666	0.207	0.459	0.377	0.166	0.097	0.732	0.120	0.670	-0.150	0.594	0.340	0.215	0.093	0.762	-0.388	0.190	-0.582	0.037
	Oligocheata (org/m^2)	0.223	0.425	0.344	0.210	-0.383	0.159	-0.516	0.049	0.385	0.156	-0.024	0.932	-0.169	0.547	0.197	0.482	0.279	0.357	0.318	0.290	-0.033	0.915

▨ P-value < 0.05.

🟦 r > 0.6 or r < -0.6.

* = benthic invertebrate community endpoint that was one or more of: 1) out of reference condition (no instances); 2) inconclusive with respect to the reference condition; and/or 3) statistically different from reference following the Control-Impact comparison.

Notes: All correlations were calculated using data < Method Detection Limit (MDL) at the MDL value. N = 13 for all analyses of water quality (n = 10 for reference, n = 3 for exposed). N = 14 for all habitat analyses (n = 9 for reference due to exclusion of REF-1 and n = 5 for the effluent-exposed area). The Spearman's Rank Correlation coefficient is represented by "r" in the above table.

Table D.12: **Spearman Correlation of Benthic Invertebrate Endpoints vs. Principal Components Results, *In situ* Measures, and Water Quality Results, Minto Mine Phase 4 EEM, 2016**

Endpoint		Water Quality														Principal Components							
		Total Phosphorus (mg/L)		Total Aluminum (mg/L)		Total Arsenic (mg/L)		Total Copper (mg/L)		Total Iron (mg/L)		Total Molybdenum (mg/L)		Total Selenium (mg/L)		Water Quality PC-1 (30.0%)		Water Quality PC-2 (23.7%)		Habitat PC-1 (45.0%)		Habitat PC-2 (28.0%)	
		n=13		n=13		n=13		n=13		n=13		n=13		n=13		n=13		n=13		n=14		n=14	
		r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value	r	P-value
Density		-0.847	<0.001	-0.604	0.029	0.025	0.935	-0.805	<0.001	-0.401	0.174	-0.599	0.031	-0.357	0.231	-0.220	0.471	-0.758	0.003	0.279	0.334	-0.495	0.072
Lowest Practical Level	Richness	-0.217	0.477	-0.216	0.478	-0.267	0.377	-0.117	0.703	-0.325	0.279	0.396	0.181	0.291	0.334	-0.560	0.046	0.117	0.705	0.051	0.863	0.443	0.113
	Evenness (Simpson's)	0.437	0.135	0.522	0.067	-0.235	0.440	0.628	0.022	0.154	0.616	0.373	0.209	0.374	0.209	0.324	0.280	0.121	0.694	-0.174	0.553	0.112	0.703
	Bray Curtis Distance	-0.327	0.275	-0.148	0.629	0.025	0.935	-0.349	0.243	-0.291	0.334	-0.208	0.494	-0.258	0.394	-0.049	0.873	-0.225	0.459	0.169	0.563	-0.455	0.102
Family Level	Richness	-0.512	0.074	-0.560	0.046	-0.442	0.130	-0.413	0.160	-0.600	0.030	0.312	0.300	0.325	0.278	-0.778	0.002	0.065	0.833	0.312	0.278	0.483	0.080
	Evenness (Simpson's)	0.421	0.152	0.176	0.566	0.106	0.729	0.213	0.485	0.269	0.374	-0.134	0.661	0.418	0.156	0.335	0.263	-0.082	0.789	-0.068	0.817	0.222	0.446
	Bray Curtis Distance	0.184	0.547	-0.132	0.668	0.388	0.190	-0.246	0.417	0.005	0.986	-0.077	0.802	-0.055	0.859	-0.022	0.943	0.000	1.000	-0.187	0.523	-0.134	0.648
Relative Density	EPT (%)	0.168	0.584	-0.495	0.086	0.442	0.131	-0.451	0.122	0.264	0.384	-0.424	0.149	0.011	0.972	0.110	0.721	-0.313	0.297	-0.244	0.401	0.130	0.659
	Ephemeroptera (%)	-0.069	0.823	-0.516	0.071	0.157	0.609	-0.362	0.224	-0.247	0.415	-0.007	0.983	0.225	0.459	-0.451	0.122	0.027	0.929	-0.134	0.648	-0.011	0.970
	Plecoptera (%)	-0.050	0.872	0.011	0.972	0.147	0.631	-0.089	0.774	0.544	0.055	-0.326	0.277	-0.456	0.117	0.495	0.086	-0.434	0.138	0.200	0.493	-0.244	0.401
	Trichoptera (%)	0.058	0.850	-0.055	0.858	-0.387	0.191	0.120	0.697	-0.204	0.503	0.257	0.397	0.707	0.007	-0.243	0.424	-0.044	0.886	0.210	0.472	0.581	0.029
	Chironomidae (%)	-0.264	0.383	0.291	0.334	-0.207	0.498	0.246	0.417	-0.143	0.642	0.242	0.426	-0.247	0.415	-0.093	0.762	0.214	0.482	0.319	0.267	-0.385	0.175
	Diptera (%)	-0.055	0.858	-0.187	0.541	0.110	0.721	-0.246	0.417	-0.209	0.494	0.020	0.948	0.209	0.494	-0.324	0.280	0.060	0.845	-0.007	0.982	0.516	0.059
	Oligocheata (%)	0.501	0.081	0.544	0.055	-0.269	0.373	0.808	<0.001	0.027	0.929	0.575	0.040	0.484	0.094	0.071	0.817	0.571	0.041	-0.068	0.817	0.226	0.436
Density	EPT (org/m²)	-0.605	0.028	-0.681	0.010	0.304	0.313	-0.871	<0.001	-0.176	0.566	-0.773	0.002	-0.379	0.201	-0.044	0.887	-0.830	<0.001	-0.002	0.994	-0.451	0.106
	Ephemeroptera (org/m²)	-0.465	0.109	-0.681	0.010	0.125	0.683	-0.788	0.001	-0.368	0.216	-0.457	0.116	-0.055	0.859	-0.335	0.263	-0.571	0.041	-0.160	0.584	-0.288	0.318
	Plecoptera (org/m²)	-0.575	0.040	-0.401	0.174	0.216	0.478	-0.617	0.025	0.055	0.859	-0.632	0.020	-0.571	0.041	0.165	0.590	-0.819	<0.001	0.169	0.563	-0.626	0.017
	Trichoptera (org/m²)	-0.432	0.140	-0.379	0.202	-0.210	0.492	-0.362	0.224	-0.481	0.096	-0.071	0.817	0.451	0.122	-0.432	0.141	-0.418	0.156	0.261	0.368	0.091	0.758
	Chironomidae (org/m²)	-0.809	<0.001	-0.335	0.263	-0.175	0.567	-0.523	0.067	-0.451	0.122	-0.272	0.368	-0.379	0.201	-0.253	0.405	-0.516	0.071	0.301	0.296	-0.591	0.026
	Diptera (org/m²)	-0.591	0.033	-0.830	<0.001	0.310	0.302	-0.805	<0.001	-0.451	0.122	-0.380	0.200	-0.033	0.915	-0.522	0.067	-0.396	0.181	0.354	0.215	0.051	0.864
	Oligocheata (org/m²)	-0.037	0.904	0.047	0.879	-0.075	0.806	0.233	0.443	-0.408	0.166	0.160	0.601	0.301	0.318	-0.163	0.595	0.074	0.809	0.000	1.000	-0.271	0.349

▨ P-value < 0.05.

🟦 r > 0.6 or r < -0.6.

* = benthic invertebrate community endpoint that was inconclusive with respect to the Reference Condition Approach and/or difference from reference following the Control-Impact comparison.

Notes: All correlations were calculated using data < Method Detection Limit (MDL) at the MDL value. N = 13 for all analyses of water quality (n = 10 for reference, n = 3 for exposed). N = 14 for all habitat analyses (n = 9 for reference due to exclusion of REF-1 and n = 5 for the effluent-exposed area). The Spearman's Rank Correlation coefficient is represented by "r" in the above table.

APPENDIX E

FISH SURVEY DATA

Table E.1: **Meristic Data for Juvenile Chinook Salmon Collected from Lower Minto Creek and Lower Big Creek, June to September 2016**

Lower Big Creek		
Month	Length (mm)	Weight (g)
June	48	1.1
	48	1.9
July	63	3.9
	58	2.8
	58	3.5
	62	4.7
	55	2.6
	56	2.8
	62	3.4
	60	2.8
	56	2.8
	57	3.4
	48	2.1
	57	2.7
	53	2.1
	65	3.9
	54	2.4
	57	2.3
	55	2.0
	52	2.8
	65	4.2
	62	3.5
	61	3.3

Lower Big Creek		
Month	Length (mm)	Weight (g)
August	73	5.01
	67	2.75
	77	5.52
	69	3.47
	68	3.83
	62	2.60
	81	6.21
	68	4.08
	75	4.60
	66	3.65
	58	2.34
	61	3.92
	66	3.59
	62	2.90
	64	3.40
	61	3.00
September	77	6.37
	78	5.89
	76	4.61
	58	3.22
	73	3.75
	72	4.44
	56	3.48
	63	3.32
	78	5.18
	62	2.90
	68	2.71
	69	4.29

Lower Minto Creek		
Month	Length (mm)	Weight (g)
September	73	4.48
	87	7.20
	62	3.03
	64	3.36
	71	4.43
	80	5.90

Table E.2: **Descriptive Summary Statistics of Juvenile Chinook Salmon Length and Weight Collected from Lower Minto Creek and Lower Big Creek, June to September 2016**

Month	Summary Statistic	Area			
		Reference (lower Big Creek)		Exposed (lower Minto Creek)	
		Fork Length (mm)	Weight (g)	Fork Length (mm)	Weight (g)
June	N	2	2	0	0
	Mean	48	1.50	-	-
	Median	48	1.50	-	-
	Minimum	48	1.10	-	-
	Maximum	48	1.90	-	-
	Standard Deviation	0	0.57	-	-
	Standard Error	0	0.40	-	-
July	N	21	21	0	0
	Mean	57.9	3.0	-	-
	Median	57.0	2.8	-	-
	Minimum	48.0	2.0	-	-
	Maximum	65.0	4.7	-	-
	Standard Deviation	4.41	0.73	-	-
	Standard Error	0.96	0.16	-	-
August	N	16	16	0	0
	Mean	67.4	3.80	-	-
	Median	66.5	3.62	-	-
	Minimum	58.0	2.34	-	-
	Maximum	81.0	6.21	-	-
	Standard Deviation	6.4	1.08	-	-
	Standard Error	1.6	0.27	-	-
September	N	12	12	6	6
	Mean	69.2	4.18	72.8	4.73
	Median	70.5	4.02	72.0	4.46
	Minimum	56.0	2.71	62.0	3.03
	Maximum	78.0	6.37	87.0	7.20
	Standard Deviation	7.8	1.17	9.5	1.57
	Standard Error	2.3	0.34	3.9	0.64

Table E.3: Raw Meristic Data of Kokanee at Day 0 (Pre-Exposed) of Control, E6, and E3 Treatments for the Minto Mine Fish Hatchery Exposure, August 2016

Date	Fish #	Control			E6			E3		
		Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)
4-Aug-2016	1	76.29	70.98	3.43	68.50	64.70	2.39	75.61	72.00	3.22
4-Aug-2016	2	79.66	73.13	3.92	75.50	71.80	3.39	81.51	76.81	4.16
4-Aug-2016	3	68.84	64.47	2.50	77.60	72.10	3.48	81.20	78.13	4.54
4-Aug-2016	4	62.99	59.59	1.74	79.00	74.30	3.81	74.13	71.29	3.14
4-Aug-2016	5	71.99	66.43	2.94	78.80	72.90	3.75	71.24	67.42	2.53
4-Aug-2016	6	79.26	74.10	4.30	80.40	75.20	4.14	79.30	75.00	3.95
4-Aug-2016	7	78.20	73.80	3.30	70.00	65.80	2.55	77.30	72.60	3.63
4-Aug-2016	8	72.29	67.88	3.00	74.60	70.10	3.15	70.20	67.20	2.39
4-Aug-2016	9	79.01	73.50	3.85	78.10	72.90	3.71	76.30	71.70	3.35
4-Aug-2016	10	66.11	61.48	2.14	77.70	72.90	3.62	72.20	68.00	2.83
4-Aug-2016	11	81.11	77.67	4.22	79.50	75.30	3.93	85.00	79.50	5.39
4-Aug-2016	12	74.72	71.39	3.35	75.30	71.30	3.17	74.70	69.20	3.05
4-Aug-2016	13	86.16	80.56	4.90	82.70	76.80	4.48	72.10	68.90	2.80
4-Aug-2016	14	81.69	75.87	4.11	83.60	79.80	4.81	72.30	68.30	3.01
4-Aug-2016	15	77.94	73.15	3.68	81.70	77.80	4.04	78.00	73.40	3.60
4-Aug-2016	16	80.18	75.48	4.02	82.80	77.90	4.50	79.10	76.10	3.82
4-Aug-2016	17	82.46	77.59	4.29	79.30	75.40	3.94	79.20	73.00	3.68
4-Aug-2016	18	77.73	73.37	3.52	75.00	70.20	3.20	68.90	63.70	2.42
4-Aug-2016	19	84.52	81.79	4.65	83.80	78.20	4.55	69.10	64.20	2.33
4-Aug-2016	20	72.23	67.39	2.80	81.40	77.50	4.31	83.00	78.50	4.46
4-Aug-2016	21	73.71	69.69	3.01	77.00	72.40	3.49	84.00	78.50	4.72
4-Aug-2016	22	85.57	80.44	5.29	76.80	72.10	3.27	77.30	71.80	3.51
4-Aug-2016	23	70.65	66.60	2.80	66.80	63.00	2.24	78.10	72.00	3.81
4-Aug-2016	24	80.19	75.82	4.02	71.20	67.20	2.70	75.80	70.20	3.48
4-Aug-2016	25	76.81	73.14	3.47	66.10	62.30	2.11	78.20	72.90	3.65
4-Aug-2016	26	77.10	71.20	3.36	63.50	60.20	1.85	75.10	70.10	2.98
4-Aug-2016	27	63.50	60.00	1.90	68.40	65.50	2.33	79.50	74.00	3.51
4-Aug-2016	28	68.50	65.30	2.32	77.60	72.20	3.45	69.60	65.50	2.42
4-Aug-2016	29	79.20	74.70	3.85	78.40	74.30	3.74	79.40	74.10	3.62
4-Aug-2016	30	76.20	71.20	3.20	73.20	70.00	2.95	66.80	62.10	2.10
4-Aug-2016	31	71.20	67.10	2.65	80.50	76.10	3.93	77.20	72.30	3.33
4-Aug-2016	32	79.30	73.80	4.07	73.00	68.30	2.93	79.70	75.10	3.88
4-Aug-2016	33	78.80	73.50	3.48	64.00	60.00	1.97	77.00	71.90	3.50
4-Aug-2016	34	80.90	76.20	4.26	80.20	74.30	4.24	78.00	72.60	3.55
4-Aug-2016	35	72.30	67.10	2.73	80.20	77.10	3.89	79.10	76.10	3.54
4-Aug-2016	36	71.10	67.30	2.80	75.00	70.70	3.20	85.50	80.40	5.01
4-Aug-2016	37	80.50	76.90	4.16	80.80	76.20	3.94	81.10	76.50	3.83
4-Aug-2016	38	80.30	76.20	4.28	72.90	68.30	2.95	83.90	79.50	4.79
4-Aug-2016	39	75.40	70.00	3.18	80.60	76.40	4.04	66.90	62.00	2.36
4-Aug-2016	40	76.90	72.70	3.58	79.20	73.90	3.92	78.10	73.60	3.56
4-Aug-2016	41	64.30	60.50	1.83	83.80	78.10	4.54	69.50	65.00	2.46
4-Aug-2016	42	76.50	72.00	3.12	78.00	73.20	3.71	81.70	77.50	3.94
4-Aug-2016	43	69.60	66.10	2.66	78.10	72.80	3.49	77.20	70.30	3.38
4-Aug-2016	44	75.30	71.20	3.16	83.60	77.70	4.27	74.10	69.90	3.07
4-Aug-2016	45	80.60	77.20	4.08	74.00	69.80	3.00	83.80	78.50	4.83
4-Aug-2016	46	80.80	76.40	4.24	78.10	74.00	3.71	76.20	72.50	3.64
4-Aug-2016	47	75.30	70.30	3.33	75.30	70.90	3.10	72.90	68.00	2.55
4-Aug-2016	48	74.10	69.80	3.00	80.80	75.50	3.92	72.30	67.90	2.88
4-Aug-2016	49	80.60	76.10	4.01	76.60	71.10	3.18	74.10	70.40	3.25
4-Aug-2016	50	71.60	68.70	2.61	75.50	71.30	3.15	73.90	69.50	3.02
4-Aug-2016	51	77.20	71.50	3.54	82.70	77.10	4.80	84.70	79.30	4.46
4-Aug-2016	52	78.40	75.10	3.74	74.20	70.90	3.08	79.30	75.10	3.89
4-Aug-2016	53	81.10	76.70	4.03	64.70	60.50	2.00	82.20	76.40	4.31
4-Aug-2016	54	65.10	62.20	2.04	80.50	76.30	3.92	63.50	59.20	1.84
4-Aug-2016	55	74.60	70.30	3.00	76.20	70.90	3.35	83.10	78.10	4.49
4-Aug-2016	56	72.80	68.80	2.80	77.80	73.70	3.69	79.70	74.90	3.69
4-Aug-2016	57	72.00	67.90	2.65	73.90	70.00	3.22	84.20	79.00	4.43
4-Aug-2016	58	71.20	66.00	2.62	76.50	72.20	3.29	82.80	78.20	4.62
4-Aug-2016	59	72.50	68.30	3.00	78.70	72.50	3.76	82.20	76.30	3.91
4-Aug-2016	60	78.70	74.10	4.06	72.60	68.70	2.87	76.90	72.30	3.43
4-Aug-2016	61	85.00	79.30	4.78	75.00	70.40	3.38	83.00	79.10	4.62
4-Aug-2016	62	71.20	67.80	2.79	78.80	73.90	3.84	72.90	68.70	2.92
4-Aug-2016	63	75.00	70.70	3.04	76.10	71.40	3.58	83.00	76.90	4.48
4-Aug-2016	64	76.20	72.80	3.41	82.20	77.50	4.27	82.20	77.70	4.45
4-Aug-2016	65	78.10	73.90	3.64	75.30	71.70	3.30	83.10	77.30	4.55
4-Aug-2016	66	77.80	73.40	3.69	75.40	71.30	3.28	64.00	60.50	1.97
4-Aug-2016	67	76.90	72.10	3.22	68.60	64.50	2.36	84.20	78.20	4.75
4-Aug-2016	68	81.80	76.50	4.35	75.40	70.60	3.23	78.00	71.30	3.66
4-Aug-2016	69	79.80	74.50	3.75	79.70	74.10	3.76	64.90	60.30	1.92
4-Aug-2016	70	78.90	73.90	3.76	84.80	78.90	5.08	72.80	67.60	2.74
4-Aug-2016	71	84.10	80.20	4.83	82.10	76.70	4.59	82.20	77.00	4.08
4-Aug-2016	72	77.20	72.00	3.55	83.10	78.10	4.64	76.10	70.30	3.10
4-Aug-2016	73	79.20	73.70	3.45	73.90	69.00	3.29	73.30	68.90	3.08
4-Aug-2016	74	72.00	67.70	2.75	82.30	77.20	4.32	80.20	75.50	3.70
4-Aug-2016	75	74.00	71.30	3.04	79.40	75.60	3.90	77.40	73.00	3.79
4-Aug-2016	76	63.10	59.80	1.81	77.50	73.20	3.25	76.10	74.20	3.47
4-Aug-2016	77	62.20	58.90	1.73	84.50	80.00	4.32	75.30	69.80	3.06
4-Aug-2016	78	74.70	68.90	3.04	74.80	69.20	3.14	69.10	63.90	2.33
4-Aug-2016	79	75.20	70.00	3.23	72.20	67.30	2.95	69.90	65.50	2.55
4-Aug-2016	80	75.10	70.30	3.27	81.10	76.00	4.31	73.60	69.60	3.20
4-Aug-2016	81	85.80	80.60	4.94	74.50	71.60	2.88	78.10	73.50	3.52
4-Aug-2016	82	81.30	77.00	3.98	75.50	70.80	3.37	79.60	74.50	3.91
4-Aug-2016	83	76.80	72.70	3.61	79.60	74.00	3.91	72.20	67.90	2.70
4-Aug-2016	84	83.30	78.10	4.31	79.10	74.70	3.60	75.40	71.00	3.23
4-Aug-2016	85	77.90	72.60	3.87	77.20	73.10	3.71	83.70	78.20	4.43
4-Aug-2016	86	80.40	75.40	3.94	80.00	74.80	4.01	77.90	72.80	3.53
4-Aug-2016	87	74.70	70.70	3.09	71.90	67.30	2.68	72.90	68.70	3.00
4-Aug-2016	88	74.90	70.00	2.90	78.10	72.60	3.71	78.50	73.10	4.04
4-Aug-2016	89	73.20	69.00	2.95	78.00	73.30	3.79	66.50	62.70	2.16
4-Aug-2016	90	77.30	72.30	3.78	67.70	63.10	2.20	65.50	60.80	2.26
4-Aug-2016	91	63.70	59.60	1.97	73.10	68.20	2.90	78.80	74.80	3.71
4-Aug-2016	92	79.50	75.00	3.60	77.60	73.50	3.35	79.00	74.50	3.76
4-Aug-2016	93	86.80	83.20	5.14	82.00	76.80	3.91	76.50	71.30	3.24
4-Aug-2016	94	76.20	72.00	3.15	79.70	76.60	3.94	73.20	68.90	2.94
4-Aug-2016	95	75.80	70.70	3.24	75.80	70.50	3.42	76.70	72.00	3.68
4-Aug-2016	96	77.70	73.30	3.56	80.20	74.20	3.80	77.40	72.90	3.38
4-Aug-2016	97	80.40	75.10	3.98	69.80	66.70	2.85	77.00	72.10	3.37
4-Aug-2016	98	76.00	71.50	3.31	68.90	64.40	2.44	75.30	70.10	3.09

Table E.3: **Raw Meristic Data of Kokanee at Day 0 (Pre-Exposed) of Control, E6, and E3 Treatments for the Minto Mine Fish Hatchery Exposure, August 2016**

Date	Fish #	Control			E6			E3		
		Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)
4-Aug-2016	99	82.10	76.90	4.25	63.60	59.20	1.92	72.30	68.50	2.75
4-Aug-2016	100	78.40	74.60	3.87	82.80	78.10	4.15	71.90	67.10	2.59
4-Aug-2016	101	80.80	75.30	4.25	75.50	70.50	3.13	78.20	73.70	3.74
4-Aug-2016	102	78.20	74.50	3.83	74.00	69.20	2.90	83.00	78.50	4.55
4-Aug-2016	103	73.30	69.80	3.18	81.90	77.20	4.21	86.20	80.40	4.74
4-Aug-2016	104	78.20	74.70	3.68	78.00	72.90	3.68	82.30	77.30	4.31
4-Aug-2016	105	79.00	72.90	3.67	80.00	75.40	3.95	82.90	77.80	4.53
4-Aug-2016	106	80.20	75.30	3.91	78.30	74.10	3.39	77.60	73.00	3.37
4-Aug-2016	107	76.80	71.90	3.18	79.80	75.30	3.96	80.00	75.10	3.72
4-Aug-2016	108	78.60	74.10	3.76	79.90	74.90	3.86	75.20	71.20	3.03
4-Aug-2016	109	78.70	74.20	3.80	83.30	77.20	4.59	80.60	75.20	4.20
4-Aug-2016	110	75.60	71.00	3.09	76.70	71.40	4.46	80.30	76.30	3.89
4-Aug-2016	111	85.70	81.20	4.61	86.40	81.00	5.43	76.20	71.20	3.07
4-Aug-2016	112	80.30	76.20	3.94	79.90	75.70	4.05	82.40	77.20	4.31
4-Aug-2016	113	85.60	79.80	4.73	77.80	73.00	3.76	70.10	66.00	2.71
4-Aug-2016	114	84.80	79.90	4.91	79.20	75.30	3.93	75.70	70.40	3.22
4-Aug-2016	115	79.60	75.10	3.82	77.40	73.70	3.64	73.00	69.10	2.72
4-Aug-2016	116	64.30	60.50	1.96	77.20	73.50	3.67	77.30	72.90	3.47
4-Aug-2016	117	79.70	75.20	3.49	82.50	77.30	4.63	76.30	72.00	3.35
4-Aug-2016	118	75.10	69.20	3.11	77.10	70.80	3.41	78.50	74.40	3.93
4-Aug-2016	119	71.70	68.60	2.68	79.10	75.20	3.76	74.90	71.00	3.29
4-Aug-2016	120	75.40	71.50	3.53	76.10	71.30	3.35	73.80	69.50	3.09
4-Aug-2016	121	82.90	78.40	4.25	75.50	71.90	3.17	77.20	72.60	3.29
4-Aug-2016	122	72.00	67.40	2.69	77.90	73.20	3.63	77.90	73.20	3.73
4-Aug-2016	123	77.10	72.10	3.60	78.00	72.20	3.67	73.90	71.00	3.10
4-Aug-2016	124	71.60	68.90	2.74	78.00	73.80	3.49	78.70	74.90	3.56
4-Aug-2016	125	84.60	79.40	4.88	75.30	71.40	3.62	77.10	72.20	3.44
4-Aug-2016	126	77.00	73.60	3.60	82.20	77.20	4.42	75.10	70.50	3.30
4-Aug-2016	127	80.10	75.20	3.89	74.90	71.00	3.01	77.90	74.50	3.83
4-Aug-2016	128	68.80	64.50	2.36	79.20	74.30	4.03	74.20	69.70	2.90
4-Aug-2016	129	82.20	77.70	4.11	79.20	74.00	3.59	73.20	68.20	2.84
4-Aug-2016	130	67.90	64.10	2.29	80.30	76.30	4.06	75.20	70.90	3.22
4-Aug-2016	131	80.30	74.90	3.91	90.00	85.90	5.80	77.90	73.00	3.68
4-Aug-2016	132	83.10	77.30	4.22	79.90	75.70	3.92	77.40	72.70	3.27
4-Aug-2016	133	68.10	63.80	2.32	73.60	69.80	2.85	85.00	81.20	4.91
4-Aug-2016	134	76.30	71.10	3.26	84.60	79.00	4.42	77.20	72.90	3.48
4-Aug-2016	135	76.10	71.50	3.43	79.20	74.50	3.77	73.00	69.30	2.92
4-Aug-2016	136	75.40	72.10	3.01	76.70	72.60	3.86	75.80	72.00	3.42
4-Aug-2016	137	74.90	71.00	3.11	73.30	70.00	2.97	80.00	75.40	4.23
4-Aug-2016	138	75.80	71.90	3.34	76.00	72.20	3.41	77.80	74.10	3.56
4-Aug-2016	139	78.50	73.30	3.60	66.50	62.30	2.12	73.70	69.90	2.95
4-Aug-2016	140	76.20	70.50	3.42	79.00	74.20	3.53	73.20	69.60	3.04
4-Aug-2016	141	79.10	75.20	3.71	83.80	78.10	4.43	77.60	74.10	3.93
4-Aug-2016	142	75.40	72.00	3.20	79.30	74.10	3.80	67.40	64.20	2.20
4-Aug-2016	143	80.30	75.60	4.23	79.20	75.00	3.91	81.80	76.90	3.96
4-Aug-2016	144	77.20	73.20	3.53	74.90	70.60	3.17	76.30	72.50	3.36
4-Aug-2016	145	82.10	77.90	4.33	83.40	78.20	4.43	82.10	77.70	4.32
4-Aug-2016	146	78.50	74.40	3.91	78.50	73.10	3.48	78.50	74.00	3.84
4-Aug-2016	147	78.60	74.20	3.90	73.80	70.00	2.87	73.70	68.20	2.86
4-Aug-2016	148	82.70	77.40	4.73	79.40	74.50	3.84	80.10	76.40	4.17
4-Aug-2016	149	78.90	73.30	3.40	77.30	73.00	3.21	76.20	71.90	3.26
4-Aug-2016	150	78.80	72.80	3.74	78.90	74.80	3.78	75.90	71.30	3.46
4-Aug-2016	151	83.00	78.10	4.51	83.00	78.40	4.30	82.00	77.40	4.02
4-Aug-2016	152	79.30	75.10	3.85	83.20	78.10	4.29	73.30	69.70	3.11
4-Aug-2016	153	77.60	74.10	3.90	77.20	73.20	3.50	73.10	68.30	3.02
4-Aug-2016	154	76.20	70.50	3.33	91.00	86.20	5.74	75.70	72.80	3.10
4-Aug-2016	155	79.20	76.00	4.05	83.50	79.20	4.47	84.70	79.80	4.75
4-Aug-2016	156	78.70	73.60	3.52	78.00	73.50	3.82	76.30	72.90	3.66
4-Aug-2016	157	85.10	81.80	4.72	76.70	71.40	3.52	81.40	77.10	4.31
4-Aug-2016	158	76.10	71.30	3.23	74.30	70.30	3.32	81.20	75.80	4.49
4-Aug-2016	159	72.90	68.90	2.86	74.30	69.90	3.20	73.50	70.20	3.11
4-Aug-2016	160	80.20	76.50	3.93	70.40	65.10	2.77	76.30	72.20	3.23

Table E.4: Raw Meristic Data of Kokanee at Day 26 of Control, E6, and E3 Treatments for the Minto Mine Fish Hatchery Exposure, September 2016

Date	Fish #	Control			E6			E3		
		Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)
1-Sep-2016	1	87.82	82.30	5.31	87.17	81.53	5.75	88.65	82.72	5.25
1-Sep-2016	2	90.45	84.55	5.99	92.97	86.14	6.78	92.63	85.20	6.39
1-Sep-2016	3	90.07	83.78	6.20	93.33	86.67	6.26	94.14	87.37	6.59
1-Sep-2016	4	93.76	87.02	6.29	95.78	88.21	6.25	92.90	86.53	6.82
1-Sep-2016	5	88.51	83.23	5.54	84.27	79.07	4.67	96.75	89.56	6.99
1-Sep-2016	6	88.64	84.72	5.11	93.28	86.00	6.45	88.27	81.55	5.41
1-Sep-2016	7	81.59	75.74	4.61	87.15	81.05	5.33	90.20	84.04	5.73
1-Sep-2016	8	90.57	85.67	5.50	94.34	86.41	6.08	89.45	82.68	4.96
1-Sep-2016	9	95.52	89.68	6.81	97.58	90.66	7.37	86.02	79.82	4.92
1-Sep-2016	10	88.12	81.74	5.33	83.74	78.65	4.97	97.00	88.77	7.45
1-Sep-2016	11	85.98	79.25	4.85	90.23	84.62	5.61	94.37	88.33	6.19
1-Sep-2016	12	94.80	90.00	6.87	91.71	84.56	6.15	89.74	82.70	6.05
1-Sep-2016	13	89.67	82.90	5.48	94.94	88.28	7.55	91.44	85.13	6.16
1-Sep-2016	14	91.42	85.65	5.99	86.45	80.72	5.13	93.76	86.55	6.90
1-Sep-2016	15	85.44	78.88	4.99	90.05	83.57	6.24	97.31	90.85	7.21
1-Sep-2016	16	92.24	85.82	5.98	96.95	90.65	7.85	86.92	82.00	5.12
1-Sep-2016	17	90.34	82.62	5.47	90.37	84.17	5.49	90.84	85.66	6.00
1-Sep-2016	18	94.33	86.99	6.87	96.32	89.88	6.68	83.09	78.08	4.32
1-Sep-2016	19	84.70	78.75	4.78	87.99	82.90	5.29	90.01	83.65	5.92
1-Sep-2016	20	91.53	84.68	6.06	92.26	85.21	6.56	95.83	88.43	6.94
1-Sep-2016	21	87.73	80.84	4.98	94.19	88.78	6.88	92.79	87.73	6.29
1-Sep-2016	22	91.85	85.02	5.81	93.51	86.15	6.19	91.34	85.29	6.85
1-Sep-2016	23	89.81	84.54	6.17	92.74	86.24	5.88	89.17	83.87	5.61
1-Sep-2016	24	85.55	79.83	4.55	95.51	88.32	6.53	90.40	85.74	6.25
1-Sep-2016	25	86.17	79.17	4.80	96.76	89.42	6.56	90.26	84.71	5.99
1-Sep-2016	26	96.02	89.55	6.67	84.15	79.20	4.11	97.45	90.55	7.21
1-Sep-2016	27	91.06	84.96	5.83	88.92	81.52	5.36	88.95	82.00	5.58
1-Sep-2016	28	90.95	84.74	5.97	93.19	86.44	6.32	87.11	81.55	5.00
1-Sep-2016	29	87.54	80.94	5.11	87.34	81.16	5.28	91.32	84.40	5.96
1-Sep-2016	30	91.63	85.88	5.93	89.98	82.57	5.27	93.55	86.62	6.60
1-Sep-2016	31	88.45	83.26	5.37	92.71	87.29	6.29	92.26	85.34	5.89
1-Sep-2016	32	89.52	82.78	5.73	87.10	80.23	5.42	92.04	85.16	5.99
1-Sep-2016	33	85.65	80.83	4.90	96.63	88.69	6.79	89.75	82.98	5.54
1-Sep-2016	34	84.61	77.66	4.51	95.68	88.59	6.89	96.38	90.08	7.58
1-Sep-2016	35	85.24	79.10	4.71	90.21	84.55	6.18	93.50	86.84	6.23
1-Sep-2016	36	91.09	84.44	5.74	91.53	85.69	5.96	91.61	86.18	6.77
1-Sep-2016	37	92.29	84.82	6.36	92.69	86.44	6.17	94.89	87.33	6.42
1-Sep-2016	38	92.67	86.15	6.18	85.72	80.08	4.91	88.41	82.42	5.71
1-Sep-2016	39	85.21	79.73	4.73	92.76	87.40	6.18	87.36	80.11	5.29
1-Sep-2016	40	92.26	87.13	6.02	78.96	74.09	3.83	97.59	89.98	7.21
1-Sep-2016	41	90.46	85.73	5.91	91.12	85.63	6.37	93.38	87.28	6.45
1-Sep-2016	42	87.43	80.79	5.02	89.15	82.75	5.58	97.21	91.20	7.29
1-Sep-2016	43	91.35	85.19	5.85	92.75	85.69	6.58	90.74	83.61	5.60
1-Sep-2016	44	86.61	79.82	5.28	93.27	87.52	6.25	89.85	83.54	5.69
1-Sep-2016	45	90.22	82.86	5.70	96.26	90.11	7.28	90.21	83.69	5.41
1-Sep-2016	46	92.29	85.40	5.82	92.14	86.00	6.31	91.87	84.07	6.03
1-Sep-2016	47	90.14	83.84	5.52	90.22	82.70	5.89	83.47	79.19	4.52
1-Sep-2016	48	95.59	91.54	6.91	94.02	87.28	6.50	88.84	82.87	5.45
1-Sep-2016	49	92.80	86.78	6.04	85.82	80.42	5.03	90.96	84.83	5.72
1-Sep-2016	50	87.57	83.26	5.37	97.72	91.27	7.38	95.03	88.82	7.04

Table E.5: Raw Meristic Data of Kokanee at Day 47 of Control, E6, and E3 Treatments for the Minto Mine Fish Hatchery Exposure, September 2016

Date	Fish #	Control			E6			E3		
		Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)
22-Sep-2016	1	99.65	91.97	7.53	100.50	93.02	7.88	107.68	100.26	9.69
22-Sep-2016	2	104.14	96.29	8.75	99.22	93.22	7.97	105.67	98.12	8.91
22-Sep-2016	3	109.43	100.48	10.54	100.26	92.70	7.44	92.33	86.75	5.85
22-Sep-2016	4	100.86	93.22	8.23	106.92	100.19	9.37	106.65	98.38	9.27
22-Sep-2016	5	101.76	94.21	7.58	106.32	98.08	8.52	104.84	96.66	9.02
22-Sep-2016	6	103.48	96.50	8.16	105.07	97.74	8.34	113.97	106.19	12.14
22-Sep-2016	7	99.14	91.36	7.72	108.06	100.44	9.14	104.45	98.66	9.69
22-Sep-2016	8	112.92	104.85	11.45	105.06	98.49	9.00	101.90	95.87	8.14
22-Sep-2016	9	111.08	103.43	10.69	105.51	98.08	8.83	100.45	93.82	8.58
22-Sep-2016	10	108.00	101.29	9.70	101.39	93.48	7.05	101.43	95.10	8.91
22-Sep-2016	11	99.04	91.82	7.74	103.46	96.38	8.67	102.89	95.45	8.56
22-Sep-2016	12	87.43	80.72	4.96	108.14	100.00	8.97	108.37	99.17	9.18
22-Sep-2016	13	99.94	91.50	7.56	98.02	91.57	6.93	103.84	98.04	8.93
22-Sep-2016	14	109.42	102.14	10.04	109.84	102.37	10.60	104.67	98.28	9.63
22-Sep-2016	15	97.35	90.66	6.80	105.26	98.10	9.06	98.24	91.33	6.84
22-Sep-2016	16	92.72	85.48	6.30	107.32	100.19	10.23	112.27	104.13	11.16
22-Sep-2016	17	86.71	79.96	5.06	96.06	88.65	7.51	100.36	93.04	8.10
22-Sep-2016	18	99.67	92.87	8.09	108.66	100.19	9.63	98.65	91.89	7.37
22-Sep-2016	19	99.96	92.70	7.42	99.83	94.73	7.39	97.01	90.42	7.81
22-Sep-2016	20	101.16	94.81	8.19	108.12	101.13	10.20	100.31	92.68	7.68
22-Sep-2016	21	104.63	97.09	9.43	97.76	91.34	7.42	109.72	102.07	10.28
22-Sep-2016	22	104.67	97.21	8.76	98.07	95.52	7.44	103.16	95.80	8.23
22-Sep-2016	23	101.88	95.06	8.23	105.55	97.55	8.66	106.86	100.95	10.53
22-Sep-2016	24	103.02	96.29	8.53	107.77	100.87	9.46	102.88	96.29	8.61
22-Sep-2016	25	101.54	94.07	7.64	108.08	101.80	9.47	112.90	106.10	11.72
22-Sep-2016	26	109.44	101.51	10.83	102.15	94.92	8.12	106.10	99.44	9.52
22-Sep-2016	27	104.81	98.25	9.10	105.13	97.75	8.29	105.18	99.06	9.53
22-Sep-2016	28	105.95	96.92	9.18	106.34	97.57	8.90	106.14	99.14	9.91
22-Sep-2016	29	111.38	103.41	10.79	100.26	94.57	7.93	103.49	96.42	8.24
22-Sep-2016	30	105.20	96.94	8.94	104.30	96.75	8.30	101.58	93.11	8.03
22-Sep-2016	31	107.75	99.01	9.21	98.80	91.39	6.84	103.32	97.11	8.62
22-Sep-2016	32	99.03	92.15	7.54	101.30	93.87	7.50	102.88	96.15	8.59
22-Sep-2016	33	103.62	94.99	8.05	100.04	92.92	7.78	100.80	94.06	8.12
22-Sep-2016	34	104.14	96.56	8.59	107.12	98.37	9.02	112.80	104.83	11.82
22-Sep-2016	35	100.21	93.24	8.62	101.43	94.73	8.06	105.90	98.95	9.13
22-Sep-2016	36	104.99	98.46	8.71	101.59	94.04	8.15	102.32	97.39	9.43
22-Sep-2016	37	106.53	99.18	9.93	110.56	102.05	10.36	106.67	100.00	9.22
22-Sep-2016	38	101.21	94.91	8.51	97.56	91.47	7.32	106.12	98.97	9.58
22-Sep-2016	39	106.17	97.89	9.38	101.54	95.26	8.43	101.03	94.40	8.66
22-Sep-2016	40	101.11	94.08	7.58	101.12	94.52	8.52	100.89	95.44	8.21
22-Sep-2016	41	105.42	98.13	8.65	99.80	92.07	7.66	107.87	100.53	10.33
22-Sep-2016	42	86.53	81.26	4.98	109.62	102.31	9.45	101.81	95.02	8.95
22-Sep-2016	43	108.25	99.09	10.02	106.69	99.54	9.20	97.15	91.61	7.34
22-Sep-2016	44	94.57	87.85	6.39	92.85	87.91	6.76	103.45	96.07	8.35
22-Sep-2016	45	104.87	96.56	8.57	102.86	96.41	7.78	111.77	104.05	10.39
22-Sep-2016	46	103.75	96.50	8.42	102.90	96.59	8.23	103.27	96.86	8.36
22-Sep-2016	47	99.44	93.44	7.83	97.55	90.86	7.45	112.19	103.00	10.91
22-Sep-2016	48	98.29	91.01	7.15	106.41	99.22	9.19	102.29	96.17	8.63
22-Sep-2016	49	104.43	97.91	8.78	108.15	101.30	9.85	96.20	89.54	7.49
22-Sep-2016	50	110.15	101.48	9.70	111.10	102.19	10.69	106.42	98.59	9.77
22-Sep-2016	51	112.53	103.02	11.53	99.23	92.75	7.60	99.51	92.64	7.38
22-Sep-2016	52	99.08	93.17	8.24	108.00	99.60	9.52	106.43	99.32	9.30
22-Sep-2016	53	103.28	95.50	8.63	98.16	91.37	7.92	107.23	99.93	9.69
22-Sep-2016	54	106.98	99.03	9.20	113.81	105.52	11.36	111.04	103.73	10.95
22-Sep-2016	55	109.29	101.48	9.73	106.46	100.22	8.97	115.99	108.20	12.29
22-Sep-2016	56	91.32	84.89	5.95	98.64	93.08	7.78	109.53	101.53	10.41
22-Sep-2016	57	112.17	104.02	10.25	102.27	97.64	8.16	99.45	92.72	7.62
22-Sep-2016	58	97.50	90.72	7.09	105.84	99.91	8.91	111.15	103.51	10.59
22-Sep-2016	59	107.04	99.26	9.16	104.77	96.92	8.35	108.09	100.49	9.38
22-Sep-2016	60	99.23	92.48	7.77	100.22	93.29	7.75	101.32	93.44	8.48
22-Sep-2016	61	104.26	97.13	9.33	105.43	97.11	8.99	109.27	102.81	10.02
22-Sep-2016	62	103.57	95.80	8.28	105.13	99.69	8.81	102.33	94.89	8.27
22-Sep-2016	63	104.78	97.11	9.28	106.03	98.19	9.40	104.71	97.04	8.80
22-Sep-2016	64	99.10	91.48	6.99	103.69	95.77	8.17	108.01	100.11	9.56
22-Sep-2016	65	100.33	93.77	7.70	105.54	97.55	9.08	102.47	96.37	8.83
22-Sep-2016	66	100.74	92.65	8.26	101.91	95.59	7.98	104.63	99.01	9.29
22-Sep-2016	67	110.83	102.05	10.04	94.43	87.62	6.22	106.54	99.15	9.22
22-Sep-2016	68	95.94	88.14	7.07	102.85	95.76	8.48	111.03	103.66	12.07
22-Sep-2016	69	102.74	94.95	9.25	94.93	89.87	6.91	102.26	94.58	8.19
22-Sep-2016	70	108.02	100.02	9.22	114.85	106.62	10.57	106.09	98.52	9.47
22-Sep-2016	71	95.67	89.19	6.76	100.40	93.08	7.63	103.80	96.74	8.81
22-Sep-2016	72	111.34	102.26	10.26	100.67	96.25	7.32	104.21	96.94	8.58
22-Sep-2016	73	97.13	89.83	7.07	88.72	82.95	5.21	110.93	102.83	10.92
22-Sep-2016	74	103.38	96.55	8.66	98.76	91.17	7.08	109.55	101.05	10.27
22-Sep-2016	75	113.10	105.05	10.96	107.07	98.32	9.06	115.27	106.89	12.05
22-Sep-2016	76	108.13	100.46	9.41	95.77	89.07	7.07	103.59	97.16	8.47
22-Sep-2016	77	101.92	95.15	7.71	99.22	93.60	8.05	103.80	96.52	8.97
22-Sep-2016	78	101.91	95.17	8.29	106.34	99.18	8.69	104.40	97.69	9.13
22-Sep-2016	79	106.54	98.29	9.00	106.57	99.29	9.31	104.69	99.03	9.73
22-Sep-2016	80	109.29	101.44	10.28	111.32	102.91	9.45	98.93	92.40	7.35
22-Sep-2016	81	104.27	96.39	8.52	105.82	100.43	9.09	106.55	100.58	9.57
22-Sep-2016	82	103.91	95.95	8.72	104.77	96.74	9.10	101.03	94.56	8.47
22-Sep-2016	83	109.05	100.95	9.56	103.63	96.89	8.21	104.88	99.50	10.06
22-Sep-2016	84	102.31	95.07	7.87	96.18	89.82	6.59	104.63	97.52	9.24
22-Sep-2016	85	100.08	93.07	7.71	97.18	90.90	6.50	110.26	103.68	11.16
22-Sep-2016	86	99.13	91.12	7.82	99.64	91.84	6.93	108.11	99.21	10.06
22-Sep-2016	87	111.11	102.16	10.45	102.54	95.38	7.93	109.67	102.48	10.51
22-Sep-2016	88	109.29	101.58	9.31	107.12	99.47	9.27	110.10	103.24	10.35
22-Sep-2016	89	102.12	96.88	8.64	107.19	101.13	9.52	102.00	95.85	9.03
22-Sep-2016	90	98.48	92.40	9.55	107.40	99.53	8.66	102.96	95.45	9.38
22-Sep-2016	91	100.06	92.69	7.79	96.49	90.22	6.41	101.58	94.10	8.24
22-Sep-2016	92	101.75	94.04	7.93	108.62	100.66	9.42	103.47	96.73	8.90
22-Sep-2016	93	96.80	89.68	6.78	93.63	87.36	6.39	96.73	89.81	7.28
22-Sep-2016	94	106.49	97.87	8.82	102.29	95.51	7.77	101.70	94.48	8.95
22-Sep-2016	95	101.39	94.87	7.69	86.25	80.57	4.97	110.78	102.14	9.95
22-Sep-2016	96	102.92	96.21	8.13	106.65	99.40	9.12	116.02	107.69	11.48
22-Sep-2016	97	104.66	98.11	10.09	106.73	100.57	8.94	98.26	92.24	7.34

Table E.5: Raw Meristic Data of Kokanee at Day 47 of Control, E6, and E3 Treatments for the Minto Mine Fish Hatchery Exposure, September 2016

Date	Fish #	Control			E6			E3		
		Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)	Total length (mm)	Fork length (mm)	Weight (g)
22-Sep-2016	98	101.30	94.29	7.84	108.67	100.77	9.53	84.80	78.59	4.72
22-Sep-2016	99	105.09	97.89	9.30	100.87	94.77	8.19	89.28	83.88	6.17
22-Sep-2016	100	106.82	98.81	9.30	106.22	98.42	9.27	107.14	101.10	10.16
22-Sep-2016	101	96.88	91.01	7.21	103.85	100.76	9.25	103.59	96.38	8.14
22-Sep-2016	102	96.26	89.22	7.00	100.95	94.59	8.06	103.28	98.15	9.34
22-Sep-2016	103	95.21	89.41	6.72	101.69	95.71	8.00	109.05	101.43	10.16
22-Sep-2016	104	105.27	96.81	8.62	111.99	102.22	10.12	107.84	100.24	9.85
22-Sep-2016	105	102.76	95.57	8.10	95.10	88.93	6.41	97.75	91.71	7.24
22-Sep-2016	106	106.04	97.44	9.15	97.37	92.40	6.97	105.44	99.43	9.60
22-Sep-2016	107	96.60	88.98	7.45	98.25	92.12	7.32	111.79	103.86	11.04
22-Sep-2016	108	105.35	96.49	9.11	109.80	102.19	10.22	102.01	95.65	9.40
22-Sep-2016	109	113.24	104.35	10.99	106.02	98.38	8.55	105.17	96.29	9.16
22-Sep-2016	110	96.30	90.84	7.32	97.96	90.45	7.10	109.59	101.87	10.72
22-Sep-2016	111	103.73	96.63	8.45	105.91	97.81	9.40	106.11	99.33	9.35
22-Sep-2016	112	104.25	97.17	8.39	110.00	101.85	9.73	109.37	100.62	9.96
22-Sep-2016	113	97.34	90.08	6.82	104.23	98.17	8.50	109.69	101.35	10.52
22-Sep-2016	114	110.52	102.70	10.43	103.07	98.75	9.32	103.37	96.11	9.19
22-Sep-2016	115	110.78	103.18	9.76	107.92	99.85	8.85	104.28	96.96	9.05
22-Sep-2016	116	107.25	100.18	9.49	105.02	95.98	8.38	112.00	103.85	11.01
22-Sep-2016	117	109.92	102.13	9.94	97.92	90.31	6.73	98.78	92.65	7.82
22-Sep-2016	118	94.70	88.44	6.33	110.80	102.20	10.89	104.81	98.82	9.59
22-Sep-2016	119	104.20	97.15	9.22	102.02	95.42	8.13	108.01	101.30	10.10
22-Sep-2016	120	108.14	99.83	9.84	99.02	92.29	7.23	99.23	92.48	8.00
22-Sep-2016	121	103.11	96.14	8.13	95.29	89.51	6.48	105.01	98.19	8.81
22-Sep-2016	122	103.85	97.30	8.29	95.25	88.68	6.15	101.21	93.43	7.36
22-Sep-2016	123	114.04	104.38	10.67	104.15	98.28	8.73	105.67	98.67	9.44
22-Sep-2016	124	103.24	95.18	8.50	95.41	89.12	6.62	110.69	103.80	10.93
22-Sep-2016	125	95.17	89.53	6.57	108.99	101.54	9.58	104.54	97.24	9.60
22-Sep-2016	126	103.01	94.93	8.35	111.09	103.33	10.72	110.47	105.05	10.39
22-Sep-2016	127	103.06	95.46	8.90	105.51	98.21	9.22	96.37	89.89	7.63
22-Sep-2016	128	101.31	94.24	8.29	103.73	97.68	8.60	102.61	96.29	8.74
22-Sep-2016	129	101.90	94.43	8.72	103.73	96.90	8.33	111.07	104.04	11.06
22-Sep-2016	130	101.31	94.18	7.84	98.76	90.38	7.29	100.71	94.74	8.36
22-Sep-2016	131	105.25	96.96	8.80	106.41	98.88	9.18	106.77	99.53	9.98
22-Sep-2016	132	92.16	86.31	6.68	102.51	94.24	8.00	93.23	87.30	6.20
22-Sep-2016	133	111.08	104.31	10.73	99.50	93.23	7.45	98.73	91.86	7.95
22-Sep-2016	134	103.69	97.30	8.75	105.56	98.06	9.03	109.36	100.89	9.88
22-Sep-2016	135	99.22	93.02	7.55	104.08	97.55	8.85	104.80	95.94	9.55
22-Sep-2016	136	99.87	92.28	7.38	99.22	91.69	7.10	96.92	89.58	7.42
22-Sep-2016	137	112.21	105.18	10.84	98.27	91.59	6.68	107.24	100.45	10.06
22-Sep-2016	138	95.08	88.90	6.04	107.89	99.79	8.40	103.20	96.43	9.11
22-Sep-2016	139	108.67	101.53	10.06	92.89	85.28	5.03	96.43	90.61	7.36
22-Sep-2016	140	107.11	98.81	9.59	106.40	98.74	8.82	110.84	102.97	10.78
22-Sep-2016	141	100.29	94.60	7.45	102.54	95.15	8.04	97.42	91.74	7.82
22-Sep-2016	142	110.98	103.09	10.01	104.39	98.78	8.99	96.33	90.18	6.83
22-Sep-2016	143	105.64	98.97	9.18	110.29	102.57	10.66	102.04	94.88	8.88
22-Sep-2016	144	106.35	97.61	8.27	105.70	98.37	9.04	103.01	95.73	8.71
22-Sep-2016	145	111.22	104.09	9.97	100.78	94.11	8.60	104.18	96.86	8.31
22-Sep-2016	146	97.06	91.96	7.37	94.74	88.43	6.34	109.90	103.07	10.91
22-Sep-2016	147	106.19	99.13	8.93	104.33	96.81	8.82	98.29	91.34	7.63
22-Sep-2016	148	107.13	99.75	9.56	107.47	99.47	9.22	103.24	96.86	8.93
22-Sep-2016	149	105.99	99.08	9.09	105.90	98.90	8.63	108.40	100.30	10.63
22-Sep-2016	150	99.80	92.75	7.02	101.35	95.30	7.48	103.82	97.56	8.41
22-Sep-2016	151	110.92	102.34	10.55	103.88	95.61	8.25	101.91	95.99	8.91
22-Sep-2016	152	101.40	94.13	8.58	109.83	101.16	10.22	107.96	99.46	9.82
22-Sep-2016	153	103.43	95.58	8.58	94.09	87.82	6.29	104.27	98.24	8.43
22-Sep-2016	154	-	-	-	107.37	99.65	9.50	104.03	95.54	9.67
22-Sep-2016	155	-	-	-	105.43	97.78	9.03	106.39	99.37	9.61
22-Sep-2016	156	-	-	-	105.79	99.35	8.82	103.61	96.44	8.72
22-Sep-2016	157	-	-	-	-	-	-	92.98	87.60	6.09
22-Sep-2016	158	-	-	-	-	-	-	110.25	103.40	11.12
22-Sep-2016	159	-	-	-	-	-	-	99.90	93.58	8.03

Table E.6: **Descriptive Summary Statistics of Kokanee Size and Weight in Control, E6, and E3 Treatments for the Minto Mine Fish Hatchery Exposure, 2016**

Time	Summary Statistic	Treatment								
		Control			E6			E3		
		Total Length (mm)	Fork Length (mm)	Weight (g)	Total Length (mm)	Fork Length (mm)	Weight (g)	Total Length (mm)	Fork Length (mm)	Weight (g)
Pre-exposed (Day 0)	N	160	160	160	160	160	160	160	160	160
	Mean	76.84	72.36	3.51	77.43	72.84	3.60	76.86	72.30	3.50
	Median	77.45	73.02	3.54	78.00	73.20	3.67	77.20	72.55	3.48
	Minimum	62.20	58.90	1.73	63.50	59.20	1.85	63.50	59.20	1.84
	Maximum	86.80	83.20	5.29	91.00	86.20	5.80	86.20	81.20	5.39
	Standard Deviation	5.09	4.85	0.73	4.76	4.50	0.70	4.69	4.50	0.71
	Standard Error	0.40	0.38	0.06	0.38	0.36	0.06	0.37	0.36	0.06
Day 26	N	50	50	50	50	50	50	50	50	50
	Mean	89.71	83.61	5.63	91.39	85.02	6.05	91.54	85.15	6.09
	Median	90.18	84.14	5.72	92.48	85.85	6.19	91.33	85.15	6.02
	Minimum	81.59	75.74	4.51	78.96	74.09	3.83	83.09	78.08	4.32
	Maximum	96.02	91.54	6.91	97.72	91.27	7.85	97.59	91.20	7.58
	Standard Deviation	3.24	3.36	0.64	4.14	3.72	0.84	3.48	3.13	0.78
	Standard Error	0.46	0.48	0.09	0.59	0.53	0.12	0.49	0.44	0.11
Day 47	N	153	153	153	156	156	156	159	159	159
	Mean	103.31	95.93	8.56	103.14	96.13	8.36	104.47	97.46	9.15
	Median	103.57	96.29	8.58	103.87	96.90	8.46	104.40	97.39	9.16
	Minimum	86.53	79.96	4.96	86.25	80.57	4.97	84.80	78.59	4.72
	Maximum	114.04	105.18	11.53	114.85	106.62	11.36	116.02	108.20	12.29
	Standard Deviation	5.42	4.93	1.30	4.98	4.52	1.20	5.08	4.67	1.32
	Standard Error	0.44	0.40	0.10	0.40	0.36	0.10	0.40	0.37	0.10

Table E.7: Statistical Differences on Day 0 between Exposure and Reference Kokanee Used in the Hatchery Exposure, Minto Mine Phase 4 EEM, 2016

Indicator	Endpoint	Variables		Comparison	Sample Size		Test	ANCOVA Statistics			Summary Statistics			Test *P*-value	Magnitude of Difference Relative to Control (%)	Estimated Minimum Detectable Difference Between Groups (%) with $\alpha=\beta=0.1$	
		Response	Covariate		Ref	Exp		Interaction *P*-value	Covariate *P*-value	Covariate Value for Comparisons [a]	Statistic	Ref	Exp			Decrease (%)	Increase (%)
Survival	Length Frequency Distribution	Fork Length (cm)	-	E6 vs. Ref	160	160	2-sample K-S	-	-	-	-	-	-	0.759	-6.9 [b]	-	-
				E3 vs. Ref	160	160	2-sample K-S				-	-	-	0.400	3.8 [b]	-	-
Energy Usage	Fork Length	Fork Length (cm)	-	E6 vs. Ref	160	160	T-test	-	-	-	Mean	7.24	7.28	0.361	-	-2.1	2.1
				E3 vs. Ref	160	160	T-test				Mean	7.24	7.23	0.918	-	-2.0	2.0
	Body Weight	Body Weight (g)	-	E6 vs. Ref	160	160	T-test	-	-	-	Mean	3.51	3.60	0.228	-	-6.6	6.6
				E3 vs. Ref	160	160	T-test				Mean	3.51	3.50	0.902	-	-6.7	6.7
Energy Storage	Condition	Log_{10} [Body Weight (g)]	Log_{10} [Fork Length (cm)]	E6 vs. Ref	160	159 [c]	ANCOVA	0.499	<0.001	7.24	Adjusted Mean (Geometric)	3.46	3.49	0.207	-	-1.6	1.7
				E3 vs. Ref	160	160	ANCOVA	0.964	<0.001	7.22	Adjusted Mean (Geometric)	3.42	3.43	0.824	-	-1.7	1.7

Notes:

▨ *P*-value < 0.05.

Bold text Magnitude of Difference > 25% (10% if compared to Condition).

[a] Mean for all data with outliers removed. For log-transformed data, the geometric mean is reported.

[b] Magnitude of difference is the largest difference (as a percentage) between the cumulative relative frequency distributions for the two sampling areas. A negative difference implies the exposure area has smaller fish compared to reference.

[c] One fish was identified as an outlier (E6 Fish #110) with a Studentized residual of 5.786.

Table E.8: Statistical Differences on Day 26 between Exposure and Reference Kokanee Used in the Hatchery Exposure, Minto Mine Phase 4 EEM, 2016

Indicator	Endpoint	Variables		Comparison	Sample Size		Test	ANCOVA Statistics			Summary Statistics			Test *P*-value	Magnitude of Difference Relative to Control (%)	Estimated Minimum Detectable Difference Between Groups (%) with α=β=0.1	
		Response	Covariate		Ref	Exp		Interaction *P*-value	Covariate *P*-value	Covariate Value for Comparisons [a]	Statistic	Ref	Exp			Decrease (%)	Increase (%)
Survival	Length Frequency Distribution	Fork Length (cm)	-	E6 vs. Ref	50	50	2-sample K-S	-	-	-	-	-	-	0.012	-12 [b]	-	-
				E3 vs. Ref	50	50	2-sample K-S				-	-	-	0.178	-14 [b]	-	-
Energy Usage	Fork Length	Fork Length (cm)	-	E6 vs. Ref	50	50	T-test	-	-	-	Mean	8.36	8.50	0.049	1.6	-	-
				E3 vs. Ref	50	50	T-test				Mean	8.36	8.52	0.020	1.8	-	-
	Body Weight	Body Weight (g)	-	E6 vs. Ref	50	50	T-test	-	-	-	Mean	5.63	6.05	0.006	7.5	-	-
				E3 vs. Ref	50	50	T-test				Mean	5.63	6.09	0.002	8.2	-	-
Energy Storage	Condition	Body Weight (g)	Fork Length (cm)	E6 vs. Ref	50	50	ANCOVA	0.062	<0.001	8.43	Adjusted Mean	5.76	5.90	0.078	2.6	-	-
		Log10 [Body Weight (g)]	Log10 [Fork Length (cm)]	E3 vs. Ref	50	50	ANCOVA	0.009	<0.001	8.43	Adjusted Mean (Geometric)	5.72	5.86	0.009	2.4	-	-

Notes:

▨ *P*-value < 0.05.

Bold text Magnitude of Difference > 25% (10% if compared to Condition).

[a] Mean for all data with outliers removed. For log-transformed data, the geometric mean is reported.

[b] Magnitude of difference is the largest difference (as a percentage) between the cumulative relative frequency distributions for the two sampling areas. A negative difference implies the exposure area has smaller fish compared to reference.

Table E.9: Statistical Differences on Day 47 between Exposure and Reference Kokanee Used in the Hatchery Exposure, Minto Mine Phase 4 EEM, 2016

Indicator	Endpoint	Variables		Comparison	Sample Size		Test	ANCOVA Statistics			Summary Statistics			Test *P*-value	Magnitude of Difference Relative to Control (%)	Estimated Minimum Detectable Difference Between Groups (%) with α=β=0.1	
		Response	Covariate		Ref	Exp		Interaction *P*-value	Covariate *P*-value	Covariate Value for Comparisons [a]	Statistic	Ref	Exp			Decrease (%)	Increase (%)
Survival	Length Frequency Distribution	Fork Length (cm)	-	E6 vs. Ref	153	156	2-sample K-S	-	-	-	-	-	-	0.160	1.0 [b]	-	-
				E3 vs. Ref	153	159	2-sample K-S				-	-	-	0.024	-8.0 [b]	-	-
Energy Usage	Fork Length	Fork Length (cm)	-	E6 vs. Ref	153	156	T-test	-	-	-	Mean	9.59	9.61	0.709	-	-2.2	2.2
				E3 vs. Ref	153	159	T-test				Mean	9.59	9.75	0.005	1.6	-	-
	Body Weight	Body Weight (g)	-	E6 vs. Ref	153	156	T-test	-	-	-	Mean	8.56	8.36	0.162	-	-5.8	5.8
				E3 vs. Ref	153	159	T-test				Mean	8.56	9.15	<0.001	6.9	-	-
Energy Storage	Condition	Log10 [Body Weight (g)]	Log10 [Fork Length (cm)]	E6 vs. Ref	152 [c]	156	ANCOVA	0.490	<0.001	9.59	Adjusted Mean (Geometric)	8.47	8.24	<0.001	-2.7	-	-
				E3 vs. Ref	152 [c]	159	ANCOVA	0.614	<0.001	9.66	Adjusted Mean (Geometric)	8.65	8.84	<0.001	2.3	-	-

Notes:

▨ *P*-value < 0.05.

Bold text Magnitude of Difference > 25% (10% if compared to Condition).

[a] Mean for all data with outliers removed. For log-transformed data, the geometric mean is reported.

[b] Magnitude of difference is the largest difference (as a percentage) between the cumulative relative frequency distributions for the two sampling areas. A negative difference implies the exposure area has smaller fish compared to reference.

[c] One fish was identified as an outlier (Control Fish #90) with a Studentized residual of 4.847.

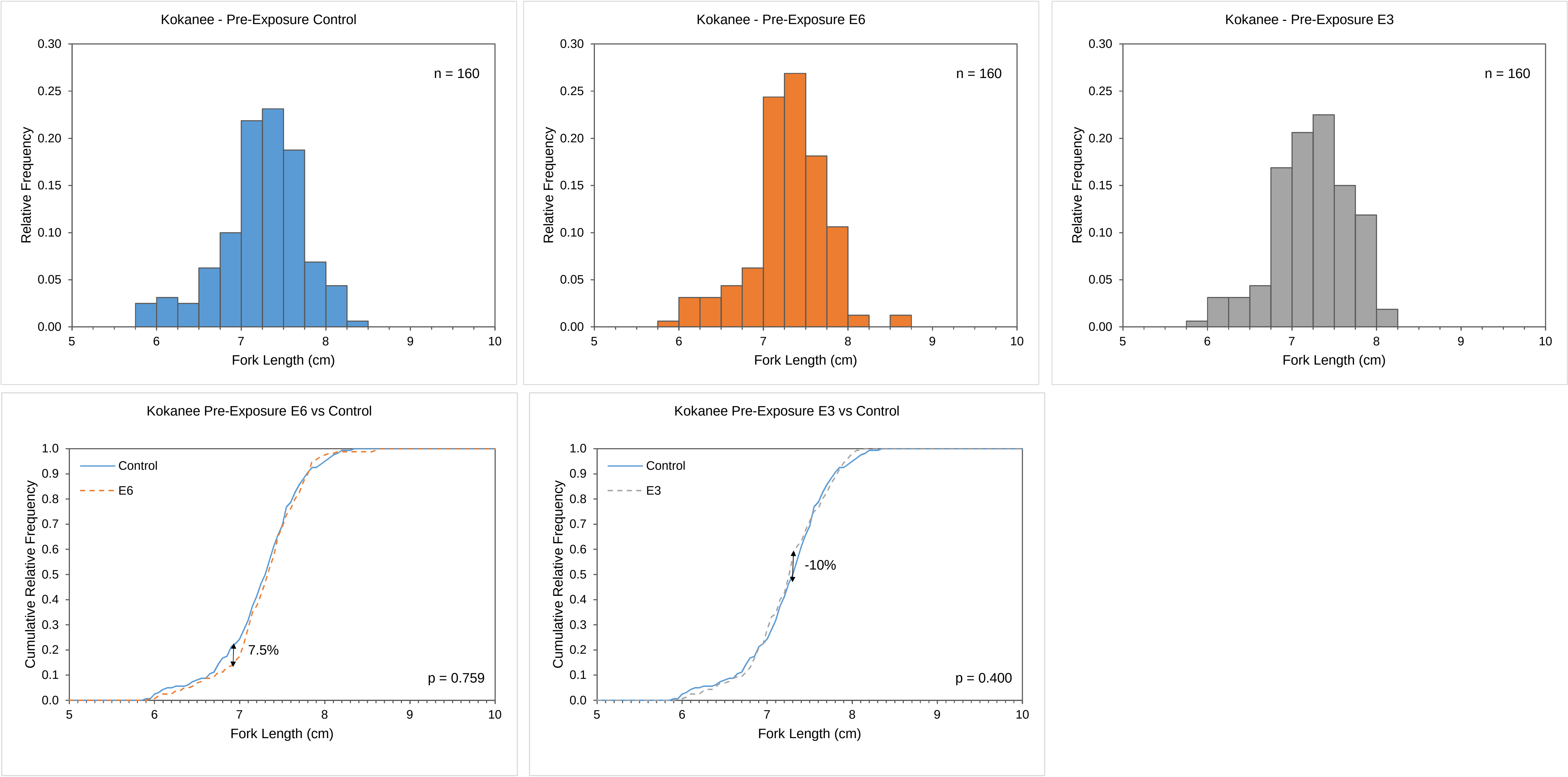


Figure E.1: **Length-frequency Distributions and Cumulative Length-frequency Distributions for Pre-exposed Kokanee in Control, E6, and E3 Treatments for Minto Mine Fish Hatchery Exposure, August 2016**

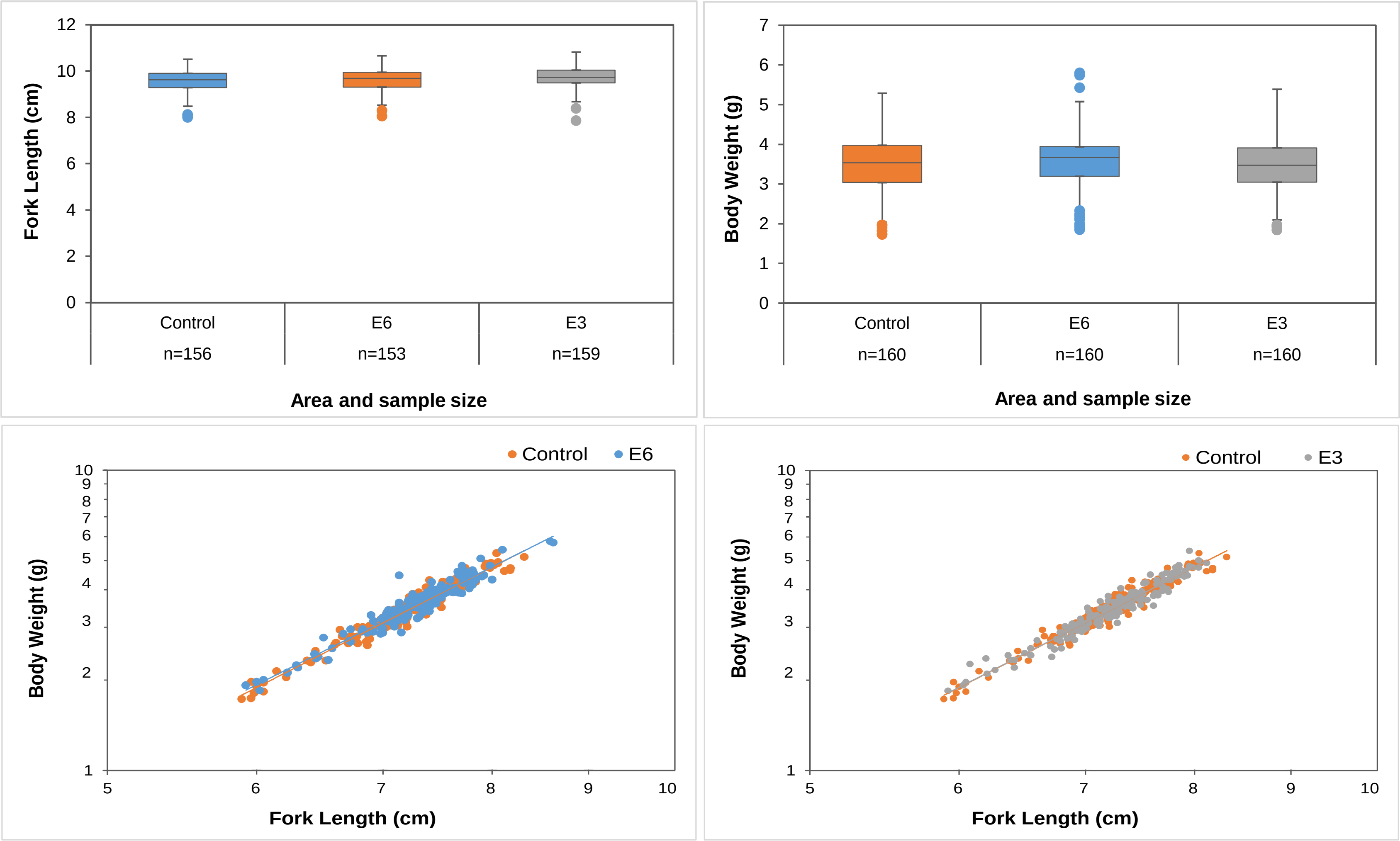


Figure E.2: Boxplots of Fork Length, Body Weight, and Regression (Body Weight on Fork Length) for Pre-exposed Kokanee in Control, E6, and E3 Treatments, Minto Mine Fish Hatchery Exposure, August 2016

Note: Boxplots for body weight and regression are plotted on a log scale.

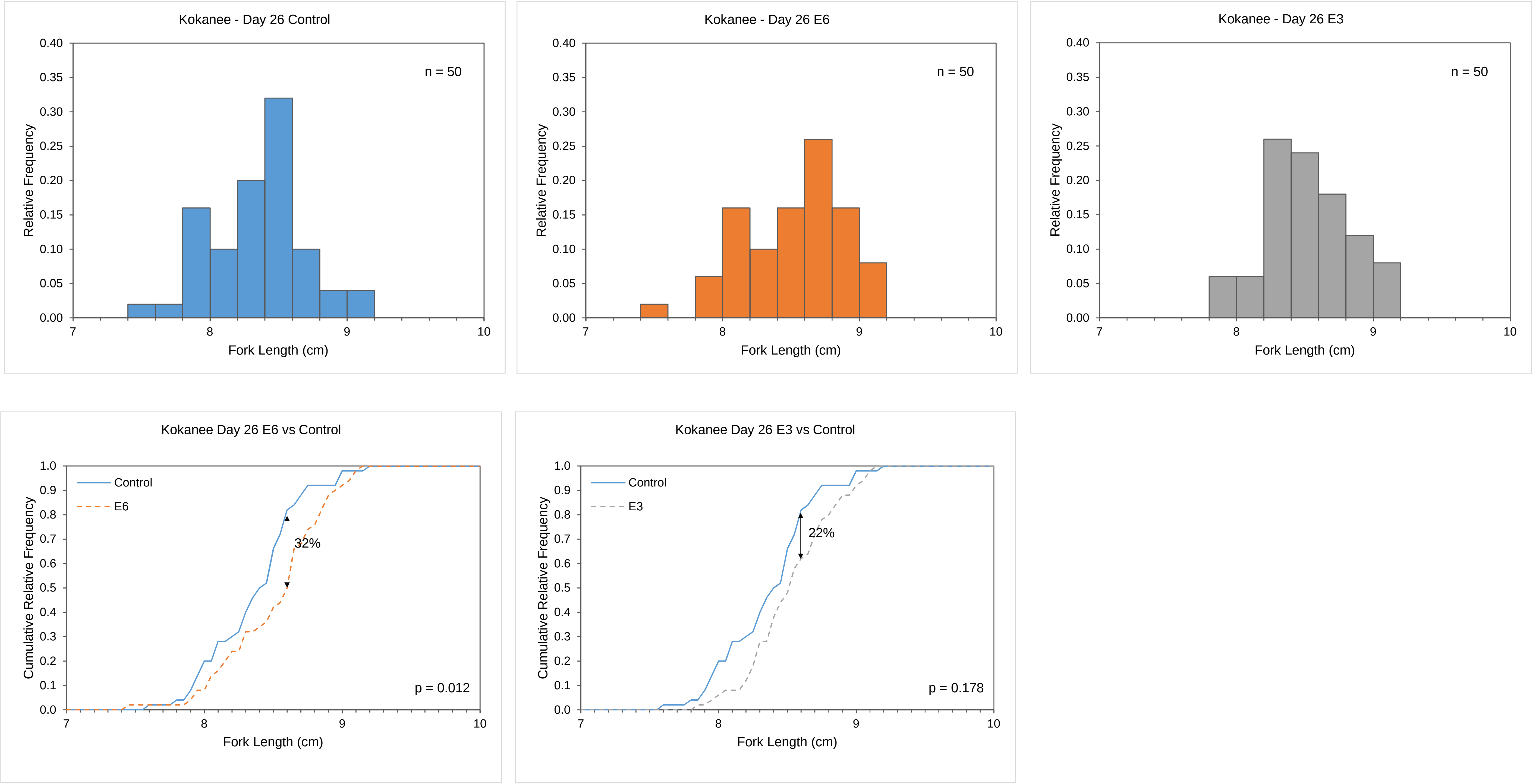


Figure E.3: **Length-frequency Distributions and Cumulative Length-frequency Distributions for Day 26 Kokanee in Control, E6, and E3 Treatments for Minto Mine Fish Hatchery Exposure, August 2016**

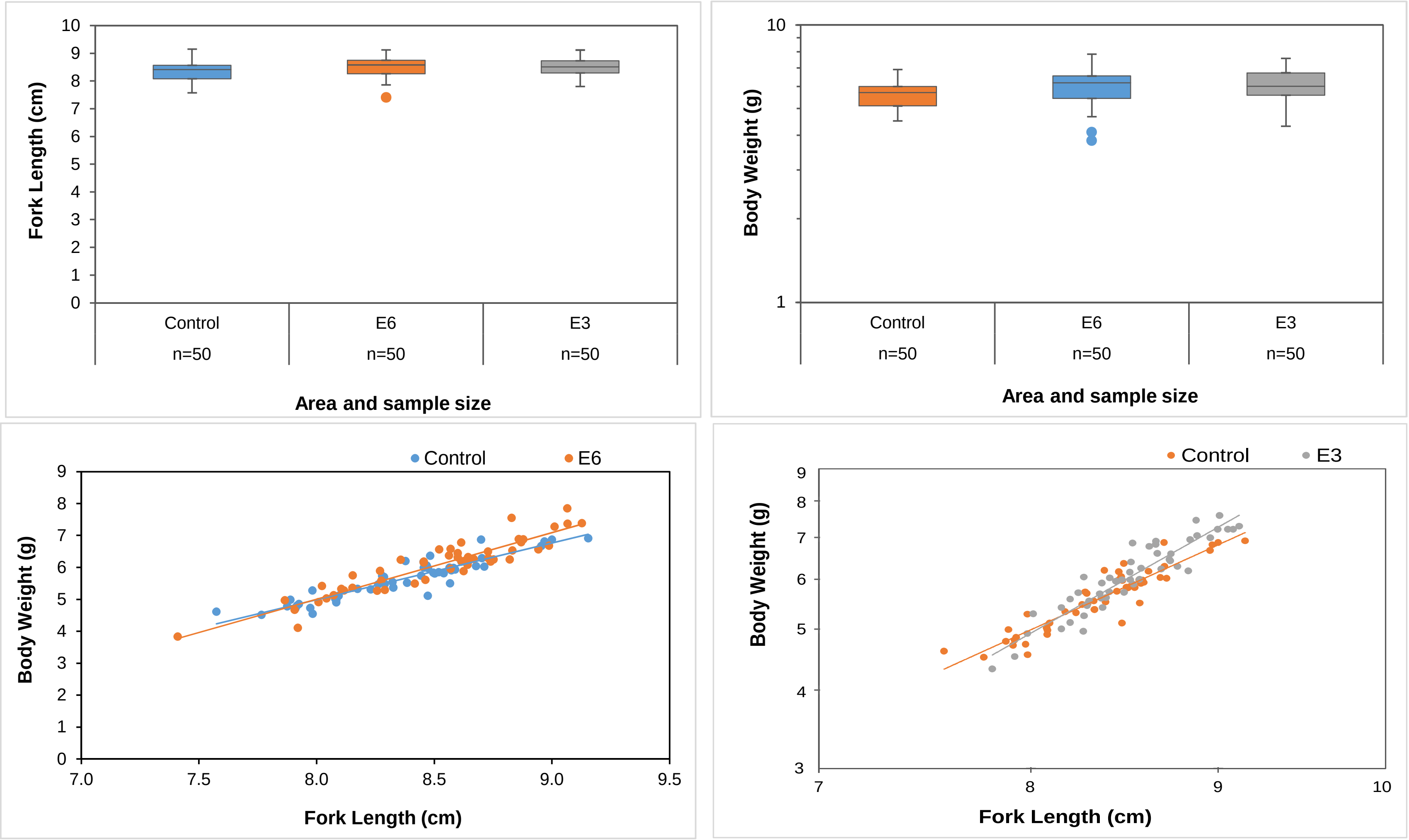
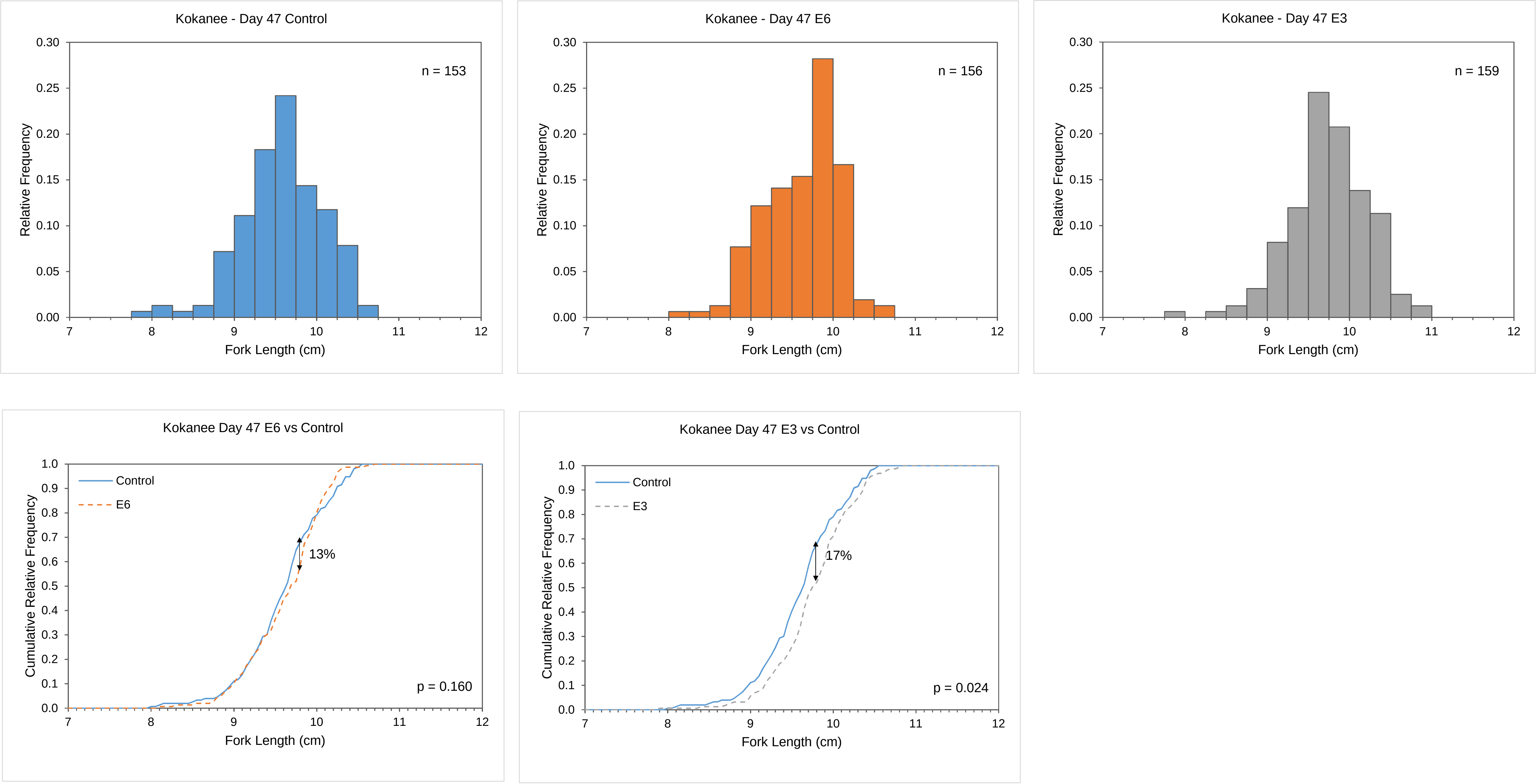


Figure E.4: **Boxplots of Fork Length, Body Weight, and Regression (Body Weight on Fork Length) for Day 26 Kokanee in Control, E6, and E3 Treatments, Minto Mine Fish Hatchery Exposure, August 2016**

Note: Boxplots for body weight and Control and E3 regression are plotted on a log scale.



Kokanee - Day 47 Control

Kokanee - Day 47 E6

Kokanee - Day 47 E3

Kokanee Day 47 E6 vs Control

Kokanee Day 47 E3 vs Control

Figure E.5: **Length-frequency Distributions and Cumulative Length-frequency Distributions for Day 47 Kokanee in Control, E6, and E3 Treatments for Minto Mine Fish Hatchery Exposure, August 2016**

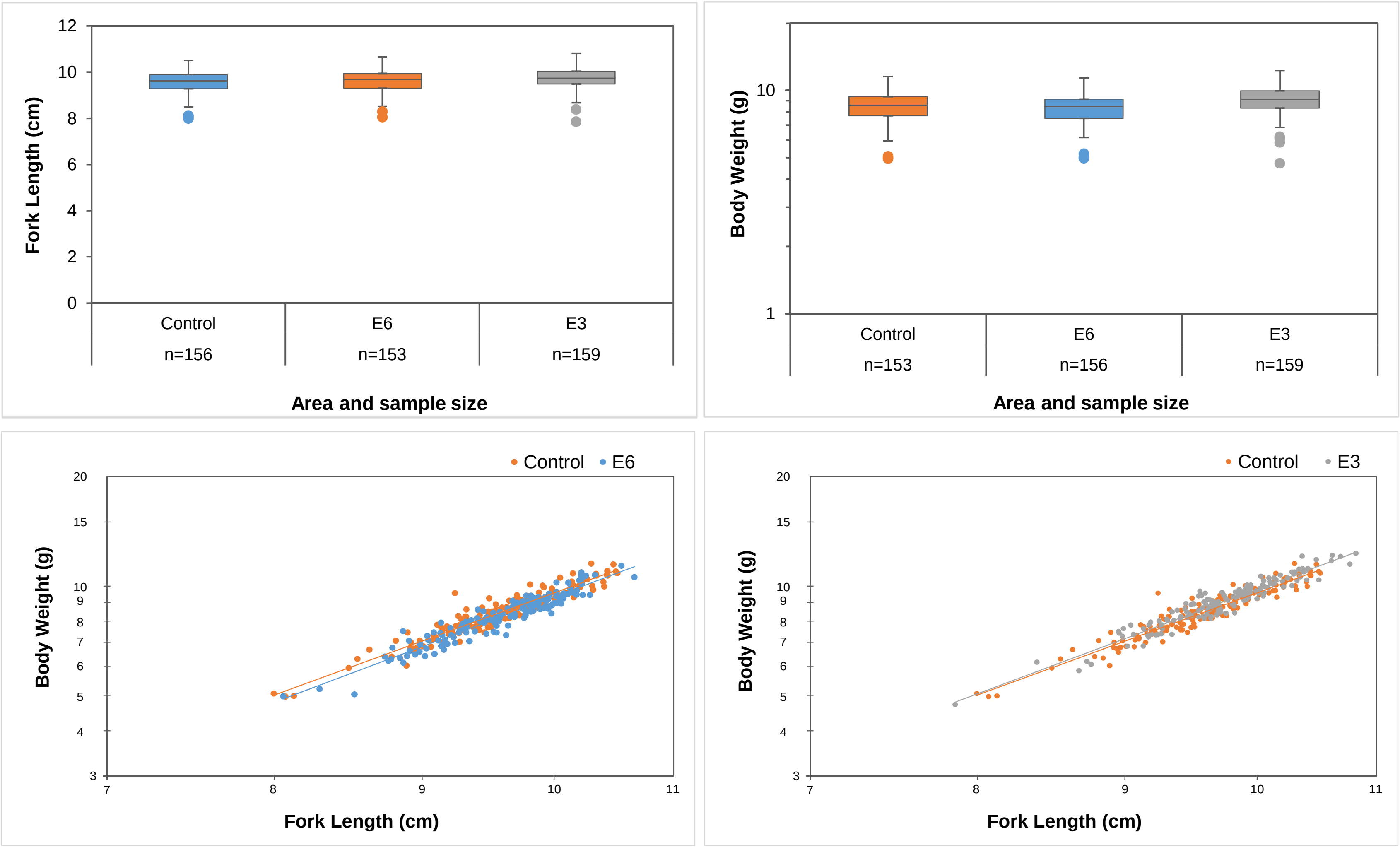


Figure E.6: Boxplots of Fork Length, Body Weight, and Regression (Body Weight on Fork Length) for Day 47 Kokanee in Control, E6, and E3 Treatments, Minto Mine Fish Hatchery Exposure, August 2016

Note: Boxplots for body weight and regressions are plotted on a log scale.

APPENDIX F

SUPPORTING PHOTOGRAPHS

Photo 1: **Upper Minto Creek (UMC-1), September 25, 2016**

Photo 2: **Upper Minto Creek (UMC-2), September 22, 2016**

Photo 3: Upper Minto Creek (UMC-3), September 22, 2016

Photo 4: Upper Minto Creek (UMC-4), September 25, 2016

Photo 5: **Upper Minto Creek (UMC-5), September 22, 2016**

Photo 6: **Reference Creek 1 (REF-1), September 25, 2016**

Photo 7: **Reference Creek 2 (REF-2), September 24, 2016**

Photo 8: **Reference Creek 3 (REF-3), September 24, 2016**

Photo 9: **Reference Creek 4 (REF-4), September 24, 2016**

Photo 10: **Reference Creek 5 (REF-5), September 23, 2016**

Photo 11: **Reference Creek 6 (REF-6), September 24, 2016**

Photo 12: **Reference Creek 7 (REF-7), September 24, 2016**

Photo 13: Reference Creek 8 (REF-8), September 25, 2016

Photo 14: Reference Creek 9 (REF-9), September 23, 2016

Photo 15: **Reference Creek 10 (REF-10), September 23, 2016**

Photo 16: **On-site Fish Exposure Laboratory, September 2016**

Photo 17: **Fish Exposure Tank, September 2016**

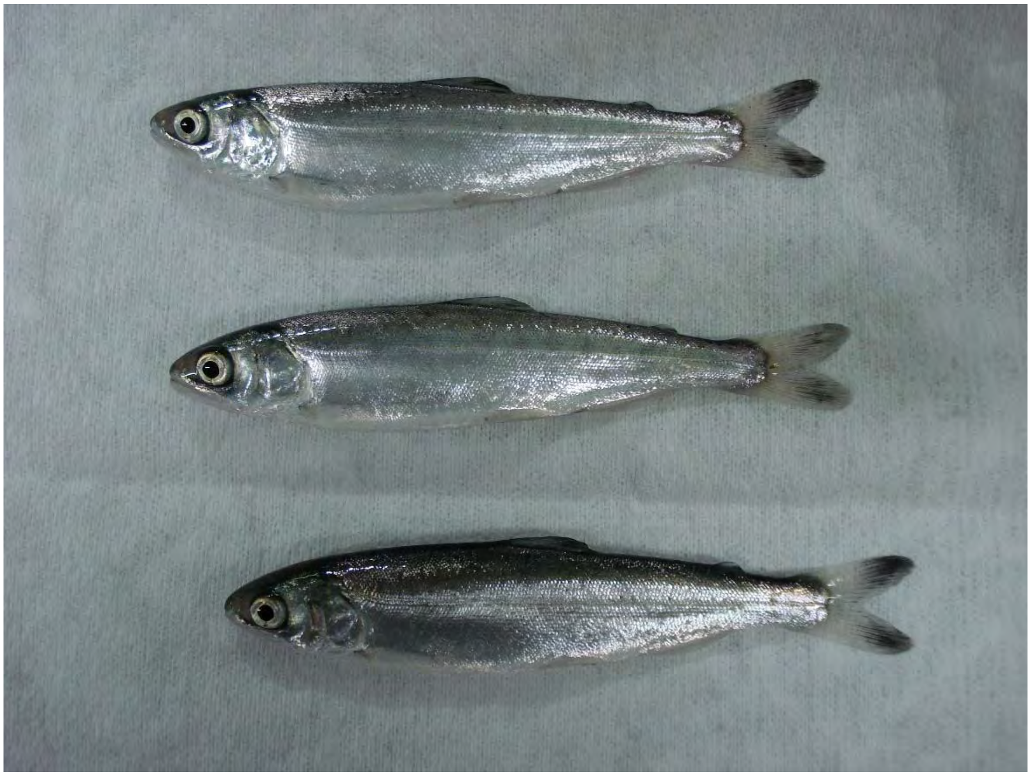


Photo 18: **Kokanee prior to Measurement, September 2016**

Photo 19: **Measuring Kokanee Length, September 2016**

Photo 20: **Measuring Kokanee Length (2), September 2016**

Photo 21: **Measuring Kokanee Weight, September 2016**

Appendix K – Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment 2017 Update

minnow
environmental inc.
A Trinity Consultants Company

Minto Creek Sediment, Periphyton, and Benthic Invertebrate Community Assessment - 2017

Prepared for:
Minto Mine
Whitehorse, Yukon

Prepared by:
Minnow Environmental Inc.
Victoria, British Columbia

March 2018

Minto Creek Sediment, Periphyton, and Benthic Invertebrate Community Assessment - 2017

Lisa Bowron, M.Sc., R.P.Bio
Project Manager
Lisa Bowron

Pierre Stecko, M.Sc., EP, R.P.Bio
Senior Project Advisor

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

1.1 Site Description

The Minto Mine is a high-grade copper mine located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A approximately 240 km northwest of Whitehorse, Yukon Territory (62°37'N latitude and 137°15'W longitude; Figure 1.1). It is owned and operated by Minto Explorations Ltd. (MintoEx), a wholly owned subsidiary of Capstone Mining Corporation (Capstone). Mine development was initiated in 1997 and commercial operations started in October 2007. The facility is permitted to conduct open pit and underground mining with milling at a rate of 4,200 tonnes of copper/gold/silver ore per day, and produced 35.9 million pounds of copper in 2017. Mill tailings are stored in the Main Pit and in in the Area 2 Pit (Figure 1.2). Mine-impacted seepage from the dry stack TSF and under the Mill Valley Fill Extension (MVFE) is collected at the toe of the MVFE and pumped to the main pit (Figure 1.2). Non-impacted water and treated mine-impacted water are collected in a Water Storage Pond (WSP; Figure 1.2). Effluent from the WSP is periodically discharged to Minto Creek under conditions specified in Water Use Licence (WUL) QZ14-031 (August 2015). Minto Creek, in turn, discharges to the Yukon River approximately 7.7 km south-east of the WSP (Figure 1.2).

1.2 Background

Under the WUL, the Minto Mine implements an Environmental Monitoring, Surveillance, and Reporting Plan (EMSRP) that includes routine water quality monitoring during the ice-free period (typically from April to October or November) in Minto Creek and reference tributaries at sampling frequencies varying from weekly to monthly. In accordance with the WUL, the Minto Mine submits water quality data to the Yukon Water Board as original laboratory reports and monthly summary reports within 30 days of month-end. Water quality monitoring data indicates that total suspended solids concentrations can increase dramatically during high flow events and concurrent concentrations of many metals (including aluminum, chromium, copper and iron) are higher than Canadian Water Quality Guidelines (CWQGs) for the protection of aquatic life even under background and reference conditions (e.g., HKP 1994, Minnow 2009a, 2010a,b).

The Minto Mine also implements biological monitoring under the EMSRP, including Environmental Effects Monitoring (EEM) in accordance with federal requirements under the *Fisheries Act* and an Aquatic Environmental Monitoring Plan (AEMP). Biological monitoring under EEM is implemented every three years and Phase 4 of the EEM was recently completed (Minnow 2018). Some mine influence was observed in routine water quality monitoring and water samples collected in conjunction with benthic invertebrate sampling. Analytes with concentrations higher than reference (or the reference range) include conductivity, hardness, nitrate, total Kjeldahl

Map of Canada

Location of the Minto Mine

0 100 200 400 km

N W E S

Projection: North American Datum 1983 UTM Zone 8V
Reproduced under licence from Her Majesty the Queen in Right of Canada,
Department of Natural Resources Canada. All rights reserved.

Date February 2018
Project 177202.0039

minnow environmental inc.

Figure 1.1

Document Path: S:\Projects\177202\177202.0039 - Minto WUL 2017\GIS\Report\17-39 Fig 1.1 Minto Mine Location.mxd

LEGEND

● Final Effluent Discharge Point
Mine Footprint
▨ Water Retention Dam
🟥 Building

0 250 500 1,000
Meters

N
W E
S

Projection: North American Datum 1983 UTM Zone 8V
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Minto Mine Site Layout and Receiving Environment

Date February 2018
Project 177202.0039

minnow environmental inc.

Figure 1.2

Document Path: S:\Projects\177202\177202.0039 - Minto WUL 2017\GIS\Report\17-39 Fig 1.2 Minto Mine Site Layout and Recieving Env.mxd nitrogen, total phosphorous, aluminum, arsenic, copper, iron, molybdenum, and selenium. Concentrations of nitrate were most strongly associated with the release of water from the Water Storage Pond, but remained below the CWQG. Mean concentrations of aluminum and arsenic were above CWQG but at both reference and exposed areas. Copper exceeded CWQG but was lower than the site specific water quality objectives. Primary EEM metrics (density, taxon richness, Simpson's evenness, and Bray-Curtis index) were within reference condition at upper Minto Creek but density was significantly lower at upper Minto Creek than reference in a control-impact comparison (Minnow 2018). The magnitude of difference was below the critical effect size (CES) of ± 2 standard deviation and considered not to be ecologically meaningful (Minnow 2018). Fish exposed to the highest concentrations of Minto Mine effluent (25%) for 47 days were slightly larger, of better condition than reference fish, but differences were less than the CES of 10%, and considered not to be ecologically meaningful (Minnow 2018).

Biological monitoring under the AEMP is implemented annually, and includes monitoring of water, sediment, periphyton, benthic invertebrates, fish, and fish habitat. Data from 1994 (baseline) and 2006 to 2016 have been reported previously (e.g., Minnow 2017), with some program modification over time. AEMP water quality monitoring has indicated that analytes were all below WUL water quality objectives. Fluoride was above CWQG at both the exposed and references areas. Total copper was above CWQG at upper and lower Minto creeks as well as at reference areas for lower Minto Creek. Concentrations of copper in upper and lower Minto Creek were greater than the Interim Sediment Quality Guidelines (ISQGs) for the protection of aquatic life and the reference areas. Similar concentrations were observed in previous years. In 2016, the periphyton community at lower Minto Creek had higher density/biomass and taxon richness but had a different community composition compared to the reference area (lower Wolverine Creek). Temporal variability was observed in periphyton community metrics and composition due to within year differences (i.e., differences in the number of taxa and Bray-Curtis index) between lower Minto and lower Wolverine creeks. Benthic invertebrate community Bray-Curtis index was significantly higher at lower Minto Creek compared to two reference areas. The high temporal variability observed was presumably due to inter-annual variability in environmental conditions.

1.3 Objectives

The objectives of this study and report are to characterize and interpret current (2017) sediment quality, periphyton and benthic invertebrate community condition, and tissue quality (periphyton and benthic invertebrate) of Minto Creek relative to reference and previous years' conditions. Supporting environmental data are also reported.

2 METHODS

Minnow Environmental Inc. implemented the Minto Creek sediment, periphyton, and benthic invertebrate assessment from September 20th to 26th, 2017 with the assistance of Minto Mine staff. The Minto Mine was not actively discharging during the study and had not been discharging since August 5th, 2017. The study was completed in accordance with specifications of the Minto Mine WUL (QZ14-031). Sediment sampling was undertaken in upper Minto Creek, lower Minto Creek, and corresponding reference areas (Table 2.1; Figure 2.1). Toxicity tests were run on sediment from lower Minto and lower Wolverine creeks (Table 2.1; Figure 2.1). Periphyton and benthic invertebrate community sampling were undertaken in erosional habitat of lower Minto Creek and their corresponding reference areas (Table 2.1; Figure 2.1). Tissue sampling (periphyton and benthic invertebrate) was undertaken in lower Minto Creek and corresponding reference areas (Table 2.1; Figure 2.1). Supporting measures (e.g., field meter measures, water quality samples, depth, flow, habitat observations) were collected at all sampling areas.

2.1 Supporting Measures

2.1.1 Field Collection

Many environmental variables were measured to support the sediment quality, periphyton community, benthic invertebrate community, and tissue chemistry data collected for the Minto Creek assessment. The location of each station was recorded using a handheld Geographic Positioning System (GPS) with coordinates recorded in Universal Transverse Mercator (UTM) units (using the North American Datum of 1983).

Supporting measures collected concurrent with sediment sampling (i.e., at depositional areas) included core penetration depth (lower creek areas only), sample texture, and the presence or absence of organic detritus. *In situ* measurements, including temperature, dissolved oxygen, specific conductance, and pH were taken at each station using either a YSI ProPlus field meter (Yellow Springs Instruments, Yellow Springs, OH) or a Hanna 4M multiparameter field meter (Woonsocket, RI).

At periphyton and benthic invertebrate stations (community and tissue), in situ water quality measurements (by field meter as described above), water depth (by meter stick), and water velocity (by HACH FH950 handheld flow meter [HACH Company, Loveland, CO]) were measured. Habitat was characterized at each periphyton and benthic invertebrate sampling area and included elevation, gradient, creek wetted and bankfull widths (by tape measure or range finder), water appearance, creek morphology, bank condition, substrate texture, instream cover, instream features, overhead canopy, aquatic vegetation, riparian vegetation, surrounding land use and anthropogenic disturbance. At each benthic invertebrate station, the intermediate axis lengths of

Table 2.1: Minto Mine Water Use Licence Sediment, Periphyton, and Benthic Invertebrate Monitoring Program Overview, September 2017

Area Type	Area	Station	Minto Mine Water Use Licence (QZ14-031, Amendment 10)								
			Water	Sediment by Spoon [a]	Sediment by Hand Corer/Petite Ponar [b]	Sediment Toxicity Testing	Periphyton Chlorophyll-a	Periphyton Community	Periphyton Tissue [c]	Benthic Community by Hess Sampler [d]	Benthic Invertebrate Tissue [c]
Lower Creek Areas	Lower Wolverine Creek (Reference)	LWC-1	✓		✓	✓	✓	✓	✓	✓	✓
		LWC-2			✓	✓	✓	✓	✓	✓	✓
		LWC-3			✓	✓	✓	✓	✓	✓	✓
		LWC-4			✓	✓	✓	✓	✓	✓	✓
		LWC-5			✓	✓	✓	✓	✓	✓	✓
	Lower Big Creek (Reference)	LBC-1	✓						✓	✓	✓
		LBC-2							✓	✓	✓
		LBC-3							✓	✓	✓
		LBC-4							✓	✓	✓
		LBC-5							✓	✓	✓
	Lower Minto Creek (Exposed)	LMC-1	✓		✓	✓	✓	✓	✓	✓	✓
		LMC-2			✓	✓	✓	✓	✓	✓	✓
		LMC-3			✓	✓	✓	✓	✓	✓	✓
		LMC-4			✓	✓	✓	✓	✓	✓	✓
		LMC-5			✓	✓	✓	✓	✓	✓	✓
Upper Creek Areas	Upper McGinty Creek (Reference)	URC-1	✓	✓							
		URC-2		✓							
		URC-3		✓							
		URC-4		✓							
		URC-5		✓							
	Upper Minto Creek (Exposed)	UMC-1	✓	✓							
		UMC-2		✓							
		UMC-3		✓							
		UMC-4		✓							
		UMC-5		✓							

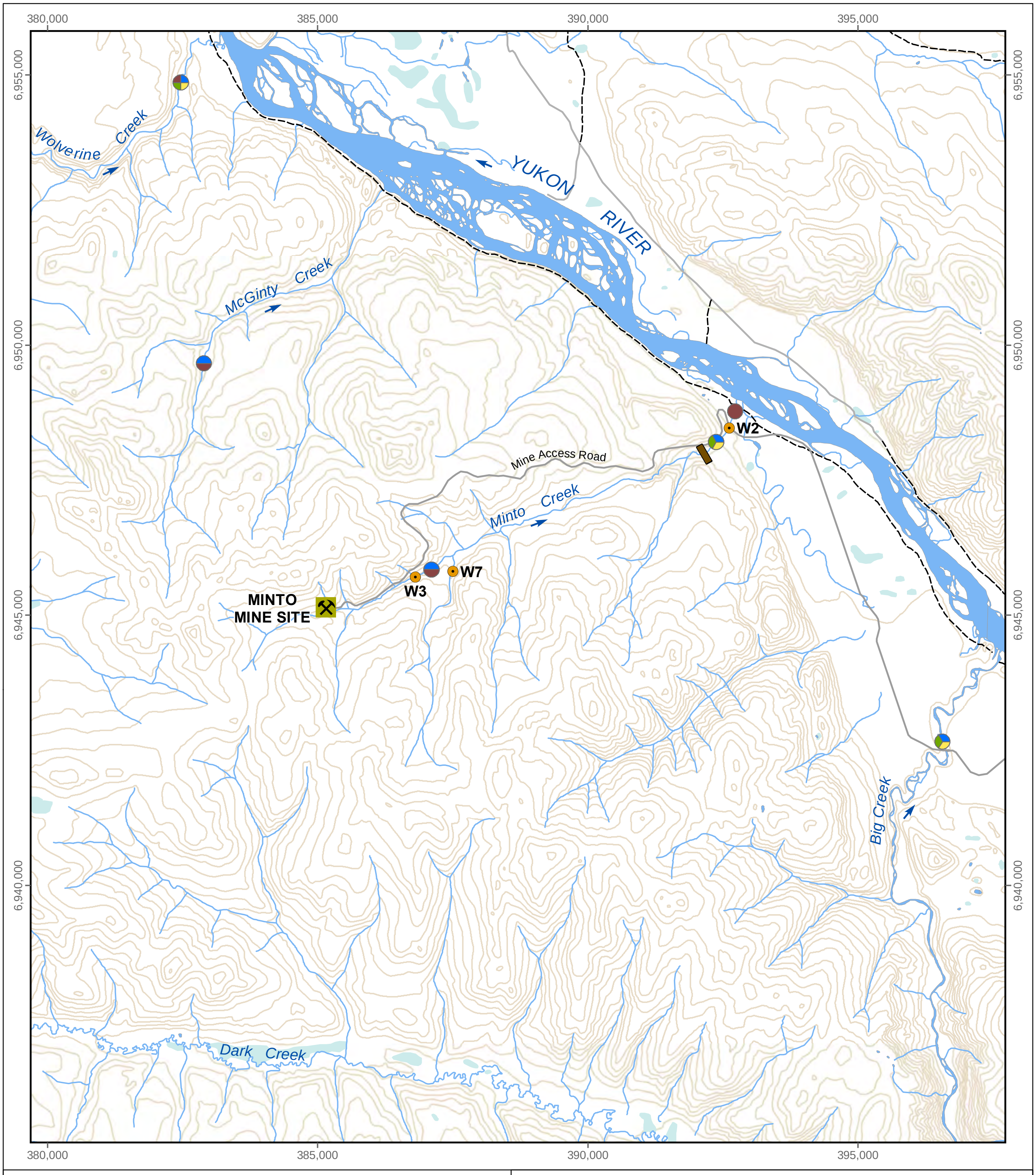
✓ - Included in the Monitoring Program.

[a] Top 2 centimeters collected; minimum 3-grab composite.

[b] Top 2 centimeters collected; 3-grab composite.

[c] Productivity permitting; in some cases, replication (of 5) may not be achieved with reasonable effort.

[d] 500 µm mesh; 3-grab composite.



LEGEND

Samples Collected

🟦 Water

🟫 Sediment

🟩 Periphyton

🟨 Benthos

● Routine Water Station

▬ Fish Barrier

Water, Sediment, Periphyton, and Benthic Invertebrate Monitoring Areas, 2017

0 1.25 2.5 5 km

Datum: NAD 83 Map Projection: UTM Zone 8V
Data Source: National Topographic Data Base (NTDB) compiled by Department of Natural Resources Canada at a scale of 1:50,000. All rights reserved.

Date: February 2018
Project 177202.0039

minnow environmental inc.

Figure 2.1

Document Path: S:\Projects\177202\177202.0039 - Minto WUL 2017\GIS\Report\17-39 Fig 2.1 Monitoring Areas for the Minto Mine.mxd

100 rocks that were washed during collection of the community sample were measured and the percent embeddedness of ten randomly selected rocks were evaluated and recorded. This type of substrate characterization is similar to those recommended under the Canadian Aquatic Biomonitoring Network (CABIN) protocol (CABIN 2012) for characterizing benthic invertebrate habitat. This provides additional information to assess and standardize habitat conditions among sampling stations and areas. Summary statistics of intermediate axis lengths (including the median and geometric mean) and median embeddedness were calculated for each station as per the CABIN protocol.

Water samples for chemical analysis were collected at all sampling areas (Table 2.1, Figure 2.1). Samples were collected using a master bottle from which the collected water was poured into pre-labeled sample bottles and preservatives were added, as required. A field duplicate was collected from one area using a split sample method; water from the master bottle was poured into one bottle and then into a duplicate bottle. Water samples for dissolved organic carbon (DOC) and for dissolved Inductively Coupled Plasma-Optical Emission Spectrophotometry (ICP-OES) metals were filtered in the field using 0.45 µm polypropylene filters. Immediately after collection, water samples were placed in a cooler and later into a refrigerator at approximately 4°C. They were later submitted to ALS Environmental in Whitehorse, YT, for analysis of alkalinity by auto titration, anions by ion chromatography, total and dissolved organic carbon by combustion, total inorganic carbon by CO_2 purge, total cyanide by Continuous Flow Analyzer (CFA), conductivity by electrode, hardness by calculation, total and dissolved mercury by Cold Vapour Atomic Fluorescence Spectrophotometry (CVAFS [low]), total and dissolved metals by Collision Cell Mass Spectrometry (CCMS) and ICP-OES, total and dissolved phosphorus by colour, total dissolved and suspended solids by gravimetrics, pH and turbidity by meter, and ammonia by fluorescence.

The productivity of lower Minto and lower Wolverine creeks was evaluated using measurements of chlorophyll-a in periphyton. Chlorophyll-a is the primary photosynthetic pigment of all oxygen-evolving photosynthetic organisms (Wetzel 2001) and therefore provides an indicator of the standing stock of photosynthetic organisms representing the lowest trophic level. Minto Creek is a lotic system and measuring chlorophyll-a in periphyton was considered more representative of productivity than measuring in water. A stainless steel razor blade was used to scrape periphyton from five rocks and then periphyton was transferred to filter paper which was placed in a pre-labeled opaque sampling jar. The surface area sampled was measured and recorded. All samples were maintained in coolers with ice packs during transport and then kept frozen on site until submission to ALS Environmental (Whitehorse, YT).

2.1.2 Data Analysis

A formal data quality report (DQR) was completed to assess the water data quality (Appendix A). The quality of the data were evaluated by comparing laboratory method detection limits (MDL) to target detection limits, which are ideally ≤1/10th of guideline values. On a subset of samples, the laboratory conducted Quality Assurance/Quality Control (QA/QC) analysis, including method blanks, laboratory duplicates, matrix spikes, spiked blanks, and certified reference materials. Field duplicates were collected and analyzed as a part of the DQR.

Water quality of Minto Creek was evaluated relative to WUL objectives, concentrations measured at reference areas, applicable water quality guidelines, and historical water quality. Supporting field measures (temperature, dissolved oxygen, pH, and specific conductance) and chlorophyll-a results were tested for differences between lower Minto Creek and reference areas (lower Wolverine and lower Big creeks) using two-sample t-tests. The assumption of normality was assessed using the Shapiro Wilks' test ($\alpha = 0.05$) and homogeneity of variance was assessed using Levene's Test ($\alpha = 0.05$). If variances were unequal, then the two-sample t-test for unequal variances was conducted (Ruxton 2006). Data that could not be normalized were log, square root, or fourth root transformed. A value of 1 was added before taking the logarithm if values of zero were in the data set. If data could not be normalized after transformation, a non-parametric Mann-Whitney test was applied. The significant p-value was set at 0.050 for all tests of supporting field measures. Statistical comparisons were conducted in excel using Real Statistics (Zaiontz 2018). Chlorophyll-a was compared to the British Columbia Water Quality Guideline (BCWQG). Creek productivity was characterized by comparing chlorophyll-a concentrations to the Dodds et al. (1998) productivity classification system for temperate streams.

2.2 Sediment Quality

2.2.1 Sample Collection and Laboratory Analysis

Sediment samples were collected for particle size and chemical analysis at depositional areas within Minto Creek and reference creeks (Table 2.1, Figure 2.1). At lower Minto and lower Wolverine creeks, sediment samples for particle size analysis were collected using a 15.24 cm x 15.24 cm (6" x 6") stainless steel petite ponar grab sampler (0.023 m^2 sampling area). A composite sample was created by collecting the surficial 2 cm of sediment from each of three acceptable grabs (i.e., full to each edge of the sampler) using a stainless steel spoon. Each sample that formed the composite was added to a plastic bin and mixed together. The mixed composite samples was placed into pre-labeled glass sampling jars. Sediment samples for chemical analyses were collected using a 4.7 cm (2"; inside diameter) Lexan™ core tube, which was carefully inserted into sediment deposits, capped using a fitted plastic cap, and retrieved by hand. From each acceptable core (i.e., each core containing an intact, representative sediment-water interface), the surficial 2 cm of sediment was manually extruded upwards into a graded core collar, cut with a stainless steel core knife, and placed into a pre-labeled glass sampling jar. Samples from three cores were composited to form a single sample from each station. At upper Minto and upper McGinty creeks, sediment deposits were rare and typically very shallow (i.e., deposits were less than one centimeters in depth). Collection of sediment by ponar or coring was ineffective in the upper creek areas and therefore sediments were collected using a stainless steel spoon. At locations of sediment deposition, surficial sediment was carefully collected by slowly spooning the sediment into a pre-labeled glass jar, with care taken to avoid the loss of fine material. In order to be as consistent as possible with the sediment collected in the lower creek areas, samples included no more than the top 1 cm of deposited sediment. Immediately after collection, sediment samples were placed in a cooler and later into a refrigerator at approximately 4°C. They were later submitted to ALS Environmental in Whitehorse, YT or Burnaby, BC, for analysis of particle size by dry and wet sieving and pipette sedimentation method, total organic carbon and loss on ignition by combustion, inorganic carbon was derived from a calculation, metals by collision/reaction cell-inductively coupled plasma mass spectrometry (CRC ICP-MS), mercury by CVAFS, total Kjeldahl nitrogen by colorimetric analysis, and pH by probe.

Survival and growth were measured in a 10-day *Chironomus dilutus* and a 14-day *Hyalella azteca* sediment toxicity tests at lower Minto and lower Wolverine creeks (Environment Canada 1997, 2013). Sediment for toxicity testing was collected using a 15.24 cm x 15.24 cm (6” x 6”) stainless steel petite ponar grab sampler (0.023 m^2 sampling area) and the top 2 cm from three grabs were collected to form a composite sample from each station (five stations formed the replicates in the toxicity tests). Samples from each station were placed into a pre-labeled 1 L jar and mixed with a stainless steel spoon. Immediately after collection, samples were placed in a cooler, then later transferred to a refrigerator and stored at approximately 4°C until they were submitted to Nautilus Environmental Inc. in Burnaby, BC for sediment toxicity testing.

2.2.2 Data Analysis

A formal DQR was completed to assess the sediment data quality (Appendix A). The MDLs achieved by the laboratory were compared to target limits, generally ≤1/10th guideline values. Laboratory QA/QC analysis included method blanks, laboratory duplicates, spiked blanks and certified reference materials (Appendix A). Sediment chemistry endpoints were summarized by reporting mean, standard deviation, minimum, and maximum for each area. Sediment quality data were evaluated relative to sediment quality guidelines (SQGs) for the protection of aquatic life (e.g., CCME 1999) and reference concentrations to identify metals with the potential to adversely affect aquatic life and/or that could be elevated due to mine activity. Sediment quality data were also compared to results obtained in previous years of sampling (1994 and 2006 to 2016). Interpretation was conducted with careful consideration of a significant methodological change made in 2010 and carried through to 2017 (sediments collected as described in Section 2.2.1) relative to previous years. Sediments collected in years before 2010 were collected within the active channel of the creek using an aluminum or Teflon scoop. Samples were submitted whole for analysis of particle size distribution, which generally included significant quantities of gravel and sand. Only material passing through a 230 mesh sieve (<63 µm; silt and clay) was digested and analyzed for metals. While this approach does analyze the geochemically-relevant fine sediment (e.g., Horowitz 1991), it impedes with interpreting the biological significance of sediment chemistry. Organisms are exposed to whole sediment (not just fines) and SQGs for the protection of aquatic life (e.g., CCME 1999) apply to whole sediment.

The laboratory performed QA/QC on sediment toxicity tests by comparing results to reference toxicant tests. Ammonia was monitored in lower Wolverine Creek treatments to ensure concentrations stayed below 0.20 mg/L of un-ionized ammonia (as N). Sediment from lower Minto Creek was compared to lower Wolverine Creek and laboratory control sediment. Results were also compared to previous sediment toxicity testing conducted in 2011, 2015, and 2016 (Minnow 2012, 2016, 2017). The mean ± standard deviation were compared for the survival and growth toxicity tests. Statistical analysis were conducted and summarized in a report by Nautilus Environmental (Appendix C).

2.3 Periphyton Community

2.3.1 Sample Collection and Laboratory Analysis

Periphyton is the assemblage of algae, bacteria, fungi, and meiofauna attached to submerged substrate in freshwaters. However, periphyton communities are generally characterized based on the attached alga community, which represent the lowest trophic level and are indicators of primary productivity. Periphyton community samples were collected in erosional habitat of lower Minto, lower Wolverine, and lower Big creeks (Table 2.1, Figure 2.1). A stainless steel razor blade was used to scrape periphyton from five randomly selected rocks in each of the five replicate stations per area. The area sampled was measured and recorded. Samples preserved with Lugol's iodine solution were placed in pre-labeled sampling jars. The samples were placed in a cooler, then later transferred to a refrigerator and stored at approximately 4 °C until they were shipped to Plankton R Us Inc. (Winnipeg, MB) for analysis to species level.

2.3.2 Data Analysis

A formal DQR was completed to assess the periphyton community data quality (Appendix A). Laboratory duplicate samples were collected on 10% of the periphyton community samples.

Periphyton communities were compared between lower Minto Creek and reference areas, lower Wolverine and lower Big creeks. Temporal comparisons were made to data collected in 1994 and 2011 to 2017.

Total organism density (cells/cm^2) and biomass (µg/cm^2) were calculated for periphyton community samples. The diversity metric “number of taxa” (also known as taxon richness) included all separate taxa identified to the species level. Simpson’s Diversity and Simpson’s Evenness indices were computed according to formulae presented by Smith and Wilson (1996) and recommended by Environment Canada (2012). These indices take into account the relative abundance of taxa and number of taxa, with values ranging from 0 (low diversity or evenness) to 1 (high diversity or evenness). The Bray-Curtis index was also calculated according to Environment Canada (2012). This metric takes into account the abundance of each taxon at each station compared to the median reference abundance (lower Wolverine Creek), to compute an index of the relative “dissimilarity” of each station from the hypothetical reference median station. Larger Bray-Curtis index values indicate greater dissimilarity from reference.

Periphyton community endpoints were summarized by reporting mean, median, minimum, maximum, and standard deviation for each study area. Differences among Minto Creek and the reference areas were tested using a two-sample t-test, with a p-value <0.10. A p-value of 0.10 was used as per suggested EEM guidelines (Environment Canada 2012). The assumptions of normality was assessed using the Shapiro Wilks’ test ($\alpha = 0.05$) and homogeneity of variance was assessed using Levene’s Test ($\alpha = 0.05$). If variances were unequal, then the two-sample t-test for unequal variances was conducted (Ruxton 2006). Data that could not be normalized were log, square root, or fourth root transformed. A value of 1 was added before taking the logarithm if values of zero were in the data set. If data could not be normalized after transformation, a non-parametric Mann-Whitney test was applied. Statistical comparisons were conducted using Real Statistics in excel (Zaiontz 2018). An observed effect size was calculated for each community metric as:

Observed Effect Size = (Exposed mean – Reference mean)/SD

where the SD is an estimate of the reference standard deviation. The estimate of the reference standard deviation was the pooled standard deviation in the two-sample t-test for equal variances or the reference standard deviation when the two-sample t-test for unequal variances was applied. The effect size calculations will be conducted on the transformed scale when the data are transformed for analysis. A study design with two areas and $n = 5$ samples per area has an approximate power of 0.9 to detect a two standard deviation difference between areas using $\alpha = 0.1$ (Environment Canada 2012).

Periphyton data collected in 2017 were compared to data collected in baseline studies (HKP 1994) and from 2011 to 2016. Due to differences in reporting of periphyton community data in the 1994 baseline report (e.g., taxa were only identified as present, common or dominant), a non-statistical comparison was performed against 1994 data using proportional abundances at the taxonomic level of Phylum.

2.4 Benthic Invertebrate Community

2.4.1 Sample Collection and Laboratory Analysis

Benthic invertebrate community samples were collected in erosional habitat of lower Minto, lower Wolverine, and lower Big creeks as required under the WUL (Table 2.1, Figure 2.1). Benthic invertebrate community samples were collected from riffle/run habitat with cobble and gravel substrate using a Hess sampler (0.10 m^2) outfitted with 500 µm mesh. Three grab composites (0.30 m^2 area in total) were collected at five replicate stations within each sampling area. For each grab, the substrate within the sampler was disturbed and scrubbed (by hand and nail brush) with care taken to ensure that all dislodged organic material was swept into the sampler collection net. The substrate was disturbed to a depth of approximately 5 cm over a period of approximately ten minutes. This procedure was repeated for the second and third grab, following which all of the material contained in the collection net was carefully transferred to a pre-labeled 2 L wide-mouth plastic jar using a stainless steel spoon and a wash bottle while working over a plastic bin to avoid any potential loss of organisms. Any organisms that adhered to the sieve bag were removed by hand and added to the sample. All samples were labeled internally (using wooden sticks) and externally with the station number, area identifier, Minnow project number, date and field personnel in order to ensure correct identification at the laboratory. Samples were preserved within six hours of collection using buffered formalin solution to a nominal concentration of 10% in ambient water.

All benthic invertebrate samples were shipped to Cordillera Consulting in Summerland, BC. Each sample was elutriated to remove sand, gravel and clay, and the remaining organic material was preserved in 70% ethanol. Elutriate was examined for any mollusc or Trichoptera cases, then each sample was examined to estimate the total number of invertebrates. If the estimated number of organisms were greater than 600 and the sample was fine and non-clumping, a subsample was taken using a Folsom Plankton Splitter (Motodo 1959, Van Guelpen et al. 1982). Empty snail or bivalve shells, empty caddisfly cases, and invertebrate fragments such as legs, gills, antennae etc. were kept but excluded from the count. When organism fragments were encountered, only the heads were counted towards the total. Larval and pupal exuviae were excluded while terrestrial stages and terrestrial drop-ins were indicated as such but excluded from the total count. Benthic invertebrates were identified to the “lowest practicable taxonomic level” (which in most cases were genus) and counted. Following identification and counting, representative specimens of each new taxon were preserved in a museum quality vial with a polyseal lid and added to the Minto Mine voucher collection. Internal labels were used to identify the taxa, the client, date collected, site code, and the project.

2.4.2 Data Analysis

A formal DQR was completed to assess the benthic invertebrate community data quality (Appendix A). Laboratory QA/QC included an assessment of sub-sampling error and sorting efficiency on at least 10% of the samples (Appendix A). Benthic invertebrate communities were evaluated using summary metrics, including invertebrate density (number of organisms per m^2, calculated based on a sample area of 0.30 m^2), number of taxa, Simpson's Diversity and Evenness, and Bray-Curtis index. Before these endpoints could be calculated, abundances of organisms identified to a less-specific level were first added to abundances of organisms within that grouping identified to a more-specific level (e.g. abundances of organisms only identified to Order were added to abundances of organisms identified to Family, Genus, or Species within that Order). This process is referred to as data compression and assess benthic invertebrate taxonomic richness without redundancy. Abundance of a less-specific taxon was redistributed within that taxon proportionally according to abundances of organisms identified to more-specific levels. Data compression was conducted proportionally because the distribution of organisms identified beyond the Family-level likely reflect the proportional distribution of organisms identified to associated less-specific levels, because those organisms are frequently at early developmental stages and lack some differentiating features. Total organism density (individuals/m^2), taxon richness, Simpson's Diversity and Evenness, and Bray-Curtis index were calculated in the same manner as periphyton community data (Section 2.3.2). Bray-Curtis index was calculated based on the median of each reference area as well as the combined reference median. The combined reference median was presented within the text, as this is the optimal method for determining potential effluent effects, since using a reference median value calculated from only one area biases the outcome toward detecting a difference between two areas regardless of potential anthropogenic stressors. This occurs because the area used to calculate the median was inherently more similar to itself than any other area (Huebert et al. 2011), even if the two areas in question are 'natural-pristine' areas.

The relative proportions of the most abundant taxa were calculated relative to the total number of organisms in the sample. Dominant taxon groups were defined as groups representing greater than 10% of total organism abundance in one or more areas or any groups considered important indicators of environmental stress. In this study, relative proportions of the major groups, such as chironomids and EPT taxa (Ephemeroptera [mayfly], Plecoptera [stonefly], Trichoptera [caddisfly] taxa) were examined. It is often possible to relate low relative abundance of sensitive taxonomic groups (e.g., EPT taxa) to environmental stress (e.g., Taylor and Bailey 1997). Similarly, high relative abundance of tolerant taxonomic groups (e.g., oligochaetes) may also indicate higher environmental stress (Chapman et al. 1982a,b).

Differences among Minto Creek and the reference areas were tested using ANOVA with a post hoc test (Tukey's), with significance set at a p-value of <0.10, as per suggested EEM guidelines (Environment Canada 2012). Prior to ANOVA, all data were transformed (log, square root, or fourth root transformation) as necessary to meet assumptions of normality (Shapiro Wilks' test; $\alpha = 0.05$) and homogeneity of variance (Levene's test; $\alpha = 0.05$). A value of 1 was added before taking the logarithm if values of zero were in the data set. If data failed the assumptions of normality and homogeneity of variance, then a non-parametric Kruskal-Wallis test was conducted using a Dunn's post hoc test. All statistical comparisons were conducted using Real Statistics in excel (Zaiontz 2018). An observed effect size was calculated for each community metric as:

Observed Effect Size = (Group 1 mean – Group 2 mean)/SD

where the SD is an estimate of the reference standard deviation.

Benthic invertebrate community data were also evaluated in comparison to results obtained in previous years of sampling (1994, 2006, 2008, and 2010 to 2016). Summary metrics from earlier years were previously re-calculated (Minnow 2011) to ensure consistency and appropriate comparisons over time.

2.5 Tissue Chemistry

2.5.1 Sample Collection and Laboratory Analysis

Periphyton and benthic invertebrate tissue samples were collected from lower Minto (exposed), lower Wolverine (reference), and lower Big creeks (reference; Table 2.1, Figure 2.1). Periphyton samples were collected by scraping submerged cobble-size rocks with a stainless steel razor blade. Scraped material (periphyton) was placed in pre-labeled sample jars. Benthic invertebrate tissue samples were collected in areas with cobble substrate using a kick-net, and by overturning rocks and collecting organisms by hand. Periphyton and benthic invertebrate tissue samples (2 to 5 grams) were placed into pre-labeled sample jars and Whirl-Pak™ bags, respectively. A total of five periphyton and five benthic invertebrate samples were collected at each area. Immediately after collection, all tissue samples were placed in a cooler, and later in a freezer until they were submitted to ALS Environmental in Burnaby, BC. Samples were analyzed for percent moisture and for metals by High-Resolution ICP-MS, and later converted to dry weight using percent moisture.

2.5.2 Data Analysis

A formal DQR was completed to assess the periphyton and benthic invertebrate tissue data quality (Appendix A). The MDLs achieved were compared to the detection limits quoted by the laboratory. Method blanks, laboratory duplicates, spiked blanks, and certified reference materials were included in the DQR for both tissue types (Appendix A). Tissue chemistry data were summarized (mean and standard deviation). Any analyte that had values with poor detection limits (a value below the detection limit that exceeds the maximum detected value) were removed from the data set when they consisted of fewer than 80% of the data values. The removal of the poor detection limits is irrelevant to the estimation of the mean or standard deviation, but does influence the overall sample size. Analytes with one or more values below a detection limit or with poor detection limits were analyzed using the non-parametric Kaplan-Meier method using a data analysis package (NADA: non-detects and data analysis for environmental data; Helsel 2012) in R statistical software (R Core Team 2016). This method involves transforming the left censored (i.e., < value) dataset to a right censored (i.e., > value) dataset, and then using the Kaplan-Meier estimator (used to estimate the mean survival time in survival analysis) to estimate the mean. The calculation was conducted using the survfit() function in the survival package (Therneau 2017) in R and involves calculating the area under the Kaplan-Meier survival curve. The Kaplan-Meier method is non-parametric and can accommodate multiple detection limits. This method of estimating the mean is equivalent to using the distribution of detectable values below the detection limit to represent values that are <MDL. If the minimum value in the data set was below the detection limit, then it was replaced with the detection limit. Therefore, if there was only one detection limit and no detected values <MDL, then the Kaplan-Meier estimate of the mean was equivalent to replacing the value below the detection limit with the detection limit (i.e., the best estimate for the values <MDL is the detection limit). The standard deviation was also estimated using the Kaplan-Meier method using the survfit() function in the survival package. When a standard deviation could not be estimated, it was reported as NA (not available). This can occur with a data set with a high proportion of censored values.

The primary objective of tissue collection was to support a selenium assessment reported under a separate cover. Accordingly, data are reported herein for future reference with limited interpretation. Tissue quality data were interpreted by statistically comparing metal concentrations at the exposed area to those collected at the reference areas using ANOVA with post-hoc testing (Tukey’s) with a p-value of 0.050. Data were first tested for normality (Shapiro Wilks’ test; $\alpha = 0.05$) and equality of variance (Levene’s test; $\alpha = 0.05$) and if data were not normally distributed, data were transformed by either log, square root, or fourth root transformations. A value of 1 was added before taking the logarithm if values of zero were in the data set. Some analytes were could not be normalized, and a non-parametric Kruskal-Wallis test with a Dunn's post-hoc was conducted. All statistical tests were conducted using Real Statistics in excel (Zaiontz 2018). When one or more values were below a detection limit, the data were analyzed using the generalized Wilcoxon score test as described in Helsel (2012). The test is nonparametric, accommodates multiple detection limits, and compares the survival curves for two or more groups. If a significant difference among groups was detected for three-group comparisons, then pairwise comparisons were conducted using two-group generalized Wilcoxon score tests. The tests were conducted using cendiff function in the NADA package (Lee 2017) in R (R Core Team 2016).

3 SUPPORTING MEASURES

3.1 Field Measures

Mean temperature at the sediment sampling area of upper Minto Creek (2.7 °C) was significantly higher than in upper McGinty Creek (1.6 °C; Figure 3.1, Appendix Table B.3). Lower Minto Creek (3.9 °C) had significantly lower temperature compared to the reference area, lower Wolverine Creek (6.2 °C; Figure 3.1, Appendix Table B.3). Specific conductance was significantly higher in upper Minto Creek (602 µS/cm) than in upper McGinty Creek (174 µS/cm). Lower Minto Creek (430 µS/cm) had significantly higher specific conductance than compared to the lower Wolverine Creek reference (247 µS/cm; Figure 3.1). Dissolved oxygen was significantly higher at lower Minto Creek (68.1% saturation) than at lower Wolverine Creek (36.6% saturation; Figure 3.1, Appendix Table B.3). Lower dissolved oxygen at lower Wolverine Creek could be attributed to sampling in back eddies, which were the only areas that support sediment deposition. No significant differences were observed between exposed areas and associated reference areas for pH (Figure 3.1, Appendix Table B.3).

Physico-chemical measurements were also taken in erosional areas of lower Minto, lower Wolverine, and lower Big creeks in support of benthic invertebrate community sampling. Temperature was significantly lower at lower Minto Creek (2.0 °C) compared to lower Big Creek (6.4 °C) but were similar to lower Wolverine Creek (3.8 °C; Figure 3.2, Appendix Table B.4). Specific conductance was the only parameter measured that was significantly higher at lower Minto Creek (412 µS/cm) compared to both reference areas, lower Wolverine (259 µS/cm) and lower Big (248 µS/cm) creeks, which was consistent with the measures supporting the sediment collections and suggest a mine influence on water quality. No significant differences were observed between lower Minto Creek and reference creeks for dissolved oxygen and pH. All areas were within the range of the WUL objective for pH.

3.2 Water Chemistry and Chlorophyll-a

Water chemistry data quality were assessed prior to data analysis and interpretation, and were judged to be of good quality (Appendix A). Fluoride exceeded the interim CWQG in Minto Creek and associated reference areas (Table 3.1). Total copper concentrations (a metal of particular interest at the Minto Mine) were above CWQG at upper Minto Creek but dissolved copper was well below water quality objectives set out in the WUL (Table 3.1, Appendix Table B.7).

Chlorophyll-a data quality was assessed prior to data analysis and interpretation, and was judged to be of good quality (Appendix A). Concentration of chlorophyll-a in periphyton was significantly higher at lower Minto Creek (51 mg/m^2) than at lower Wolverine Creek (13 mg/m^2; Figure 3.3) but was below the BCWQG of 100 mg/m^2 for the protection of aquatic life (BCMOE 1985).

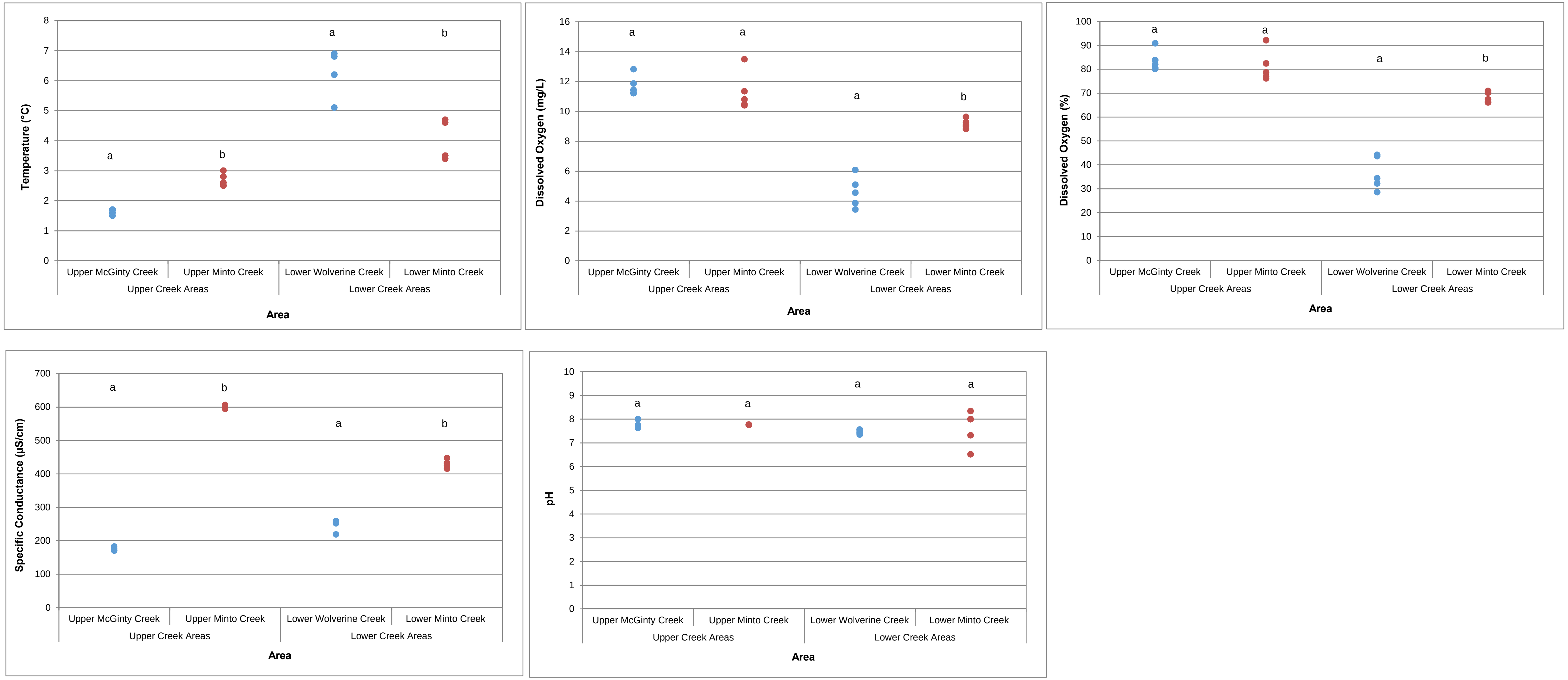


Figure 3.1: Physico-chemical Measurements in Depositional Areas of Upper and Lower Minto Creek Relative to Reference Areas, Minto Mine, 2017

Notes: Samples sizes were n = 5 in all areas (except for pH at upper Minto Creek, n = 4). Different letters represent a significant difference between areas within each creek area.

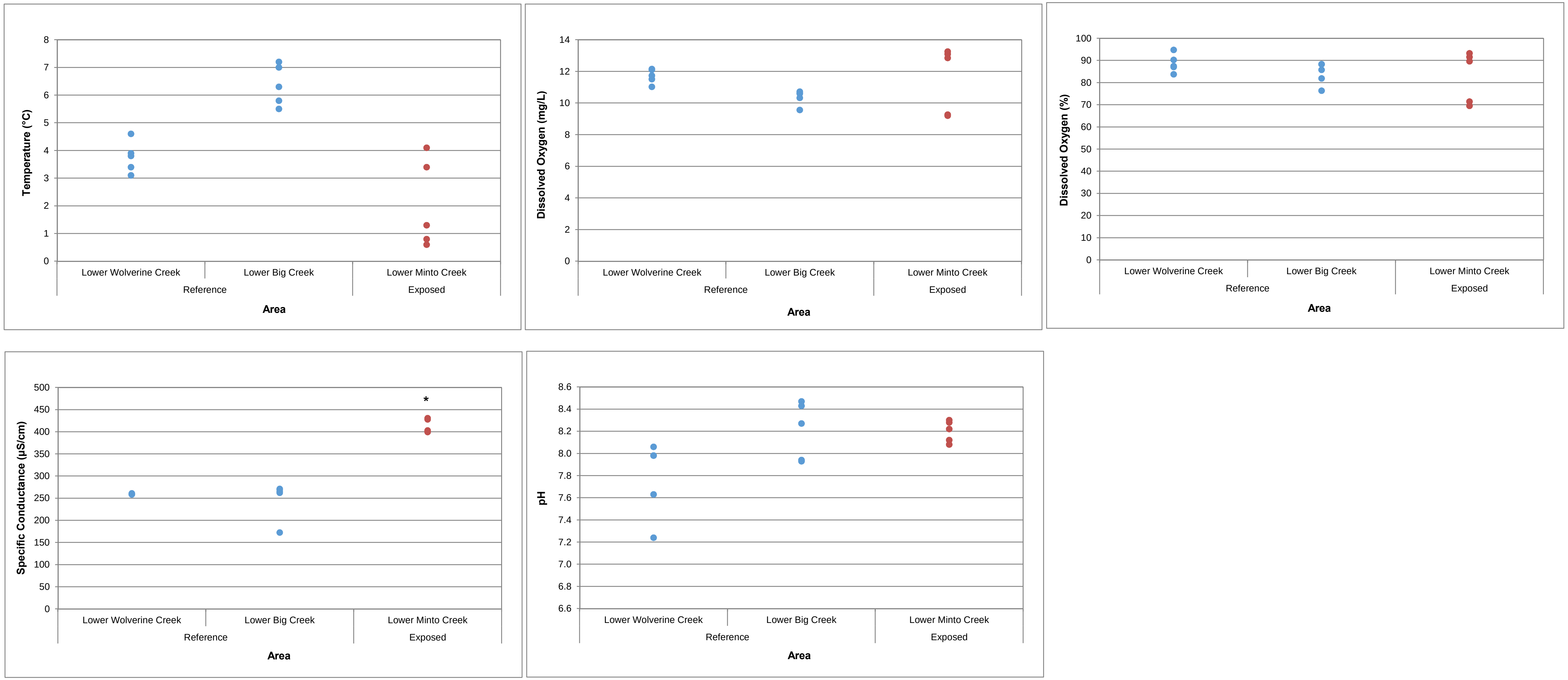


Figure 3.2: **Physico-chemical Measurements in Erosional Areas in Lower Minto Creek and Reference Areas, Minto Mine, 2017**

Notes: Samples sizes were n = 5 in all areas. Asterisk (*) indicate when lower Minto Creek was significantly different from lower Wolverine and lower Big creeks.

Table 3.1: Water Quality Results at Exposed and Reference Areas, Minto Mine WUL, September 2017

	Analyte	Units	CCME Water Quality Guidelines [a]		WUL Objectives at W2	Upper McGinty Creek (Reference)	Upper Minto Creek (Exposed)	Lower Wolverine Creek (Reference)	Little Big Creek (Reference)	Lower Minto Creek (Exposed)
			30 Day	Max						
Physical Tests	Conductivity	µS/cm	-	-	-	164	523	219	217	340
	Hardness (as $CaCO_3$)	mg/L	-	-	-	113	260	107	103	175
	pH	pH Units	6.5 - 9.0	-	6.0 - 9.0	7.82	8.08	8.03	8.18	8.22
	Total Suspended Solids	mg/L	-	-	-	<3.0	<3.0	3.1	<3.0	3.5
	Total Dissolved Solids	mg/L	-	-	-	163	317	165	152	225
	Turbidity	NTU	-	-	-	0.87	0.20	0.87	0.89	0.75
Anions and Nutrients	Total Alkalinity	mg/L	-	-	-	77	234	105	105	172
	Total Ammonia (as N)	mg/L	0.41 [b]	-	0.25	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Chloride (Cl)	mg/L	120	640	-	0.27	4.4	0.45	0.59	1.7
	Fluoride (F)	mg/L	0.12	-	-	0.33	0.58	0.13	0.13	0.44
	Nitrate (as N)	mg/L	3.0	124	9.1	0.069	0.16	<0.0050	0.0053	0.042
	Nitrite (as N)	mg/L	0.060	-	0.060	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Phosphorus (P)-Total dissolved	mg/L	-	-	-	0.011	0.0056	0.0055	0.0023	0.0038
	Phosphorus (P)-Total	mg/L	-	-	-	0.0089	0.0053	0.0063	0.0037	0.0050
	Sulfate (SO_4)	mg/L	-	-	-	14	55	21	16	20
Other	Total Cyanide	mg/L	-	-	-	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Dissolved Organic Carbon	mg/L	-	-	-	10	5.8	14	7.6	9.0
	Total Inorganic Carbon	mg/L	-	-	-	16	54	22	22	38
	Total Organic Carbon	mg/L	-	-	-	12	5.5	14	7.5	9.0
Total Metals	Total Aluminum (Al)	mg/L	0.10 [c]	-	-	0.022	0.0055	0.038	0.038	0.018
	Total Antimony (Sb)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	0.00014	<0.00010
	Total Arsenic (As)	mg/L	0.0050	-	-	0.00042	0.00025	0.00045	0.00081	0.00048
	Total Barium (Ba)	mg/L	-	-	-	0.032	0.068	0.041	0.066	0.060
	Total Beryllium (Be)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Bismuth (Bi)	mg/L	-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Total Boron (B)	mg/L	1.5	29	-	<0.010	0.025	<0.010	<0.010	<0.010
	Total Cadmium (Cd)	mg/L	0.00016 [d]	0.0022 [d]	-	<0.0000050	<0.0000050	<0.0000050	0.0000078	<0.0000050
	Total Calcium (Ca)	mg/L	-	-	-	24	59	24	26	45
	Total Chromium (Cr)	mg/L	0.0010 Cr(VI)	-	-	0.00034	<0.00010	0.00052	0.00030	0.00024
	Total Cobalt (Co)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Copper (Cu)	mg/L	0.0024 [d]	-	-	0.0012	0.0025	0.0019	0.0019	0.0016
	Total Iron (Fe)	mg/L	0.30	-	-	0.26	0.025	0.13	0.079	0.067
	Total Lead (Pb)	mg/L	0.0033 [d]	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Total Lithium (Li)	mg/L	-	-	-	<0.0010	0.0032	0.0016	0.0012	0.0014
	Total Magnesium (Mg)	mg/L	-	-	-	6.6	29	13	10	16
	Total Manganese (Mn)	mg/L	-	-	-	0.021	0.047	0.0058	0.015	0.0034
	Total Mercury (Hg)	mg/L	0.000026	-	-	<0.0000050	<0.0000050	<0.0000050	<0.000025	<0.0000050
	Total Molybdenum (Mo)	mg/L	0.073	-	-	0.0013	0.0048	0.00057	0.0013	0.0016
	Total Nickel (Ni)	mg/L	0.098 [d]	-	-	0.00091	0.00092	0.0017	0.0011	0.00097
	Total Phosphorus (P)	mg/L	-	-	-	<0.30	<0.30	<0.30	<0.30	<0.30
	Total Potassium (K)	mg/L	-	-	-	0.59	2.4	0.76	0.87	1.5
	Total Selenium (Se)	mg/L	0.0010	-	-	0.00036	0.00031	0.00011	0.000072	0.000081
	Total Silicon (Si)	mg/L	-	-	-	6.4	6.3	5.2	5.9	6.2
	Total Silver (Ag)	mg/L	0.00025	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Total Sodium (Na)	mg/L	-	-	-	4.4	19	8.5	7.8	10
	Total Strontium (Sr)	mg/L	-	-	-	0.16	0.77	0.22	0.28	0.45
	Total Thallium (Tl)	mg/L	0.00080	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Total Tin (Sn)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Titanium (Ti)	mg/L	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
	Total Uranium (U)	mg/L	0.015	0.033	-	0.00054	0.0026	0.00081	0.0028	0.0017
	Total Vanadium (V)	mg/L	-	-	-	0.00056	<0.00050	0.00091	0.00081	0.00060
	Total Zinc (Zn)	mg/L	0.030	-	-	0.0051	<0.0030	<0.0030	<0.0030	0.0044
Dissolved Metals	Dissolved Aluminum (Al)	mg/L	-	-	0.10	0.0056	0.0029	0.020	0.013	0.0050
	Dissolved Antimony (Sb)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	0.00012	<0.00010
	Dissolved Arsenic (As)	mg/L	-	-	0.0050	0.00019	0.00024	0.00041	0.00067	0.00046
	Dissolved Barium (Ba)	mg/L	-	-	-	0.022	0.071	0.041	0.068	0.063
	Dissolved Beryllium (Be)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Bismuth (Bi)	mg/L	-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Dissolved Boron (B)	mg/L	-	-	-	<0.010	0.021	<0.010	<0.010	<0.010
	Dissolved Cadmium (Cd)	mg/L	-	-	0.00022 [e]	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Dissolved Calcium (Ca)	mg/L	-	-	-	33	56	22	24	42
	Dissolved Chromium (Cr)	mg/L	-	-	0.0010	0.00015	<0.00010	0.00041	0.00021	0.00019
	Dissolved Cobalt (Co)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Copper (Cu)	mg/L	-	-	0.020/0.013 [f]	0.00032	0.0025	0.0033	0.0017	0.0015
	Dissolved Iron (Fe)	mg/L	-	-	1.1	0.055	0.020	0.090	0.039	0.040
	Dissolved Lead (Pb)	mg/L	-	-	0.0040	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Dissolved Lithium (Li)	mg/L	-	-	-	<0.0010	0.0033	0.0019	0.0016	0.0017
	Dissolved Magnesium (Mg)	mg/L	-	-	-	9.2	29	13	10	17
	Dissolved Manganese (Mn)	mg/L	-	-	-	0.0060	0.047	0.0035	0.013	0.0022
	Dissolved Mercury (Hg)	mg/L	-	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Dissolved Molybdenum (Mo)	mg/L	-	-	0.073	0.0029	0.0041	0.00049	0.0011	0.0014
	Dissolved Nickel (Ni)	mg/L	-	-	0.11	<0.00050	0.00081	0.0016	0.00090	0.00086
	Dissolved Phosphorus (P)	mg/L	-	-	-	<0.30	<0.30	<0.30	<0.30	<0.30
	Dissolved Potassium (K)	mg/L	-	-	-	0.73	2.5	0.79	0.90	1.6
	Dissolved Selenium (Se)	mg/L	-	-	0.0020	0.00086	0.00032	0.00010	<0.000050	0.00010
	Dissolved Silicon (Si)	mg/L	-	-	-	5.7	6.0	4.9	5.6	6.0
	Dissolved Silver (Ag)	mg/L	-	-	0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Dissolved Sodium (Na)	mg/L	-	-	-	6.5	19	8.6	7.8	11
	Dissolved Strontium (Sr)	mg/L	-	-	-	0.25	0.71	0.20	0.26	0.43
	Dissolved Thallium (Tl)	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Dissolved Tin (Sn)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Titanium (Ti)	mg/L	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010
	Dissolved Uranium (U)	mg/L	-	-	-	0.0012	0.0023	0.00069	0.0025	0.0016
	Dissolved Vanadium (V)	mg/L	-	-	-	0.0011	<0.00050	0.00086	0.00074	0.00057
	Dissolved Zinc (Zn)	mg/L	-	-	0.030	<0.0010	<0.0010	<0.0010	<0.0010	0.0027

☐ Water use licence objectives not met.

▨ Water quality guideline not met.

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment Winnipeg. See Appendix Table B.6 for explanatory notes on selected water quality guidelines.

[b] Based on lowest guideline using highest temperature and pH

[c] Based on lowest guideline using highest pH

[d] Based on lowest guideline using lowest hardness

[e] Dissolved Cadmium (µg/L) guidelines based on the following formula using the lowest hardness: e(0.736(ln(Hardness)-4.943)

[f] Dissolved Copper water quality objective depends on concentration of dissolved organic carbon (DOC). If DOC is > 10 mg/L/ DOC is≤ 10 mg/L.

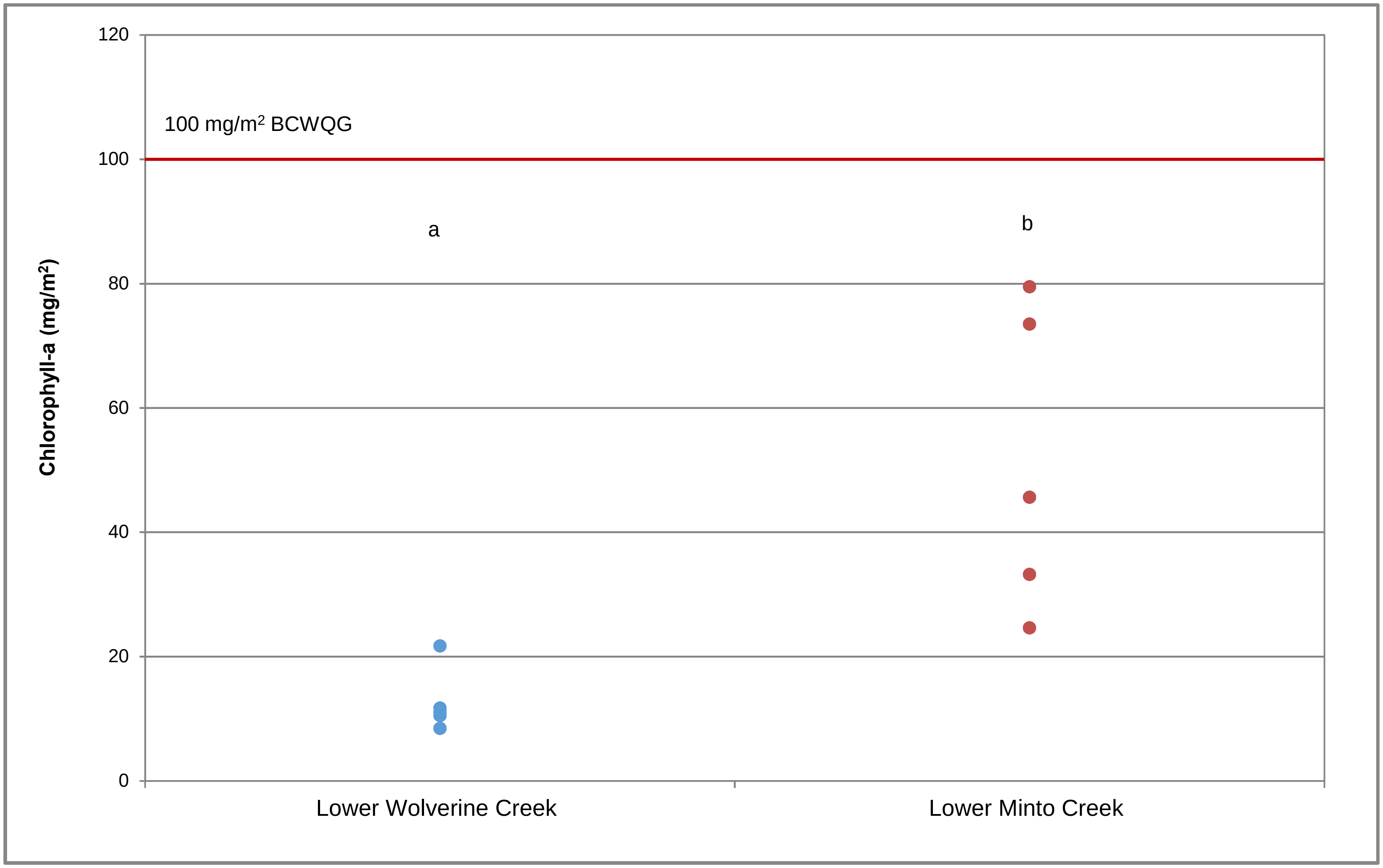


Figure 3.3: **Concentrations of Chlorophyll-a in Periphyton Measured at Five Benthic Stations in Lower Wolverine and Lower Minto Creeks, Minto Mine WUL, 2017**

Note: Different letters represent significant differences between areas.

Chlorophyll-a concentrations have been variable over time and between areas but concentrations are often higher (not always significantly different) and below BCWQG at lower Minto Creek (Appendix Figure B.1). Dodd's et al (1998) classification system sets the trophic status of lower Minto Creek (51 mg/m^2) as mesotrophic and lower Wolverine Creek (13 mg/m^2) as oligotrophic. Based on only total phosphorus, both creeks would be defined as oligotrophic as was observed in previous years (Dodds et al. 1998).

3.3 Summary

Supporting measures collected in September 2017 indicated good Minto Creek water quality. Influence of the Minto Mine was evident in higher specific conductance than in reference creeks, however, water quality parameter concentrations were lower than WUL water quality objectives. Concentration of total copper at upper Minto Creek was higher than CWQG and the reference area but dissolved copper was much lower than the WUL water quality objectives. Moving downstream, total copper concentrations were lower than CWQG at lower Minto Creek indicating natural elevation in upper Minto Creek. Mean concentrations of chlorophyll-a was significantly higher at lower Minto Creek compared to lower Wolverine Creek but were below BCWQG. Compared to 2016, production at the exposure and reference areas were different than in 2017; Minto Creek was defined as mesotrophic and lower Wolverine was oligotrophic.

4 SEDIMENT QUALITY

4.1 Sediment Particle Size and Chemistry

Sediment data quality were assessed prior to data analysis and interpretation, and were judged to be of good quality (Appendix A). Sediments collected in 2017 were largely composed of fine particles in the silt and sand size categories (Figure 4.1, Table 4.1, Appendix Table C.1). Mean total organic carbon (TOC) content of sediment collected from upper Minto Creek (2.8%) was slightly higher than at the upper McGinty Creek reference area (2.6%; Table 4.1). Lower Minto Creek (5.2%) had lower TOC than the lower Wolverine Creek reference area (6.5%; Table 4.1). Arsenic and copper were the only analytes with mean concentrations greater than Interim Sediment Quality Guidelines (ISQG) for the protection of aquatic life (CCME 1999) in an effluent-exposed area (Table 4.1, Appendix Table C.1). However, mean arsenic concentration in upper Minto Creek was below ISQG and lower than the reference area, upper McGinty Creek (which was greater than ISQG). This suggests that arsenic concentrations were unrelated to the mine. Mean copper concentrations in upper and lower Minto Creek were greater than the ISQG, and maximum copper concentration at upper Minto Creek was above the Probable Effect Level (PEL). Both areas had higher concentrations than the corresponding reference areas, which were lower than the ISQG (Figure 4.2, Table 4.1). With progression from upper to lower Minto Creek, sediment copper concentrations decreased from a mean of 155 to 49 mg/kg, respectively, indicating improvement with distance downstream.

Due to the predominantly erosional habitat in upper Minto Creek, relatively few areas had deposited sediment and even this only occurred in small quantities that likely wash away each year during freshet. Therefore, elevated copper in fine sediment in the upper reaches of Minto Creek may be of limited importance in terms of exposure and potential effects to biota. In lower Minto Creek, fine sediment deposits were somewhat more common and therefore more relevant to aquatic life.

4.2 Temporal Comparisons

Particle size distribution in 2017 was similar to distribution observed from 2010 to 2016 but was notably different from data collected prior to 2010, which employed different sampling methodology (Figure 4.1). Mean copper concentration at upper Minto Creek in 2017 was greater than the ISQG as was the case in all previous years, including the 1994 baseline (Figure 4.2). At lower Minto Creek, mean copper concentration in 2017 was greater than ISGQ as was the case during most years, and was greater than 1994 baseline (Figure 4.2, Table 4.1, Appendix Table C.1). This does not necessarily indicate an influence of the Minto Mine as concentrations were within the historical range and sampling methodology applied in 1994 was

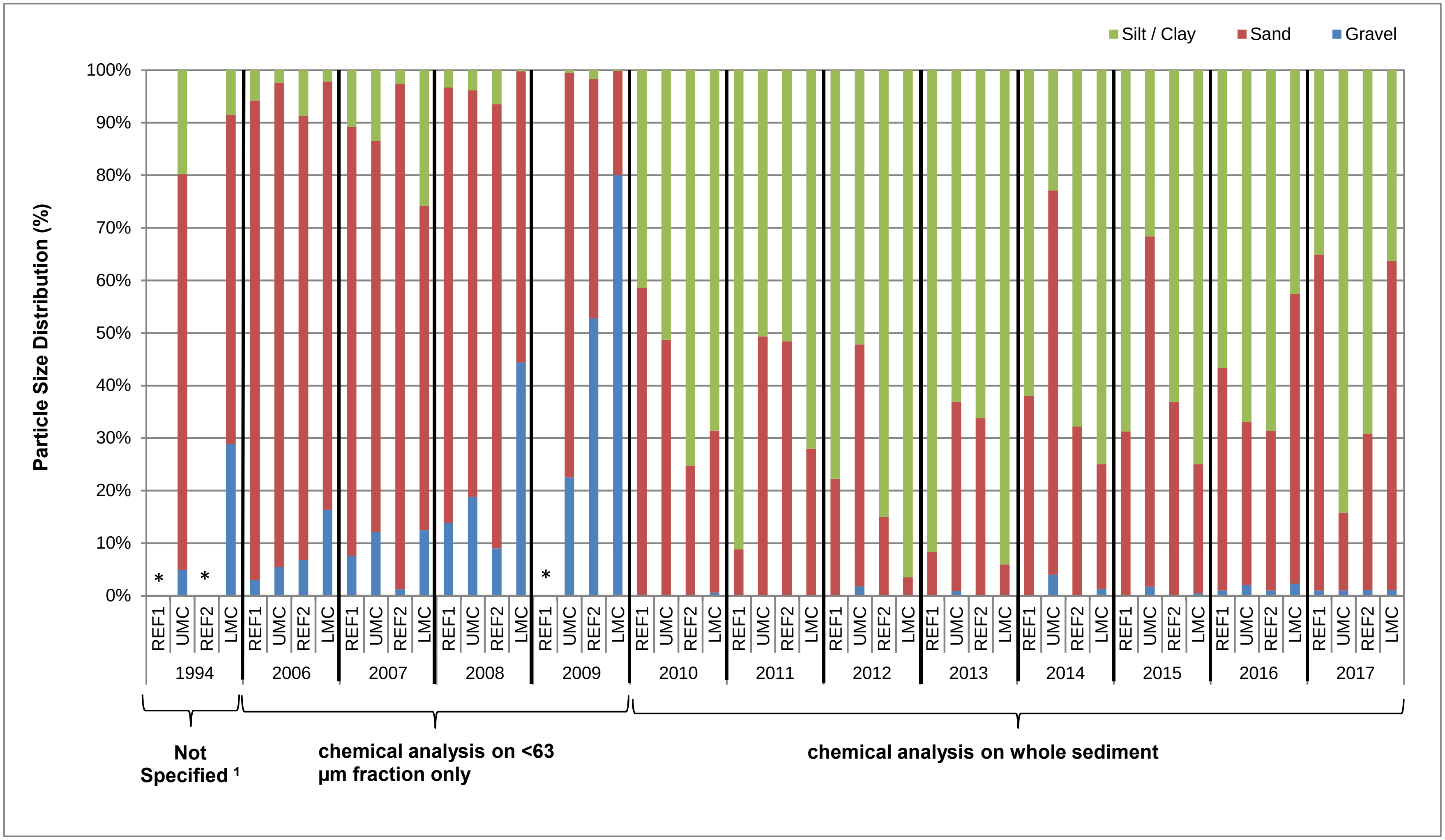


Figure 4.1: Particle Size Distribution of Sediment Collected in Minto Creek and Reference Locations, 1994 to 2017 [2]

---

[1] Methods were not specified, fine sediment was collected in triplicate in the mainstem of Minto Creek (HKP 1994).

[2] REF1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2017; UMC = Upper Minto Creek; REF2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2017; LMC = Lower Minto Creek.

* No data.

Table 4.1: Summary of Sediment Chemistry Data Collected at Exposed and Reference Areas, Minto Mine WUL, 2017

	Analytes	Units	CSQG [a]		Upper McGinty Creek (Reference)				Upper Minto Creek (Exposed)				Lower Wolverine Creek (Reference)				Lower Minto Creek (Exposed)			
			ISQG	PEL	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Particle size, TKN, carbon analytes and pH	Loss on Ignition	%	-	-	5.8	2.5	4.0	10	5.6	2.6	2.0	9.0	14	2.8	10	17	10	2.3	8.0	14
	pH (1:2 soil:water)	pH units	-	-	7.09	0.45	6.63	7.69	7.88	0.26	7.46	8.16	6.92	0.19	6.69	7.18	7.86	0.12	7.70	8.02
	% Gravel (>2mm)	%	-	-	-	-	-	-	-	-	-	-	<1.0	-	<1.0	<1.0	1.0	-	<1.0	1.2
	% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	-	-	-	-	30	18	11	57	15	12	3.3	33
	% Silt (0.063mm - 4μm)	%	-	-	-	-	-	-	-	-	-	-	65	17	40	84	75	13	55	87
	% Clay (<4μm)	%	-	-	-	-	-	-	-	-	-	-	5.1	1.0	3.4	6.0	10	0.85	9.1	11
	Total Kjeldahl Nitrogen	%	-	-	0.13	0.042	0.096	0.20	0.13	0.058	0.049	0.19	0.31	0.073	0.21	0.39	0.26	0.044	0.22	0.33
	Inorganic Carbon	%	-	-	0.081	0.019	0.055	0.11	0.12	0.041	0.064	0.16	0.14	0.024	0.11	0.16	0.16	0.021	0.14	0.19
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%	-	-	0.68	0.16	0.46	0.91	1.0	0.34	0.54	1.3	1.1	0.20	0.93	1.4	1.4	0.17	1.2	1.6
	Total Carbon by Combustion	%	-	-	2.7	0.99	1.8	4.4	2.9	1.5	0.99	4.6	6.7	1.7	5.1	9.4	5.4	1.5	4.0	7.6
	Total Organic Carbon	%	-	-	2.6	0.97	1.8	4.3	2.8	1.5	0.93	4.4	6.5	1.7	5.0	9.2	5.2	1.5	3.9	7.4
Total Metals	Aluminum (Al)	mg/kg	-	-	8,100	1,733	6,050	10,700	10,658	1,133	9,060	11,800	15,540	1,989	13,000	18,500	13,820	1,152	12,300	15,200
	Antimony (Sb)	mg/kg	-	-	0.30	0.052	0.26	0.39	0.49	0.13	0.38	0.71	0.49	0.031	0.46	0.54	0.52	0.056	0.45	0.58
	Arsenic (As)	mg/kg	5.9	17	6.5	1.6	4.1	8.1	5.8	0.32	5.5	6.3	5.6	0.98	4.3	6.7	7.3	0.67	6.6	8.2
	Barium (Ba)	mg/kg	-	-	141	46	87	213	202	70	127	281	202	12	187	220	236	20	214	257
	Beryllium (Be)	mg/kg	-	-	0.26	0.049	0.21	0.34	0.41	0.037	0.36	0.45	0.80	0.031	0.77	0.85	0.48	0.049	0.41	0.53
	Bismuth (Bi)	mg/kg	-	-	<0.20	-	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	-	<0.20	<0.20
	Boron (B)	mg/kg	-	-	<5.0	-	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	-	<5.0	<5.0
	Cadmium (Cd)	mg/kg	0.60	3.5	0.11	0.056	0.076	0.21	0.20	0.086	0.10	0.30	0.26	0.036	0.23	0.31	0.22	0.036	0.17	0.25
	Calcium (Ca)	mg/kg	-	-	6,150	1,938	4,850	9,560	7,754	1,393	5,770	9,120	10,776	908	9,580	11,700	10,830	1,372	8,650	12,100
	Chromium (Cr)	mg/kg	37	90	16	3.2	12	21	26	1.9	25	29	48	4.7	42	55	32	2.2	29	34
	Cobalt (Co)	mg/kg	-	-	7.2	1.9	5.8	10	10	1.1	9.2	12	13	0.33	13	13	11	0.53	10	12
	Copper (Cu)	mg/kg	36	197	14	3.6	11	20	155	96	46	274	30	4.3	28	38	49	5.5	44	57
	Iron (Fe)	mg/kg	-	-	19,820	3,175	15,400	23,800	23,080	1,361	21,700	25,200	27,000	587	26,200	27,700	25,140	1,563	23,800	27,700
	Lead (Pb)	mg/kg	35	91	3.4	0.61	2.8	4.5	5.6	0.56	4.9	6.3	6.5	0.47	6.0	7.3	6.0	0.47	5.5	6.6
	Lithium (Li)	mg/kg	-	-	5.3	0.77	4.4	6.5	7.7	1.0	6.6	8.6	11	1.5	9.4	14	11	0.96	9.2	12
	Magnesium (Mg)	mg/kg	-	-	3,384	515	2,760	4,190	6,356	521	5,660	6,880	9,674	825	8,760	11,000	7,118	413	6,600	7,610
	Manganese (Mn)	mg/kg	-	-	519	312	245	1,050	2,085	1,506	491	3,690	410	174	204	549	975	140	813	1,120
	Mercury (Hg)	mg/kg	0.17	0.49	0.039	0.020	0.017	0.060	0.022	0.0064	0.012	0.028	0.044	0.0026	0.041	0.047	0.035	0.0058	0.028	0.041
	Molybdenum (Mo)	mg/kg	-	-	0.44	0.12	0.32	0.65	1.5	0.73	0.76	2.4	0.59	0.058	0.54	0.68	0.68	0.071	0.59	0.76
	Nickel (Ni)	mg/kg	-	-	13	2.0	11	16	26	2.3	24	29	38	2.5	35	42	28	1.3	28	30
	Phosphorus (P)	mg/kg	-	-	771	79	687	882	892	30	861	933	1,050	36	988	1,080	870	43	832	937
	Potassium (K)	mg/kg	-	-	548	97	440	690	1,298	147	1,140	1,510	1,134	110	1,020	1,300	1,196	86	1,100	1,330
	Selenium (Se)	mg/kg	-	-	0.35	0.078	0.24	0.45	0.51	0.24	<0.20	0.78	0.39	0.044	0.34	0.44	0.57	0.11	0.44	0.70
	Silver (Ag)	mg/kg	-	-	<0.10	-	<0.10	<0.10	0.13	0.063	<0.10	0.24	0.10	0.0057	<0.10	0.11	0.10	0.0057	<0.10	0.11
	Sodium (Na)	mg/kg	-	-	173	20	147	198	326	18	308	350	458	33	417	500	317	22	281	335
	Strontium (Sr)	mg/kg	-	-	50	10	39	66	91	22	62	116	103	10	91	114	108	16	83	125
	Thallium (Tl)	mg/kg	-	-	0.053	-	<0.05	0.063	0.082	0.010	0.071	0.10	0.093	0.012	0.080	0.11	0.10	0.010	0.087	0.11
	Tin (Sn)	mg/kg	-	-	<2.0	-	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	-	<2.0	<2.0
	Titanium (Ti)	mg/kg	-	-	525	112	355	645	622	47	573	683	762	187	436	916	747	84	648	867
	Uranium (U)	mg/kg	-	-	0.87	0.33	0.56	1.4	0.89	0.25	0.54	1.2	3.2	0.44	2.7	3.8	1.2	0.25	0.94	1.5
	Vanadium (V)	mg/kg	-	-	37	6.3	31	48	52	4.0	50	59	70	2.1	67	73	54	3.6	51	60
	Zinc (Zn)	mg/kg	123	315	34	6.4	27	44	59	9.5	48	68	63	6.8	55	74	60	5.2	55	68

🟦 Indicates sediment concentration exceeding CSQG ISQG.

🟩 Indicates sediment concentration exceeding CSQG PEL.

☐ Indicates sediment concentration exceeding higher reference mean by more than two times.

[a] Canadian Sediment Quality Guidelines: ISQG = interim sediment quality guideline; PEL = probable effect level (CCME 1999).

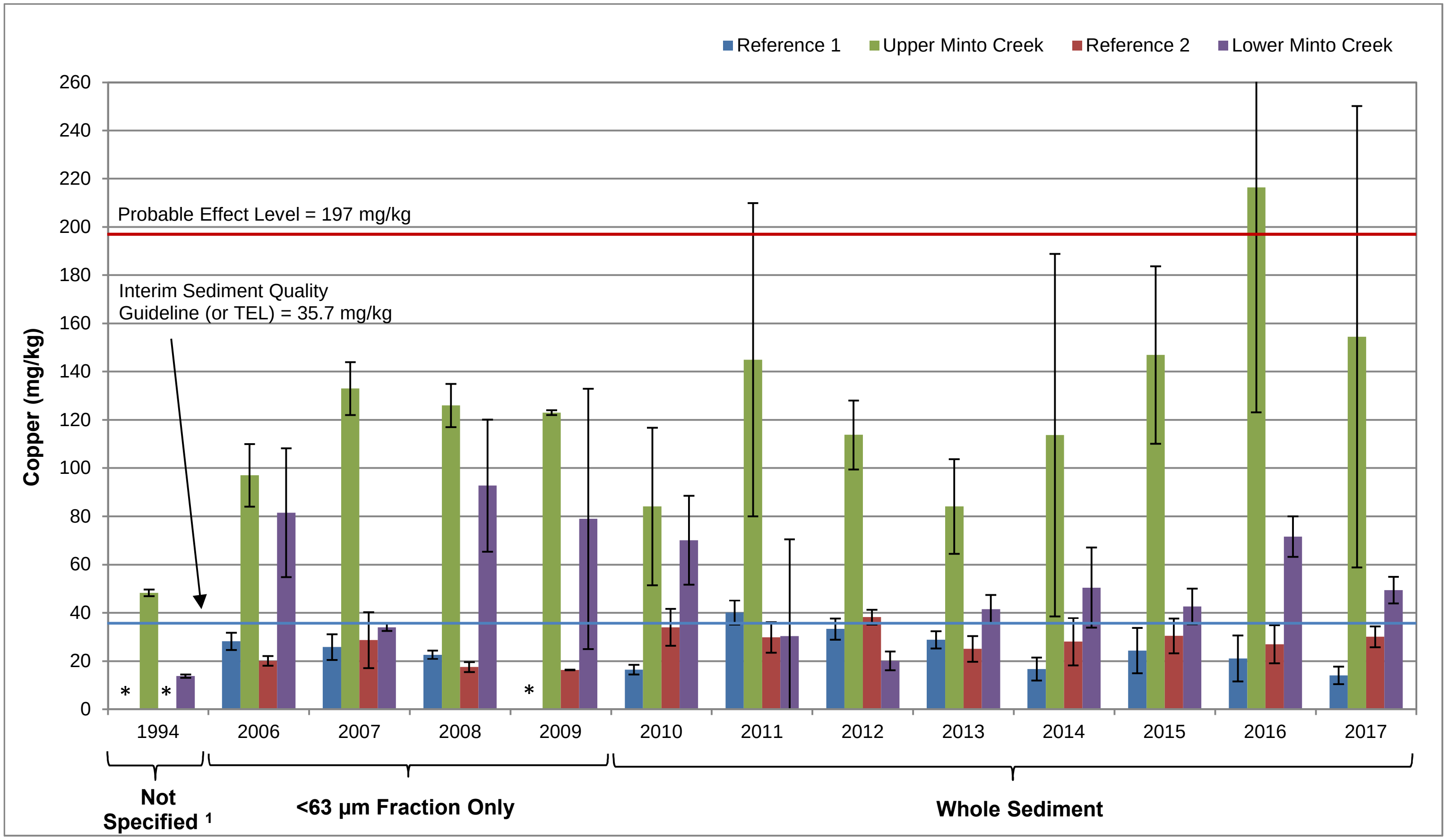


Figure 4.2: **Copper Concentrations (Mean ± Standard Deviation) in Sediment Collected in Minto Creek and Reference Locations, 1994 to 2017** [2]

[1] Methods were not specified, fine sediment was collected in triplicate in the mainstem of Minto Creek (HKP 1994).

[2] Reference 1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2017; Reference 2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2017.

* = no data.

TEL = Threshold Effect Level.

unspecified.

4.3 Sediment Toxicity

Sediment toxicity test conditions and associated supporting water quality parameters were all within the range outlined in the test protocols, and testing was judged to be acceptable (Appendix A). Survival and growth were evaluated using the 10-day test of *C. dilutus* (midge) and the 14-day test of *H. azteca* (amphipod).

No effects to *H. azteca* survival or growth were observed (Table 4.2). Survival of *C. dilutus* was significantly lower in sediment collected from lower Minto Creek than in laboratory control sediment (sand) and field reference sediment (lower Wolverine Creek) (Table 4.2). Growth of *C. dilutus* was significantly greater in lower Minto Creek sediment compared to the reference sediment. In 2016, growth of *C. dilutus* was greater at lower Minto Creek but not significantly so. *H. azteca* results (no effects in 2017) were similar to those of 2011, 2015, and 2016 (Minnow 2012, 2016, 2017). Differences from previous years observed at lower Minto Creek in *C. dilutus* survival and growth suggest a possible adverse effect, but are not consistent with the results of previous years despite similar sediment chemistry.

4.4 Summary

Overall, concentrations of metals in Minto Creek sediments were similar to reference and lower than sediment quality guidelines with the exception of copper. Concentrations of copper in Minto Creek (both upper and lower) were greater than the sediment quality guideline and reference. Copper concentrations in sediment were similar to results seen after the methodology change and lower than concentrations in 2008. Sediment toxicity testing of *C. dilutus* suggested adverse effects to survival or growth in lower Minto Creek sediment when compared to the laboratory control (no significant difference for growth) and the field reference (lower Wolverine Creek). No effects to *H. azteca* were observed.

Table 4.2: Minto Mine Effluent Sediment Toxicity Test Results Collected for Lower Wolverine and Lower Minto Creeks, September 2017

Area	*Hyalella azteca*		*Chironomus dilutus*	
	Survival (%)	**Dry Weight (mg)**	**Survival (%)**	**Dry Weight (mg)**
Control Sediment	96 ± 5.5	0.11 ± 0.020	86 ± 8.9	1.2 ± 0.25
Lower Wolverine Creek (Reference)	94 ± 5.5	0.13 ± 0.030	90 ± 17	2.0 ± 0.24
Lower Minto Creek (Exposed)	92 ± 13	0.11 ± 0.020	🟦 48 ± 38	🟩 1.6 ± 0.32

▨ Significantly different than control sediment.
🟩 Significantly different than reference sediment.
🟦 Significantly different than reference and control sediment.

Note: Data presented as mean ± standard deviation.

5 PERIPHYTON COMMUNITY

5.1 Primary Metrics and Community Composition

Quality of periphyton community data was assessed prior to data analysis and interpretation, and close agreement was shown between field duplicate samples except for Rhodophyta, due to low abundance of this group (Appendix A). Analysis of periphyton community density (cells/cm^2) indicated that four of the five periphyton community metrics (density, Simpson's Diversity, Simpson's Evenness and Bray-Curtis index) were significantly higher at lower Minto Creek than at lower Wolverine Creek (Table 5.1a, Appendix Table D.1, D.3). Only taxon richness was not significantly different between areas. This indicates that the lower Minto Creek benthic invertebrate community had higher density and a different community structure than the reference areas.

Analysis of periphyton community biomass (µg/cm^2) indicated that one out of five metrics (Bray-Curtis index) was significantly higher at lower Minto Creek compared to lower Wolverine Creek, both areas had similar density, taxon richness, and Simpson's diversity and evenness (Table 5.1b, Appendix Table D.2, D.4).

Dominant phyla in lower Minto and Wolverine creeks were Bacillariophycae and Cyanophyta (blue-green algae). Cyanophyta were dominant at lower Minto Creek (51% of community) and Bacillariophycae (95% of the community; Figure 5.1) dominated lower Wolverine Creek. Little information is available regarding specific periphyton taxon group sensitivities and tolerances to mining activities to assist in interpretation (Deniseger et al. 1986, De Jonge et al. 2008).

5.2 Temporal Comparisons

Substantial temporal variability in periphyton community composition was evident among samples taken in Minto Creek and reference since 1994 (Figure 5.1). For example, at lower Minto Creek, Bacillariophycae (diatoms) were dominant in 1994, 2013, 2014, and 2016, Rhodophyta (red algae) in 2012, and Cyanophyta (blue-green algae) in 2011, 2015, and 2017 (Figure 5.1). This lack of temporal consistency was also observed at lower Wolverine Creek, with Cyanophyta dominant in 2011 and 2013 and Bacillariophycae in 2012 and 2014 to 2017 (Minnow 2013a, 2014, 2015, 2016, 2017).

5.3 Summary

Evaluation of periphyton community density (cells/cm^2) and biomass (µg/cm^2) indicated significant differences in a number of metrics in lower Minto Creek relative to the lower Wolverine Creek reference. In general, the periphyton community of lower Minto Creek and lower Wolverine Creek had different community structures. However, differences in periphyton community summary

Table 5.1: Statistical Contrasts of Periphyton Density (cells/cm^2) and Biomass (µg/cm^2) Community Metrics between Lower Wolverine Creek and Lower Minto Creek Areas, Minto Mine WUL, 2017

A) Density (cells/cm^2)

Endpoint	Data Transformation	Test	Test P-value	Mean or Median [a]		Observed Effect Size (LMC - LWC)/SD
				LMC	LWC	
Density	log	T	0.046	83,619	51,274	1.6
Taxon Richness	none	T	0.178	14	12	0.99
Simpson's Evenness	none	T	0.001	0.36	0.25	3.3
Simpson's Diversity	rank	MW	0.009	0.82	0.67	-
Bray-Curtis Index	square root	T	<0.001	0.84	0.12	11

B) Biomass (µg/cm^2)

Endpoint	Data Transformation	Test	Test P-value	Mean or Median [a]		Observed Effect Size (LMC - LWC)/SD
				LMC	LWC	
Density	square root	T	0.228	33	45	-0.88
Taxon Richness	none	T	0.178	14	12	0.99
Simpson's Evenness	none	T	0.156	0.39	0.32	1.0
Simpson's Diversity	rank	MW	0.117	0.82	0.75	-
Bray-Curtis Index	none	T	<0.001	0.76	0.35	3.6

▨ P-value < 0.10.

🟦 Effect size magnitude > 2.

Notes: Observed effect size = (exposure mean - reference mean)/pooled standard deviation.

T = Two-sample t-test.

MW = Mann Whitney test.

[a] For transformed data, the back-transformed mean is reported; for ranked data, the median is reported.

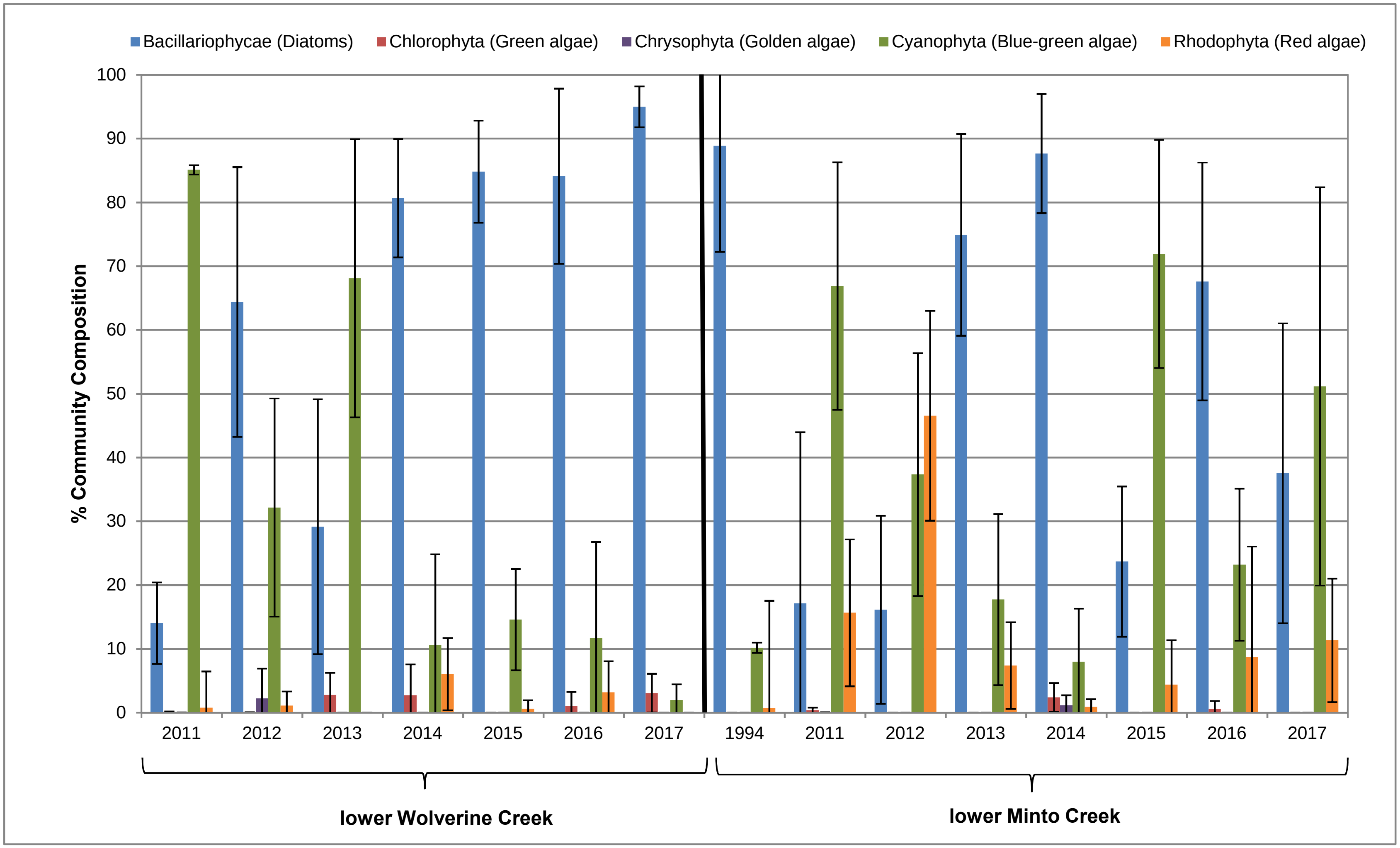


Figure 5.1: Periphyton Community (cells/cm^2) Composition in Lower Minto Creek (1994, 2011 to 2017) and Lower Wolverine Creek (2011 to 2017)

Note: Data presented as mean ± standard deviation.

metrics and community composition were apparent among years at both lower Minto Creek and lower Wolverine Creek, indicating substantial temporal variability. The differences observed in the periphyton communities of lower Minto Creek and lower Wolverine Creek in 2017 were within natural temporal variability and do not provide any resolution of potential mine influence.

6 BENTHIC INVERTEBRATE COMMUNITY

6.1 Primary Metrics and Community Composition

Benthic invertebrate community data quality were assessed prior to data analysis and interpretation, and were judged to be of good quality (Appendix A). Benthic invertebrate community metrics of density, Simpson's diversity, and Simpson's evenness were not significantly different among areas (Table 6.1, Appendix Table E.3). Number of taxa and Bray-Curtis index showed significant differences among areas, but lower Minto Creek was intermediate between the reference areas (Table 6.1, Figure 6.1). This suggests a limited mine influence (Table 6.1, Appendix Table E.3).

Dominant taxonomic groups in lower Minto, lower Wolverine and lower Big creeks included EPT taxa, chironomids (non-biting midges) and oligochaetes (worms; only dominant at reference areas). Percent EPT did not differ significantly among areas, but there were differences in the abundances of chironomids and oligochaetes (Figure 6.2, Table 6.1, Appendix Table E.1 to E.3). The relative abundance of chironomids was significantly greater at lower Minto Creek (31%) compared to lower Wolverine Creek (4.7%; Figure 6.2, Table 6.1, Appendix Table E.1 to E.3). Oligochaetes were a small proportion of the community at lower Minto Creek (6.8%) compared to higher proportions at lower Wolverine (68%; significantly higher) and lower Big creeks (15%; not significantly higher). The higher proportion of chironomids suggests a potential mine influence, but in combination with the lower proportion of oligochaetes together with similar percent EPT taxa between areas, suggests a limited influence of the mine on benthic invertebrate community (Chapman et al. 1982a,b, Rosenberg and Resh 1993, Taylor and Bailey 1997).

Correspondence Analysis (CA) explained 63.7 percent of the total community variance in the first two CA axes (Appendix Table E.5). The first CA axis explained 34.8 percent of the total variation in the original benthic abundance data, and significantly separated lower Minto Creek from lower Wolverine and lower Big creeks (Table 6.1, Figure 6.3). Lower Minto Creek had strong positive CA Axis-1 scores and were separated from lower Wolverine and lower Big creeks by high relative abundance of the Plecoptera (stonefly) *Nemoura*, chironomids *Eukiefferiella*, the mite *Sperchon*, and the cranefly *Antocha* (Figure 6.3, Appendix Table E.4, E.5). The reference areas had strong negative CA Axis-1 scores and was dominated by the Ephemeroptera (mayflies) Family Heptageiidae (Figure 6.3, Appendix Table E.4, E.5). The reference areas were separated on CA Axis-2 (which explained 28.9% of the total variation) and lower Minto Creek was significantly different and intermediate between both reference areas. (Table 6.1, Figure 6.3).

Table 6.1: **Statistical Comparisons of Benthic Invertebrate Community Metrics, Minto Mine WUL, 2017**

Metric	Comparison		Area Means		Statistical Contrasts		
	Exposure Site	Reference Site			Significant Difference between areas?	Direction	P-value [a]
Density (organisms/m^2)	lower Minto Creek	lower Wolverine Creek	345	174	NO	-	0.208
		lower Big Creek		229	NO	-	
Number of Taxa	lower Minto Creek	lower Wolverine Creek	18	16	NO	-	0.813
		lower Big Creek		24	NO	-	0.213
Simpson's Diversity [b]	lower Minto Creek	lower Wolverine Creek	0.70	0.48	NO	-	0.105
		lower Big Creek		0.78	NO	-	
Simpson's Evenness [b]	lower Minto Creek	lower Wolverine Creek	0.22	0.18	NO	-	0.555
		lower Big Creek		0.20	NO	-	
BC Index to Combined Reference Median	lower Minto Creek	lower Wolverine Creek	0.79	0.82	NO	-	0.847
		lower Big Creek		0.67	NO	-	0.192
EPT (%) [c]	lower Minto Creek	lower Wolverine Creek	48	25	NO	-	0.161
		lower Big Creek		47	NO	-	
Chironomids (%)	lower Minto Creek	lower Wolverine Creek	31	4.7	YES	Minto > Wolverine	0.004
		lower Big Creek		27	NO	-	0.800
Oligochaetes (%)	lower Minto Creek	lower Wolverine Creek	6.8	65	YES	Minto < Wolverine	0.001
		lower Big Creek		15	NO	-	0.389
CA Axis-1 (34.8%)	lower Minto Creek	lower Wolverine Creek	224	-212	YES	Minto > Wolverine	0.011
		lower Big Creek		-214	YES	Minto > Wolverine	0.006
CA Axis-2 (28.9%)	lower Minto Creek	lower Wolverine Creek	10	190	YES	Minto < Wolverine	0.007
		lower Big Creek		-169	YES	Minto < Wolverine	0.007

▨ Indicates a statistically significant difference between exposed and reference areas, p = 0.10.

[a] The overall p-value of the 3 group comparison used if there were no significant differences between all areas.

[b] Calculated as recommended by Environment Canada 2012.

[c] Percent Ephemeroptera (mayfly), Plecoptera (stonefly), Trichoptera (caddisfly).

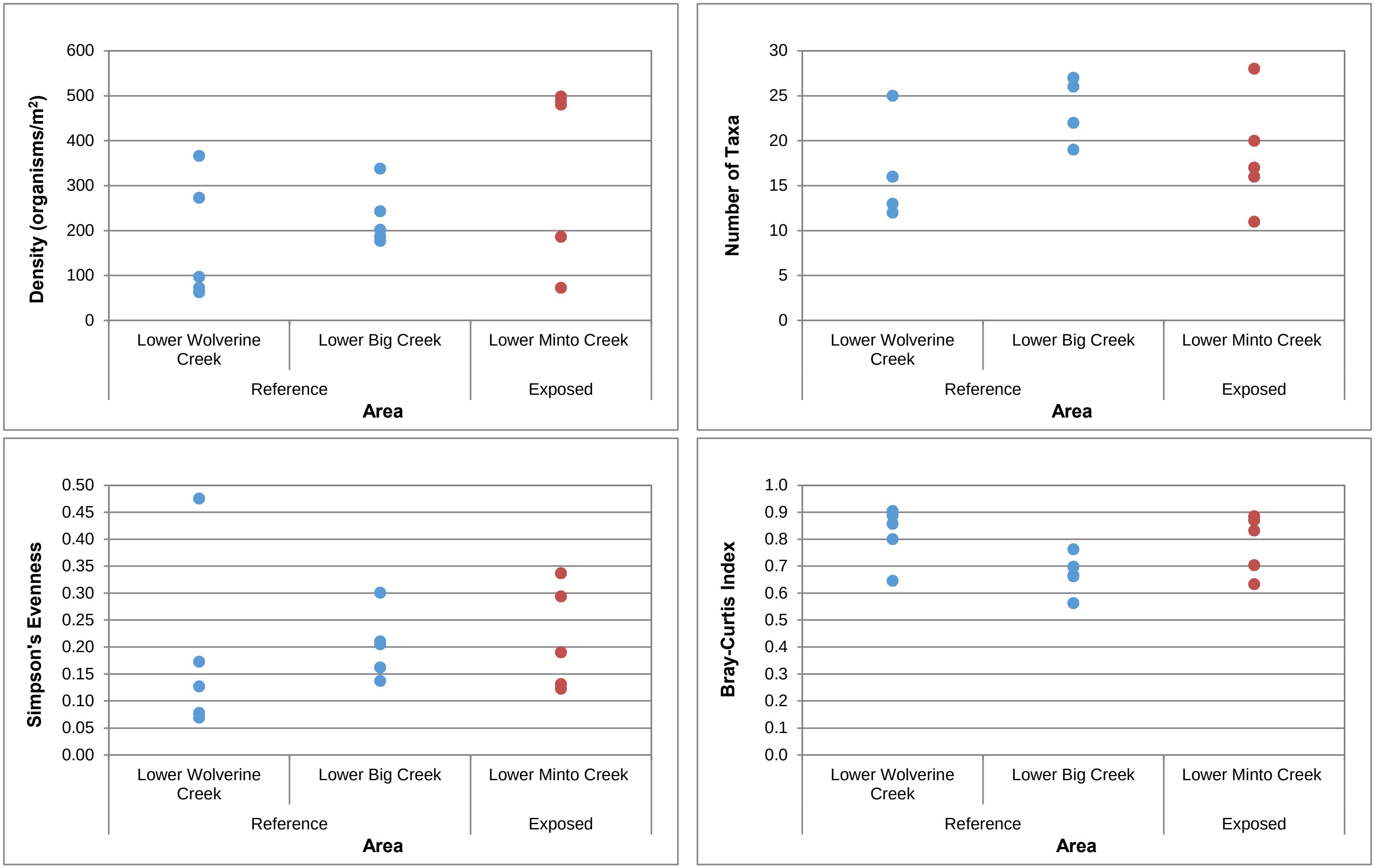


Figure 6.1: Comparison of Benthic Invertebrate Primary Metrics, Minto Mine, 2017

Notes: An Asterisk (*) above lower Minto Creek indicates exposed area was significantly different ($p < 0.10$) from both reference areas.

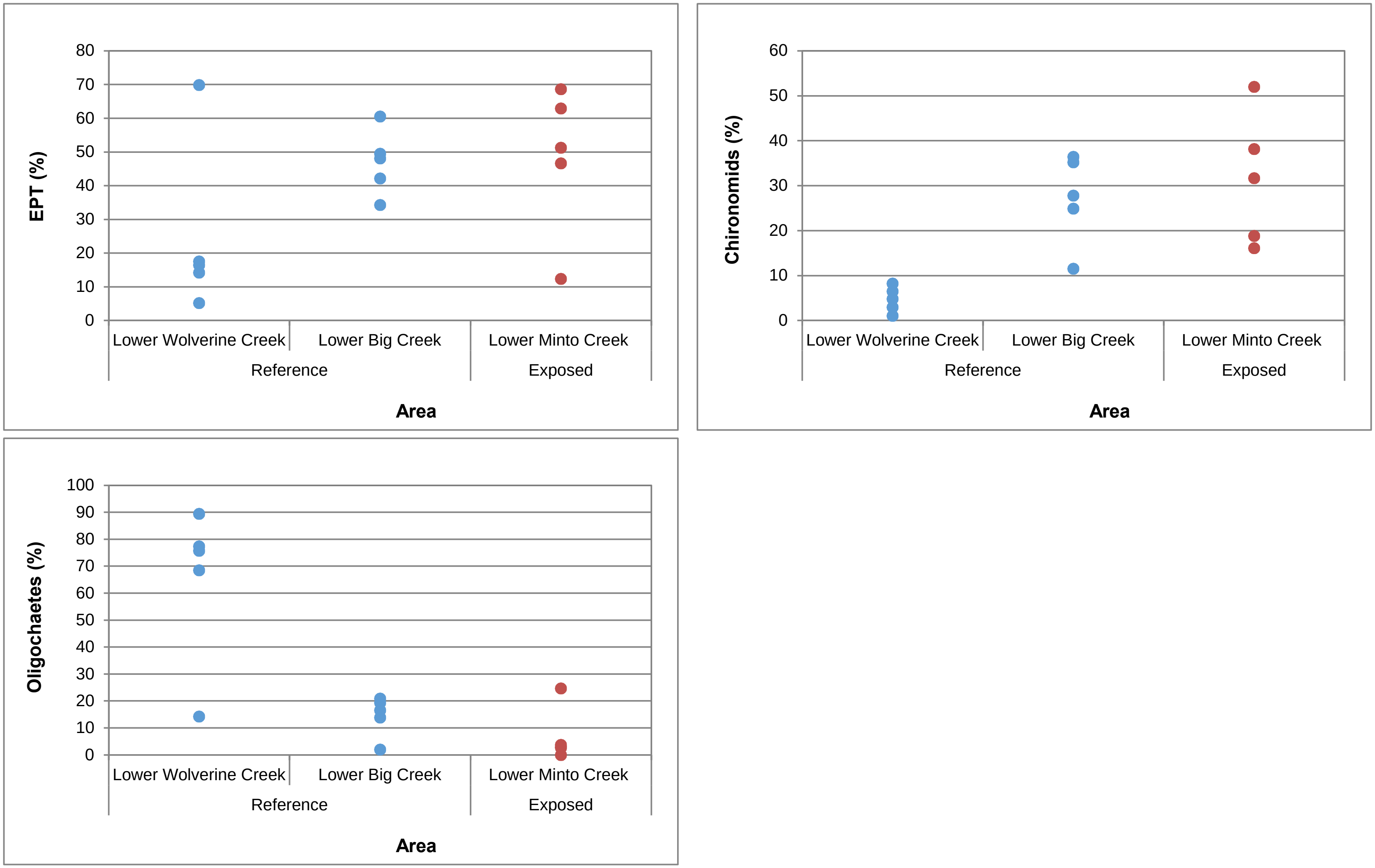


Figure 6.2: **Comparison of Benthic Invertebrate Supporting Metrics, Minto Mine, 2017**

Notes: An Asterisk (*) above lower Minto Creek indicates exposed area was significantly different ($p < 0.10$) from both reference areas.

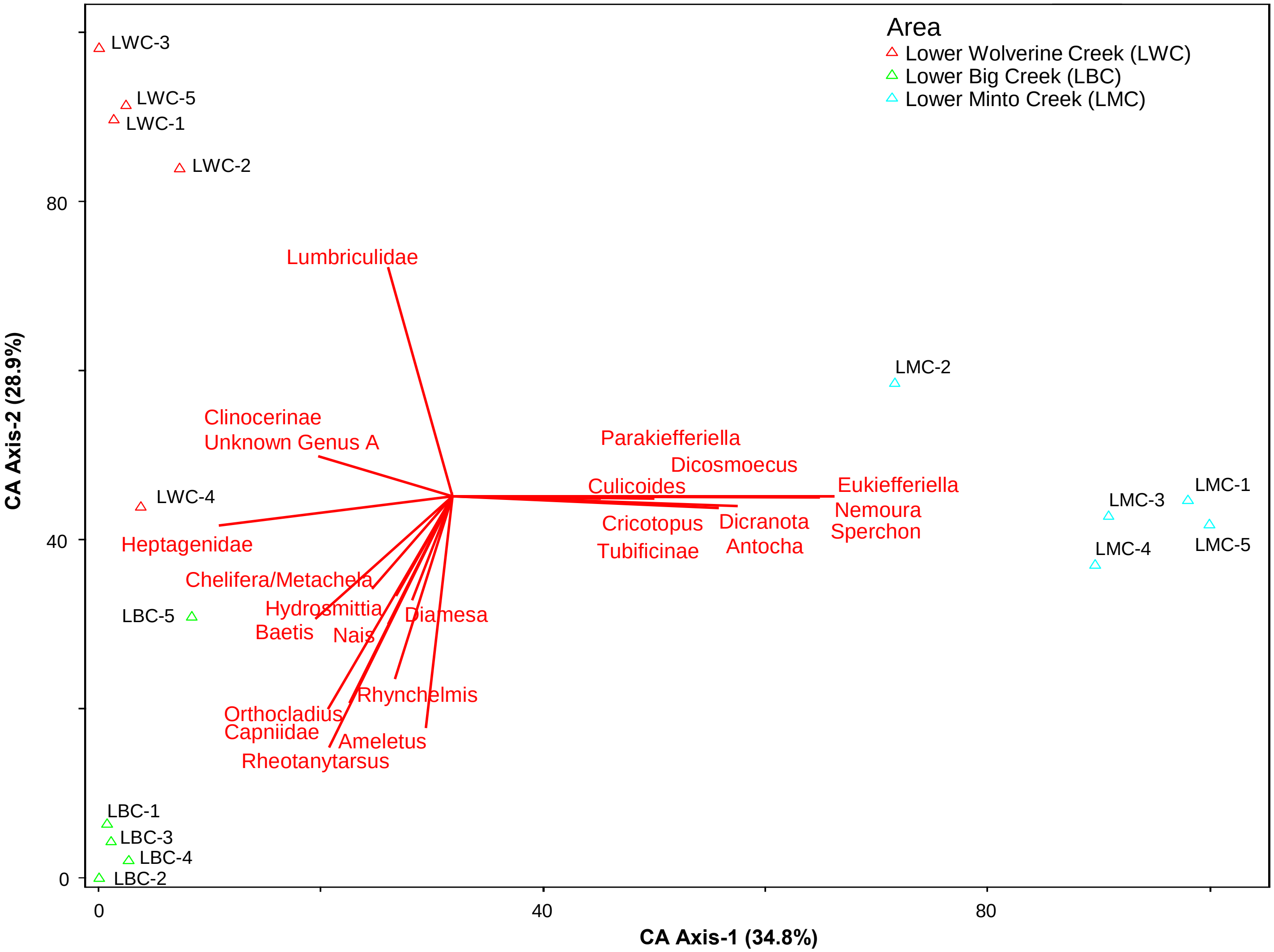


Figure 6.3: **Correspondence Analysis (CA) Ordination Biplot Displaying CA Axis-1 and CA Axis-2 of Benthic Invertebrate Community Lower Minto Creek and Associated Reference Areas, Minto Mine, 2017**

6.2 Correlation Analysis

Correlation analysis between eight benthic indices and six supporting measurements resulted in 16 significant correlations at a p-level of 0.050, of which four were significant at the Bonferroni-corrected p-level of 0.0010 (Table 6.2). It is important to consider that illustration of a significant or suggestive degree of correlation between two variables does not necessarily imply a cause-and-effect relationship, although it is cause to investigate further and to consider known biological responses to environmental differences.

Of the four correlations significant at the Bonferroni-corrected p-level, two were with specific conductance (Table 6.2, Figure 6.4). Percent Ephemeroptera was positively correlated and CA Axis-1 was negatively correlated with specific conductance (Table 6.2, Figure 6.4). CA Axis-1 scores were negatively correlated with depth and percent oligochaetes were negatively correlated with average depth Hess was pushed into the substrate (Table 6.2, Figure 6.4). High specific conductance is a mine influence but the CA Axis-1 score indicates a high proportion of the chironomid *Eukiefferiella*. Chironomid taxa are typically tolerant, but this taxon can be associated with very good to fair water quality in terms of organic pollution (Mandeville 2002).

6.3 Temporal Comparisons

Temporal comparisons of the benthic invertebrate community condition of lower Minto Creek were made in order to augment data interpretation, but their power was tempered by temporal changes in sampling location, sampling methodology, level of replication and analytical processing techniques. Baseline data (1994) were collected near the mouth of Minto Creek as three single grab samples, 2006 data were collected at Station W2 in the same manner, 2008 and 2010 data were collected at Station W2 as three-grab composites whereas 2011 to 2017 data were collected as five replicate three-grab samples from a large area upstream of Station W2. Only in the later years (2011 to 2017) do data represent an area (i.e., lower Minto Creek) rather than a station. In addition, data collected in 2013 to 2017 were sieved using 500 µm mesh as recommended for federal EEM (Environment Canada 2012), whereas all years prior to 2011 used 250 µm (both mesh sizes were used in 2012 to assist in transition). This was expected to result in lower densities in 2013 and later.

Benthic invertebrate density at lower Minto Creek in 2017 was lower than or similar to densities in 2012 (500 µm) and 2014 to 2016 but higher than in 2013 (Figure 6.5). Number of taxa at lower Minto Creek in 2017 was lower than in 1994 and within the historical range from 2006 onwards (Figure 6.5). Simpson’s Evenness was within the historical range documented after methodological change in 2011 (Figure 6.5). Over the 2012 to 2017 period, benthic invertebrate community metrics were stable.

Table 6.2: Correlations between Benthic Invertebrate Metrics and Supporting Environmental Measurements at Minto Mine WUL, 2017

		Depth (m)	Water Velocity (m/s)	Temperature (°C)	Specific Conductivity (µS/cm)	pH	Average Depth HESS into substrate (cm)
Number of Taxa	Pearson Correlation	0.019	0.45	0.38	-0.22	-0.065	0.28
	Sig. (2-tailed)	0.945	0.094	0.167	0.427	0.819	0.313
	N	15	15	15	15	15	15
BC Distance to Combined Reference Median	Pearson Correlation	0.056	-0.50	-0.41	0.18	-0.22	-0.38
	Sig. (2-tailed)	0.843	0.056	0.129	0.515	0.437	0.160
	N	15	15	15	15	15	15
Ephemeroptera (%)	Pearson Correlation	0.64	0.27	0.59	-0.85	-0.20	-0.51
	Sig. (2-tailed)	0.011	0.324	0.021	0.000	0.467	0.053
	N	15	15	15	15	15	15
Trichoptera (%)	Pearson Correlation	-0.49	-0.45	-0.43	0.58	0.020	0.43
	Sig. (2-tailed)	0.063	0.094	0.106	0.024	0.944	0.112
	N	15	15	15	15	15	15
Chironomids (%)	Pearson Correlation	-0.50	0.46	-0.057	0.50	0.50	0.61
	Sig. (2-tailed)	0.056	0.084	0.841	0.056	0.056	0.016
	N	15	15	15	15	15	15
Oligochaeta (%)	Pearson Correlation	0.57	-0.21	0.024	-0.56	-0.50	-0.80
	Sig. (2-tailed)	0.026	0.448	0.933	0.029	0.060	0.000
	N	15	15	15	15	15	15
CA Axis-1 (34.8%)	Pearson Correlation	-0.80	-0.36	-0.69	0.95	0.30	0.59
	Sig. (2-tailed)	0.000	0.192	0.005	0.000	0.283	0.021
	N	15	15	15	15	15	15
CA Axis-2 (28.9%)	Pearson Correlation	0.24	-0.63	-0.53	0.059	-0.52	-0.58
	Sig. (2-tailed)	0.396	0.011	0.040	0.835	0.044	0.024
	N	15	15	15	15	15	15

🟦 Correlation scatterplot inspected: $p < 0.050$.

🟧 Significant after Bonferroni correction; $p < 0.0010$ ($p = 0.050$ adjusted for 48 comparisons).

Note: Correlations only conducted with endpoints that were signficantly different between areas.

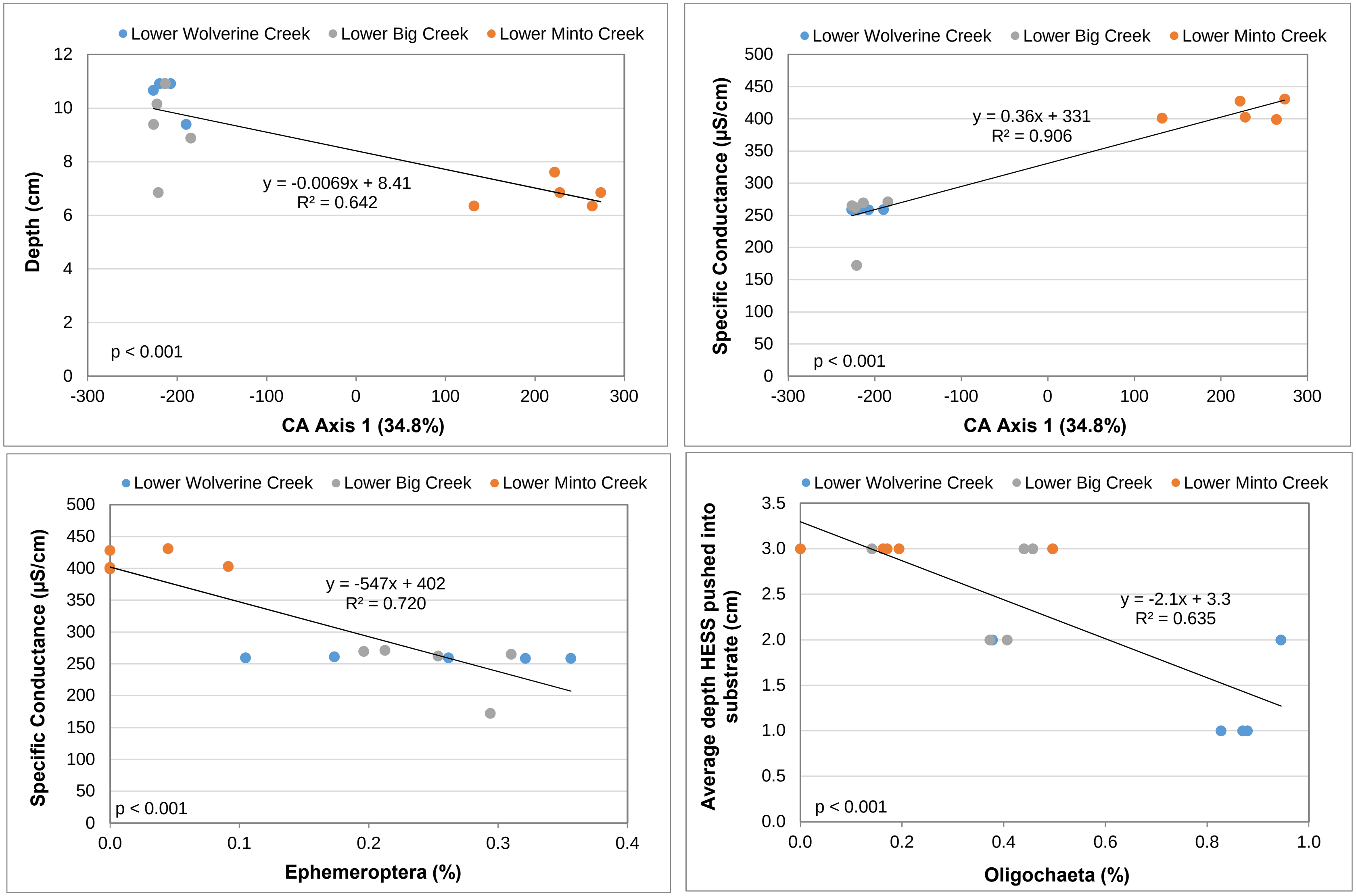


Figure 6.4: **Scatterplots of Significant Relationships (Bonferroni Corrected; p < 0.0010), Minto Mine WUL, 2017**

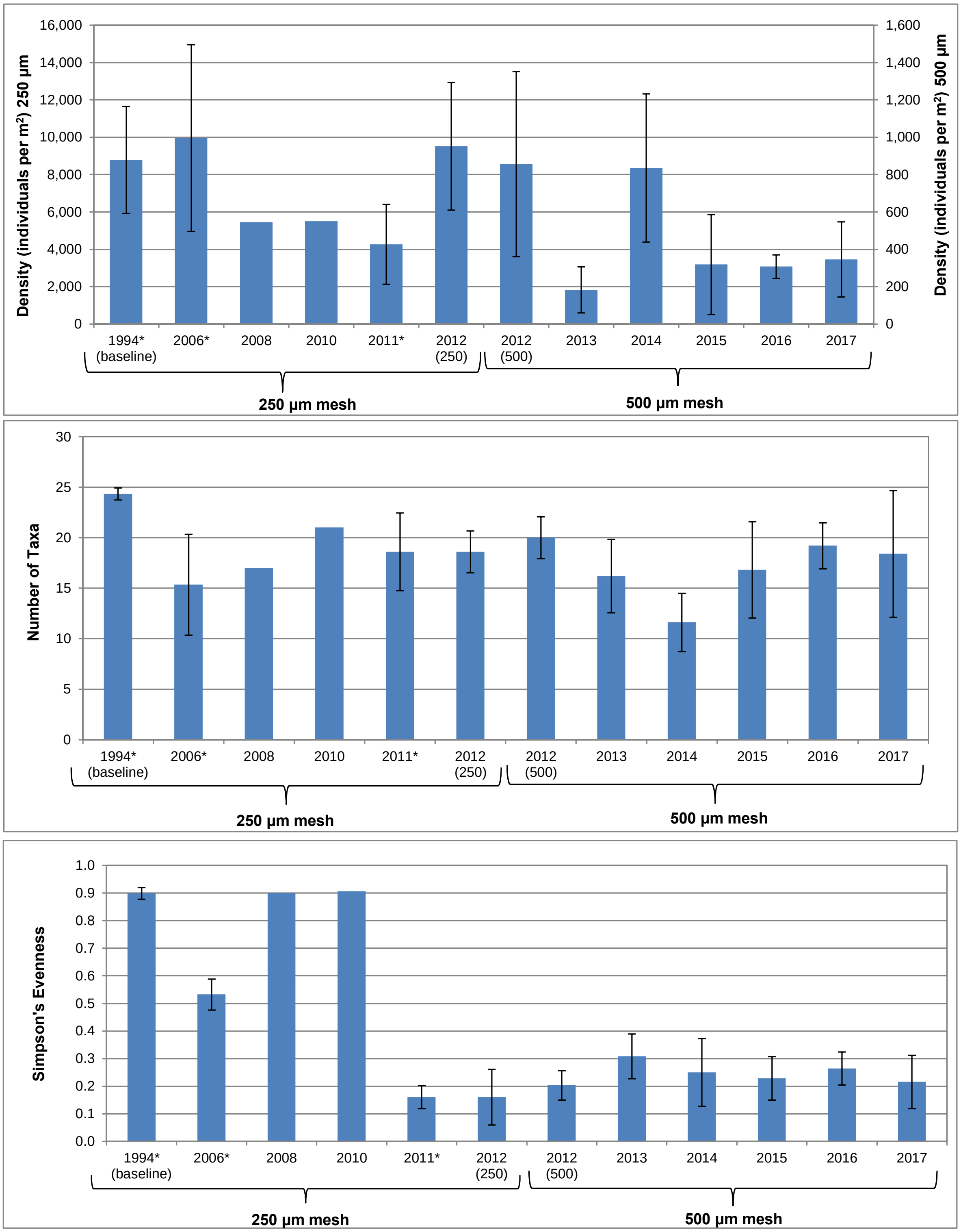


Figure 6.5: **Primary Benthic Invertebrate Community Metrics at Lower Minto Creek, 1994 to 2017**

Notes: Data presented as mean ± standard deviation where replicated. Asterisk (*) indicates a year the mine was not discharging.

6.4 Summary

The erosional benthic invertebrate community of lower Minto Creek did not differ from reference communities, or was intermediate between reference communities, for all metrics. A potential decrease in number of taxa from 2012 to 2014 identified in previous reporting (Minnow 2015) was not supported by the higher number of taxa in 2015 to 2017 and appears to represent natural variability (Minnow 2015, 2016, 2017). The similarity of the benthic community of lower Minto Creek to reference communities and the temporal stability in the benthic community of lower Minto Creek suggest limited mine influence.

7 TISSUE CHEMISTRY

As indicated in Section 2.5, tissue chemistry data are provided here simply to report the ancillary data collected along with the selenium data reported separately. Data interpretation were therefore limited to basic comparisons of metal concentrations in tissue collected at the exposure area (lower Minto Creek) to those collected at reference creeks (lower Wolverine and lower Big creeks).

7.1 Periphyton Tissue

Periphyton tissue data quality were assessed prior to data analysis and interpretation, and field duplicates showed poor agreement for seven analytes (Appendix A). However, none of these seven analytes differed between lower Minto Creek and both reference areas (Table 7.1, Appendix A).

Periphyton tissue concentrations were significantly greater at lower Minto Creek than at both reference areas for eight analytes (Table 7.1, Appendix Table C.2). Analytes of concern such as copper were significantly different from both reference areas whereas selenium was only significantly different from lower Minto Creek and lower Big Creek (Table 7.1). No significant differences were observed between areas for selenium in 2013 (Figure 7.1), whereas from 2014 to 2017, periphyton selenium concentrations were significantly greater at lower Minto Creek than at the reference areas (only between lower Big Creek in 2017; Figure 7.1). Significantly higher concentrations of selenium at lower Minto Creek compared to reference areas over the last three years suggest an influence of the mine on Minto Creek.

7.2 Benthic Invertebrate Tissue

Benthic invertebrate tissue data quality were assessed prior to data analysis and interpretation, and were judged to be of good quality, with the exception that field duplicate samples lacked close agreement for several analytes (Appendix A). Of the analytes that lacked close agreement, only eight analytes differed significantly at lower Minto Creek compared to both references areas (Figure 7.1, Appendix A).

Benthic invertebrate tissue concentrations were significantly higher at lower Minto Creek compared to both reference areas for ten analytes, significantly lower for sodium, and intermediate between reference for two analytes (Table 7.1, Appendix Table C.3). Only selenium has been identified as strongly mine-related (Sections 3.0 and 4.0) and was significantly higher at lower Minto Creek than at lower Wolverine and lower Big creeks (Table 7.1, Appendix Table C.3). Concentration of copper at lower Minto Creek was also significantly higher than at lower Wolverine and lower Big creeks. Variability in concentrations of copper in benthic invertebrate

Table 7.1: Periphyton and Benthic Invertebrate Tissue Chemistry Results, Minto Mine WUL, September 2017

Analyte	Units	Periphyton						Benthic Invertebrates					
		Lower Wolverine Creek (Reference)		Lower Big Creek (Reference)		Lower Minto Creek (Exposed)		Lower Wolverine Creek (Reference)		Lower Big Creek (Reference)		Lower Minto Creek (Exposed)	
		n = 5		n = 5		n = 5		n = 5		n = 5		n = 5	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Aluminum (Al)	mg/kg dwt	2,021	733	2,870	664	1,963	838	12,631	2,189	11,077	2,921	9,823	4,699
Antimony (Sb) [a]	mg/kg dwt	0.059	0.0056	0.12	0.031	0.087	0.010	0.039	0.0084	0.13	0.045	0.13	0.089
Arsenic (As)	mg/kg dwt	1.7	0.71	5.5	1.8	2.0	0.68	4.7	0.65	12	2.7	8.9	1.8
Barium (Ba) [b]	mg/kg dwt	58	22	78	20	135	30	166	29	208	31	537	245
Beryllium (Be) [b]	mg/kg dwt	0.16	0.064	0.16	0.037	0.089	0.034	0.62	0.11	0.48	0.10	0.38	0.13
Bismuth (Bi) [a,c]	mg/kg dwt	0.017	0.0048	0.17	0.030	0.023	0.0081	0.074	0.015	0.62	0.38	0.11	0.031
Boron (B) [a,d]	mg/kg dwt	1.2	0.18	1.4	0.29	6.4	3.9	3.1	0.92	3.5	1.2	17	13
Cadmium (Cd) [b,e]	mg/kg dwt	0.43	0.28	0.96	0.63	0.33	0.099	0.14	0.031	0.17	0.042	0.41	0.18
Calcium (Ca)	mg/kg dwt	2,195	585	3,277	795	2,673	348	7,634	1,080	7,329	1,528	11,392	2,303
Cesium (Cs)	mg/kg dwt	0.26	0.087	0.63	0.13	0.19	0.084	1.5	0.29	2.2	0.68	0.82	0.36
Chromium (Cr)	mg/kg dwt	12	5.5	11	3.6	10	4.9	38	4.7	27	5.2	23	9.7
Cobalt (Co)	mg/kg dwt	2.9	1.1	3.0	0.66	2.2	0.58	12	1.3	8.5	1.3	17	6.0
Copper (Cu)	mg/kg dwt	19	3.8	21	5.9	30	2.4	17	2.8	21	5.3	45	5.3
Iron (Fe)	mg/kg dwt	4,768	1,944	5,773	1,138	4,266	1,742	23,905	2,467	21,898	2,250	20,520	6,022
Lead (Pb)	mg/kg dwt	1.2	0.47	2.6	0.34	1.3	0.22	5.4	0.75	7.7	1.6	5.2	1.5
Lithium (Li) [a]	mg/kg dwt	1.9	0.82	3.0	0.84	1.8	0.84	11	2.0	8.7	1.8	8.4	3.7
Magnesium (Mg)	mg/kg dwt	2,268	826	2,479	541	1,917	291	8,644	1,076	6,186	1,241	5,631	1,592
Manganese (Mn) [f]	mg/kg dwt	330	141	433	136	580	142	686	150	698	225	8,671	6,089
Mercury (Hg) [b,d]	mg/kg dwt	0.026	0.014	0.035	0.014	0.022	0.0092	0.021	0.0054	0.028	0.013	0.032	0.019
Molybdenum (Mo) [f]	mg/kg dwt	0.74	0.18	0.61	0.13	0.94	0.25	0.53	0.39	0.71	0.14	1.1	0.47
Nickel (Ni)	mg/kg dwt	11	5.5	8.0	2.2	7.8	1.9	35	3.9	22	4.5	29	4.4
Phosphorus (P)	mg/kg dwt	5,340	1,419	4,550	1,587	6,552	684	1,218	86	1,188	177	1,545	457
Potassium (K)	mg/kg dwt	5,307	2,547	4,395	1,481	10,176	2,783	1,121	138	1,428	434	2,400	963
Rubidium (Rb) [e]	mg/kg dwt	4.1	0.82	5.5	2.4	3.5	0.17	12	2.1	11	3.3	10	3.6
Selenium (Se) [a]	mg/kg dwt	1.2	0.43	0.90	0.42	1.7	0.31	0.28	0.054	0.21	0.086	1.8	0.73
Sodium (Na) [a]	mg/kg dwt	1,798	453	1,644	736	2,286	163	386	41	395	78	255	7.1
Strontium (Sr) [g]	mg/kg dwt	23	6.5	33	11	29	4.9	70	13	64	16	125	24
Tellurium (Te) [a,d]	mg/kg dwt	<0.014	-	0.011	0.00042	<0.016	-	0.017	0.0021	0.036	0.011	0.030	0.00043
Thallium (Tl) [b]	mg/kg dwt	0.018	0.0036	0.033	0.0082	0.018	0.0070	0.077	0.015	0.11	0.029	0.092	0.031
Tin (Sn) [a,d]	mg/kg dwt	0.26	0.091	0.33	0.28	0.12	0.028	0.33	0.034	0.34	0.075	0.38	0.038
Uranium (U)	mg/kg dwt	0.60	0.29	0.86	0.38	0.48	0.079	0.98	0.13	1.4	0.30	0.71	0.18
Vanadium (V)	mg/kg dwt	12	4.5	14	2.0	10	4.4	55	4.9	53	6.5	44	11
Zinc (Zn)	mg/kg dwt	88	23	78	24	144	48	59	7.7	56	11	64	9.4
Zirconium (Zr)	mg/kg dwt	3.1	1.4	3.3	0.53	2.5	1.2	11	1.4	8.0	1.8	6.7	4.0

▨	Indicates a mean concentration in lower Minto Creek that is significantly different than the mean concentration in lower Wolverine Creek (ANOVA; p = 0.050).
🟨	Indicates a mean concentration in lower Minto Creek that is significantly different than the mean concentration in lower Big Creek (ANOVA; p = 0.050).
🟩	Indicates a mean concentration in lower Minto Creek that is significantly different than the mean concentration in lower Wolverine and lower Big creeks (ANOVA; p = 0.050).

Note: Standard deviation was not calculated if all samples are < MDL.

[a] Benthic invertebrate tissue data were analyzed using a non-parametric Wilcoxon Score Test (p = 0.050)

[b] Benthic invertebrate tissue data were normalized by log transformation (ANOVA, p = 0.050)

[c] Periphyton tissue data were normalized by square root transformation (ANOVA, p = 0.050)

[d] Periphyton tissue data were analyzed using a non-parametric Wilcoxon Score Test (p = 0.050)

[e] Periphyton tissue data were normalized by log transformation (ANOVA, p = 0.050)

[f] Benthic invertebrate tissue data were analyzed using a non-parametric Mann-Whitney U-test (p = 0.050)

[g] Benthic invertebrate tissue data were normalized by fourth root transformation (ANOVA, p = 0.050)

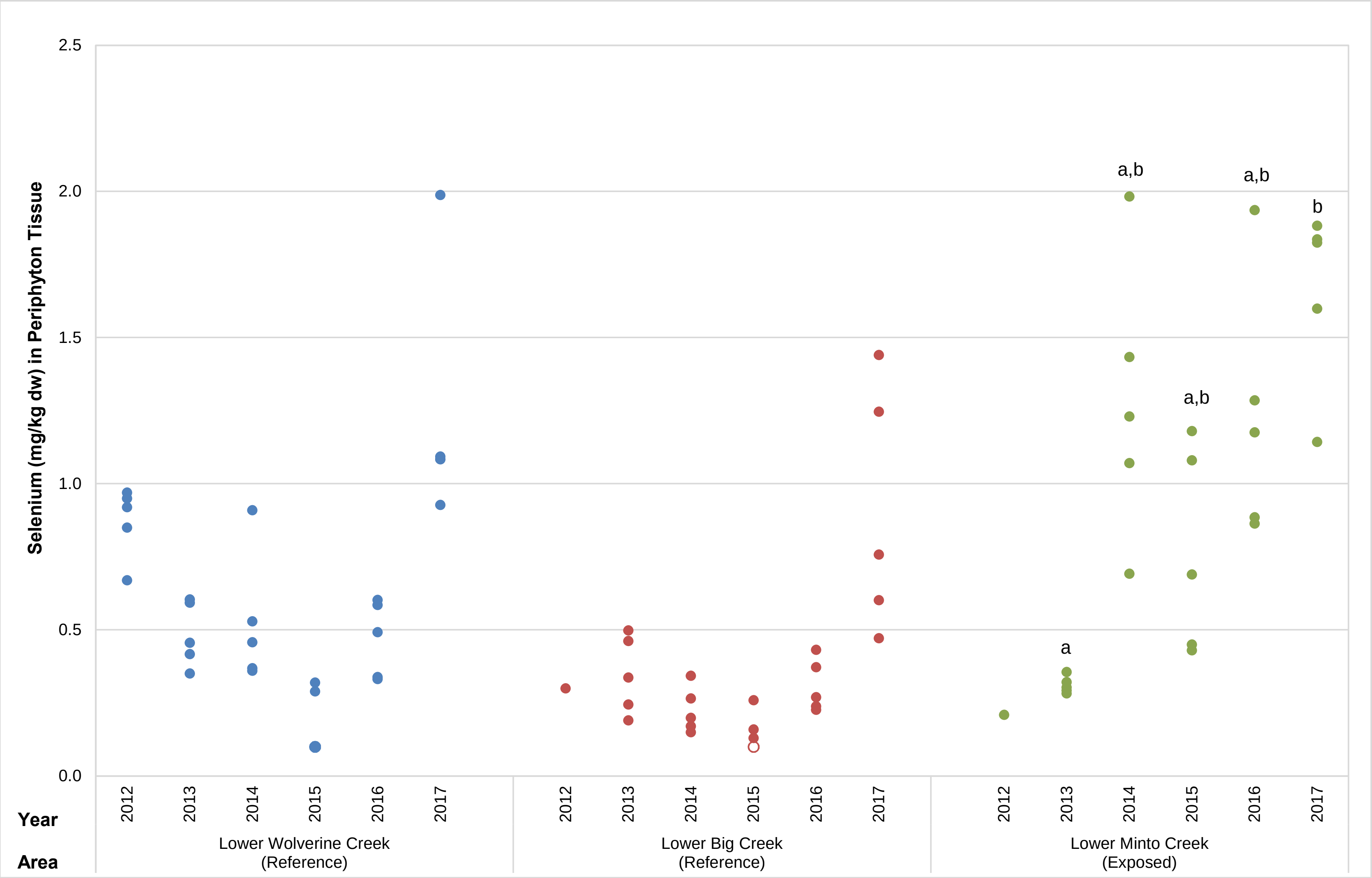


Figure 7.1: Periphyton Tissue Selenium Concentrations, 2012 to 2017

Notes: Mean concentrations at exposure areas that differ significantly ($p < 0.05$) within year from a reference area are marked with an **"a"** for differences between lower Wolverine Creek and **"b"** for differences between lower Big Creek, n = 5, except in lower Minto and lower Big creeks in 2012 (n = 1). Unfilled circles represents samples < method detection limits.

tissue has been high among years. In 2013, 2016, and 2017 copper was significantly higher in benthic invertebrates from lower Minto Creek compared to lower Wolverine Creek, but in 2014 copper was non-significantly different among areas (Figure 7.2). In 2015, copper was significantly lower at lower Minto Creek compared to lower Big Creek (Figure 7.2). This lack of consistency suggests observed differences likely represent natural variability.

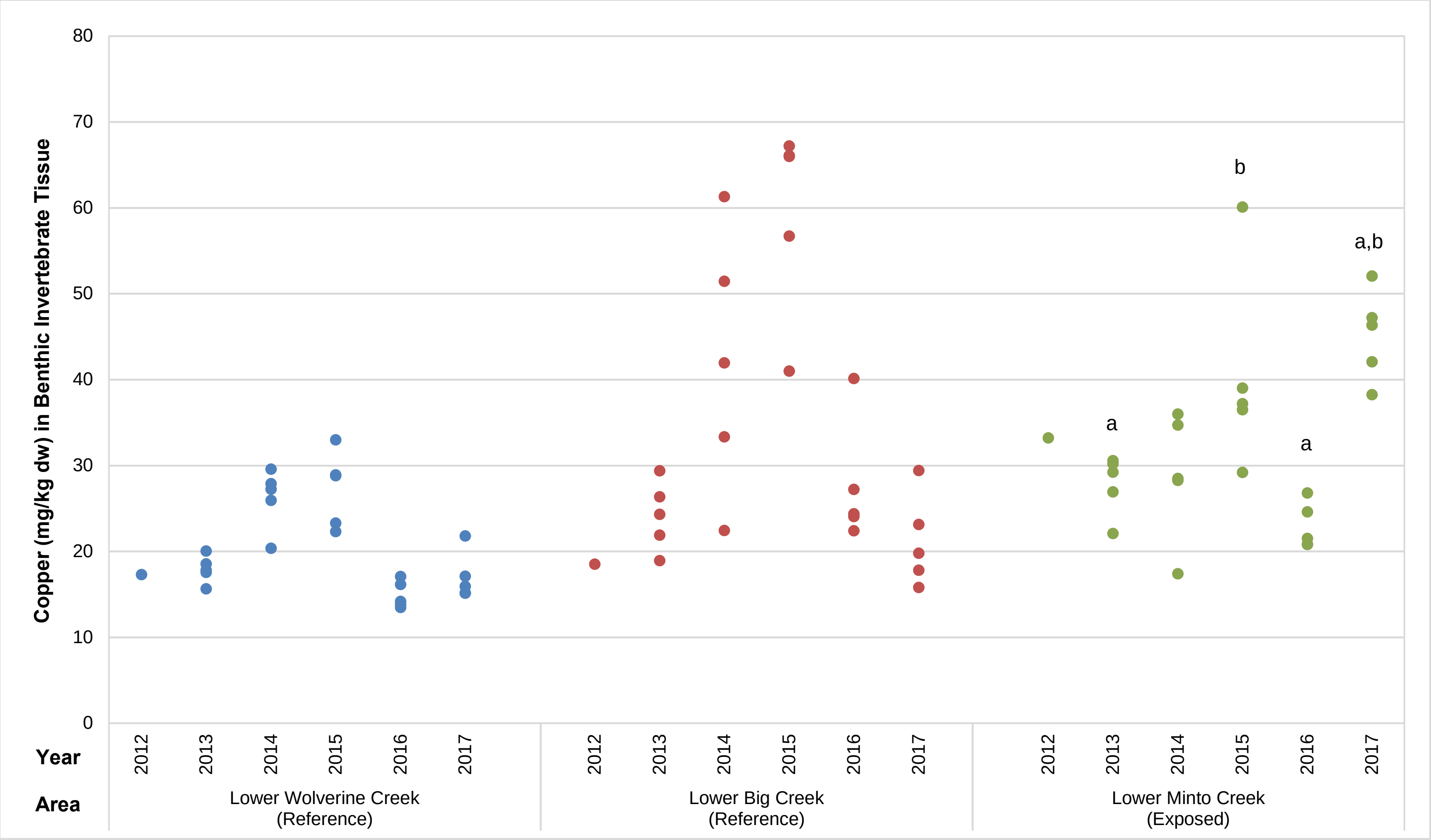


Figure 7.2: Benthic Invertebrate Tissue Copper Concentrations, 2012 to 2017

Notes: Mean concentrations at exposure areas that differ significantly ($p < 0.05$) within year from a reference area are marked with an **"a"** for differences between lower Wolverine Creek and **"b"** for differences between lower Big Creek, n = 5, except in 2012 (n = 1). Statistics not conducted in 2012 due to low sample size. Unfilled circles represents samples < method detection limits.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The Minto Mine sediment, periphyton, and benthic assessment undertaken from September 20th to 26th, 2017 serves to quantitatively compare water quality (field measures and chemistry), sediment quality, periphyton and benthic invertebrate community, and tissue quality of Minto Creek to reference creeks and previous data.

Supporting measures collected in September 2017 indicated good Minto Creek water quality. The influence of the Minto Mine was evident in higher specific conductance than in reference creeks; however, water quality met WUL water quality objectives. Concentration of total copper at upper Minto Creek was above CWQG and reference areas but dissolved copper was below the WUL water quality objective. Moving downstream, copper concentration at lower Minto Creek and associated reference areas were below CWQG. Mean concentrations of chlorophyll-a at lower Minto and lower Wolverine creeks were significantly different but were below BCWQG. Trophic status in 2017 was different from previous years since lower Minto Creek was classified as mesotrophic (Dodds et al. 1998).

Concentrations of metals in Minto Creek sediments were similar to reference and lower than sediment quality guidelines with the exception of arsenic and/or copper. Concentrations of copper in Minto Creek (both upper and lower) were greater than the sediment quality guideline and reference, but were similar to concentrations observed in previous years. Sediment toxicity testing of *C. dilutus* indicated adverse effects to survival and growth in lower Minto Creek sediment when compared to the laboratory control and the field reference (lower Wolverine Creek) sediment. However, no effects on survival or growth occurred in tests of *H. azteca*.

Periphyton community density (cells/cm^2) and biomass (µg/cm^2) indicated significant differences in a number of metrics in lower Minto Creek relative to the lower Wolverine Creek reference. In general, lower Minto Creek had a different community structure compared to lower Wolverine Creek. However, differences in periphyton community summary metrics and community composition were apparent among years at both lower Minto Creek and lower Wolverine Creek, indicating substantial temporal variability. The differences observed in the periphyton communities of lower Minto Creek and lower Wolverine Creek in 2017 were within natural temporal variability and do not provide any resolution of potential mine influence.

The erosional benthic invertebrate community of lower Minto Creek did not differ from both references, or was intermediate between references, for all community metrics. High temporal variability has been observed at the exposure and reference areas (Minnow 2009b, 2011, 2012, 2013b, 2014, 2015, 2016, 2017), presumably due to inter-annual variability in environmental conditions (e.g., flow, ice scour).

The chemical quality of biological tissues (periphyton and benthic invertebrates) collected at mine-exposed lower Minto Creek and reference areas indicated selenium concentrations were significantly different between areas. Significantly higher concentrations of selenium at lower Minto Creek compared to either reference areas over the last three years could indicate an influence of the mine on Minto Creek. Copper concentration in benthic invertebrate tissue was significantly higher at lower Minto Creek than at lower Wolverine and lower Big creeks.

8.2 Recommendations

Based on results and conclusions of the 2017 Minto Mine sediment, periphyton, and benthic assessment, it is recommended the program be repeated in 2018. It is recommended that both lower Wolverine Creek and lower Big Creek continue to be sampled as reference areas for the benthic invertebrate community assessment to provide better perspective on whether any of the observed differences are actually due to mine influence or simply due to natural differences among creeks. It is also recommended that periphyton community monitoring be removed from the WUL monitoring program as results are highly variable and are not effective in determining potential mine-related effects.

9 REFERENCES

BCMOE (British Columbia Ministry of Environment). 1985. Water Quality Criteria for Nutrients and Algae: Technical Appendix. Prepared by Richard Nordin, Water Quality Unit, Resource Quality Section, Water Management Branch. October 1985.

CABIN (Canadian Aquatic Biomonitoring Network). 2012. Field Manual: Wadeable Streams. Environment Canada. March 2012.

CCME (Canadian Council of Ministers of the Environment). 1999 (plus updates). Canadian Environmental Quality Guidelines. CCME, Winnipeg.

Chapman, P.M., M.O. Farrell and R.O. Brinkhurst. 1982a. Relative tolerances of selected aquatic oligochaetes to combinations of pollutants and environmental factors. Aquat. Toxicol. 2: 47–67.

Chapman, P.M., M.O. Farrell and R.O. Brinkhurst. 1982b. Relative tolerances of selected aquatic oligochaetes to combinations of pollutants and environmental factors. Aquat. Toxicol. 2: 69-78.

De Jonge M., B. Van de Vijver, R. Blust and L. Bervoets. 2008. Response of aquatic organisms to metal pollution in a low land river in Flanders: A comparison of diatoms and macroinvertebrates. Sci. Total Environ. 407:615-629.

Deniseger, J., A. Austin and W.P. Lucey. 1986. Periphyton communities in a pristine mountain stream above and below heavy metal mining operations. Freshw. Biol. 16:209-218.

Dodds, W.K., J.R. Jones and E.B. Welch. 1998. Suggested Classification of stream trophic state: Distribution of temperate stream types by chlorophyll, total nitrogen, and phosphorus, Water Res. 32(5):1455-1462.

Environment Canada. 1997. Biological test method: test for survival and growth in sediment using the larvae of freshwater midges (Chironomus tentans and Chironomus riparius). Environmental Protection Series EPS 1/RM/32 December 1997. Environment Canada, Method Development and Application Section, Environmental Technology Centre, Ottawa, ON. 131 pp.

Environment Canada. 2012. 2012 Metal Mining Environmental Effects Monitoring (EEM) Technical Guidance Document. Environment Canada Report.

Environment Canada. 2013. Biological test method: test for survival and growth in sediment and water using the freshwater amphipod Hyalella azteca. Environmental Protection Series EPS 1/RM/33 Second Edition. January 2013. Environment Canada, Method Development and Application Unit, Science and Technology Branch, ON. 150 pp.

Helsel, D.R., 2012. Statistics for censored environmental data using Minitab and R, 2nd edition. John Wiley and Sons, New York. 344 p.

HKP (Hallam Knight Piesold). 1994. Minto Explorations Limited Minto Project: Volume II Environmental Setting. Prepared for Minto Explorations Limited. December 1994.

Horowitz, A.J. 1991. A Primer on Sediment-Trace Element Chemistry. Second Edition. Lewis Publishers.

Huebert, D.B., M. McKernan and C. Paquette. 2011. Canada's Environmental Effects Monitoring Program: Areas for Improvement. Integr. Enviro. Assess. and Manage. 7:143-144.

Lee, L. 2017. Nondetects and data analysis for environmental data. Package “NADA” for R. March 31, 2017. https://cran.r-project.org/web/packages/NADA/NADA.pdf

Mandaville, S.M. 2002. Benthic Macroinvertebrates in Freshwaters-Taxa Tolerance Values, Metrics, and Protocols. Project H-1. Soil and Water Conservation Society of Metro Halifax.

Minnow (Minnow Environmental Inc.). 2009a. Evaluation of the Background Water Quality Minto Creek and Options for the Derivation of Site-Specific Water Quality Objectives. Prepared for the Access Consulting Group and Minto Explorations Ltd, April 2009.

Minnow. 2009b. Minto Mine Water Use Licence Benthic Invertebrate Community Survey Results. Letter Report prepared for the Access Consulting Group and Minto Explorations Ltd, January 2009.

Minnow. 2010a. Minto Mine Annual Water Quality Monitoring Report 2010. Prepared for the Access Consulting Group, July 2010.

Minnow. 2010b. Characterization of Baseline and Operational Water Quality of Minto Creek 2010. Prepared for Minto Explorations Ltd., August 2010.

Minnow. 2011. Minto Creek Sediment and Benthic Invertebrate Community Assessment – 2010. Prepared for Minto Explorations Ltd., June 2011.

Minnow. 2012. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2011. Prepared for Minto Explorations Ltd, March 2012.

Minnow. 2013a. Periphyton Community Monitoring in Minto Creek - September 2012. Letter report prepared for Minto Explorations Ltd., November 19, 2013.

Minnow. 2013b. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2012. Prepared for Minto Explorations Ltd, March 2013.

Minnow. 2014. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2013. Prepared for Minto Explorations Ltd, March 2014.

Minnow. 2015. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2014. Prepared for Minto Explorations Ltd, March 2015.

Minnow. 2016. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2015. Prepared for Minto Explorations Ltd, March 2016.

Minnow. 2017. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment – 2016. Prepared for Minto Explorations Ltd, March 2017.

Minnow. 2018. Minto Mine Phase 4 Environmental Effects Monitoring Interpretive Report. Prepared for Minto Explorations Ltd, January 2018.

Motodo, S. 1959. Devices of simple plankton apparatus. Mem. Fac. Fish., Hokkaido Univ., 7:73-94.

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Rosenberg, D.M., and V.H. Resh. (Ed). 1993. Freshwater Biomonitoring and Benthic Invertebrates. Routledge, Chapman and Hall, Inc. New York, NY. 488 p.

Ruxton, G.D. 2006. The unequal variance t-test is an underused alternative to Student's t-test and the Mann–Whitney U test. Behavioral Ecology. 17: 668-690.

Smith, B. and J.B. Wilson. 1996. A consumer’s guide to evenness indices. Oikos 76: 70-82.

Taylor, B.R. and R.C. Bailey. 1997. Aquatic Effects Technology Evaluation (AETE) Program: Technical Evaluation on Methods for Benthic Invertebrate Data Analysis and Interpretation. AETE Project 2.1.1. 93 p.

Therneau, T.M. 2017. Survival analysis. Package “survival” for R. April 4, 2017. https://cran.r-project.org/web/packages/survival/survival.pdf

Van Guelpen, L., D.F. Markle, and D.J. Duggan. 1982. An evaluation of accuracy, precision, and speed of several zooplankton sub-sampling techniques. J. Cons. Int. Explor. Mer., 40:226-236. plankton apparatus. Mem. Fac. Fish., Hokkaido Univ., 7:73-94.

Wetzel, R.G. 2001. Limnology: Lake and River Ecosystems. Third Edition. Academic Press. San Diego, CA, USA. 1006 p.

Zaiontz, C. 2018. Real Statistics Using Excel. www.real-statistics.com

APPENDIX A

DATA QUALITY REPORT

APPENDIX A DATA QUALITY REPORT

LIST OF TABLES **AFTER PAGE…**

A1 INTRODUCTION

This Data Quality Report (DQR) provides an evaluation of data collected as part of the 2017 Minto Creek Sediment, Periphyton, and Benthic Invertebrate Community Assessment Report. The objective of the DQR is to define the overall quality of the data presented in the report, and, by extension, the confidence with which the data can be used to derive conclusions.

A1.1 Background

A variety of factors can influence the chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. The DQR involves comparison of actual field and laboratory measurement performance to data quality objectives (DQOs) established for a particular study, such as evaluation of method detection limits, blank sample data, data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spike recoveries and/or analysis of standards or certified reference materials). A trusted analytical laboratory certified by Canadian Association for Laboratory Accreditation (CALA) with a rigorous internal quality assurance program was selected to ensure the highest possible quality.

DQOs were established either at the outset of the field program or by the laboratory (e.g., ALS Environmental) and reflect reasonable and achievable performance expectations. The method detection limit (MDL) was set at the outset of the field program for water, sediment, and tissue quality. Only samples that were below the laboratory detection limits were evaluated against target detection limits. Target detection limits should be at least as low as applicable guidelines, ideally ≤ 1/10th guideline values. Tissue samples are compared to the detection limit the laboratory quoted they could achieve. Programs involving a large numbert of samples and analytes usually result in some analytes that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP scans for metals) since the analytical conditions are not necessarily optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure that any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

A1.2 Types of Quality Control Samples

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples include the following:

- **Blanks** are samples of de-ionized water and/or appropriate reagent(s) that are handled and analyzed the same way as regular samples. These samples will reflect any contamination that occurred in the field (in the case of field or travel blanks) or the laboratory (in the case of laboratory or method blanks). Analyte concentrations should be non-detectable although a DQO of twice the method detection limit allows for slight “noise” around the detection limit.
- **Field Duplicates** are sub-sample pairs collected from a randomly selected field station using identical collection and handling methods that are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field duplicate samples reflect natural variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.
- **Laboratory Duplicates** are sub-sample pairs created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.
- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks (or blank spikes) are created using laboratory control materials whereas matrix spikes are

created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

The following QC was applied to benthic invertebrate community samples as follows:

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

A2 WATER SAMPLES

A2.1 Method Detection Limits

The MDL for total mercury was higher than targeted detection limits but was lower than guideline levels (Table A.1). Therefore, data for this project can be reliably interpreted relative to guidelines.

A2.2 Laboratory Blank Samples Analysis

All blank samples contained non-detectable analyte concentrations indicating no inadvertent contamination of samples within the laboratory during analysis (Appendix B).

A2.3 Data Precision

Relative percent differences (RPDs) between field duplicate samples were greater than 25% for five analytes: total suspended solids, total phosphorus, total cadmium, total mercury, and dissolved zinc (Table A.2). Fewer than 20% of the field duplicate samples failed the DQO, therefore the samples were associated with good field precision.

Agreement was achieved between all laboratory duplicate samples (Appendix B). This indicates that samples were associated with good analytical precision.

A2.4 Data Accuracy

Analyte recoveries for spiked blanks all met the DQO indicating excellent analytical accuracy for the water sample analyses (Appendix B).

The analyte recoveries for matrix spiked samples met the DQO for all analytes except for dissolved organic carbon, total inorganic carbon and total organic carbon. Recovery of these analytes could not be accurately calculated due to high analyte background in the samples. The matrix spiked samples indicate good analytical accuracy for the water sample analyses (Appendix B).

Recoveries of certified reference materials all met the DQO indicating excellent analytical accuracy (Appendix B).

Table A.1: Laboratory Method Detection Limits (MDLs) Relative to Targets and Water Quality Guidelines, Minto Mine, 2017 [a]

Analyte		Units	Method Detection Limit		Water Use Licence Objectives	CCME Water Quality Guidelines [b]	
			Target	Achieved		30 Day	Max
Physical Tests	Total Suspended Solids	mg/L	-	3.0	-	-	-
Anions and Nutrients	Total Ammonia (as N)	mg/L	0.025	0.0050	0.25	0.41 [c]	-
	Nitrate (as N)	mg/L	0.30	0.0050	9.1	3.0	124
	Nitrite (as N)	mg/L	0.0060	0.0010	0.060	0.060	-
Cyanides	Total Cyanide	mg/L	-	0.0050	-	-	-
Total Metals	Total Antimony (Sb)	mg/L	-	0.00010	-	-	-
	Total Beryllium (Be)	mg/L	-	0.00010	-	-	-
	Total Bismuth (Bi)	mg/L	-	0.000050	-	-	-
	Total Boron (B)	mg/L	0.15	0.010	-	1.5	29
	Total Cadmium (Cd)	mg/L	0.000016	0.0000050	-	0.00016 [d]	0.0022 [d]
	Total Chromium (Cr)	mg/L	0.00010	0.00010	-	0.0010 [e]	-
	Total Cobalt (Co)	mg/L	-	0.00010	-	-	-
	Total Lead (Pb)	mg/L	0.00033	0.000050	-	0.0033 [d]	-
	Total Lithium (Li)	mg/L	-	0.0010	-	-	-
	Total Mercury (Hg)	mg/L	0.0000026	▨ 0.0000050 - 0.000025	-	0.000026	-
	Total Phosphorus (P)	mg/L	-	0.30	-	-	-
	Total Silver (Ag)	mg/L	0.000025	0.000010	-	0.00025	
	Total Thallium (Tl)	mg/L	0.000080	0.000010	-	0.00080	-
	Total Tin (Sn)	mg/L	-	0.00010	-	-	-
	Total Titanium (Ti)	mg/L	-	0.010	-	-	-
	Total Vanadium (V)	mg/L	-	0.00050	-	-	-
	Total Zinc (Zn)	mg/L	0.0030	0.0030	-	0.030	-
Dissolved Metals	Dissolved Antimony (Sb)	mg/L	-	0.00010	-	-	-
	Dissolved Beryllium (Be)	mg/L	-	0.00010	-	-	-
	Dissolved Bismuth (Bi)	mg/L	-	0.000050	-	-	-
	Dissolved Boron (B)	mg/L	-	0.010	-	-	-
	Dissolved Cadmium (Cd)	mg/L	0.000022	0.0000050	0.00022 [f]	-	-
	Dissolved Chromium (Cr)	mg/L	0.00010	0.00010	0.0010	-	-
	Dissolved Cobalt (Co)	mg/L	-	0.00010	-	-	-
	Dissolved Lead (Pb)	mg/L	0.00040	0.000050	0.0040	-	-
	Dissolved Lithium (Li)	mg/L	-	0.0010	-	-	-
	Dissolved Mercury (Hg)	mg/L	-	0.0000050	-	-	-
	Dissolved Nickel (Ni)	mg/L	0.011	0.00050	0.11	-	-
	Dissolved Phosphorus (P)	mg/L	-	0.30	-	-	-
	Dissolved Selenium (Se)	mg/L	0.00020	0.000050	0.002	-	-
	Dissolved Silver (Ag)	mg/L	0.000010	0.000010	0.00010	-	-
	Dissolved Thallium (Tl)	mg/L	-	0.000010	-	-	-
	Dissolved Tin (Sn)	mg/L	-	0.00010	-	-	-
	Dissolved Titanium (Ti)	mg/L	-	0.010	-	-	-
	Dissolved Vanadium (V)	mg/L	-	0.00050	-	-	-
	Dissolved Zinc (Zn)	mg/L	0.0030	0.0010	0.030	-	-

▨ Value greater than target.

[a] Only analytes with any reported values less than MDL were presented.

[b] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg. See Appendix Table B.6 for explanatory notes on selected water quality guidelines.

[c] Based on lowest guideline using highest temperature and pH.

[d] Based on lowest guideline using lowest hardness.

[e] Based on hexavalent Chromium (Cr VI).

[f] Dissolved Cadmium (µg/L) calculations based on the following formula using the lowest hardness: $e^{(0.736(\ln(\text{Hardness})-4.943)}$.

Table A.2: Field Duplicate Results for Analysis of Water Quality, Minto Mine, 2017

Analytes		Units	Lab Report L1998329		RPD (%)
			LBC	LBCX	
			26-Sep-2017	26-Sep-2017	
Physical Tests	Conductivity	µS/cm	217	214	1.4
	Hardness (as $CaCO_3$)	mg/L	103	103	0
	pH	pH Units	8.18	8.16	0.24
	Total Suspended Solids	mg/L	<3.0	4.1	31
	Total Dissolved Solids	mg/L	152	150	1.3
	Turbidity	NTU	0.89	0.87	2.3
Anions and Nutrients	Total Alkalinity (as $CaCO_3$)	mg/L	105	98	6.7
	Total Ammonia (as N)	mg/L	<0.0050	<0.0050	0
	Chloride (Cl)	mg/L	0.59	0.59	0
	Fluoride (F)	mg/L	0.13	0.14	3.0
	Nitrate (as N)	mg/L	0.0053	0.0055	3.7
	Nitrite (as N)	mg/L	<0.0010	<0.0010	0
	Total dissolved Phosphorus (P)	mg/L	0.0023	0.0023	0
	Total Phosphorus (P)	mg/L	0.0037	0.0022	51
	Sulfate (SO_4)	mg/L	16	16	0
Other	Total Cyanide	mg/L	<0.0050	<0.0050	0
	Dissolved Organic Carbon	mg/L	7.6	7.7	0.52
	Total Inorganic Carbon	mg/L	22	22	0
	Total Organic Carbon	mg/L	7.5	7.6	0.93
Total Metals	Total Aluminum (Al)	mg/L	0.038	0.041	8.4
	Total Antimony (Sb)	mg/L	0.00014	0.00015	6.9
	Total Arsenic (As)	mg/L	0.00081	0.00079	2.5
	Total Barium (Ba)	mg/L	0.0664	0.0661	0.45
	Total Beryllium (Be)	mg/L	<0.00010	<0.00010	0
	Total Bismuth (Bi)	mg/L	<0.000050	<0.000050	0
	Total Boron (B)	mg/L	<0.010	<0.010	0
	Total Cadmium (Cd)	mg/L	0.0000078	0.0000051	42
	Total Calcium (Ca)	mg/L	26	25	2.0
	Total Chromium (Cr)	mg/L	0.00030	0.00025	18
	Total Cobalt (Co)	mg/L	<0.00010	<0.00010	0
	Total Copper (Cu)	mg/L	0.0019	0.0020	3.6
	Total Iron (Fe)	mg/L	0.079	0.087	9.6
	Total Lead (Pb)	mg/L	<0.000050	<0.000050	0
	Total Lithium (Li)	mg/L	0.0012	0.0014	15
	Total Magnesium (Mg)	mg/L	10.2	10.3	0.98
	Total Manganese (Mn)	mg/L	0.015	0.014	0.69
	Total Mercury (Hg)	mg/L	<0.000025	<0.0000050	133
	Total Molybdenum (Mo)	mg/L	0.0013	0.0012	4.0
	Total Nickel (Ni)	mg/L	0.0011	0.0010	1.9
	Total Phosphorus (P)	mg/L	<0.30	<0.30	0
	Total Potassium (K)	mg/L	0.865	0.869	0.46
	Total Selenium (Se)	mg/L	0.000072	0.000076	5.4
	Total Silicon (Si)	mg/L	5.86	5.85	0.17
	Total Silver (Ag)	mg/L	<0.000010	<0.000010	0
	Total Sodium (Na)	mg/L	7.8	8.0	2.2
	Total Strontium (Sr)	mg/L	0.28	0.28	0
	Total Thallium (Tl)	mg/L	<0.000010	<0.000010	0
	Total Tin (Sn)	mg/L	<0.00010	<0.00010	0
	Total Titanium (Ti)	mg/L	<0.010	<0.010	0
	Total Uranium (U)	mg/L	0.00279	0.00276	1.1
	Total Vanadium (V)	mg/L	0.00081	0.00081	0
	Total Zinc (Zn)	mg/L	<0.0030	<0.0030	0
Dissolved Metals	Dissolved Aluminum (Al)	mg/L	0.013	0.013	0
	Dissolved Antimony (Sb)	mg/L	0.00012	0.00012	0
	Dissolved Arsenic (As)	mg/L	0.00067	0.00066	1.5
	Dissolved Barium (Ba)	mg/L	0.068	0.067	1.3
	Dissolved Beryllium (Be)	mg/L	<0.00010	<0.00010	0
	Dissolved Bismuth (Bi)	mg/L	<0.000050	<0.000050	0
	Dissolved Boron (B)	mg/L	<0.010	<0.010	0
	Dissolved Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	0
	Dissolved Calcium (Ca)	mg/L	24	24	0
	Dissolved Chromium (Cr)	mg/L	0.00021	0.00021	0
	Dissolved Cobalt (Co)	mg/L	<0.00010	<0.00010	0
	Dissolved Copper (Cu)	mg/L	0.00174	0.00173	0.58
	Dissolved Iron (Fe)	mg/L	0.039	0.041	5.0
	Dissolved Lead (Pb)	mg/L	<0.000050	<0.000050	0
	Dissolved Lithium (Li)	mg/L	0.0016	0.0015	6.5
	Dissolved Magnesium (Mg)	mg/L	10	10	0
	Dissolved Manganese (Mn)	mg/L	0.0128	0.0129	0.78
	Dissolved Mercury (Hg)	mg/L	<0.0000050	<0.0000050	0
	Dissolved Molybdenum (Mo)	mg/L	0.0011	0.0011	0
	Dissolved Nickel (Ni)	mg/L	0.00090	0.00088	2.2
	Dissolved Phosphorus (P)	mg/L	<0.30	<0.30	0
	Dissolved Potassium (K)	mg/L	0.897	0.900	0.33
	Dissolved Selenium (Se)	mg/L	<0.000050	0.000051	2.0
	Dissolved Silicon (Si)	mg/L	5.63	5.60	0.53
	Dissolved Silver (Ag)	mg/L	<0.000010	<0.000010	0
	Dissolved Sodium (Na)	mg/L	7.8	7.7	0.52
	Dissolved Strontium (Sr)	mg/L	0.262	0.259	1.2
	Dissolved Thallium (Tl)	mg/L	<0.000010	<0.000010	0
	Dissolved Tin (Sn)	mg/L	<0.00010	<0.00010	0
	Dissolved Titanium (Ti)	mg/L	<0.010	<0.010	0
	Dissolved Uranium (U)	mg/L	0.00248	0.00246	0.81
	Dissolved Vanadium (V)	mg/L	0.00074	0.00074	0
	Dissolved Zinc (Zn)	mg/L	<0.0010	0.0013	26

▨ > 25% Relative Percent Difference (RPD).

A3 SEDIMENT SAMPLES

A3.1 Method Detection Limits

Results for seven analytes were reported as <MDL but did not have any guidelines associated with them. Analytes with guidelines were all detectable indicating that the data can be reliably interpreted.

A3.2 Laboratory Blank Samples Analysis

All blank samples contained non-detectable analyte concentrations indicating no inadvertent contamination of samples within the laboratory during analysis (Appendix C).

A3.3 Data Precision

The RPD between field duplicate samples all showed close agreement, as they were lower than the DQO (40% RPD; Table A.3). This indicates that the results were associated with excellent field precision.

Agreement was achieved between all laboratory duplicate samples as the RPD were lower than the laboratory set DQO (Appendix C). This indicates that reported sample results were associated with excellent analytical precision.

A3.4 Data Accuracy

Analyte recoveries for spiked blanks all met the DQO indicating excellent analytical accuracy for the sediment sample analyses (Appendix C).

Recoveries of all analytes in certified reference materials met the DQO (Appendix C). These data indicated excellent analytical accuracy associated with the analysis of sediment samples.

Table A.3: Field Duplicate Results for Analysis of Sediment Quality, Minto Mine, 2017

Analytes		Units	Lab Report L1998308		
			LWC-5	LWC-5X	RPD (%)
			24-Sep-2017	24-Sep-2017	
Physical Tests	Loss on Ignition	%	15	16	6.5
	pH (1:2 soil:water)	pH	6.92	6.77	2.2
Particle Size	Gravel (> 2 mm)	%	<1.0	<1.0	0
	Sand (2.0 mm - 0.063 mm)	%	17	21	18
	Silt (0.063 mm - 4 µm)	%	77	74	4.0
	Clay (< 4 µm)	%	5.7	5.4	5.4
Other	Total Kjeldahl Nitrogen	%	0.35	0.34	4.0
	Inorganic Carbon	%	0.141	0.137	2.9
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%	1.2	1.1	2.6
	Total Carbon by Combustion	%	7.2	5.4	28
	Total Organic Carbon	%	7.0	5.2	29
Total Metals	Total Aluminum (Al)	mg/kg	16,000	15,900	0.63
	Total Antimony (Sb)	mg/kg	0.46	0.48	4.3
	Total Arsenic (As)	mg/kg	4.9	5.7	15
	Total Barium (Ba)	mg/kg	200	221	10
	Total Beryllium (Be)	mg/kg	0.78	0.83	6.2
	Total Bismuth (Bi)	mg/kg	<0.20	<0.20	0
	Total Boron (B)	mg/kg	<5.0	<5.0	0
	Total Cadmium (Cd)	mg/kg	0.23	0.26	14
	Total Calcium (Ca)	mg/kg	10,200	11,100	8.5
	Total Chromium (Cr)	mg/kg	48	49	1.7
	Total Cobalt (Co)	mg/kg	12.8	13.1	2.3
	Total Copper (Cu)	mg/kg	28	30	6.3
	Total Iron (Fe)	mg/kg	26,700	28,400	6.2
	Total Lead (Pb)	mg/kg	6.5	6.6	1.8
	Total Lithium (Li)	mg/kg	11.7	11.6	0.86
	Total Magnesium (Mg)	mg/kg	9,760	9,730	0.31
	Total Manganese (Mn)	mg/kg	236	259	9.3
	Total Mercury (Hg)	mg/kg	0.041	0.047	13
	Total Molybdenum (Mo)	mg/kg	0.56	0.52	7.4
	Total Nickel (Ni)	mg/kg	37	38	2.4
	Total Phosphorus (P)	mg/kg	1,070	1,120	4.6
	Total Potassium (K)	mg/kg	1,140	1,130	0.88
	Total Selenium (Se)	mg/kg	0.34	0.43	23
	Total Silver (Ag)	mg/kg	0.10	0.12	18
	Total Sodium (Na)	mg/kg	458	456	0.44
	Total Strontium (Sr)	mg/kg	93	103	9.9
	Total Thallium (Tl)	mg/kg	0.095	0.099	4.1
	Total Tin (Sn)	mg/kg	<2.0	<2.0	0
	Total Titanium (Ti)	mg/kg	841	908	7.7
	Total Uranium (U)	mg/kg	2.7	3.2	14
	Total Vanadium (V)	mg/kg	69	68	0.58
	Total Zinc (Zn)	mg/kg	63.5	64.4	1.4

▨ > 40% Relative Percent Difference (RPD).

A4 SEDIMENT TOXICITY TESTING

Results for the reference toxicant tests for both the 10-day *Chironomus dilutus* and the 14-day *Hyalella azteca* tests were within the acceptability range for organism performance of mean and two standard deviations (Appendix C – Nautilus Environmental Report). Water quality parameters remained within the acceptability criteria throughout testing. The sensitivity of the organisms was deemed to be appropriate when compared to historical results obtained by the laboratory (Appendix C – Nautilus Environmental Report).

A5 PERIPHYTON COMMUNITY

Close agreement was achieved between laboratory duplicate samples for both density (cells/cm^2; Table A.4) and biomass (µg/cm^2; Table A.5), except for Rhodophyta. The RPD between duplicate samples and Rhodophyta (density and biomass) was 46% (Tables A.4 and A.5). The higher magnitude of difference between the duplicate samples could be due to the low abundance of Rhodophyta present. Data can be reliably interpreted.

Table A.4: Laboratory Duplicate Results for Analysis of Periphyton Group Density (cells/cm^2)

Algal Density (cells/cm^2)	LMC-5	LMC-5R	RPD (%)
Cyanobacteria	76,371	79,242	3.7
Bacillariophycae	29,859	28,424	4.9
Rhodophyta	2,871	4,594	46
Total	109,101	112,260	2.9

▨ > 30% Relative Percent Difference (RPD).

Table A.5: Laboratory Duplicate Results for Analysis of Periphyton Group Biomass (µg/cm^2)

Algal Biomass (µg/cm^2)	LMC-4	LMC-4R	RPD (%)
Cyanobacteria	12	15	22
Bacillariophycae	18.6	19.0	2.0
Rhodophyta	2.1	3.4	46
Total	32	37	13

▨ > 30% Relative Percent Difference (RPD).

A6 BENTHIC INVERTEBRATE COMMUNITY

Two re-sorted samples met the objective for percent organism recovery, with a percent recovery of 99% and 100% (Table A.6). All benthic invertebrate samples were analyzed whole (Table A.7), and therefore no analysis of sub-sampling variability was required. This indicates that the data can be reliably interpreted.

Table A.6: Percent Sorting Efficiency of Benthic Invertebrates, Minto Mine, 2017

Station	Initial Sort	Re-sort	Percent sorting efficiency [a]
LMC-4	186	1	99%
LWC-2	73	0	100%

[a] Percent sorting efficiency = (1-(# in QA/AC re-sort / (# sorted originally + # in QA/QC re-sort)))* 100.

▨ Sorting efficiency < 90%.

Table A.7: Percent of Benthic Invertebrate Sample Analyzed for Each Station

Area	Station				
	1	2	3	4	5
LWC	100%	100%	100%	100%	100%
LBC	100%	100%	100%	100%	100%
LMC	100%	100%	100%	100%	100%

A7 TISSUE SAMPLES

A7.1 Method Detection Limits

For periphyton tissue samples, only one analyte (total mercury) was below laboratory detection limits and greater than the targeted detection limit (Table A.8). Target concentrations are not based on guidelines; rather represent detection limits the laboratory quoted were achievable.

Eight benthic invertebrate tissue analytes were below the laboratory detection limits and did not meet targets: total antimony, bismuth, boron, lithium, selenium, sodium, tellurium, and tin. For each analyte only 3 out of 16 samples exceeded targets (Table A.9). Target concentrations are not guidelines but represent detection limits quoted by the laboratory. Data for this project can be reliably interpreted.

All chlorophyll-a periphyton samples were detectable and interpretable.

A7.2 Laboratory Blank Samples Analysis

Periphyton (chlorophyll-a, tissue) and benthic invertebrate tissue blank samples contained non-detectable analyte concentrations indicating no inadvertent contamination of samples within the laboratory during analysis (Appendix C).

A7.3 Data Precision

Periphyton field duplicate samples showed close agreement among analytes except for seven analytes: Calcium, magnesium, manganese, mercury, nickel, selenium, and uranium. This represents 20% of the analytes measured and will be considered when interpreting the results (Table A.10).

Laboratory duplicate periphyton tissue samples showed good agreement among all duplicate analyte concentrations (Appendix C). Periphyton samples were associated with good analytical precision.

Benthic invertebrate field duplicate samples did not meet the DQO for most analytes (Table A.11). Tissue samples can be highly variable and this will be considered when analyzing the data.

Laboratory benthic invertebrate duplicate samples showed good agreement among all comparisons as they were all below the DQO set out by the laboratory (Appendix C). Benthic invertebrate samples were associated with good analytical precision.

The RPD between the field duplicate periphyton chlorophyll-a samples was 14%, indicating that the data was associated with good laboratory precision (Table A.12).

Table A.8: Laboratory Method Detection Limits (MDL) for Periphyton Tissue Samples Relative to Targets, Minto Mine, 2017 [a]

Analyte	Units	Method Detection Limits	
		Target	Achieved
Total Boron (B)	mg/kg wwt	0.20	0.20
Total Mercury (Hg)	mg/kg wwt	0.0010	0.0010 - 0.014
Total Tellurium (Te)	mg/kg wwt	0.0040	0.0040
Total Tin (Sn)	mg/kg wwt	0.020	0.020

▨ Target MDL were exceeded.

[a] Only analytes with any reported values less than MDL were presented.

Table A.9: Laboratory Method Detection Limits (MDL) for Benthic Invertebrate Tissue Samples Relative to Targets, Minto Mine, 2017 [a]

Analyte	Units	Method Detection Limits	
		Target	Achieved
Total Antimony (Sb)	mg/kg wwt	0.0020	0.0020 - 0.050
Total Bismuth (Bi)	mg/kg wwt	0.0020	0.0020 - 0.050
Total Boron (B)	mg/kg wwt	0.20	0.20 - 5.0
Total Lithium (Li)	mg/kg wwt	0.10	0.10 - 2.5
Total Selenium (Se)	mg/kg wwt	0.010	0.010 - 0.50
Total Sodium (Na)	mg/kg wwt	4.0	4.0 - 100
Total Tellurium (Te)	mg/kg wwt	0.0040	0.0040 - 0.10
Total Tin (Sn)	mg/kg wwt	0.020	0.020 - 0.50

▨ Target MDL were exceeded.

[a] Only analytes with any reported values less than MDL were presented.

Table A.10: Field Duplicate Results for Analysis of Periphyton Tissue Quality, Minto Mine, 2017

Analyte		Units	Lab Report L1998303		
			LWC-3	LWC-3X	RPD (%)
			23-Sep-2017	23-Sep-2017	
Physical Tests	% Moisture	%	71	62	14
Metals	Total Aluminum (Al)	mg/kg wwt	852	862	1.2
	Total Antimony (Sb)	mg/kg wwt	0.018	0.019	4.9
	Total Arsenic (As)	mg/kg wwt	0.46	0.53	13
	Total Barium (Ba)	mg/kg wwt	18	24	29
	Total Beryllium (Be)	mg/kg wwt	0.066	0.081	21
	Total Bismuth (Bi)	mg/kg wwt	0.0057	0.0072	23
	Total Boron (B)	mg/kg wwt	0.38	0.41	7.6
	Total Cadmium (Cd)	mg/kg wwt	0.17	0.16	3.7
	Total Calcium (Ca)	mg/kg wwt	813	985	19
	Total Cesium (Cs)	mg/kg wwt	0.086	0.12	33
	Total Chromium (Cr)	mg/kg wwt	5.9	5.1	15
	Total Cobalt (Co)	mg/kg wwt	1.3	1.1	17
	Total Copper (Cu)	mg/kg wwt	6.6	5.8	13
	Total Iron (Fe)	mg/kg wwt	1,990	1,990	0
	Total Lead (Pb)	mg/kg wwt	0.42	0.51	19
	Total Lithium (Li)	mg/kg wwt	0.67	0.84	23
	Total Magnesium (Mg)	mg/kg wwt	1,040	766	30.3
	Total Manganese (Mn)	mg/kg wwt	110	161	38
	Total Mercury (Hg)	mg/kg wwt	<0.010	<0.014	33
	Total Molybdenum (Mo)	mg/kg wwt	0.22	0.27	21
	Total Nickel (Ni)	mg/kg wwt	5.7	3.6	45
	Total Phosphorus (P)	mg/kg wwt	1,280	1,390	8.2
	Total Potassium (K)	mg/kg wwt	982	986	0.41
	Total Rubidium (Rb)	mg/kg wwt	1.4	1.6	15
	Total Selenium (Se)	mg/kg wwt	0.32	0.48	41
	Total Sodium (Na)	mg/kg wwt	495	382	26
	Total Strontium (Sr)	mg/kg wwt	8.8	9.8	11
	Total Tellurium (Te)	mg/kg wwt	<0.0040	<0.0040	0
	Total Thallium (Tl)	mg/kg wwt	0.0062	0.0071	15
	Total Tin (Sn)	mg/kg wwt	0.080	0.082	2.5
	Total Uranium (U)	mg/kg wwt	0.23	0.50	76
	Total Vanadium (V)	mg/kg wwt	4.4	5.1	16
	Total Zinc (Zn)	mg/kg wwt	23	29	25
	Total Zirconium (Zr)	mg/kg wwt	1.5	1.3	18

▨ > 30% Relative Percent Differences (RPD).

Table A.11: Field Duplicate Results for Analysis of Benthic Invertebrate Tissue Quality, Minto Mine, 2017

Analyte		Units	Lab Report L1998305		
			LWC-3	LWC-3X	RPD (%)
			23-Sep-2017	23-Sep-2017	
Physical Tests	% Moisture	%	60	72	19
Metals	Total Aluminum (Al)	mg/kg wwt	5,350	3,630	38
	Total Antimony (Sb)	mg/kg wwt	0.0153	0.0147	4.0
	Total Arsenic (As)	mg/kg wwt	1.9	1.3	37
	Total Barium (Ba)	mg/kg wwt	69	50	33
	Total Beryllium (Be)	mg/kg wwt	0.26	0.17	42
	Total Bismuth (Bi)	mg/kg wwt	0.029	0.021	34
	Total Boron (B)	mg/kg wwt	1.2	1.1	6.1
	Total Cadmium (Cd)	mg/kg wwt	0.055	0.041	28
	Total Calcium (Ca)	mg/kg wwt	3,240	2,250	36
	Total Cesium (Cs)	mg/kg wwt	0.59	0.45	26
	Total Chromium (Cr)	mg/kg wwt	16	11	38
	Total Cobalt (Co)	mg/kg wwt	4.9	3.1	44
	Total Copper (Cu)	mg/kg wwt	6.9	5.0	31
	Total Iron (Fe)	mg/kg wwt	9,550	6,280	41
	Total Lead (Pb)	mg/kg wwt	2.2	1.5	37
	Total Lithium (Li)	mg/kg wwt	4.4	3.0	40
	Total Magnesium (Mg)	mg/kg wwt	3,560	2,270	44
	Total Manganese (Mn)	mg/kg wwt	262	222	17
	Total Mercury (Hg)	mg/kg wwt	0.0086	0.0063	31
	Total Molybdenum (Mo)	mg/kg wwt	0.15	0.10	35
	Total Nickel (Ni)	mg/kg wwt	14	8.9	43
	Total Phosphorus (P)	mg/kg wwt	501	359	33
	Total Potassium (K)	mg/kg wwt	443	344	25
	Total Rubidium (Rb)	mg/kg wwt	4.9	3.5	33
	Total Selenium (Se)	mg/kg wwt	0.12	0.11	4.4
	Total Sodium (Na)	mg/kg wwt	162	108	40
	Total Strontium (Sr)	mg/kg wwt	30	21	35
	Total Tellurium (Te)	mg/kg wwt	0.0071	<0.0040	56
	Total Thallium (Tl)	mg/kg wwt	0.031	0.024	27
	Total Tin (Sn)	mg/kg wwt	0.13	0.10	24
	Total Uranium (U)	mg/kg wwt	0.42	0.27	44
	Total Vanadium (V)	mg/kg wwt	22	15	40
	Total Zinc (Zn)	mg/kg wwt	23	15	40
	Total Zirconium (Zr)	mg/kg wwt	4.6	3.2	37

▨ > 30% Relative Percent Differences (RPD).

Table A.12: Field Duplicate Results for Analysis of Chlorophyll-a Quality, Minto Mine, 2017

Analytes	**Units**	**Lab Report L1998299**		
		LWC-3	LWC-3X	**RPD (%)**
		23-Sep-2017	23-Sep-2017	
Chlorophyll-a	mg/m^2	22	19	14

▨ > 30% Relative Percent Difference (RPD).

A7.4 Data Accuracy

Analyte recoveries for spiked blanks all met the DQO indicating excellent analytical accuracy for periphyton (chlorophyll-a, tissue) and benthic invertebrate tissue (Appendix C).

Certified reference material met the DQO for periphyton and benthic invertebrate tissue indicating good analytical accuracy (Appendix C).

A8 DATA QUALITY STATEMENT

Water, sediment, and benthic community data were all of good quality compared to DQO indicating that they can be reliably interpreted. Periphyton community showed close agreement between duplicate samples except for Rhodophyta samples. The RPD was 46% and differences could be due to the low abundance of Rhodophyta. Lack of agreement between duplicate tissue samples (periphyton, benthic invertebrate) were observed. Over 20% of the analytes measured for periphyton and benthic invertebrate duplicate tissue samples had RPDs that were greater than 30%, failing the DQO. This will be considered when analyzing the data. The overall quality of data for this project was good to serve the project objectives.

APPENDIX B

SUPPORTING INFORMATION AND DATA

Figures and Tables

Laboratory Reports

APPENDIX B

SUPPORTING INFORMATION AND DATA

Figures and Tables

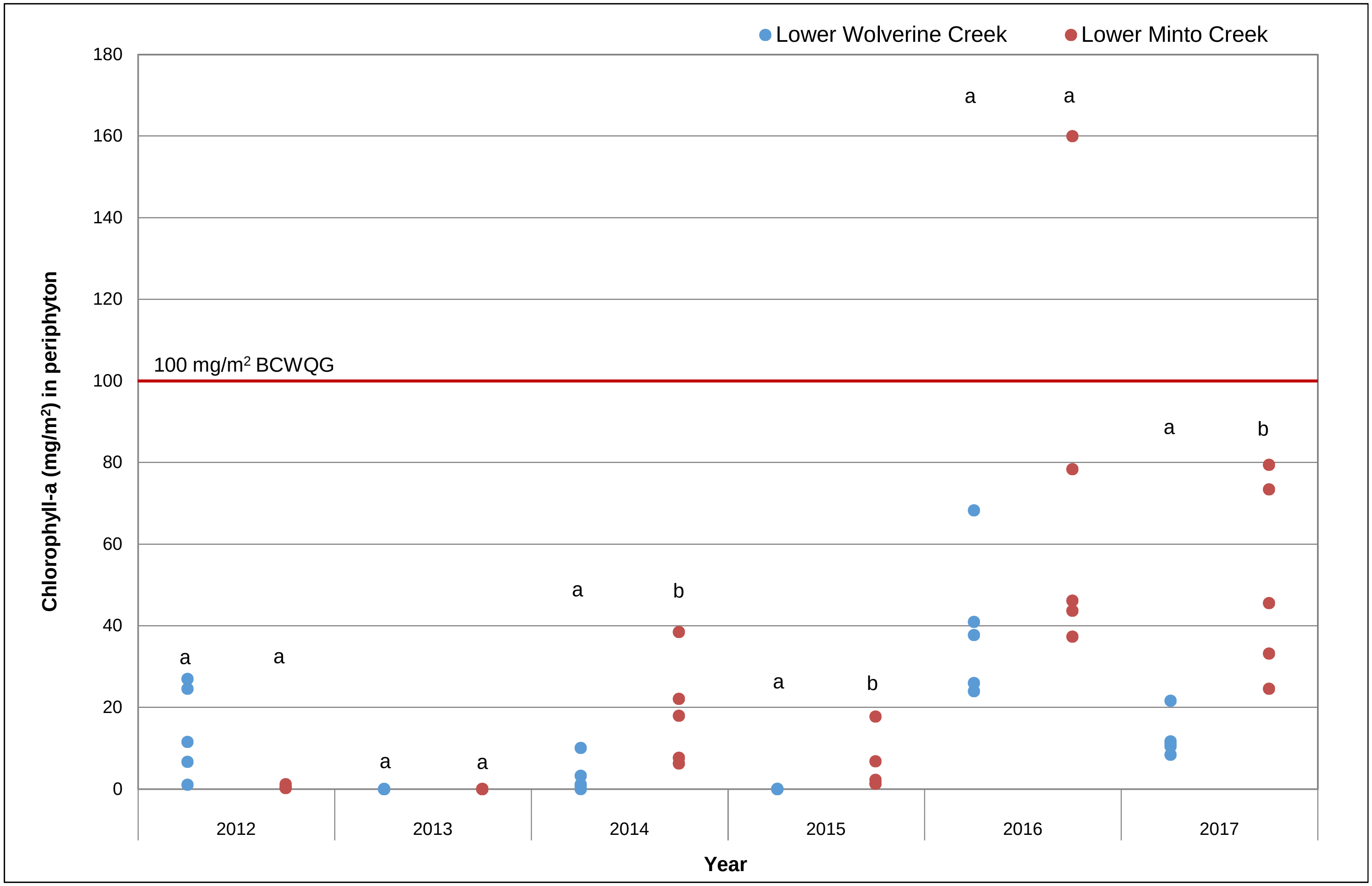


Figure B.1: Concentrations of Chlorophyll-a in Periphyton Measured in Lower Wolverine and Lower Minto Creeks, Minto Mine WUL, 2012 - 2017

Note: Different letters represent significant differences between sites within years.

Table B.1: Habitat Characteristics for Benthic Invertebrate Areas, Minto Mine, September 2017

Characteristics		Lower Wolverine Creek (Reference)	Lower Big Creek (Reference)	Lower Minto Creek (Exposed)
UTM (NAD83, Zone 8V)	Easting	382472	396627	392236
	Northing	6954814	694270	6948025
Approximate Length of Reach Assessed (m)		200	150	20
Gradient (%)		2	1	1
Velocity (m/s)	Mean (min-max)	0.28 (0.26 - 0.29)	0.32 (0.29 - 0.35)	0.28 (0.26 - 0.30)
Depth (cm)	Mean	35	70	13
	Maximum	83	106	16.5
Width (m)	Wetted	8.0	32	1.8
	Bankfull	25	49	2.6
General Morphology	% pool	5	10	10
	% riffle	85	60	60
	% run	10	30	30
Bank Condition		Moderate (some undercut banks)	Moderate (some undercut banks)	Moderate (some undercut banks)
Substrate Coverage	% bedrock	0	0	0
	% boulder	5	10	5
	% cobble	85	80	80
	% gravel	5	5	5
	% sand and finer	5	5	10
Instream Cover (% total Surface)	undercut banks	10	5	10
	boulder	5	10	5
	woody debris	5	5	20
	deep pool	5	10	1
	macrophytes	0	0	0
	other	-	-	-
Overhead Canopy (%Surface)	Dense	0	10	40
	Partially Open	0	0	40
	Open	100	90	20
Aquatic Vegetation (% areal coverage)	Emergent	0	0	0
	Submergent	0	0	0
	Floating	0	0	0
	Attached Algae	0	80 (brown filamentous)	0
Riparian vegetation		willow, alder, birch, fir, rose bush, grasses	willows, alders, birch, spruce	willow, alder, grasses
Surrounding Land Use		forested	forested	mine upstream, forested, previous forest fires
Evidence of Anthropogenic Disturbance		none	bridge downstream / access road	mine

Table B.2: Supporting Information for Erosional Benthic Invertebrate Grab Sample Collections, Minto Mine, September 2017

Characteristics		Lower Wolverine Creek (Reference)				
		LWC-1	**LWC-2**	**LWC-3**	**LWC-4**	**LWC-5**
Date		24-Sep-17	24-Sep-17	23-Sep-17	23-Sep-17	23-Sep-17
Time		10:32	8:39	14:59	12:11	9:35
UTM (NAD83, Zone 8V)	Easting	382419	382422	382472	382546	382561
	Northing	6954622	6954726	6954814	6955032	6955149
Sampling Device		Hess Sampler	Hess Sampler	Hess Sampler	Hess Sampler	Hess Sampler
Sampler Size (m^2)		0.10	0.10	0.10	0.10	0.10
Mesh Size (µm)		500	500	500	500	500
Grabs in Composite		3	3	3	3	3
Water Velocity (m/s)		0.27	0.26	0.29	0.29	0.29
Depth (m)		11	9	11	11	11
Number of Jars		1	1	1	1	1
Average Depth (cm) (Sampler pushed into substrate)		1	1	2	2	1
Average Depth (cm) (Substrate is sampled/cleaned)		2	3	3	3	3
Average Sampling Time per Grab (min)		5	5	5	4	5
Macrophytes (in sample)		sparse (bryophytes)	none	none	sparse (bryophytes)	none
Algae (in sample)		none	none	none	none	sparse (brown)
Sample Texture	% cobble	90	90	92.5	95	95
	% gravel	5	5	2.5	2.5	2.5
	% sand and finer	5	5	5	2.5	2.5
	% organic	0	0	0	0	0

Table B.2: Supporting Information for Erosional Benthic Invertebrate Grab Sample Collections, Minto Mine, September 2017

Characteristics		Lower Big Creek (Reference)				
		LBC-1	LBC-2	LBC-3	LBC-4	LBC-5
Date		22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17
Time		16:48	15:53	13:42	11:15	8:50
UTM (NAD83, Zone 8V)	Easting	396397	396499	396627	396623	396493
	Northing	6942238	6942203	694270	6942519	6942694
Sampling Device		Hess Sampler	Hess Sampler	Hess Sampler	Hess Sampler	Hess Sampler
Sampler Size (m^2)		0.10	0.10	0.10	0.10	0.10
Mesh Size (µm)		500	500	500	500	500
Grabs in Composite		3	3	3	3	3
Water Velocity (m/s)		0.34	0.35	0.29	0.32	0.31
Depth (m)		10	9	7	11	9
Number of Jars		1	1	1	1	1
Average Depth (cm) (Sampler pushed into substrate)		3	2	3	2	3
Average Depth (cm) (Substrate is sampled/cleaned)		3	3	2	3	3
Average Sampling Time per Grab (min)		5	5	5	5	5
Macrophytes (in sample)		none	none	none	none	none
Algae (in sample)		common (brown filamentous)	common (brown filamentous)	common (brown filamentous)	common (brown filamentous)	sparse (brown filamentous)
Sample Texture	% cobble	90	90	85	90	92.5
	% gravel	5	5	10	5	2.5
	% sand and finer	5	5	5	5	5
	% organic	0	0	0	0	0

Table B.2: Supporting Information for Erosional Benthic Invertebrate Grab Sample Collections, Minto Mine, September 2017

Characteristics		Lower Minto Creek (Exposed)				
		LMC-1	**LMC-2**	**LMC-3**	**LMC-4**	**LMC-5**
Date		26-Sep-17	26-Sep-17	26-Sep-17	21-Sep-17	21-Sep-17
Time		13:46	11:35	8:58	15:07	12:26
UTM (NAD83, Zone 8V)	Easting	392102	392131	392216	392236	392263
	Northing	6948052	6948044	6948009	6948025	6948077
Sampling Device		Hess sampler	Hess Sampler	Hess Sampler	Hess Sampler	Hess Sampler
Sampler Size (m^2)		0.10	0.10	0.10	0.10	0.10
Mesh Size (µm)		500	500	500	500	500
Grabs in Composite		3	3	3	3	3
Water Velocity (m/s)		0.29	0.30	0.30	0.27	0.26
Depth (m)		6	6	7	8	7
Number of Jars		1	1	1	1	1
Average Depth (cm) (Sampler pushed into substrate)		3	3	3	3	3
Average Depth (cm) (Substrate is sampled/cleaned)		2	3	3	3	3
Average Sampling Time per Grab (min)		5	5	5	5	7
Macrophytes (in sample)		none	none	sparse (roots)	none	sparse (roots)
Algae (in sample)		none	none	sparse (brown on rocks)	sparse (brown on rocks)	sparse (brown on rocks)
Sample Texture	% cobble	90	95	90	80	90
	% gravel	5	2.5	5	5	5
	% sand and finer	5	2.5	5	15	5
	% organic	0	0	0	0	0

Table B.3: *In situ* Water Quality Measures at Sediment Sampling Stations, Minto Mine WUL, September 2017

Area	Variable	Temperature	Specific Conductance	Dissolved Oxygen	Dissolved Oxygen	pH
	Unit	°C	µS/cm	mg/L	%	pH units
	CCME Water Quality Guidelines	-	-	6.5 - 9.5	54	6.5 - 9.0 [a]
Upper McGinty Creek (Reference)	URC-1	1.7	170.0	11.86	83.8	7.66
	URC-2	1.7	171.4	11.43	82.0	7.63
	URC-3	1.7	170.6	11.22	80.5	7.67
	URC-4	1.6	177.0	11.24	80.1	7.74
	URC-5	1.5	182.4	12.82	90.8	7.99
	Mean	1.6	174.3	11.71	83.4	7.74
	Standard Deviation	0.089	5.3	0.67	4.4	0.15
Upper Minto Creek (Exposed)	UMC-1	2.8	605.7	11.35	82.4	7.76
	UMC-2	2.6	601.5	10.48	76.9	7.76
	UMC-3	2.5	604.0	10.80	78.6	7.77
	UMC-4	2.5	603.2	10.40	76.1	7.76
	UMC-5	3.0	594.0	13.49	92.1	-
	Mean	2.7	601.7	11.30	81.2	7.76
	Standard Deviation	0.22	4.6	1.3	6.5	0.0050
Lower Wolverine Creek (Reference)	LWC-1	5.1	258.4	6.08	44.2	7.47
	LWC-2	6.2	253.3	3.86	32.2	7.35
	LWC-3	6.2	218.8	4.55	34.3	7.56
	LWC-4	6.8	252.6	5.09	43.6	7.41
	LWC-5	6.9	251.9	3.43	28.5	7.55
	Mean	6.2	247.0	4.60	36.6	7.47
	Standard Deviation	0.72	16	1.0	7.0	0.090
Lower Minto Creek (Exposed)	LMC-1	3.5	433.0	8.82	66.1	8.00
	LMC-2	3.4	430.5	8.97	67.3	7.99
	LMC-3	3.5	425.0	9.08	66.2	8.34
	LMC-4	4.6	415.2	9.26	70.9	7.32
	LMC-5	4.7	446.9	9.63	70.2	6.51
	Mean	3.9	430.1	9.15	68.1	7.63
	Standard Deviation	0.65	12	0.31	2.3	0.73

▨ Value does not meet the water quality objective.

[a] Range for the Water Use Licence is 6.0 - 9.0.

Table B.4: *In situ* Water Quality Measures at Benthic Invertebrate Sampling Stations, Minto Mine WUL, September 2017

Area	Variable	Temperature	Specific Conductance	Dissolved Oxygen	Dissolved Oxygen	pH	Mean Depth	Mean Velocity
	Unit	°C	µS/cm	mg/L	%	pH units	m	m/s
	CCME Water Quality Guidelines	-	-	6.5 - 9.5	54	6.5 - 9.0 [a]	-	-
Lower Wolverine Creek (Reference)	LWC-1	3.1	258.7	11.73	87.4	7.98	11	0.27
	LWC-2	3.4	259.3	12.10	90.2	7.98	9	0.26
	LWC-3	4.6	259.3	12.15	94.7	8.06	11	0.29
	LWC-4	3.9	258.6	11.51	87.0	7.63	11	0.29
	LWC-5	3.8	261.0	11.02	83.7	7.24	11	0.29
	Mean	3.8	259.4	11.70	88.6	7.78	11	0.28
	Standard Deviation	0.57	1.0	0.46	4.1	0.34	0.66	0.014
Lower Big Creek (Reference)	LBC-1	7.0	262.2	10.72	88.3	8.47	10	0.34
	LBC-2	7.2	265.0	10.63	88.2	8.43	9	0.35
	LBC-3	6.3	172.3	10.60	85.7	8.27	7	0.29
	LBC-4	5.8	269.6	9.56	76.3	7.93	11	0.32
	LBC-5	5.5	271.0	10.33	81.9	7.94	9	0.31
	Mean	6.4	248.0	10.37	84.1	8.21	9	0.32
	Standard Deviation	0.74	42	0.47	5.1	0.26	1.5	0.024
Lower Minto Creek (Exposed)	LMC-1	1.3	399.3	13.25	93.2	8.28	6	0.29
	LMC-2	0.8	401.2	13.10	91.5	8.22	6	0.30
	LMC-3	0.6	402.8	12.85	89.6	8.08	7	0.30
	LMC-4	4.1	427.9	9.20	71.4	8.30	8	0.27
	LMC-5	3.4	430.9	9.27	69.5	8.12	7	0.26
	Mean	2.0	412.4	11.53	83.0	8.20	7	0.28
	Standard Deviation	1.6	16	2.10	12	0.10	0.52	0.018

▨ Value does not meet the water quality objective.

[a] Range for the Water Use Licence is 6.0 - 9.0.

Table B.5: Water Quality Results at Reference and Exposed Areas, Minto Mine WUL, September 2017

Analyte		Units	URC (Reference)	UMC (Exposed)	LWC (Reference)	LBC (Reference)	LMC (Exposed)
Sampling Dates:			25-Sep-17	26-Sep-17	25-Sep-17	26-Sep-17	26-Sep-17
Physical Tests	Conductivity	µS/cm	164	523	219	217	340
	Hardness (as $CaCO_3$)	mg/L	113	260	107	103	175
	pH	pH Units	7.82	8.08	8.03	8.18	8.22
	Total Suspended Solids	mg/L	<3.0	<3.0	3.1	<3.0	3.5
	Total Dissolved Solids	mg/L	163	317	165	152	225
	Turbidity	NTU	0.87	0.20	0.87	0.89	0.75
Anions and Nutrients	Total Alkalinity	mg/L	77	234	105	105	172
	Total Ammonia (as N)	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
	Chloride (Cl)	mg/L	0.27	4.4	0.45	0.59	1.7
	Fluoride (F)	mg/L	0.33	0.58	0.13	0.13	0.44
	Nitrate (as N)	mg/L	0.069	0.16	<0.0050	0.0053	0.042
	Nitrite (as N)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Phosphorus (P)-Total dissolved	mg/L	0.011	0.0056	0.0055	0.0023	0.0038
	Phosphorus (P)-Total	mg/L	0.0089	0.0053	0.0063	0.0037	0.0050
	Sulfate (SO_4)	mg/L	14	55	21	16	20
Cyanides	Total Cyanide	mg/L	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Organic/inorganic carbon	Dissolved Organic Carbon	mg/L	10	5.8	14	7.6	9.0
	Total Inorganic Carbon	mg/L	16	54	22	22	38
	Total Organic Carbon	mg/L	12	5.5	14	7.5	9.0
Total Metals	Total Aluminum (Al)	mg/L	0.022	0.0055	0.038	0.038	0.018
	Total Antimony (Sb)	mg/L	<0.00010	<0.00010	<0.00010	0.00014	<0.00010
	Total Arsenic (As)	mg/L	0.00042	0.00025	0.00045	0.00081	0.00048
	Total Barium (Ba)	mg/L	0.032	0.068	0.041	0.066	0.060
	Total Beryllium (Be)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Bismuth (Bi)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Total Boron (B)	mg/L	<0.010	0.025	<0.010	<0.010	<0.010
	Total Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	<0.0000050	0.0000078	<0.0000050
	Total Calcium (Ca)	mg/L	24	59	24	26	45
	Total Chromium (Cr)	mg/L	0.00034	<0.00010	0.00052	0.00030	0.00024
	Total Cobalt (Co)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Copper (Cu)	mg/L	0.0012	0.0025	0.0019	0.0019	0.0016
	Total Iron (Fe)	mg/L	0.26	0.025	0.13	0.079	0.067
	Total Lead (Pb)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Total Lithium (Li)	mg/L	<0.0010	0.0032	0.0016	0.0012	0.0014
	Total Magnesium (Mg)	mg/L	6.6	29	13	10	16
	Total Manganese (Mn)	mg/L	0.021	0.047	0.0058	0.015	0.0034
	Total Mercury (Hg)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.000025	<0.0000050
	Total Molybdenum (Mo)	mg/L	0.0013	0.0048	0.00057	0.0013	0.0016
	Total Nickel (Ni)	mg/L	0.00091	0.00092	0.0017	0.0011	0.00097
	Total Phosphorus (P)	mg/L	<0.30	<0.30	<0.30	<0.30	<0.30
	Total Potassium (K)	mg/L	0.59	2.4	0.76	0.87	1.5
	Total Selenium (Se)	mg/L	0.00036	0.00031	0.00011	0.000072	0.000081
	Total Silicon (Si)	mg/L	6.4	6.3	5.2	5.9	6.2
	Total Silver (Ag)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Total Sodium (Na)	mg/L	4.4	19	8.5	7.8	10
	Total Strontium (Sr)	mg/L	0.16	0.77	0.22	0.28	0.45
	Total Thallium (Tl)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Total Tin (Sn)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Titanium (Ti)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
	Total Uranium (U)	mg/L	0.00054	0.0026	0.00081	0.0028	0.0017
	Total Vanadium (V)	mg/L	0.00056	<0.00050	0.00091	0.00081	0.00060
	Total Zinc (Zn)	mg/L	0.0051	<0.0030	<0.0030	<0.0030	0.0044
Dissolved Metals	Dissolved Aluminum (Al)	mg/L	0.0056	0.0029	0.020	0.013	0.0050
	Dissolved Antimony (Sb)	mg/L	<0.00010	<0.00010	<0.00010	0.00012	<0.00010
	Dissolved Arsenic (As)	mg/L	0.00019	0.00024	0.00041	0.00067	0.00046
	Dissolved Barium (Ba)	mg/L	0.022	0.071	0.041	0.068	0.063
	Dissolved Beryllium (Be)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Bismuth (Bi)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Dissolved Boron (B)	mg/L	<0.010	0.021	<0.010	<0.010	<0.010
	Dissolved Cadmium (Cd)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Dissolved Calcium (Ca)	mg/L	33	56	22	24	42
	Dissolved Chromium (Cr)	mg/L	0.00015	<0.00010	0.00041	0.00021	0.00019
	Dissolved Cobalt (Co)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Copper (Cu)	mg/L	0.00032	0.0025	0.0033	0.0017	0.0015
	Dissolved Iron (Fe)	mg/L	0.055	0.020	0.090	0.039	0.040
	Dissolved Lead (Pb)	mg/L	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Dissolved Lithium (Li)	mg/L	<0.0010	0.0033	0.0019	0.0016	0.0017
	Dissolved Magnesium (Mg)	mg/L	9.2	29	13	10	17
	Dissolved Manganese (Mn)	mg/L	0.0060	0.047	0.0035	0.013	0.0022
	Dissolved Mercury (Hg)	mg/L	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Dissolved Molybdenum (Mo)	mg/L	0.0029	0.0041	0.00049	0.0011	0.0014
	Dissolved Nickel (Ni)	mg/L	<0.00050	0.00081	0.0016	0.00090	0.00086
	Dissolved Phosphorus (P)	mg/L	<0.30	<0.30	<0.30	<0.30	<0.30
	Dissolved Potassium (K)	mg/L	0.73	2.5	0.79	0.90	1.6
	Dissolved Selenium (Se)	mg/L	0.00086	0.00032	0.00010	<0.000050	0.00010
	Dissolved Silicon (Si)	mg/L	5.7	6.0	4.9	5.6	6.0
	Dissolved Silver (Ag)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Dissolved Sodium (Na)	mg/L	6.5	19	8.6	7.8	11
	Dissolved Strontium (Sr)	mg/L	0.25	0.71	0.20	0.26	0.43
	Dissolved Thallium (Tl)	mg/L	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Dissolved Tin (Sn)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Titanium (Ti)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010
	Dissolved Uranium (U)	mg/L	0.0012	0.0023	0.00069	0.0025	0.0016
	Dissolved Vanadium (V)	mg/L	0.0011	<0.00050	0.00086	0.00074	0.00057
	Dissolved Zinc (Zn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	0.0027

Table B.6: Explanatory Notes for Selected Water Quality Guidelines, Minto Mine WUL, 2017

Analyte		Water Quality Guidelines	Unit	CCME [a]
Physical, anion and nutrient analytes	Total Ammonia	**0.41**	mg/L	Ammonia guideline is based on highest field pH of 8.27 and highest temperature of 6.3°C
	Fluoride	**0.12**	mg/L	Guideline is an interim level
Total Metals	Aluminum	**0.10**	mg/L	Guideline is based on pH of > 6.5
	Cadmium	**0.00016 / 0.0022** [b]	mg/L	Guideline is based on lowest hardness of 103 mg/L
	Chromium	**0.0010**	mg/L	Guideline is based hexavalent chromium (Cr VI)
	Copper	**0.0024**	mg/L	Guideline is based on lowest hardness of 103 mg/L
	Lead	**0.0033**	mg/L	Guideline is based on lowest hardness of 103 mg/L
	Nickel	**0.098**	mg/L	Guideline is based on lowest hardness of 103 mg/L

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg.

[b] 30 day guideline / Max guideline.

Table B.7: Comparison of Water Quality Results at Reference and Exposed Areas in 2016 and 2017, Minto Mine WUL

Analyte		Units	CCME Water Quality Guidelines [a]		WUL Objectives at W2	2016					2017				
			30 Day	Max		Upper McGinty Creek (Reference)	Upper Minto Creek (Exposed)	Lower Wolverine Creek (Reference)	Little Big Creek (Reference)	Lower Minto Creek (Exposed)	Upper McGinty Creek (Reference)	Upper Minto Creek (Exposed)	Lower Wolverine Creek (Reference)	Little Big Creek (Reference)	Lower Minto Creek (Exposed)
Physical Tests	Total Suspended Solids	mg/L	-	-	-	<3.0	<3.0	<3.0	<3.0	3.9	<3.0	<3.0	3.1	<3.0	3.5
Total Metals	Total Aluminum (Al)	mg/L	0.10 [b]	-	-	0.095	0.023	0.060	0.059	0.041	0.022	0.0055	0.038	0.038	0.018
	Total Antimony (Sb)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	0.00018	0.00010	<0.00010	<0.00010	<0.00010	0.00014	<0.00010
	Total Arsenic (As)	mg/L	0.0050	-	-	0.00065	0.00021	0.00052	0.00095	0.00051	0.00042	0.00025	0.00045	0.00081	0.00048
	Total Barium (Ba)	mg/L	-	-	-	0.034	0.039	0.035	0.066	0.058	0.032	0.068	0.041	0.066	0.060
	Total Beryllium (Be)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Bismuth (Bi)	mg/L	-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Total Boron (B)	mg/L	1.5	2.9	-	<0.010	0.028	<0.010	<0.010	0.012	<0.010	0.025	<0.010	<0.010	<0.010
	Total Cadmium (Cd)	mg/L	0.00016 [c]	0.0022 [c]	-	0.0000051	0.000015	<0.0000050	0.0000066	<0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000078	<0.0000050
	Total Calcium (Ca)	mg/L	-	-	-	21	32	21	25	43	24	59	24	26	45
	Total Chromium (Cr)	mg/L	0.0010 Cr(VI)	-	-	0.00058	0.00010	0.00063	0.00031	0.00025	0.00034	<0.00010	0.00052	0.00030	0.00024
	Total Cobalt (Co)	mg/L	-	-	-	0.00019	<0.00010	0.00011	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Copper (Cu)	mg/L	0.0024 [c]	-	-	0.0017	0.0066	0.0022	0.0023	0.0023	0.0012	0.0025	0.0019	0.0019	0.0016
	Total Iron (Fe)	mg/L	0.30	-	-	0.69	0.046	0.22	0.12	0.20	0.26	0.025	0.13	0.079	0.067
	Total Lead (Pb)	mg/L	0.0033 [c]	-	-	<0.000050	<0.000050	<0.000050	0.000071	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Total Lithium (Li)	mg/L	-	-	-	<0.0010	0.0010	0.0016	0.0014	0.0014	<0.0010	0.0032	0.0016	0.0012	0.0014
	Total Magnesium (Mg)	mg/L	-	-	-	6.1	10	11	10	14	6.6	29	13	10	16
	Total Manganese (Mn)	mg/L	-	-	-	0.050	0.039	0.015	0.017	0.013	0.021	0.047	0.0058	0.015	0.0034
	Total Mercury (Hg)	mg/L	0.000026	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.000025	<0.0000050
	Total Molybdenum (Mo)	mg/L	0.073	-	-	0.0010	0.0024	0.00057	0.0014	0.0016	0.0013	0.0048	0.00057	0.0013	0.0016
	Total Nickel (Ni)	mg/L	0.098 [c]	-	-	0.0014	0.00053	0.0021	0.0013	0.0011	0.00091	0.00092	0.0017	0.0011	0.0010
	Total Phosphorus (P)	mg/L	-	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
	Total Potassium (K)	mg/L	-	-	-	0.47	1.8	0.63	0.86	1.4	0.59	2.4	0.76	0.87	1.5
	Total Selenium (Se)	mg/L	0.0010	-	-	0.00027	0.00059	0.00011	0.000055	0.00022	0.00036	0.00031	0.00011	0.000072	0.000081
	Total Silicon (Si)	mg/L	-	-	-	7.1	2.3	6.0	6.5	5.4	6.4	6.3	5.2	5.9	6.2
	Total Silver (Ag)	mg/L	0.00025		-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Total Sodium (Na)	mg/L	-	-	-	4.2	12	7.3	7.9	9.9	4.4	19	8.5	7.8	10
	Total Strontium (Sr)	mg/L	-	-	-	0.13	0.33	0.19	0.27	0.36	0.16	0.77	0.22	0.28	0.45
	Total Thallium (Tl)	mg/L	0.00080	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Total Tin (Sn)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Total Titanium (Ti)	mg/L	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Total Uranium (U)	mg/L	0.015	0.033	-	0.00043	0.00074	0.00068	0.0027	0.0010	0.00054	0.0026	0.00081	0.0028	0.0017
	Total Vanadium (V)	mg/L	-	-	-	0.0011	<0.00050	0.0012	0.0011	0.00075	0.00056	<0.00050	0.00091	0.00081	0.00060
	Total Zinc (Zn)	mg/L	0.030	-	-	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0051	<0.0030	<0.0030	<0.0030	0.0044

▭	Water use licence objectives not met.
▨	Water quality guideline not met.

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg. See Appendix Table B.6 for explanatory notes on selected water quality guidelines.

[b] Based on lowest guideline using highest pH.

[c] Based on lowest guideline using lowest hardness.

[d] Dissolved Cadmium (μg/L) guidelines based on the following formula using the lowest hardness: $e^{(0.736(\ln(\text{Hardness})-4.943)}$.

[e] Dissolved copper water quality objective depends on concentration of dissolved organic carbon (DOC). If DOC is > 10 mg/L/ DOC is ≤ 10 mg/L.

Table B.7: Comparison of Water Quality Results at Reference and Exposed Areas in 2016 and 2017, Minto Mine WUL

Analyte		Units	CCME Water Quality Guidelines [a]		WUL Objectives at W2	2016					2017				
			30 Day	Max		Upper McGinty Creek (Reference)	Upper Minto Creek (Exposed)	Lower Wolverine Creek (Reference)	Little Big Creek (Reference)	Lower Minto Creek (Exposed)	Upper McGinty Creek (Reference)	Upper Minto Creek (Exposed)	Lower Wolverine Creek (Reference)	Little Big Creek (Reference)	Lower Minto Creek (Exposed)
Dissolved Metals	Dissolved Aluminum (Al)	mg/L	-	-	0.10	0.029	0.0017	0.027	0.017	0.0052	0.0056	0.0029	0.020	0.013	0.0050
	Dissolved Antimony (Sb)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	0.00014	<0.00010	<0.00010	<0.00010	<0.00010	0.00012	<0.00010
	Dissolved Arsenic (As)	mg/L	-	-	0.0050	0.00053	0.00018	0.00046	0.00075	0.00047	0.00019	0.00024	0.00041	0.00067	0.00046
	Dissolved Barium (Ba)	mg/L	-	-	-	0.032	0.038	0.036	0.066	0.058	0.022	0.071	0.041	0.068	0.063
	Dissolved Beryllium (Be)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Bismuth (Bi)	mg/L	-	-	-	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Dissolved Boron (B)	mg/L	-	-	-	<0.010	0.027	<0.010	<0.010	0.012	<0.010	0.021	<0.010	<0.010	<0.010
	Dissolved Cadmium (Cd)	mg/L	-	-	0.00022 [d]	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Dissolved Calcium (Ca)	mg/L	-	-	-	20	32	21	25	42	33	56	22	24	42
	Dissolved Chromium (Cr)	mg/L	-	-	0.0010	0.00037	<0.00010	0.00049	0.00021	0.00016	0.00015	<0.00010	0.00041	0.00021	0.00019
	Dissolved Cobalt (Co)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Copper (Cu)	mg/L	-	-	0.020/0.013 [e]	0.0013	0.0057	0.0020	0.0019	0.0021	0.00032	0.0025	0.0033	0.0017	0.0015
	Dissolved Iron (Fe)	mg/L	-	-	1.1	0.35	<0.010	0.17	0.047	0.10	0.055	0.020	0.090	0.039	0.040
	Dissolved Lead (Pb)	mg/L	-	-	0.0040	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
	Dissolved Lithium (Li)	mg/L	-	-	-	<0.0010	<0.0010	0.0015	0.0014	0.0014	<0.0010	0.0033	0.0019	0.0016	0.0017
	Dissolved Magnesium (Mg)	mg/L	-	-	-	6.0	10	11	10	13	9.2	29	13	10	17
	Dissolved Manganese (Mn)	mg/L	-	-	-	0.029	0.015	0.012	0.015	0.0051	0.0060	0.047	0.0035	0.013	0.0022
	Dissolved Mercury (Hg)	mg/L	-	-	-	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
	Dissolved Molybdenum (Mo)	mg/L	-	-	0.073	0.00080	0.0021	0.00044	0.0012	0.0015	0.0029	0.0041	0.00049	0.0011	0.0014
	Dissolved Nickel (Ni)	mg/L	-	-	0.11	0.0012	<0.00050	0.0019	0.0011	0.0010	<0.00050	0.00081	0.0016	0.00090	0.00086
	Dissolved Phosphorus (P)	mg/L	-	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
	Dissolved Potassium (K)	mg/L	-	-	-	0.47	1.8	0.65	0.85	1.4	0.73	2.5	0.79	0.90	1.6
	Dissolved Selenium (Se)	mg/L	-	-	0.0020	0.00030	0.00069	0.00013	0.000073	0.00023	0.00086	0.00032	0.00010	<0.000050	0.00010
	Dissolved Silicon (Si)	mg/L	-	-	-	6.8	2.2	5.8	6.3	5.1	5.7	6.0	4.9	5.6	6.0
	Dissolved Silver (Ag)	mg/L	-	-	0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Dissolved Sodium (Na)	mg/L	-	-	-	4.1	11	7.3	7.7	9.7	6.5	19	8.6	7.8	11
	Dissolved Strontium (Sr)	mg/L	-	-	-	0.12	0.32	0.18	0.26	0.36	0.25	0.71	0.20	0.26	0.43
	Dissolved Thallium (Tl)	mg/L	-	-	-	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Dissolved Tin (Sn)	mg/L	-	-	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Dissolved Titanium (Ti)	mg/L	-	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
	Dissolved Uranium (U)	mg/L	-	-	-	0.00036	0.00065	0.00061	0.0025	0.00090	0.0012	0.0023	0.00069	0.0025	0.0016
	Dissolved Vanadium (V)	mg/L	-	-	-	0.00050	<0.00050	0.00092	0.00080	<0.00050	0.0011	<0.00050	0.00086	0.00074	0.00057
	Dissolved Zinc (Zn)	mg/L	-	-	0.030	<0.0010	0.0036	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0027

▭	Water use licence objectives not met.
▨	Water quality guideline not met.

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg. See Appendix Table B.6 for explanatory notes on selected water quality guidelines.

[b] Based on lowest guideline using highest pH.

[c] Based on lowest guideline using lowest hardness.

[d] Dissolved Cadmium (µg/L) guidelines based on the following formula using the lowest hardness: $e^{(0.736(\ln(\text{Hardness})-4.943)}$.

[e] Dissolved copper water quality objective depends on concentration of dissolved organic carbon (DOC). If DOC is > 10 mg/L/ DOC is ≤ 10 mg/L.

Table B.8: Concentration of Chlorophyll-a Measured at Five Benthic Stations in Lower Wolverine and Lower Minto Creeks, Minto Mine WUL, 2017

Lower Wolverine Creek (Reference)		**Lower Minto Creek (Exposed)**	
Station	mg/m^2	Station	mg/m^2
LWC-1	8.4	LMC-1	25
LWC-2	11	LMC-2	80
LWC-3	22	LMC-3	46
LWC-4	11	LMC-4	33
LWC-5	12	LMC-5	74
Mean	13	Mean	51
Standard Deviation	5.2	Standard Deviation	24

▬ Chlorophyll-a exceeded the BCWQG of 100 mg/m^2.

APPENDIX B

SUPPORTING INFORMATION AND DATA

Laboratory Reports

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 27-SEP-17
Report Date: 03-OCT-17 18:08 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1998023

Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT
C of C Numbers: 1 of 1
Legal Site Desc:

Can Dang
Senior Account Manager

	Sample ID	L1998023-1	L1998023-2			
	Description	Water	Water			
	Sampled Date	25-SEP-17	25-SEP-17			
	Sampled Time					
	Client ID	URC	LWC			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	164	219			
	Hardness (as CaCO3) (mg/L)	113	107			
	pH (pH)	7.82	8.03			
	Total Suspended Solids (mg/L)	<3.0	3.1			
	Total Dissolved Solids (mg/L)	163	165			
	Turbidity (NTU)	0.87	0.87			
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	77.3	105			
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050			
	Chloride (Cl) (mg/L)	0.27	0.45			
	Fluoride (F) (mg/L)	0.326	0.134			
	Nitrate (as N) (mg/L)	0.0688	<0.0050			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Phosphorus (P)-Total Dissolved (mg/L)	0.0106	0.0055			
	Phosphorus (P)-Total (mg/L)	0.0089	0.0063			
	Sulfate (SO4) (mg/L)	13.7	20.6			
Cyanides	Cyanide, Total (mg/L)	<0.0050	<0.0050			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	10.3	13.6			
	Total Inorganic Carbon (mg/L)	15.9	21.5			
	Total Organic Carbon (mg/L)	11.5	13.5			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0219	0.0379			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00042	0.00045			
	Barium (Ba)-Total (mg/L)	0.0318	0.0413			
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050			
	Boron (B)-Total (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Total (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Total (mg/L)	23.8	23.8			
	Chromium (Cr)-Total (mg/L)	0.00034	0.00052			
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Total (mg/L)	0.00118	0.00185			
	Iron (Fe)-Total (mg/L)	0.263	0.130			
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Total (mg/L)	<0.0010	0.0016			
	Magnesium (Mg)-Total (mg/L)	6.62	12.6			
	Manganese (Mn)-Total (mg/L)	0.0208	0.00582			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998023-1	L1998023-2			
	Description	Water	Water			
	Sampled Date	25-SEP-17	25-SEP-17			
	Sampled Time					
	Client ID	URC	LWC			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Total (mg/L)	0.00127	0.000570			
	Nickel (Ni)-Total (mg/L)	0.00091	0.00174			
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
	Potassium (K)-Total (mg/L)	0.591	0.757			
	Selenium (Se)-Total (mg/L)	0.000356	0.000109			
	Silicon (Si)-Total (mg/L)	6.38	5.20			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	4.44	8.53			
	Strontium (Sr)-Total (mg/L)	0.164	0.220			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
	Uranium (U)-Total (mg/L)	0.000537	0.000812			
	Vanadium (V)-Total (mg/L)	0.00056	0.00091			
	Zinc (Zn)-Total (mg/L)	0.0051	<0.0030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0056	0.0199			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00019	0.00041			
	Barium (Ba)-Dissolved (mg/L)	0.0221	0.0408			
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Calcium (Ca)-Dissolved (mg/L)	32.7 DTC	21.8			
	Chromium (Cr)-Dissolved (mg/L)	0.00015	0.00041			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00032	0.00332			
	Iron (Fe)-Dissolved (mg/L)	0.055	0.090			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	<0.0010	0.0019			
	Magnesium (Mg)-Dissolved (mg/L)	9.23 DTC	12.7			
	Manganese (Mn)-Dissolved (mg/L)	0.00604	0.00347			
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00293 DTC	0.000489			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998023-1	L1998023-2			
	Description	Water	Water			
	Sampled Date	25-SEP-17	25-SEP-17			
	Sampled Time					
	Client ID	URC	LWC			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	<0.00050	0.00156			
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30			
	Potassium (K)-Dissolved (mg/L)	0.734 DTC	0.794			
	Selenium (Se)-Dissolved (mg/L)	0.000857 DTC	0.000102			
	Silicon (Si)-Dissolved (mg/L)	5.73	4.88			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	6.46 DTC	8.57			
	Strontium (Sr)-Dissolved (mg/L)	0.245 DTC	0.201			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010			
	Uranium (U)-Dissolved (mg/L)	0.00119 DTC	0.000692			
	Vanadium (V)-Dissolved (mg/L)	0.00105	0.00086			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1998023-1, -2
Matrix Spike	Total Inorganic Carbon	MS-B	L1998023-1, -2
Matrix Spike	Total Inorganic Carbon	MS-B	L1998023-1, -2
Matrix Spike	Total Organic Carbon	MS-B	L1998023-1, -2
Matrix Spike	Total Organic Carbon	MS-B	L1998023-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DTC	Dissolved concentration exceeds total. Results were confirmed by re-analysis.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-TIC-VA	Water	Total inorganic carbon by CO2 purge	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

CN-T-CFA-VA	Water	Total Cyanide in water by CFA	ISO 14403:2002

This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)

Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)

Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Reference Information

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR	Water	Nitrite in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR	Water	Nitrate in Water by IC (Low Level)	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.
Samples with very high dissolved solids (i.e. seawaters, brackish waters) may produce a negative bias by this method. Alternate methods are available for these types of samples.

Arsenic (5+), at elevated levels, is a positive interference on colourimetric phosphate analysis.

P-TD-COL-VA	Water	Total Dissolved P in Water by Colour	APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.
Samples with very high dissolved solids (i.e. seawaters, brackish waters) may produce a negative bias by this method. Alternate methods are available for these types of samples.

Arsenic (5+), at elevated levels, is a positive interference on colourimetric phosphate analysis.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

1 of 1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytica
Canada Toll Free: 1 80
www.alsglobal.c

L1998023-COFC

COC #

Page 1 of 1

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21
Fax:	(250) 595-1625
Invoice To	Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Cindy Keehn
Address:	Suite 2100 - 510 West Georgia St., Vancouver, BC
Phone:	604-684-8894
Fax:	604-688-2180
Lab Work Order # (lab use only)	

Report Format / Distribution	
☑ Standard ☐ Other	
☑ PDF ☑ Excel ☐ Digital ☐ Fax	
Email 1:	lbowron@minnow.ca
Email 2:	pstecko@minnow.ca
Email 3:	
Client / Project Information	
Job #:	Minnow Project
PO / AFE:	
LSD:	
Quote #:	Q51327
ALS Contact:	Jerry Holzbecher
Sampler:	Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

○ Regular (Standard Turnaround Times - Business Days)
● Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	**Sample Identification** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Metals by CCMS & ICPOES	Mercury by CVAFS (Low)	Alkalinity by Auto Titration	Phosphorus in water by colour	Organic/Inorganic Carbon	Cyanide	Conductivity, Hardness and pH	TDS & TSS by Gravimetric	Turbidity by Meter	Anions by Ion Chromatography	Ammonia by Fluorescence	**See Complete Quote #Q51327	Number of Containers
	URC	25-Sep-17		Water	X	X	X	X	X	X	X	X	X	X	X	X	9
	LWC	25-Sep-17		Water	X	X	X	X	X	X	X	X	X	X	X	X	9

RUSH

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Lisa Bowron	25-Sep-17	13:17		Sept 27/17	09:05	4 °C				

GENF 20.00 Front

Carrie Sep 28/17 10:25 A.M. 2°C.

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received:	27-SEP-17
Report Date:	02-OCT-17 16:28 (MT)
Version:	FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1998329

Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT
C of C Numbers:	1 of 1
Legal Site Desc:	

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998329-1	L1998329-2	L1998329-3	L1998329-4
	Description	Water	Water	Water	Water
	Sampled Date	26-SEP-17	26-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time				
	Client ID	LMC	LBC	LBCX	4MC
Grouping	**Analyte**				
WATER					
Physical Tests	Conductivity (uS/cm)	340	217	214	523
	Hardness (as CaCO3) (mg/L)	175	103	103	260
	pH (pH)	8.22	8.18	8.16	8.08
	Total Suspended Solids (mg/L)	3.5	<3.0	4.1	<3.0
	Total Dissolved Solids (mg/L)	225	152	150	317
	Turbidity (NTU)	0.75	0.89	0.87	0.20
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	172	105	98.2	234
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
	Chloride (Cl) (mg/L)	1.65	0.59	0.59	4.41
	Fluoride (F) (mg/L)	0.442	0.132	0.136	0.583
	Nitrate (as N) (mg/L)	0.0423	0.0053	0.0055	0.160
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010
	Phosphorus (P)-Total Dissolved (mg/L)	0.0038	0.0023	0.0023	0.0056
	Phosphorus (P)-Total (mg/L)	0.0050	0.0037	0.0022	0.0053
	Sulfate (SO4) (mg/L)	20.0	16.4	16.4	55.3
Cyanides	Cyanide, Total (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	9.02	7.63	7.67	5.84
	Total Inorganic Carbon (mg/L)	38.1	22.3	22.3	54.2
	Total Organic Carbon (mg/L)	9.02	7.50	7.57	5.54
Total Metals	Aluminum (Al)-Total (mg/L)	0.0181	0.0376	0.0409	0.0055
	Antimony (Sb)-Total (mg/L)	<0.00010	0.00014	0.00015	<0.00010
	Arsenic (As)-Total (mg/L)	0.00048	0.00081	0.00079	0.00025
	Barium (Ba)-Total (mg/L)	0.0604	0.0664	0.0661	0.0680
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	0.025
	Cadmium (Cd)-Total (mg/L)	<0.0000050	0.0000078	0.0000051	<0.0000050
	Calcium (Ca)-Total (mg/L)	45.3	25.8	25.3	59.0
	Chromium (Cr)-Total (mg/L)	0.00024	0.00030	0.00025	<0.00010
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Copper (Cu)-Total (mg/L)	0.00159	0.00193	0.00200	0.00251
	Iron (Fe)-Total (mg/L)	0.067	0.079	0.087	0.025
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.0014	0.0012	0.0014	0.0032
	Magnesium (Mg)-Total (mg/L)	16.3	10.2	10.3	28.8
	Manganese (Mn)-Total (mg/L)	0.00336	0.0145	0.0144	0.0474

	Sample ID	L1998329-1	L1998329-2	L1998329-3	L1998329-4	
	Description	Water	Water	Water	Water	
	Sampled Date	26-SEP-17	26-SEP-17	26-SEP-17	26-SEP-17	
	Sampled Time					
	Client ID	LMC	LBC	LBCX	4MC	
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.0000050	DLM <0.000025	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Total (mg/L)	0.00163	0.00127	0.00122	0.00480	
	Nickel (Ni)-Total (mg/L)	0.00097	0.00106	0.00104	0.00092	
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	
	Potassium (K)-Total (mg/L)	1.51	0.865	0.869	2.35	
	Selenium (Se)-Total (mg/L)	0.000081	0.000072	0.000076	0.000310	
	Silicon (Si)-Total (mg/L)	6.22	5.86	5.85	6.33	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Total (mg/L)	10.2	7.81	7.98	18.7	
	Strontium (Sr)-Total (mg/L)	0.448	0.275	0.275	0.767	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	0.00174	0.00279	0.00276	0.00259	
	Vanadium (V)-Total (mg/L)	0.00060	0.00081	0.00081	<0.00050	
	Zinc (Zn)-Total (mg/L)	0.0044	<0.0030	<0.0030	<0.0030	
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	
	Aluminum (Al)-Dissolved (mg/L)	0.0050	0.0126	0.0126	0.0029	
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00012	0.00012	<0.00010	
	Arsenic (As)-Dissolved (mg/L)	0.00046	0.00067	0.00066	0.00024	
	Barium (Ba)-Dissolved (mg/L)	0.0628	0.0683	0.0674	0.0709	
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Bismuth (Bi)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	<0.010	0.021	
	Cadmium (Cd)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Calcium (Ca)-Dissolved (mg/L)	42.4	24.1	24.1	55.6	
	Chromium (Cr)-Dissolved (mg/L)	0.00019	0.00021	0.00021	<0.00010	
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Copper (Cu)-Dissolved (mg/L)	0.00153	0.00174	0.00173	0.00253	
	Iron (Fe)-Dissolved (mg/L)	0.040	0.039	0.041	0.020	
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Dissolved (mg/L)	0.0017	0.0016	0.0015	0.0033	
	Magnesium (Mg)-Dissolved (mg/L)	16.9	10.4	10.4	29.4	
	Manganese (Mn)-Dissolved (mg/L)	0.00221	0.0128	0.0129	0.0467	
	Mercury (Hg)-Dissolved (mg/L)	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
	Molybdenum (Mo)-Dissolved (mg/L)	0.00142	0.00111	0.00111	0.00414	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998329-1	L1998329-2	L1998329-3	L1998329-4
	Description	Water	Water	Water	Water
	Sampled Date	26-SEP-17	26-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time				
	Client ID	LMC	LBC	LBCX	4MC
Grouping	**Analyte**				
WATER					
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00086	0.00090	0.00088	0.00081
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	1.59	0.897	0.900	2.48
	Selenium (Se)-Dissolved (mg/L)	0.000101	<0.000050	0.000051	0.000321
	Silicon (Si)-Dissolved (mg/L)	6.01	5.63	5.60	6.00
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	10.5	7.77	7.73	18.7
	Strontium (Sr)-Dissolved (mg/L)	0.428	0.262	0.259	0.711
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)	0.00156	0.00248	0.00246	0.00227
	Vanadium (V)-Dissolved (mg/L)	0.00057	0.00074	0.00074	<0.00050
	Zinc (Zn)-Dissolved (mg/L)	0.0027	<0.0010	0.0013	<0.0010

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1998329-1, -2, -3, -4
Matrix Spike	Total Inorganic Carbon	MS-B	L1998329-1, -2, -3, -4
Matrix Spike	Total Inorganic Carbon	MS-B	L1998329-1, -2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1998329-1, -2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1998329-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-TITR-VA	Water	Alkalinity Species by Titration	APHA 2320 Alkalinity
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
BR-L-IC-N-WR	Water	Bromide in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)
This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.			
CARBONS-TIC-VA	Water	Total inorganic carbon by CO2 purge	APHA 5310B TOTAL ORGANIC CARBON (TOC)
This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".			
CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)
This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".			
CL-L-IC-N-WR	Water	Chloride in Water by IC (Low Level)	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
CN-T-CFA-VA	Water	Total Cyanide in water by CFA	ISO 14403:2002
This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.			
EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.
This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.			
F-IC-N-WR	Water	Fluoride in Water by IC	EPA 300.1 (mod)
Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.			
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B
Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.			
HG-D-CVAA-VA	Water	Diss. Mercury in Water by CVAAS or CVAFS	APHA 3030B/EPA 1631E (mod)
Water samples are filtered (0.45 um), preserved with hydrochloric acid, then undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
HG-T-CVAA-VA	Water	Total Mercury in Water by CVAAS or CVAFS	EPA 1631E (mod)
Water samples undergo a cold-oxidation using bromine monochloride prior to reduction with stannous chloride, and analyzed by CVAAS or CVAFS.			
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)
Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS. Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.			
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Reference Information

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

NH3-F-VA Water Ammonia in Water by Fluorescence APHA 4500 NH3-NITROGEN (AMMONIA)

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

NO2-L-IC-N-WR Water Nitrite in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-L-IC-N-WR Water Nitrate in Water by IC (Low Level) EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

P-T-PRES-COL-VA Water Total P in Water by Colour APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.
Samples with very high dissolved solids (i.e. seawaters, brackish waters) may produce a negative bias by this method. Alternate methods are available for these types of samples.

Arsenic (5+), at elevated levels, is a positive interference on colourimetric phosphate analysis.

P-TD-COL-VA Water Total Dissolved P in Water by Colour APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.
Samples with very high dissolved solids (i.e. seawaters, brackish waters) may produce a negative bias by this method. Alternate methods are available for these types of samples.

Arsenic (5+), at elevated levels, is a positive interference on colourimetric phosphate analysis.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

SO4-IC-WR Water Sulfate in Water by IC EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.
Samples containing very high dissolved solid content (i.e. seawaters, brackish waters) may produce a positive bias by this method. Alternate analysis methods are available for these types of samples.

TURBIDITY-VA Water Turbidity by Meter APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

1 of 1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytic
Canada Toll Free: 1 8
www.alsglobal.

L1998329-COFC

COC #

Page 1 of 1

R[illegible]t To
Company: Minnow Environmental Inc.
Contact: Lisa Bowron
Address: 101 - 1025 Hillside Ave.
Victoria, BC
Phone: (250)595-1627 x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report? ☑ Yes ☐ No
Company: Minto Explorations Ltd
Contact: Cindy Keehn
Address: Suite 2100 - 510 West Georgia St., Vancouver, BC
Phone: 604-684-8894 Fax: 604-688-2180

Lab Work Order # (lab use only) [redacted]

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information
Job #: Minnow Project
PO / AFE:
LSD:
Quote #: Q51327

ALS Contact: Jerry Holzbecher
Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)
○ Regular (Standard Turnaround Times - Business Days)
● Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	**Sample Identification** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Metals by CCMS & ICPOES	Mercury by CVAFS (Low)	Alkalinity by Auto Titration	Phosphorus in water by colour	Organic/Inorganic Carbon	Cyanide	Conductivity, Hardness and pH	TDS & TSS by Gravimetric	Turbidity by Meter	Anions by Ion Chromatography	Ammonia by Fluorescence	**See Complete Quote #Q51327	Number of Containers
[redacted]	LMC	26-Sep-17		Water	X	X	X	X	X	X	X	X	X	X	X	X	9
[redacted]	LBC	26-Sep-17		|	X	X	X	X	X	X	X	X	X	X	X	X	9
[redacted]	LBCX	26-Sep-17		|	X	X	X	X	X	X	X	X	X	X	X	X	9
[redacted]	UMC	26-Sep-17		|	X	X	X	X	X	X	X	X	X	X	X	X	9
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Sep-17			Sept 27/17	12:15	2 °C				

GENF 20.00 Front

Laurie SEP 28/17. 10:25 AM 3°C.

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 27-SEP-17
Report Date: 13-OCT-17 15:16 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1998299

Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT
C of C Numbers: 1 of 1
Legal Site Desc:

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1998299-1	L1998299-2	L1998299-3	L1998299-4	L1998299-5
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	21-SEP-17	21-SEP-17	23-SEP-17	23-SEP-17	23-SEP-17
	Sampled Time					
	Client ID	LMC-5	LMC-4	LWC-5	LWC-4	LWC-3
Grouping	**Analyte**					
BIOTA						
Field Tests	Area Sampled (cm2)	16	16	16	16	16
Plant Pigments	Chlorophyll a (mg/m2)	73.5	33.2	11.7	10.5	21.7

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1998299-6 Tissue 24-SEP-17 LWC-2	L1998299-7 Tissue 24-SEP-17 LWC-1	L1998299-8 Tissue 23-SEP-17 LWC-3X	L1998299-9 Tissue 26-SEP-17 LMC-3	L1998299-10 Tissue 26-SEP-17 LMC-2
Grouping	**Analyte**					
BIOTA						
Field Tests	Area Sampled (cm2)	16	16	16	16	16
Plant Pigments	Chlorophyll a (mg/m2)	11.1	8.43	18.9	45.6	79.5

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998299-11				
	Description	Tissue				
	Sampled Date	26-SEP-17				
	Sampled Time					
	Client ID	LMC-1				
Grouping	**Analyte**					
BIOTA						
Field Tests	Area Sampled (cm2)	16				
Plant Pigments	Chlorophyll a (mg/m2)	24.6				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AREA SAMPLED-VA	Biota	Area Sampled (cm2)	Not Applicable
CHLOROA-F-VA	Biota	Chlorophyll a in Biota by Fluorometer	EPA 445.0

This analysis is done using procedures adapted from EPA Method 445.0. Chlorophyll-a is determined by a routine acetone extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b. Note: Biota samples are typically submitted as scrapings on a filter.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 of 1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytical F
Canada Toll Free: 1 800 6
www.alsglobal.com

L1998299-COFC

OC #

Page 1 of 1

Report To
Company: Minnow Environmental Inc.
Contact: Lisa Bowron
Address: 101 - 1025 Hillside Ave.
Victoria, BC
Phone: (250)595-1627 x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report? ☑ Yes ☐ No
Company: Minto Explorations Ltd
Contact: Cindy Keehn
Address: Suite 2100 - 510 West George St., Vancouver, BC
Phone: 604-684-8894 Fax: 604-688-2180

[redacted] Lab Work Order # (lab use only) [redacted]

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information
Job #: Minnow Project
PO / AFE:
LSD:
Quote #: Q51327

ALS Contact: Jerry Holzbecher
Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)
● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Chlorophyll a	**See Complete Quote #Q51327	Number of Containers
[redacted]	LMC - 5	21-Sep-17		Tissue	X	X	1
[redacted]	LMC - 4	21-Sep-17		″	X	X	1
[redacted]	LWC - 5	23-Sep-17			X	X	1
[redacted]	LWC - 4	23-Sep-17			X	X	1
[redacted]	LWC - 3	23-Sep-17			X	X	1
[redacted]	LWC - 2	24-Sep-17			X	X	1
[redacted]	LWC - 1	24-Sep-17			X	X	1
[redacted]	LWC - 3x	23-Sep-17			X	X	1
[redacted]	LMC - 3	26-Sep-17			X	X	1
[redacted]	LMC - 2	26-Sep-17			X	X	1
[redacted]	LMC - 1	26-Sep-17			X	X	1
[redacted]							

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Periphyton samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)		SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 27-Sep-17	Time (hh:mm)	Received by:	Date: Sept 27/17	Time: 12:15	Temperature: 2 °C	Verified by:	Date:	Time:

Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

(Quinn Sept 28/17 10:25 A.M. 3°C.

APPENDIX C

SEDIMENT, PERIPHYTON AND BENTHIC INVERTEBRATE QUALITY DATA

Tables

Laboratory Reports

APPENDIX C

SEDIMENT, PERIPHYTON AND BENTHIC INVERTEBRATE QUALITY DATA

Tables

Table C.1: Sediment Chemistry Data Collected at Reference and Exposed Areas, Minto Mine WUL, 2017

Analyte		Units	CSQG [a]		Upper McGinty Creek (Reference)						Upper Minto Creek (Exposed)					
					URC-1	URC-2	URC-3	URC-4	URC-5	URC	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5	UMC
			ISQG	PEL	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17	25-Sep-17
Particle size, TKN, carbon analytes and pH	Loss on Ignition @ 550 °C	%	-	-	10	4.0	6.0	5.0	4.0	-	5.0	7.0	9.0	2.0	5.0	-
	pH (1:2 soil:water)	pH units	-	-	7.04	6.70	6.63	7.39	7.69	-	7.46	7.93	7.89	8.16	7.97	-
	Gravel (> 2 mm)	%	-	-	-	-	-	-	-	<1.0	-	-	-	-	-	<1.0
	Sand (2.0 mm - 0.063 mm)	%	-	-	-	-	-	-	-	64	-	-	-	-	-	63
	Silt (0.063 mm - 4 µm)	%	-	-	-	-	-	-	-	31	-	-	-	-	-	30
	Clay (< 4 µm)	%	-	-	-	-	-	-	-	4.7	-	-	-	-	-	6.7
	Total Kjeldahl Nitrogen (TKN)	%	-	-	0.20	0.096	0.14	0.11	0.11	-	0.12	0.19	0.18	0.049	0.11	-
	Inorganic Carbon	%	-	-	0.11	0.055	0.081	0.083	0.078	-	0.12	0.16	0.16	0.064	0.095	-
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%	-	-	0.91	0.46	0.68	0.69	0.65	-	1.0	1.3	1.3	0.54	0.79	-
	Total Carbon by Combustion	%	-	-	4.4	1.8	2.8	2.4	2.2	-	2.3	4.4	4.6	0.99	2.3	-
	Total Organic Carbon	%	-	-	4.3	1.8	2.8	2.3	2.2	-	2.2	4.2	4.4	0.93	2.2	-
Total Metals	Aluminum (Al)	mg/kg	-	-	10,700	8,640	7,840	6,050	7,270	-	11,400	11,100	11,800	9,060	9,930	-
	Antimony (Sb)	mg/kg	-	-	0.39	0.28	0.30	0.27	0.26	-	0.42	0.54	0.71	0.38	0.42	-
	Arsenic (As)	mg/kg	5.9	17	8.1	5.6	7.1	7.6	4.1	-	5.5	5.8	6.3	5.5	5.8	-
	Barium (Ba)	mg/kg	-	-	213	138	140	125	87	-	170	274	281	127	160	-
	Beryllium (Be)	mg/kg	-	-	0.34	0.24	0.26	0.21	0.24	-	0.41	0.44	0.45	0.36	0.39	-
	Bismuth (Bi)	mg/kg	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	-	<0.20	<0.20	<0.20	<0.20	<0.20	-
	Boron (B)	mg/kg	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	-	<5.0	<5.0	<5.0	<5.0	<5.0	-
	Cadmium (Cd)	mg/kg	0.60	3.5	0.21	0.077	0.099	0.076	0.079	-	0.18	0.30	0.29	0.10	0.15	-
	Calcium (Ca)	mg/kg	-	-	9,560	4,850	5,430	5,120	5,790	-	7,180	9,120	9,030	5,770	7,670	-
	Chromium (Cr)	mg/kg	37	90	21	17	16	12	15	-	28	25	29	25	25	-
	Cobalt (Co)	mg/kg	-	-	10	7.3	6.5	5.8	6.1	-	9.6	11	12	9.2	9.6	-
	Copper (Cu)	mg/kg	36	197	20	12	14	11	13	-	170	274	212	46	71	-
	Iron (Fe)	mg/kg	-	-	23,800	18,300	21,400	20,200	15,400	-	23,100	23,300	25,200	22,100	21,700	-
	Lead (Pb)	mg/kg	35	91	4.5	3.4	3.3	2.8	3.2	-	5.9	6.0	6.3	4.9	5.2	-
	Lithium (Li)	mg/kg	-	-	6.5	5.5	5.0	4.4	5.3	-	8.4	8.4	8.6	6.6	6.7	-
	Magnesium (Mg)	mg/kg	-	-	4,190	3,240	3,350	2,760	3,380	-	6,230	6,880	6,870	5,660	6,140	-
	Manganese (Mn)	mg/kg	-	-	1,050	383	245	514	404	-	1,760	3,690	3,620	491	865	-
	Mercury (Hg)	mg/kg	0.17	0.49	0.042	0.057	0.060	0.017	0.021	-	0.024	0.027	0.028	0.012	0.021	-
	Molybdenum (Mo)	mg/kg	-	-	0.65	0.32	0.43	0.41	0.41	-	1.3	2.4	2.2	0.76	0.95	-
	Nickel (Ni)	mg/kg	-	-	16	12	12	11	12	-	25	28	29	24	26	-
	Phosphorus (P)	mg/kg	-	-	815	687	882	755	715	-	861	873	933	914	881	-
	Potassium (K)	mg/kg	-	-	690	550	580	440	480	-	1,310	1,350	1,510	1,140	1,180	-
	Selenium (Se)	mg/kg	-	-	0.45	0.24	0.31	0.38	0.35	-	0.56	0.78	0.73	<0.20	0.30	-
	Silver (Ag)	mg/kg	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	-	0.11	0.24	0.12	<0.10	<0.10	-
	Sodium (Na)	mg/kg	-	-	198	173	185	147	160	-	316	308	340	315	350	-
	Strontium (Sr)	mg/kg	-	-	66	39	45	46	54	-	80	116	109	62	87	-
	Thallium (Tl)	mg/kg	-	-	0.063	<0.050	<0.050	<0.050	<0.050	-	0.086	0.083	0.096	0.071	0.074	-
	Tin (Sn)	mg/kg	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	-	<2.0	<2.0	<2.0	<2.0	<2.0	-
	Titanium (Ti)	mg/kg	-	-	645	596	543	484	355	-	650	573	579	683	625	-
	Uranium (U)	mg/kg	-	-	1.4	0.72	0.56	0.68	1.0	-	0.84	1.1	1.2	0.54	0.80	-
	Vanadium (V)	mg/kg	-	-	48	38	37	31	33	-	51	50	59	51	50	-
	Zinc (Zn)	mg/kg	123	315	44	33	34	27	31	-	62	67	68	48	50	-

🟦 Indicates sediment concentration exceeding CSQG ISQG.

🟩 Indicates sediment concentration exceeding CSQG PEL.

[a] Canadian Sediment Quality Guidelines: ISQG = interim sediment quality guideline; PEL = probable effect level (CCME 1999).

Table C.1: Sediment Chemistry Data Collected at Reference and Exposed Areas, Minto Mine WUL, 2017

Analyte		Units	CSQG [a]		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposed)				
					LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
			ISQG	PEL	24-Sep-17	24-Sep-17	24-Sep-17	24-Sep-17	24-Sep-17	21-Sep-17	21-Sep-17	21-Sep-17	20-Sep-17	20-Sep-17
Particle size, TKN, carbon analytes and pH	Loss on Ignition @ 550 °C	%	-	-	12	10	17	15	15	9.0	10	14	8.0	9.0
	pH (1:2 soil:water)	pH units	-	-	6.69	7.18	6.82	7.01	6.92	8.02	7.83	7.88	7.70	7.89
	Gravel (> 2 mm)	%	-	-	<1.0	<1.0	<1.0	<1.0	<1.0	1.2	<1.0	<1.0	<1.0	<1.0
	Sand (2.0 mm - 0.063 mm)	%	-	-	38	57	11	28	17	21	7.2	3.3	33	9.4
	Silt (0.063 mm - 4 µm)	%	-	-	57	40	84	66	77	68	83	87	55	80
	Clay (< 4 µm)	%	-	-	5.0	3.4	5.4	6.0	5.7	9.3	9.8	9.1	11	11
	Total Kjeldahl Nitrogen (TKN)	%	-	-	0.25	0.21	0.39	0.32	0.35	0.26	0.26	0.33	0.22	0.23
	Inorganic Carbon	%	-	-	0.11	0.11	0.16	0.16	0.14	0.18	0.17	0.19	0.14	0.15
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%	-	-	0.93	0.94	1.3	1.4	1.2	1.5	1.4	1.6	1.2	1.2
	Total Carbon by Combustion	%	-	-	5.1	5.2	9.4	6.6	7.2	4.8	6.0	7.6	4.0	4.3
	Total Organic Carbon	%	-	-	5.0	5.1	9.2	6.4	7.0	4.6	5.8	7.4	3.9	4.2
Total Metals	Aluminum (Al)	mg/kg	-	-	15,200	13,000	15,000	18,500	16,000	13,300	12,300	14,700	15,200	13,600
	Antimony (Sb)	mg/kg	-	-	0.48	0.49	0.47	0.54	0.46	0.48	0.52	0.57	0.58	0.45
	Arsenic (As)	mg/kg	5.9	17	6.0	6.7	6.0	4.3	4.9	6.6	7.6	7.5	8.2	6.7
	Barium (Ba)	mg/kg	-	-	201	187	204	220	200	216	237	254	257	214
	Beryllium (Be)	mg/kg	-	-	0.77	0.80	0.79	0.85	0.78	0.46	0.47	0.52	0.53	0.41
	Bismuth (Bi)	mg/kg	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B)	mg/kg	-	-	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd)	mg/kg	0.60	3.5	0.24	0.28	0.24	0.31	0.23	0.19	0.25	0.25	0.24	0.17
	Calcium (Ca)	mg/kg	-	-	9,580	11,700	10,800	11,600	10,200	10,400	11,700	12,100	11,300	8,650
	Chromium (Cr)	mg/kg	37	90	48	42	47	55	48	30	29	33	34	31
	Cobalt (Co)	mg/kg	-	-	13	13	13	13	13	10	11	11	12	10
	Copper (Cu)	mg/kg	36	197	28	28	29	38	28	44	51	52	57	44
	Iron (Fe)	mg/kg	-	-	27,700	26,200	27,000	27,400	26,700	24,500	23,800	25,500	27,700	24,200
	Lead (Pb)	mg/kg	35	91	6.4	6.0	6.3	7.3	6.5	5.8	5.8	6.5	6.6	5.5
	Lithium (Li)	mg/kg	-	-	11	9.4	11	14	12	10	9.2	11	12	10
	Magnesium (Mg)	mg/kg	-	-	9,430	8,760	9,420	11,000	9,760	7,010	6,600	7,460	7,610	6,910
	Manganese (Mn)	mg/kg	-	-	520	549	539	204	236	813	1,090	1,010	1,120	844
	Mercury (Hg)	mg/kg	0.17	0.49	0.047	0.046	0.042	0.045	0.041	0.031	0.038	0.040	0.041	0.028
	Molybdenum (Mo)	mg/kg	-	-	0.54	0.61	0.55	0.68	0.56	0.63	0.72	0.72	0.76	0.59
	Nickel (Ni)	mg/kg	-	-	38	35	37	42	37	28	28	30	30	28
	Phosphorus (P)	mg/kg	-	-	1,060	988	1,050	1,080	1,070	833	832	865	937	885
	Potassium (K)	mg/kg	-	-	1,050	1,020	1,160	1,300	1,140	1,150	1,100	1,210	1,330	1,190
	Selenium (Se)	mg/kg	-	-	0.37	0.43	0.36	0.44	0.34	0.46	0.63	0.61	0.70	0.44
	Silver (Ag)	mg/kg	-	-	0.10	0.11	<0.10	0.11	0.10	<0.10	<0.10	0.10	0.11	<0.10
	Sodium (Na)	mg/kg	-	-	436	417	478	500	458	316	281	332	335	323
	Strontium (Sr)	mg/kg	-	-	91	114	107	108	93	103	118	125	113	83
	Thallium (Tl)	mg/kg	-	-	0.087	0.080	0.090	0.11	0.095	0.092	0.087	0.11	0.11	0.092
	Tin (Sn)	mg/kg	-	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti)	mg/kg	-	-	436	803	812	916	841	867	718	648	791	713
	Uranium (U)	mg/kg	-	-	2.8	3.8	3.1	3.5	2.7	0.96	1.4	1.4	1.5	0.94
	Vanadium (V)	mg/kg	-	-	70	67	72	73	69	53	51	55	60	52
	Zinc (Zn)	mg/kg	123	315	63	55	61	74	64	57	55	61	68	61

🟦	Indicates sediment concentration exceeding CSQG ISQG.
🟩	Indicates sediment concentration exceeding CSQG PEL.

[a] Canadian Sediment Quality Guidelines: ISQG = interim sediment quality guideline; PEL = probable effect level (CCME 1999).

Table C.2: Periphyton Tissue Quality Results at Reference and Exposure Areas, Minto Mine WUL, 2017

Analyte		Units	Lower Wolverine Creek (Reference)							Lower Big Creek (Reference)							Lower Minto Creek (Exposed)						
			LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	Mean	Standard Deviation	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	Mean	Standard Deviation	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	Mean	Standard Deviation
Physical Tests	Moisture	%	55	72	71	66	65	66	6.5	93	61	66	74	56	70	15	70	76	65	76	76	72	5.0
Total Metals	Total Aluminum (Al)	mg/kg dw	2,309	2,042	2,958	945	1,850	2,021	733	2,739	2,149	2,928	2,594	3,941	2,870	664	2,643	730	1,867	2,837	1,736	1,963	838
	Total Antimony (Sb)	mg/kg dw	0.060	0.061	0.063	0.050	0.063	0.059	0.0056	0.17	0.12	0.10	0.14	0.086	0.12	0.031	0.092	0.069	0.092	0.093	0.090	0.087	0.010
	Total Arsenic (As)	mg/kg dw	1.7	2.9	1.6	1.1	1.4	1.7	0.71	7.6	3.5	3.9	5.5	6.8	5.5	1.8	2.5	0.88	2.0	2.5	2.4	2.0	0.68
	Total Barium (Ba)	mg/kg dw	57	92	63	35	42	58	22	100	50	96	71	72	78	20	165	111	97	161	139	135	30
	Total Beryllium (Be)	mg/kg dw	0.23	0.14	0.23	0.078	0.15	0.16	0.064	0.16	0.13	0.13	0.16	0.22	0.16	0.037	0.10	0.035	0.12	0.11	0.077	0.089	0.034
	Total Bismuth (Bi)	mg/kg dw	0.022	0.018	0.020	0.0090	0.018	0.017	0.0048	0.21	0.14	0.17	0.15	0.19	0.17	0.030	0.029	0.0098	0.025	0.030	0.021	0.023	0.0081
	Total Boron (B)	mg/kg dw	1.1	1.3	1.3	0.90	1.2	1.2	0.18	<2.9	1.1	1.4	1.4	1.8	1.4	0.29	5.7	13	2.7	6.0	4.6	6.4	3.9
	Total Cadmium (Cd)	mg/kg dw	0.26	0.15	0.58	0.86	0.31	0.43	0.28	2.1	0.50	0.74	0.83	0.65	0.96	0.63	0.29	0.51	0.26	0.30	0.30	0.33	0.099
	Total Calcium (Ca)	mg/kg dw	2,668	1,435	2,823	1,783	2,266	2,195	585	4,232	2,188	3,362	2,844	3,759	3,277	795	2,387	2,320	3,192	2,718	2,749	2,673	348
	Total Cesium (Cs)	mg/kg dw	0.37	0.25	0.30	0.13	0.25	0.26	0.087	0.80	0.53	0.48	0.67	0.69	0.63	0.13	0.26	0.061	0.19	0.27	0.16	0.19	0.084
	Total Chromium (Cr)	mg/kg dw	11	8.8	21	6.3	14	12	5.5	14	6.8	7.5	15	10	11	3.6	9.8	3.3	17	11	8.7	10	4.9
	Total Cobalt (Co)	mg/kg dw	3.3	2.7	4.5	1.8	2.3	2.9	1.1	3.6	2.3	2.5	2.9	3.8	3.0	0.66	2.6	1.3	2.0	2.8	2.1	2.2	0.58
	Total Copper (Cu)	mg/kg dw	13	20	23	20	17	19	3.8	31	18	19	23	16	21	5.9	31	29	26	32	31	30	2.4
	Total Iron (Fe)	mg/kg dw	6,211	3,930	6,910	1,986	4,802	4,768	1,944	5,145	4,910	5,159	5,977	7,677	5,773	1,138	6,296	1,643	4,237	5,265	3,887	4,266	1,742
	Total Lead (Pb)	mg/kg dw	1.8	1.0	1.5	0.54	1.2	1.2	0.47	2.7	2.1	2.4	2.8	3.0	2.6	0.34	1.5	1.1	1.5	1.5	1.1	1.3	0.22
	Total Lithium (Li)	mg/kg dw	2.9	1.6	2.3	0.72	1.8	1.9	0.82	2.3	2.6	2.9	2.5	4.4	3.0	0.84	2.4	0.61	1.7	2.8	1.6	1.8	0.84
	Total Magnesium (Mg)	mg/kg dw	2,399	2,102	3,611	1,510	1,718	2,268	826	2,551	2,139	2,177	2,133	3,394	2,479	541	2,101	1,680	1,655	2,331	1,820	1,917	291
	Total Manganese (Mn)	mg/kg dw	307	544	382	223	193	330	141	496	293	635	342	401	433	136	549	400	506	690	753	580	142
	Total Mercury (Hg)	mg/kg dw	0.014	0.018	<0.035	0.038	0.042	0.026	0.014	0.058	0.028	0.030	0.037	0.024	0.035	0.014	0.013	0.013	0.025	0.024	0.035	0.022	0.0092
	Total Molybdenum (Mo)	mg/kg dw	0.75	1.0	0.76	0.68	0.50	0.74	0.18	0.73	0.57	0.77	0.55	0.45	0.61	0.13	0.86	1.4	0.93	0.71	0.85	0.94	0.25
	Total Nickel (Ni)	mg/kg dw	11	10	20	5.1	8.5	11	5.5	11	5.4	6.6	7.8	9.2	8.0	2.2	8.9	5.1	8.0	10	6.9	7.8	1.9
	Total Phosphorus (P)	mg/kg dw	4,013	5,930	4,444	7,536	4,774	5,340	1,419	6,580	4,704	4,348	4,961	2,159	4,550	1,587	6,330	7,418	5,819	6,082	7,113	6,552	684
	Total Potassium (K)	mg/kg dw	3,543	9,368	3,410	6,261	3,955	5,307	2,547	6,377	4,216	4,290	4,844	2,251	4,395	1,481	10,000	13,811	6,045	10,980	10,042	10,176	2,783
	Total Rubidium (Rb)	mg/kg dw	3.9	3.1	4.8	5.1	3.7	4.1	0.82	9.6	4.6	3.6	5.2	4.6	5.5	2.4	3.6	3.3	3.4	3.7	3.4	3.5	0.17
	Total Selenium (Se)	mg/kg dw	0.93	1.1	1.1	2.0	1.1	1.2	0.43	1.2	0.60	1.4	0.76	0.47	0.90	0.42	1.6	1.1	1.8	1.8	1.9	1.7	0.31
	Total Sodium (Na)	mg/kg dw	1,305	1,811	1,719	2,533	1,624	1,798	453	2,725	1,465	1,287	1,957	784	1,644	736	2,212	2,209	2,096	2,457	2,456	2,286	163
	Total Strontium (Sr)	mg/kg dw	28	16	31	17	21	23	6.5	49	20	30	30	34	33	11	24	26	37	28	31	29	4.9
	Total Tellurium (Te)	mg/kg dw	<0.0090	<0.014	<0.014	<0.012	<0.011	<0.014	-	<0.058	0.011	<0.012	<0.016	0.011	0.011	0.00042	<0.013	<0.016	<0.011	<0.016	<0.017	<0.016	-
	Total Thallium (Tl)	mg/kg dw	0.021	0.016	0.021	0.013	0.018	0.018	0.0036	0.045	0.024	0.027	0.034	0.034	0.033	0.0082	0.023	0.0066	0.018	0.024	0.017	0.018	0.0070
	Total Tin (Sn)	mg/kg dw	0.37	0.12	0.28	0.24	0.28	0.26	0.091	0.81	0.18	0.15	0.38	0.15	0.33	0.28	0.11	<0.082	0.11	0.15	0.17	0.12	0.028
	Total Uranium (U)	mg/kg dw	0.99	0.47	0.78	0.24	0.54	0.60	0.29	0.90	0.38	1.4	0.98	0.65	0.86	0.38	0.57	0.46	0.40	0.56	0.42	0.48	0.079
	Total Vanadium (V)	mg/kg dw	16	10	15	4.6	13	12	4.5	12	12	15	16	16	14	2.0	16	4.3	8.6	13	9.5	10	4.4
	Total Zinc (Zn)	mg/kg dw	53	92	78	114	101	88	23	113	62	75	86	51	78	24	124	223	95	128	147	144	48
	Total Zirconium (Zr)	mg/kg dw	3.5	2.5	5.2	1.6	2.8	3.1	1.4	3.8	2.7	2.7	3.7	3.4	3.3	0.53	3.1	0.29	2.8	2.9	3.2	2.5	1.2

▨ Indicates periphyton tissue concentration exceeding the higher reference mean by more than two times.

Table C.3: Benthic Tissue Quality Results at Reference and Exposure Areas, Minto Mine WUL, 2017

Analyte		Units	Lower Wolverine Creek (Reference)							Lower Big Creek (Reference)							Lower Minto Creek (Exposed)						
			LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	Mean	Standard Deviation	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	Mean	Standard Deviation	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	Mean	Standard Deviation
Physical Tests	Moisture	%	59	52	60	45	59	55	6.3	67	67	57	57	82	66	10	67	61	55	70	62	63	5.5
Total Metals	Total Aluminum (Al)	mg/kg dw	16,102	10,750	13,275	12,095	10,934	12,631	2,189	14,202	7,394	10,913	9,144	13,730	11,077	2,921	12,091	17,041	6,465	6,033	7,487	9,823	4,699
	Total Antimony (Sb)	mg/kg dw	0.042	0.037	0.038	0.028	0.051	0.039	0.0084	0.15	0.13	0.096	0.082	0.20	0.13	0.045	0.084	0.071	<0.11	0.28	0.15	0.13	0.089
	Total Arsenic (As)	mg/kg dw	5.7	4.6	4.6	3.9	4.9	4.7	0.65	13	10	10	11	17	12	2.7	8.1	10	6.8	11	8.3	8.9	1.8
	Total Barium (Ba)	mg/kg dw	215	152	171	152	142	166	29	236	212	197	159	234	208	31	352	367	548	951	468	537	245
	Total Beryllium (Be)	mg/kg dw	0.80	0.54	0.64	0.55	0.57	0.62	0.11	0.55	0.37	0.43	0.41	0.62	0.48	0.10	0.43	0.58	0.28	0.31	0.29	0.38	0.13
	Total Bismuth (Bi)	mg/kg dw	0.097	0.064	0.072	0.075	0.059	0.074	0.015	0.58	0.33	0.31	1.2	0.63	0.62	0.38	0.10	0.16	<0.11	<0.13	0.090	0.11	0.031
	Total Boron (B)	mg/kg dw	4.7	2.6	2.9	2.5	2.9	3.1	0.92	4.1	4.2	2.9	1.8	4.8	3.5	1.2	10	6.5	<11	32	30	17	13
	Total Cadmium (Cd)	mg/kg dw	0.19	0.11	0.14	0.12	0.15	0.14	0.031	0.19	0.14	0.14	0.14	0.23	0.17	0.042	0.28	0.26	0.45	0.69	0.34	0.41	0.18
	Total Calcium (Ca)	mg/kg dw	9,298	6,521	8,040	7,286	7,027	7,634	1,080	9,080	5,455	7,799	6,042	8,270	7,329	1,528	12,182	12,321	7,606	11,148	13,704	11,392	2,303
	Total Cesium (Cs)	mg/kg dw	2.0	1.2	1.5	1.4	1.3	1.5	0.29	2.5	1.6	1.8	1.8	3.2	2.2	0.68	1.0	1.4	0.55	0.54	0.62	0.82	0.36
	Total Chromium (Cr)	mg/kg dw	46	34	39	36	35	38	4.7	33	22	28	21	31	27	5.2	27	38	13	19	19	23	9.7
	Total Cobalt (Co)	mg/kg dw	14	11	12	11	12	12	1.3	9.8	6.8	8.3	7.8	9.8	8.5	1.3	12	14	21	26	14	17	6.0
	Total Copper (Cu)	mg/kg dw	22	15	17	15	16	17	2.8	23	16	18	20	29	21	5.3	46	52	38	47	42	45	5.3
	Total Iron (Fe)	mg/kg dw	27,603	22,708	23,697	20,947	24,570	23,905	2,467	23,988	22,030	20,890	18,634	23,946	21,898	2,250	22,182	30,357	17,159	15,705	17,196	20,520	6,022
	Total Lead (Pb)	mg/kg dw	6.6	4.6	5.5	5.2	4.9	5.4	0.75	8.9	6.0	6.7	7.1	9.7	7.7	1.6	5.5	7.7	3.9	4.0	4.9	5.2	1.5
	Total Lithium (Li)	mg/kg dw	14	8.8	11	10	8.9	11	2.0	10	6.2	8.2	8.3	10	8.7	1.8	9.7	14	5.8	<6.6	6.6	8.4	3.7
	Total Magnesium (Mg)	mg/kg dw	10,436	8,063	8,834	8,124	7,764	8,644	1,076	7,607	4,455	6,183	5,602	7,081	6,186	1,241	6,091	8,214	4,295	4,689	4,868	5,631	1,592
	Total Manganese (Mn)	mg/kg dw	937	604	650	546	690	686	150	758	621	555	495	1,059	698	225	3,424	3,112	12,998	16,918	6,905	8,671	6,089
	Total Mercury (Hg)	mg/kg dw	0.030	0.016	0.021	0.017	0.021	0.021	0.0054	0.037	0.018	0.019	0.021	0.048	0.028	0.013	0.025	0.065	0.018	0.025	0.028	0.032	0.019
	Total Molybdenum (Mo)	mg/kg dw	0.40	0.39	0.36	0.29	1.2	0.53	0.39	0.81	0.59	0.63	0.62	0.92	0.71	0.14	0.75	0.78	1.0	1.9	1.0	1.1	0.47
	Total Nickel (Ni)	mg/kg dw	41	33	34	31	35	35	3.9	26	16	21	19	26	22	4.5	27	35	26	33	25	29	4.4
	Total Phosphorus (P)	mg/kg dw	1,358	1,156	1,243	1,169	1,165	1,218	86	1,402	973	1,316	1,060	1,189	1,188	177	1,336	1,416	1,025	2,233	1,717	1,545	457
	Total Potassium (K)	mg/kg dw	1,349	1,023	1,099	1,004	1,133	1,121	138	1,571	1,109	1,244	1,093	2,124	1,428	434	2,021	2,112	1,320	3,902	2,646	2,400	963
	Total Rubidium (Rb)	mg/kg dw	15	10	12	11	11	12	2.1	13	7.9	9.9	9.6	16	11	3.3	12	16	7.5	8.0	8.4	10	3.6
	Total Selenium (Se)	mg/kg dw	0.37	0.26	0.29	0.22	0.26	0.28	0.054	0.20	0.20	0.16	0.15	0.36	0.21	0.086	1.5	1.3	<1.1	3.0	2.0	1.8	0.73
	Total Sodium (Na)	mg/kg dw	409	348	402	337	432	386	41	469	376	368	289	475	395	78	272	276	<224	<262	262	255	7.1
	Total Strontium (Sr)	mg/kg dw	91	58	74	66	62	70	13	79	47	59	54	82	64	16	112	121	113	168	110	125	24
	Total Tellurium (Te)	mg/kg dw	0.019	0.017	0.018	0.014	0.019	0.017	0.0021	0.044	0.026	0.025	0.036	0.049	0.036	0.011	0.030	0.031	<0.22	<0.26	<0.11	0.030	0.00043
	Total Thallium (Tl)	mg/kg dw	0.10	0.063	0.078	0.074	0.068	0.077	0.015	0.12	0.081	0.089	0.089	0.15	0.11	0.029	0.10	0.14	0.069	0.079	0.071	0.092	0.031
	Total Tin (Sn)	mg/kg dw	0.39	0.31	0.32	0.31	0.34	0.33	0.034	0.39	0.31	0.29	0.27	0.45	0.34	0.075	0.36	0.41	<1.1	<1.3	<0.53	0.38	0.038
	Total Uranium (U)	mg/kg dw	1.0	0.82	1.0	0.86	1.1	0.98	0.13	1.4	1.8	1.1	1.1	1.5	1.4	0.30	0.86	0.95	0.55	0.64	0.55	0.71	0.18
	Total Vanadium (V)	mg/kg dw	62	54	55	48	55	55	4.9	58	59	52	43	55	53	6.5	47	62	34	39	39	44	11
	Total Zinc (Zn)	mg/kg dw	67	50	57	53	66	59	7.7	66	43	52	51	69	56	11	59	75	58	73	55	64	9.4
	Total Zirconium (Zr)	mg/kg dw	13	9.6	11	9.7	11	11	1.4	9.2	6.9	6.9	6.5	11	8.0	1.8	9.5	12	2.9	4.3	4.5	6.7	4.0

▨ Indicates periphyton tissue concentration exceeding the higher reference mean by more than two times.

APPENDIX C

SEDIMENT, PERIPHYTON AND BENTHIC INVERTEBRATE QUALITY DATA

Laboratory Reports

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 27-SEP-17
Report Date: 11-OCT-17 17:38 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1998308

Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT
C of C Numbers: 1 of 2, 2 of 2
Legal Site Desc:

Can Dang
Senior Account Manager

	Sample ID	L1998308-1	L1998308-2	L1998308-3	L1998308-4	L1998308-5
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	20-SEP-17	20-SEP-17	21-SEP-17	21-SEP-17	21-SEP-17
	Sampled Time					
	Client ID	LMC-5	LMC-4	LMC-3	LMC-2	LMC-1
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	9	8	14	10	9
	pH (1:2 soil:water) (pH)	7.89	7.70	7.88	7.83	8.02
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	1.2
	% Sand (2.0mm - 0.063mm) (%)	9.4	33.0	3.3	7.2	21.2
	% Silt (0.063mm - 4um) (%)	79.9	55.2	87.4	82.6	68.4
	% Clay (<4um) (%)	10.6	11.1	9.1	9.8	9.3
	Texture	Silt	Silt loam	Silt	Silt	Silt loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.233 DLHC	0.217	0.332 DLHC	0.257 DLHC	0.263 DLHC
Organic / Inorganic Carbon	Inorganic Carbon (%)	0.146	0.139	0.189	0.171	0.175
	Inorganic Carbon (as CaCO3 Equivalent) (%)	1.22	1.16	1.57	1.43	1.46
	Total Carbon by Combustion (%)	4.34	4.04	7.63	5.97	4.79
	Total Organic Carbon (%)	4.19	3.90	7.44	5.80	4.62
Metals	Aluminum (Al) (mg/kg)	13600	15200	14700	12300	13300
	Antimony (Sb) (mg/kg)	0.45	0.58	0.57	0.52	0.48
	Arsenic (As) (mg/kg)	6.68	8.21	7.51	7.55	6.62
	Barium (Ba) (mg/kg)	214	257	254	237	216
	Beryllium (Be) (mg/kg)	0.41	0.53	0.52	0.47	0.46
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.169	0.244	0.245	0.245	0.191
	Calcium (Ca) (mg/kg)	8650	11300	12100	11700	10400
	Chromium (Cr) (mg/kg)	30.8	34.4	33.1	29.1	30.1
	Cobalt (Co) (mg/kg)	10.2	11.5	11.0	10.5	10.4
	Copper (Cu) (mg/kg)	44.1	56.6	51.6	51.2	43.7
	Iron (Fe) (mg/kg)	24200	27700	25500	23800	24500
	Lead (Pb) (mg/kg)	5.48	6.56	6.48	5.83	5.83
	Lithium (Li) (mg/kg)	10.2	11.6	11.3	9.2	10.2
	Magnesium (Mg) (mg/kg)	6910	7610	7460	6600	7010
	Manganese (Mn) (mg/kg)	844	1120	1010	1090	813
	Mercury (Hg) (mg/kg)	0.0277	0.0408	0.0397	0.0379	0.0307
	Molybdenum (Mo) (mg/kg)	0.59	0.76	0.72	0.72	0.63
	Nickel (Ni) (mg/kg)	27.5	29.9	29.8	27.5	27.5
	Phosphorus (P) (mg/kg)	885	937	865	832	833
	Potassium (K) (mg/kg)	1190	1330	1210	1100	1150
	Selenium (Se) (mg/kg)	0.44	0.70	0.61	0.63	0.46
	Silver (Ag) (mg/kg)	<0.10	0.11	0.10	<0.10	<0.10

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1998308-6	L1998308-7	L1998308-8	L1998308-9	L1998308-10
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	24-SEP-17	24-SEP-17	24-SEP-17	24-SEP-17	24-SEP-17
	Sampled Time					
	Client ID	LWC-5	LWC-5X	LWC-4	LWC-3	LWC-2
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	15	16	15	17	10
	pH (1:2 soil:water) (pH)	6.92	6.77	7.01	6.82	7.18
Particle Size	% Gravel (>2mm) (%)	<1.0	<1.0	<1.0	<1.0	<1.0
	% Sand (2.0mm - 0.063mm) (%)	17.1	20.5	27.7	10.9	56.7
	% Silt (0.063mm - 4um) (%)	76.8	73.8	66.3	83.7	39.7
	% Clay (<4um) (%)	5.7	5.4	6.0	5.4	3.4
	Texture	Silt loam	Silt loam	Silt loam	Silt	Sandy loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.354 DLHC	0.340 DLHC	0.315	0.394 DLHC	0.214 DLHC
Organic / Inorganic Carbon	Inorganic Carbon (%)	0.141	0.137	0.163	0.157	0.113
	Inorganic Carbon (as CaCO3 Equivalent) (%)	1.17	1.14	1.36	1.31	0.94
	Total Carbon by Combustion (%)	7.15	5.38	6.60	9.35	5.22
	Total Organic Carbon (%)	7.01	5.24	6.44	9.19	5.11
Metals	Aluminum (Al) (mg/kg)	16000	15900	18500	15000	13000
	Antimony (Sb) (mg/kg)	0.46	0.48	0.54	0.47	0.49
	Arsenic (As) (mg/kg)	4.88	5.66	4.30	6.03	6.72
	Barium (Ba) (mg/kg)	200	221	220	204	187
	Beryllium (Be) (mg/kg)	0.78	0.83	0.85	0.79	0.80
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.227	0.262	0.313	0.244	0.278
	Calcium (Ca) (mg/kg)	10200	11100	11600	10800	11700
	Chromium (Cr) (mg/kg)	48.0	48.8	54.9	47.0	41.7
	Cobalt (Co) (mg/kg)	12.8	13.1	13.2	13.4	12.7
	Copper (Cu) (mg/kg)	27.9	29.7	37.8	28.5	28.2
	Iron (Fe) (mg/kg)	26700	28400	27400	27000	26200
	Lead (Pb) (mg/kg)	6.49	6.61	7.27	6.31	5.99
	Lithium (Li) (mg/kg)	11.7	11.6	13.5	10.9	9.4
	Magnesium (Mg) (mg/kg)	9760	9730	11000	9420	8760
	Manganese (Mn) (mg/kg)	236	259	204	539	549
	Mercury (Hg) (mg/kg)	0.0411	0.0466	0.0449	0.0420	0.0455
	Molybdenum (Mo) (mg/kg)	0.56	0.52	0.68	0.55	0.61
	Nickel (Ni) (mg/kg)	37.0	37.9	41.9	37.4	35.0
	Phosphorus (P) (mg/kg)	1070	1120	1080	1050	988
	Potassium (K) (mg/kg)	1140	1130	1300	1160	1020
	Selenium (Se) (mg/kg)	0.34	0.43	0.44	0.36	0.43
	Silver (Ag) (mg/kg)	0.10	0.12	0.11	<0.10	0.11

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998308-11	L1998308-12	L1998308-13	L1998308-14	L1998308-15
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	24-SEP-17	25-SEP-17	25-SEP-17	25-SEP-17	25-SEP-17
	Sampled Time					
	Client ID	LWC-1	URC-5	URC-4	URC-3	URC-2
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	12	4	5	6	4
	pH (1:2 soil:water) (pH)	6.69	7.69	7.39	6.63	6.70
Particle Size	% Gravel (>2mm) (%)	<1.0				
	% Sand (2.0mm - 0.063mm) (%)	38.0				
	% Silt (0.063mm - 4um) (%)	56.9				
	% Clay (<4um) (%)	5.0				
	Texture	Silt loam				
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	DLHC 0.253	0.108	0.105	0.136	0.096
Organic / Inorganic Carbon	Inorganic Carbon (%)	0.112	0.078	0.083	0.081	0.055
	Inorganic Carbon (as CaCO3 Equivalent) (%)	0.93	0.65	0.69	0.68	0.46
	Total Carbon by Combustion (%)	5.07	2.24	2.35	2.84	1.83
	Total Organic Carbon (%)	4.96	2.16	2.27	2.76	1.78
Metals	Aluminum (Al) (mg/kg)	15200	7270	6050	7840	8640
	Antimony (Sb) (mg/kg)	0.48	0.26	0.27	0.30	0.28
	Arsenic (As) (mg/kg)	6.03	4.08	7.57	7.10	5.60
	Barium (Ba) (mg/kg)	201	87.2	125	140	138
	Beryllium (Be) (mg/kg)	0.77	0.24	0.21	0.26	0.24
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0	<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.236	0.079	0.076	0.099	0.077
	Calcium (Ca) (mg/kg)	9580	5790	5120	5430	4850
	Chromium (Cr) (mg/kg)	47.6	15.0	12.2	15.6	16.9
	Cobalt (Co) (mg/kg)	13.4	6.13	5.84	6.51	7.34
	Copper (Cu) (mg/kg)	28.0	13.1	10.7	13.9	12.4
	Iron (Fe) (mg/kg)	27700	15400	20200	21400	18300
	Lead (Pb) (mg/kg)	6.42	3.21	2.83	3.31	3.37
	Lithium (Li) (mg/kg)	11.3	5.3	4.4	5.0	5.5
	Magnesium (Mg) (mg/kg)	9430	3380	2760	3350	3240
	Manganese (Mn) (mg/kg)	520	404	514	245	383
	Mercury (Hg) (mg/kg)	0.0474	0.0209	0.0173	0.0598	0.0570
	Molybdenum (Mo) (mg/kg)	0.54	0.41	0.41	0.43	0.32
	Nickel (Ni) (mg/kg)	38.1	12.2	10.5	12.3	11.7
	Phosphorus (P) (mg/kg)	1060	715	755	882	687
	Potassium (K) (mg/kg)	1050	480	440	580	550
	Selenium (Se) (mg/kg)	0.37	0.35	0.38	0.31	0.24
	Silver (Ag) (mg/kg)	0.10	<0.10	<0.10	<0.10	<0.10

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998308-16	L1998308-17	L1998308-18	L1998308-19	L1998308-20
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	25-SEP-17	25-SEP-17	25-SEP-17	25-SEP-17	25-SEP-17
	Sampled Time					
	Client ID	URC-1	URC	UMC	UMC-5	UMC-4
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	10			5	2
	pH (1:2 soil:water) (pH)	7.04			7.97	8.16
Particle Size	% Gravel (>2mm) (%)		<1.0	<1.0		
	% Sand (2.0mm - 0.063mm) (%)		64.4	63.2		
	% Silt (0.063mm - 4um) (%)		30.7	29.9		
	% Clay (<4um) (%)		4.7	6.7		
	Texture		Sandy loam	Sandy loam		
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.199			0.111	0.049
Organic / Inorganic Carbon	Inorganic Carbon (%)	0.109			0.095	0.064
	Inorganic Carbon (as CaCO3 Equivalent) (%)	0.91			0.79	0.54
	Total Carbon by Combustion (%)	4.38			2.30	0.99
	Total Organic Carbon (%)	4.27			2.20	0.927
Metals	Aluminum (Al) (mg/kg)	10700			9930	9060
	Antimony (Sb) (mg/kg)	0.39			0.42	0.38
	Arsenic (As) (mg/kg)	8.09			5.75	5.45
	Barium (Ba) (mg/kg)	213			160	127
	Beryllium (Be) (mg/kg)	0.34			0.39	0.36
	Bismuth (Bi) (mg/kg)	<0.20			<0.20	<0.20
	Boron (B) (mg/kg)	<5.0			<5.0	<5.0
	Cadmium (Cd) (mg/kg)	0.207			0.149	0.103
	Calcium (Ca) (mg/kg)	9560			7670	5770
	Chromium (Cr) (mg/kg)	21.0			25.4	24.9
	Cobalt (Co) (mg/kg)	10.4			9.57	9.21
	Copper (Cu) (mg/kg)	20.2			70.9	45.7
	Iron (Fe) (mg/kg)	23800			21700	22100
	Lead (Pb) (mg/kg)	4.47			5.21	4.92
	Lithium (Li) (mg/kg)	6.5			6.7	6.6
	Magnesium (Mg) (mg/kg)	4190			6140	5660
	Manganese (Mn) (mg/kg)	1050			865	491
	Mercury (Hg) (mg/kg)	0.0417			0.0205	0.0124
	Molybdenum (Mo) (mg/kg)	0.65			0.95	0.76
	Nickel (Ni) (mg/kg)	15.8			25.6	23.6
	Phosphorus (P) (mg/kg)	815			881	914
	Potassium (K) (mg/kg)	690			1180	1140
	Selenium (Se) (mg/kg)	0.45			0.30	<0.20
	Silver (Ag) (mg/kg)	<0.10			<0.10	<0.10

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998308-21	L1998308-22	L1998308-23		
	Description	Sediment	Sediment	Sediment		
	Sampled Date	25-SEP-17	25-SEP-17	25-SEP-17		
	Sampled Time					
	Client ID	UMC-3	UMC-2	UMC-1		
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	9	7	5		
	pH (1:2 soil:water) (pH)	7.89	7.93	7.46		
Particle Size	% Gravel (>2mm) (%)					
	% Sand (2.0mm - 0.063mm) (%)					
	% Silt (0.063mm - 4um) (%)					
	% Clay (<4um) (%)					
	Texture					
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.179	0.192	0.120		
Organic / Inorganic Carbon	Inorganic Carbon (%)	0.156	0.160	0.121		
	Inorganic Carbon (as CaCO3 Equivalent) (%)	1.30	1.34	1.01		
	Total Carbon by Combustion (%)	4.59	4.37	2.27		
	Total Organic Carbon (%)	4.43	4.21	2.15		
Metals	Aluminum (Al) (mg/kg)	11800	11100	11400		
	Antimony (Sb) (mg/kg)	0.71	0.54	0.42		
	Arsenic (As) (mg/kg)	6.26	5.79	5.53		
	Barium (Ba) (mg/kg)	281	274	170		
	Beryllium (Be) (mg/kg)	0.45	0.44	0.41		
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20		
	Boron (B) (mg/kg)	<5.0	<5.0	<5.0		
	Cadmium (Cd) (mg/kg)	0.289	0.297	0.179		
	Calcium (Ca) (mg/kg)	9030	9120	7180		
	Chromium (Cr) (mg/kg)	28.6	24.5	28.0		
	Cobalt (Co) (mg/kg)	11.8	10.7	9.55		
	Copper (Cu) (mg/kg)	212	274	170		
	Iron (Fe) (mg/kg)	25200	23300	23100		
	Lead (Pb) (mg/kg)	6.26	5.96	5.89		
	Lithium (Li) (mg/kg)	8.6	8.4	8.4		
	Magnesium (Mg) (mg/kg)	6870	6880	6230		
	Manganese (Mn) (mg/kg)	3620	3690	1760		
	Mercury (Hg) (mg/kg)	0.0283	0.0268	0.0244		
	Molybdenum (Mo) (mg/kg)	2.21	2.35	1.27		
	Nickel (Ni) (mg/kg)	29.2	28.1	24.9		
	Phosphorus (P) (mg/kg)	933	873	861		
	Potassium (K) (mg/kg)	1510	1350	1310		
	Selenium (Se) (mg/kg)	0.73	0.78	0.56		
	Silver (Ag) (mg/kg)	0.12	0.24	0.11		

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998308-1	L1998308-2	L1998308-3	L1998308-4	L1998308-5
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	20-SEP-17	20-SEP-17	21-SEP-17	21-SEP-17	21-SEP-17
	Sampled Time					
	Client ID	LMC-5	LMC-4	LMC-3	LMC-2	LMC-1
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	323	335	332	281	316
	Strontium (Sr) (mg/kg)	83.2	113	125	118	103
	Thallium (Tl) (mg/kg)	0.092	0.111	0.105	0.087	0.092
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	713	791	648	718	867
	Uranium (U) (mg/kg)	0.943	1.45	1.37	1.37	0.962
	Vanadium (V) (mg/kg)	52.3	60.1	55.1	51.2	52.5
	Zinc (Zn) (mg/kg)	61.2	68.1	61.0	54.6	56.7

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1998308-6 Sediment 24-SEP-17 LWC-5	L1998308-7 Sediment 24-SEP-17 LWC-5X	L1998308-8 Sediment 24-SEP-17 LWC-4	L1998308-9 Sediment 24-SEP-17 LWC-3	L1998308-10 Sediment 24-SEP-17 LWC-2
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	458	456	500	478	417
	Strontium (Sr) (mg/kg)	93.3	103	108	107	114
	Thallium (Tl) (mg/kg)	0.095	0.099	0.113	0.090	0.080
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	841	908	916	812	803
	Uranium (U) (mg/kg)	2.74	3.15	3.51	3.09	3.75
	Vanadium (V) (mg/kg)	68.6	68.2	72.5	71.7	67.4
	Zinc (Zn) (mg/kg)	63.5	64.4	73.8	61.3	55.0

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998308-11	L1998308-12	L1998308-13	L1998308-14	L1998308-15
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	24-SEP-17	25-SEP-17	25-SEP-17	25-SEP-17	25-SEP-17
	Sampled Time					
	Client ID	LWC-1	URC-5	URC-4	URC-3	URC-2
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	436	160	147	185	173
	Strontium (Sr) (mg/kg)	91.1	54.2	46.0	45.2	39.0
	Thallium (Tl) (mg/kg)	0.087	<0.050	<0.050	<0.050	<0.050
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	436	355	484	543	596
	Uranium (U) (mg/kg)	2.81	1.03	0.676	0.556	0.717
	Vanadium (V) (mg/kg)	69.6	32.9	31.3	36.5	38.1
	Zinc (Zn) (mg/kg)	62.9	31.1	27.1	34.4	32.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L1998308-16 Sediment 25-SEP-17 URC-1	L1998308-17 Sediment 25-SEP-17 URC	L1998308-18 Sediment 25-SEP-17 UMC	L1998308-19 Sediment 25-SEP-17 UMC-5	L1998308-20 Sediment 25-SEP-17 UMC-4
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	198			350	315
	Strontium (Sr) (mg/kg)	65.9			87.4	61.5
	Thallium (Tl) (mg/kg)	0.063			0.074	0.071
	Tin (Sn) (mg/kg)	<2.0			<2.0	<2.0
	Titanium (Ti) (mg/kg)	645			625	683
	Uranium (U) (mg/kg)	1.37			0.796	0.541
	Vanadium (V) (mg/kg)	47.5			50.3	51.4
	Zinc (Zn) (mg/kg)	44.3			50.2	47.6

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998308-21	L1998308-22	L1998308-23		
	Description	Sediment	Sediment	Sediment		
	Sampled Date	25-SEP-17	25-SEP-17	25-SEP-17		
	Sampled Time					
	Client ID	UMC-3	UMC-2	UMC-1		
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	340	308	316		
	Strontium (Sr) (mg/kg)	109	116	79.8		
	Thallium (Tl) (mg/kg)	0.096	0.083	0.086		
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0		
	Titanium (Ti) (mg/kg)	579	573	650		
	Uranium (U) (mg/kg)	1.15	1.11	0.835		
	Vanadium (V) (mg/kg)	59.4	49.8	51.1		
	Zinc (Zn) (mg/kg)	68.2	66.7	61.8		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil	CSSS (2008) P216-217

A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.

C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation	CSSS (2008) 21.2

Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	CSSS (2008) 21.2

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.

IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
LOI-420-SK	Soil	Loss on Ignition @ 420 C	CSSS (1978) METHOD 3.81

The dry-ash method involves the removal of organic matter by combustion at 420OC for 2 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 3.81

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

This method uses a heated strong acid digestion with HNO3 and HCl and is intended to liberate metals that may be environmentally available. Silicate minerals are not solubilized. Dependent on sample matrix, some metals may be only partially recovered, including Al, Ba, Be, Cr, Sr, Ti, Tl, V, W, and Zr. Volatile forms of sulfur (including sulfide) may not be captured, as they may be lost during sampling, storage, or digestion. Analysis is by Collision/Reaction Cell ICPMS.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

PSA-PIPET+GRAVEL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

1 of 2 2 of 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytical
Canada Toll Free: 1 800
www.alsglobal.cc

L1998308-COFC

COC #

Page 1 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21 Fax: (250) 595-1625
Invoice To	Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Cindy Keehn
Address:	Suite 2100-510 West Georgia Street, Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2180
Lab Work Order # (lab use only)	[redacted]

Report Format / Distribution

☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information

Job #: Minnow Project
PO / AFE:
LSD:
Quote #: Q51327
ALS Contact: Jerry ~~Selam Worku~~ Holzbecher
Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Rescan Low Level Sediments	Inorganic Carbon	Total Carbon by combustion	Mercury by CVAFS	Loss on Ignition	pH in soil	Particle Size	Total Organic Carbon	Total Kjeldahl Nitrogen	**See Complete Quote #Q51327			Number of Containers
[redacted]	LMC-5	20-Sep-17		Sediment	X	X	X	X	X	X	X	X	X	X			2
[redacted]	LMC-4	20-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LMC-3	21-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LMC-2	21-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LMC-1	21-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LWC-5	24-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LWC-5X	24-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LWC-4	24-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	CWC-3	24-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LWC-2	24-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LWC-1	24-Sep-17			X	X	X	X	X	X	X	X	X	X			2
[redacted]	LIRC-5	25-Sep-17			X	X	X	X	X	X	X	X	X	X			1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Lisa Bowron	27-Sep-17		D	Sept 27/17	12:15	2 °C				

Tauin Sep 28/17 10:25, 3°C.

GENF 20.00 Front

ALS Environmental

Chain of Custody / Analyt
Canada Toll Free: 1
www.alsgloba

L1998308-COFC

COC #

Page 2 of 2

Report To
Company: Minnow Environmental Inc.
Contact: Lisa Bowron
Address: 101 - 1025 Hillside Ave.
Victoria, BC
Phone: (250)595-1627 x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report? ☑ Yes ☐ No
Company: Minto Explorations Ltd
Contact: Cindy Keehn
Address: Suite 2100-510 West Georgia Street, Vancouver, BC
Phone: 604-684-8894 Fax: 604-688-2180

Lab Work Order # (lab use only) [redacted]

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information
Job #: Minnow Project
PO / AFE:
LSD:

Quote #: Q51327

ALS Contact: Jerry Holzbecher
Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)
● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Rescan Low Level Sediments	Inorganic Carbon	Total Carbon by combustion	Mercury by CVAFS	Loss on Ignition	pH in soil	Particle Size	Total Organic Carbon	Total Kjeldahl Nitrogen	**See Complete Quote #Q51327			Number of Containers
[redacted]	URC-4	25-Sep-17		Sediment	X	X	X	X	X	X		X	X	X			1
[redacted]	URC-3	25-Sep-17			X	X	X	X	X	X		X	X	X			1
[redacted]	URC-2	25-Sep-17			X	X	X	X	X	X		X	X				1
[redacted]	URC-1	25-Sep-17			X	X	X	X	X	X		X	X	X			1
[redacted]	~~URC~~	~~25-Sep-17~~			~~X~~	~~X~~	~~X~~	~~X~~	~~X~~	~~X~~		~~X~~	~~X~~	~~X~~			
[redacted]	URC	25-Sep-17		Sediment							X						1
[redacted]	UMC	25-Sep-17									X						1
[redacted]	UMC-5	25-Sep-17			X	X	X	X	X	X		X	X	X			1
[redacted]	UMC-4	25-Sep-17			X	X	X	X	X	X		X	X	X			1
[redacted]	UMC-3	25-Sep-17			X	X	X	X	X	X		X	X	X			1
[redacted]	UMC-2	25-Sep-17			X	X	X	X	X	X		X	X	X			1
[redacted]	UMC-1	25-Sep-17			X	X	X	X	X	X		X	X	X			1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Sep-17		D	Sept 27/17	12:15	2 °C				

Laurie SEP 28/17 10:25 A.M. 3°C.

GENF 20.00 Front

Toxicity testing for Minnow Environmental Inc.

September 2017 Sediment Samples

Final Report

December 11, 2017

Submitted to: **Minnow Environmental Inc.**
Victoria, BC

TABLE OF CONTENTS

Page

List of Tables

List of Appendices

SIGNATURE PAGE

Eric Cheung

Report By:
Eric Cheung, B. Sc.
Laboratory Biologist

Reviewed By:
Edmund Canaria, R.P.Bio.
Senior Analyst

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

SUMMARY

Sample and Test Type Information

Sample ID	LMC and LWC
Sample collection date	September 20, 21 and 24, 2017
Sample receipt date	September 28, 2017
Sample receipt temperature	11.0°C
Test types	14-d *Hyalella azteca* survival and growth 10-d *Chironomus dilutus* survival and growth

Results

Endpoint (mean + SD)	Sample ID		
	Control Sediment	LWC	LMC
H. azteca survival	96.0 ± 5.5	94.0 ± 5.5	92.0 ± 13.0
H. azteca growth	0.11 ± 0.02	0.11 ± 0.02	0.13 ± 0.03
C. dilutus survival	86.0 ± 8.9	90.0 ± 17.3	48.0 ± 38.3$^{*, \alpha}$
C. dilutus growth	1.22 ± 0.25	1.92 ± 0.24	1.57 ± 0.32$^{\alpha}$

SD = Standard Deviation

(*) Indicates a statistically significant effect relative to the control sediment

(α) Indicates a statistically significant effect relative to reference sediment LWC

1.0 INTRODUCTION

Nautilus Environmental Company Inc. conducted freshwater sediment toxicity tests for Minnow Environmental Inc. on samples identified as LMC and LWC. The samples were collected on September 20, 21, and 24, 2017; each sample was transported in one 500-mL plastic container and delivered to laboratory in Burnaby, BC on September 28, 2017. The samples had a temperature of 11°C on receipt and were stored in the dark at 4 ± 2°C prior to testing. The following toxicity tests were performed on the samples:

- 14-d *Hyalella azteca* survival and growth
- 10-d *Chironomus dilutus* survival and growth

This report describes the results of these toxicity tests. Copies of raw laboratory data sheets and statistical analyses for each test species are provided in Appendices A and B. Analytical chemistry results and chain-of-custody form are provided in Appendices C and D, respectively.

2.0 METHODS

Methods for the toxicity tests are summarized in Tables 1 and 2. Testing was conducted according to procedures described by Environment Canada (1997 and 2013). Statistical analyses for all tests were performed using CETIS (Tidepool Scientific Software, 2013).

Ammonia concentrations were measured in-house three times per week on reference sediment sample LWC to ensure that un-ionized ammonia was below 0.2 mg/L (Environment Canada, 2013). Samples of overlying water were also collected at test initiation and termination and sent to ALS Environmental, Burnaby, BC for measurements of total ammonia concentration. Analytical results are provided in Appendix C.

Table 1. Summary of test conditions: *Hyalella azteca* survival and growth test.

Test species	*Hyalella azteca*
Organism source	Aquatic Research Organisms, Hampton, NH
Organism age	2- to 9-days old
Test type	Static
Test duration	14 days
Test vessel	375-mL glass container
Test volume	100 mL sediment; 175 mL overlying water
Test replicates	5 per sample
Number of organisms	10 per replicate
Control/dilution water	Reconstituted water
Test solution renewal	None
Test temperature	23 ± 1°C
Feeding	0.75 mL of YCT and 1.35 mg of Tetramin per replicate daily
Light intensity	500 to 1000 lux at water surface
Photoperiod	16 hours light/8 hours dark
Aeration	Continuous gentle aeration
Test measurements	Temperature, dissolved oxygen, pH and conductivity of overlying water measured daily; hardness, alkalinity and total ammonia of overlying water measured at test initiation and termination; unionized ammonia measured three times weekly in overlying water of reference sample
Test protocol	Environment Canada (2013), EPS 1/RM/33
Statistical software	CETIS Version 1.8.7
Test endpoints	Survival and dry weight
Test acceptability criteria for controls	≥80% survival and ≥0.1 mg/amphipod dry weight
Reference toxicant	Sodium chloride (NaCl)

Table 2. Summary of test conditions: *Chironomus dilutus* survival and growth test.

Test species	*Chironomus dilutus*
Organism source	Aquatic BioSystems, Fort Collins, CO
Organism age	Third instar
Test type	Static
Test duration	10 days
Test vessel	375-mL glass container
Test volume	100 mL sediment; 175 mL overlying water
Test replicates	5 per sample
Number of organisms	10 per replicate
Control/dilution water	Reconstituted water
Test solution renewal	None
Test temperature	23 ± 1°C
Feeding	6 mg of Tetramin per replicate daily
Light intensity	500 to 1000 lux at water surface
Photoperiod	16 hours light/8 hours dark
Aeration	Continuous gentle aeration
Test measurements	Temperature, dissolved oxygen, pH and conductivity of overlying water measured daily; hardness, alkalinity and total ammonia of overlying water measured at test initiation and termination
Test protocol	Environment Canada (1997), EPS 1/RM/32
Statistical software	CETIS Version 1.8.7
Test endpoints	Survival and dry weight
Test acceptability criteria for controls	≥70% survival and ≥0.6 mg/worm dry weight
Reference toxicant	Potassium chloride (KCl)

3.0 RESULTS

Sample LMC did not show any adverse effects on either survival or dry weight of *H. azteca* relative to the control sediment or the reference sediment LWC (Table 3).

A significant difference in survival of *C. dilutus* was observed in sample LMC when compared to either the laboratory control and the reference sediment LWC (Table 4). A significant decrease in dry weight of *C. dilutus* was also observed in the sample LMC relative to the reference sediment LWC.

Measured total ammonia concentrations in the *H. azteca* and *C. dilutus* tests are summarized in Tables 5. These concentrations are at levels that are not expected to cause adverse effects to either species. Un-ionized ammonia measurements on the reference sediment sample were below 0.2 mg/L throughout the *H. azteca* test, therefore, no water change was required as specified by Environment Canada (2013).

Table 3. Results: *Hyalella azteca* survival and growth test.

Sample ID	Mean ± SD	
	Survival (%)	**Average Dry Weight (mg/org)**
Control Sediment	96.0 ± 5.5	0.11 ± 0.02
LWC	94.0 ± 5.5	0.13 ± 0.03
LMC	92.0 ± 13.0	0.11 ± 0.02

SD = Standard Deviation

Table 4. Results: *Chironomus dilutus* survival and growth test.

Sample ID	Mean ± SD	
	Survival (%)	**Average Dry Weight (mg/org)**
Control Sediment	86.0 ± 8.9	1.22 ± 0.25
LWC	90.0 ± 17.3	1.92 ± 0.24
LMC	48.0 ± 38.3$^{*,\alpha}$	1.57 ± 0.32$^{\alpha}$

SD = Standard Deviation
(*) Indicates a statistically significant effect relative to the control sediment
(α) Indicates a statistically significant effect relative to reference sediment LWC

Table 5. Summary of total overlying ammonia concentrations (mg/L N) measured in the toxicity tests.

Sample ID	***Hyalella azteca***		***Chironomus dilutus***	
	Day 0	**Day 14**	**Day 0**	**Day 10**
Control Sediment	0.137	1.920	0.137	0.682
LWC	0.335	0.091	0.335	0.882
LMC	0.084	0.066	0.084	0.123

4.0 QA/QC

The health histories of the test organisms used in the exposures were acceptable and met the requirements of the Environment Canada protocols. The tests met all control acceptability criteria and water quality parameters remained within ranges specified in the protocols throughout the tests. There were no deviations from the test methodologies. Uncertainty associated with these tests is best described by the standard deviations around the means.

Results of the reference toxicant tests conducted during the testing program are summarized in Table 7. Results for these tests fell within the acceptable range for organism performance of mean and two standard deviations, based on historical results obtained by the laboratory with these tests. Thus, the sensitivity of the organisms used in these tests was appropriate.

Table 6. Reference toxicant test results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
H. azteca	Survival (LC50): 5.2 g/L NaCl	5.8 (5.2–6.5)	6	October 13, 2017
C. dilutus	Survival (LC50): 2.9 g/L KCl	4.8 (2.7 – 8.7)	34	October 13, 2017

SD = Standard Deviation, CV = Coefficient of Variation, LC = Lethal Concentration

5.0 REFERENCES

Environment Canada. 2013. Biological test method: test for survival and growth in sediment and water using the freshwater amphipod, *Hyalella azteca*. EPS 1/RM/33, Second Edition, January 2013.

Environment Canada. 1997. Biological test method: test for survival and growth in sediment using the larvae of freshwater midges (*Chironomus tentans* and *Chrironomus riparius*). Environmental Protection Series EPS 1/RM/32. December 1997. Environment Canada, Method Development and Application Section, Environmental Technology Centre, Ottawa, ON. 131 pp.

Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 Tidepool Scientific Software, McKinleyville, CA. 275 pp.

APPENDIX A – *Hyalella azteca* Toxicity Test Data

Hyalella azteca Sediment Test Summary Sheet

Client: Minnow
Work Order No.: 171052

Start Date: Oct 13/17
Set up by: EC

Sample Information:

Sample ID: Various (See below)
Sample Date: Sept 20, 21/17
Date Received: Sept 28/17
Sample Volume: 1 x 500mL per Sample

Test Organism Information:

Species: *Hyalella azteca*
Supplier: Aquatic Biosystems, CO
Date received: Oct 13/17
Age or size (Day 0): 2-9 days

NaCl Reference Toxicant Results:

Reference Toxicant ID: HA141
Stock Solution ID: n/a
Date Initiated: Oct 13/17

96-h LC50 (95% CL): 5.2 (4.3-6.4) g/L NaCl

96-h LC50 Reference Toxicant Mean and Range: 5.8 (5.2-6.5) g/L NaCl CV (%): 6

Test Results:

Sample ID	Survival ± SD (%)	Average Dry Wt. ± SD (mg)
Control Sediment	96.0 ± 5.5	0.~~09~~11 ± 0.0~~3~~2
LMC	92.0 ± 13.0	0.11 ± 0.02
LWC	94.0 ± 5.5	0.13 ± 0.0~~4~~3
	±	±
	±	±
	±	±
	±	±
	±	±

Reviewed by:

Date reviewed: Nov. 28, 2017

P1/2

Chronic *H. azteca* Sediment Toxicity Test Data Sheet
Freshwater Sediment Water Quality

Client: Minnow
Work Order No.: 171052

Start Date: Oct 13/17
Termination Date: Oct ~~23/17~~ EL 27/17
CER #: 6
Test Organism: *Hyalella azteca*

Temperature (°C)

Sample ID	Day														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Control	22.0	22.0	22.0	22.0	22.0	22.0	22.0	21.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
LMC	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
LWC (ref)	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
Technician Initials	EC	EL	MLT	EL	EL	EL	AWB	EL	K	UM	MLT	MLT	MLT	MLT	MLT

Thermometer: 6

Conductivity (µS)

Sample ID	Day														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Control	418	436	437	436	423	453	450	489	466	476	489	487	460	463	488
LMC	465	473	530	547	587	582	604	640	657	676	699	691	723	733	758
LWC	392	409	419	415	423	431	418	450	450	461	472	458	475	479	491
Technician Initials	EL	EL	MLT	EL	EL	EL	AWB	EL	K	UM	MLT	MLT	MLT	MLT	MLT

Conductivity meter/probe: 1/1

Comments:

Reviewed by:

Date Reviewed: November 28, 2017

P2/2

Chronic *H. azteca* Sediment Toxicity Test Data Sheet
Freshwater Sediment Water Quality

Client: Minnow
Work Order No.: 171052

Start Date: Oct 13/17
Termination Date: Oct ~~23~~ 27/17
CER #: 6
Test Organism: *Hyalella azteca*

Dissolved oxygen (mg/L)

Sample ID	Day														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Control	8.1	8.2	8.2	7.6	7.8	8.1	8.0	8.1	7.8	7.8	7.9	7.8	7.9	7.9	7.9
LMC	8.2	8.0	8.1	7.7	7.9	8.2	8.1	8.2	7.9	7.9	8.0	7.9	7.9	8.0	7.9
LWC (ref)	8.1	8.2	8.1	7.7	8.0	8.1	8.2	8.0	7.9	8.0	7.9	7.8	8.0	8.2	7.9
Technician Initials	EL	EL	MLT	EL	EL	EL	AWT	EL	K	MW	MLT	MLT	MLT	MLT	MLT

DO meter/probe: 1/1

pH

Sample ID	Day														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Control	7.6	7.5	7.5	7.5	7.6	7.5	7.7	7.8	7.8	7.7	7.8	7.8	7.8	7.9	7.9
LMC	7.9	7.9	7.8	7.8	8.0	8.0	8.2	8.2	8.3	8.2	8.3	8.2	8.2	8.1	8.2
LWC	7.7	7.7	7.7	7.8	7.9	7.9	7.9	8.1	8.0	8.1	8.2	8.1	8.2	8.1	8.2
Technician Initials	EL	EL	MLT	EL	EL	EL	AWT	EL	K	MW	MLT	MLT	MLT	MLT	MLT

pH meter/probe: 1/1

Light meter: Lit 1

Light intensity (Lux): 510-820

Comments:

Reviewed by:

Date Reviewed: November 28, 2017

H. azteca Sediment Toxicity Test Data Sheet

Freshwater Sediment 14-d Survival and Weight

Client: Minnow

Work Order No: 171052

Sample ID: Various

Start Date: Oct 13/17

Termination Date: Oct 27/17

Test Organism: *Hyalella azteca*

Balance: 1

Sample ID	Pan No.	Rep	No. alive	No. dead	No. missing	Initials	Pan weight (mg)	Pan + organism (mg)	No. weighed	Initials
Control Sediment	1	A	~~10~~ 9	0	0	MLT	1027.49	1028.76	9 ②	EC
	2	B	~~9~~ 10	0	1		1035.27	1036.30	10	
	3	C	10	0	0		1016.38	1017.53	10	
	4	D	10	0	0		1037.17	1038.17	10	
	5	E	9	0	1		1017.41	1018.42	9	
LMC-1	6	A	10	0	0		1008.95	1010.02	10	
LMC-2	7	B	10	0	0		1013.68	1014.72	10	
LMC-3	8	C	10	0	0		1020.31	1021.50	10	
LMC-4	9	D	9	1	1		1019.86	1021.17	9	
LMC-5	10	E	7 ①	0	3		1035.95	1036.55	7	
LWC-1	11	A	10	0	0		1049.33	1050.89	10	
LWC-2	12	B	9	0	1		1015.18	1015.97	9	
LWC-3	13	C	9	0	1		1009.14	1010.34	9	
LWC-4	14	D	9	0	1		1018.52	1019.85	8 ②	
LWC-5	15	E	10	0	0		1010.32	1011.38	10	
		A								
		B								
		C								
		D								
		E								

Comments: ① Checked by CMP ② Lost in transfer

Reweighed on Pan 2 : 1037.11 mg , Pan 4 : 1038.01 mg

Reviewed by:

Date Reviewed: Nov. 28/17

Version 1.1; Issued March 6, 2017

Nautilus Environmental Company Inc.

CETIS Summary Report

Report Date:	05 Dec-17 11:08 (p 1 of 1)
Test Code:	171052 | 17-2296-8735

Hyalella 14-d Survival and Growth Sediment Test **Nautilus Environmental**

Batch ID:	20-6218-0957	**Test Type:**	Growth-Survival (~~10~~14d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	27 Oct-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	14d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	2-9d

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control SED	03-7657-6483	13 Oct-17	13 Oct-17	NA		
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control SED	Sediment Sample	Minnow Environmental	Control Sediment		
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

10d Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control SED	5	0.96	0.892	1	0.9	1	0.02449	0.05477	5.71%	0.0%
LMC	5	0.92	0.7581	1	0.7	1	0.05831	0.1304	14.17%	4.17%
LWC	5	0.94	0.872	1	0.9	1	0.02449	0.05477	5.83%	2.08%

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control SED	5	0.1143	0.0941	0.1344	0.1	0.1411	0.007266	0.01625	14.22%	0.0%
LMC	5	0.1123	0.08481	0.1397	0.08573	0.1456	0.009884	0.0221	19.69%	1.76%
LWC	5	0.1299	0.08888	0.1709	0.08778	0.1662	0.01476	0.03301	25.42%	-13.66%

14 ~~10~~d Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	0.9	1	1	1	0.9
LMC	1	1	1	0.9	0.7
LWC	1	0.9	0.9	0.9	1

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	0.1411	0.103	0.115	0.1	0.1122
LMC	0.107	0.104	0.119	0.1456	0.08573
LWC	0.156	0.08778	0.1333	0.1662	0.106

14 ~~10~~d Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	9/10	10/10	10/10	10/10	9/10
LMC	10/10	10/10	10/10	9/10	7/10
LWC	10/10	9/10	9/10	9/10	10/10

Analyst: FN QA: Dec 5/17

CETIS Analytical Report

Report Date:	05 Dec-17 11:08 (p 1 of 2)
Test Code:	171052 | 17-2296-8735

Hyalella 14-d Survival and Growth Sediment Test

Nautilus Environmental

Analysis ID:	18-5087-2458	**Endpoint:**	~~10~~14d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	05 Dec-17 11:07	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	20-6218-0957	**Test Type:**	Growth-Survival (~~10~~14d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	27 Oct-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	14d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	2-9d

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control SED	03-7657-6483	13 Oct-17	13 Oct-17	NA		
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control SED	Sediment Sample	Minnow Environmental	Control Sediment		
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
Control SED		LMC	0.3389	0.6777	Exact	Non-Significant Effect
Control SED		LWC	0.5	0.5000	Exact	Non-Significant Effect

Data Summary

Sample Code		NR	R	NR + R	Prop NR	Prop R	%Effect
Control SED	Negative Contr	48	2	50	0.96	0.04	0.0%
LMC		46	4	50	0.92	0.08	4.17%
LWC		47	3	50	0.94	0.06	2.08%

14 ~~10~~d Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	0.9	1	1	1	0.9
LMC	1	1	1	0.9	0.7
LWC	1	0.9	0.9	0.9	1

14 ~~10~~d Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	9/10	10/10	10/10	10/10	9/10
LMC	10/10	10/10	10/10	9/10	7/10
LWC	10/10	9/10	9/10	9/10	10/10

Analyst: EC QA: Dec-5/17

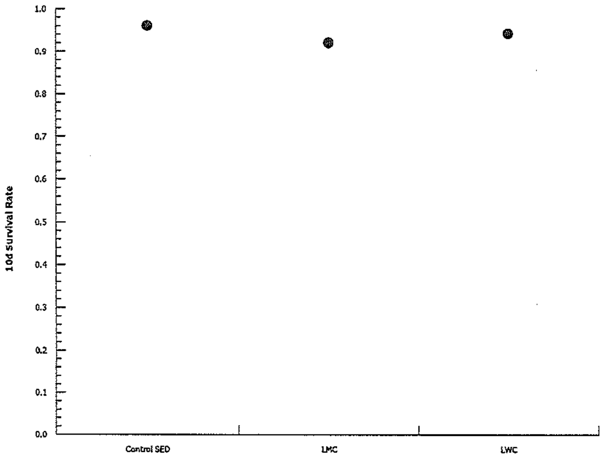
CETIS Analytical Report

Report Date:	05 Dec-17 11:08 (p 2 of 2)
Test Code:	171052 | 17-2296-8735

Hyalella 14-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	18-5087-2458	**Endpoint:**	14 ~~10~~d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	05 Dec-17 11:07	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Graphics



Hyalella 14-d Survival and Growth Sediment Test

Nautilus Environmental

Analysis ID:	12-8931-4019	**Endpoint:**	14 ~~10~~d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:23	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	20-6218-0957	**Test Type:**	Growth-Survival (14 ~~10~~d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	27 Oct-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	14d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	2-9d

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
LWC		LMC	0.5	0.5000	Exact	Non-Significant Effect

Data Summary

Sample Code		NR	R	NR + R	Prop NR	Prop R	%Effect
LMC		46	4	50	0.92	0.08	2.13%
LWC	Reference Sed	47	3	50	0.94	0.06	0.0%

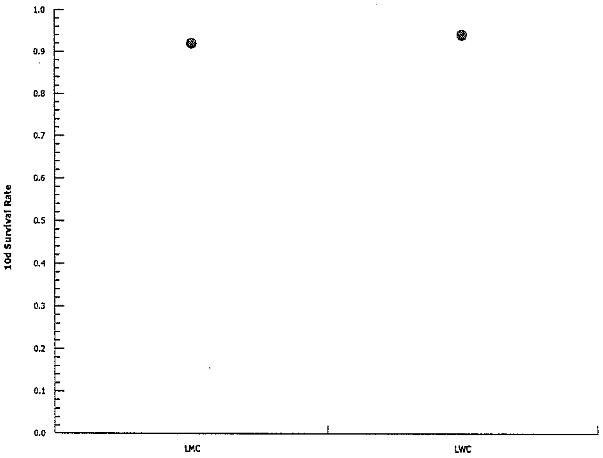
14 ~~10~~d Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
LMC	1	1	1	0.9	0.7
LWC	1	0.9	0.9	0.9	1

14 ~~10~~d Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
LMC	10/10	10/10	10/10	9/10	7/10
LWC	10/10	9/10	9/10	9/10	10/10

Graphics



Nov 28/17

Analyst: Ec QA:

CETIS Analytical Report

Report Date: 05 Dec-17 11:08 (p 1 of 2)
Test Code: 171052 | 17-2296-8735

Hyalella 14-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	01-8339-2184	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	05 Dec-17 11:08	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	20-6218-0957	**Test Type:**	Growth-Survival (~~10~~14d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	27 Oct-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	14d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	2-9d

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control SED	03-7657-6483	13 Oct-17	13 Oct-17	NA		
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control SED	Sediment Sample	Minnow Environmental	Control Sediment		
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	28.9%	

Dunnett Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control SED		LMC	0.1284	2.108	0.033	8	0.6152	CDF	Non-Significant Effect
		LWC	-0.9955	2.108	0.033	8	0.9293	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.0009297162	0.0004648581	2	0.7569	0.4902	Non-Significant Effect
Error	0.007369674	0.0006141395	12			
Total	0.00829939		14			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	1.799	9.21	0.4068	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.961	0.8328	0.7104	Normal Distribution

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control SED	5	0.1143	0.0941	0.1344	0.1122	0.1	0.1411	0.007266	14.22%	0.0%
LMC	5	0.1123	0.08481	0.1397	0.107	0.08573	0.1456	0.009884	19.69%	1.76%
LWC	5	0.1299	0.08888	0.1709	0.1333	0.08778	0.1662	0.01476	25.42%	-13.66%

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	0.1411	0.103	0.115	0.1	0.1122
LMC	0.107	0.104	0.119	0.1456	0.08573
LWC	0.156	0.08778	0.1333	0.1662	0.106

Analyst: EC QA: Dec 5/17

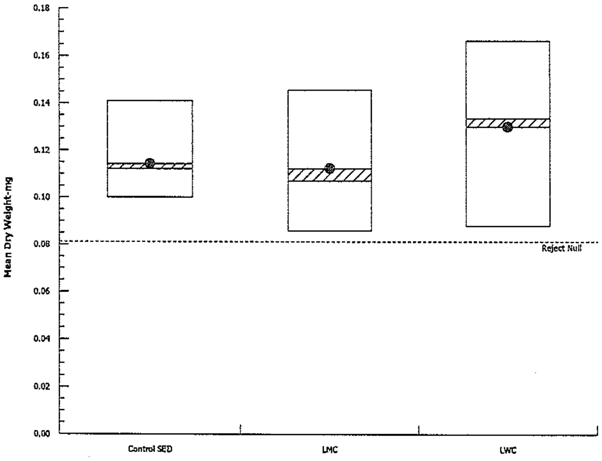
CETIS Analytical Report

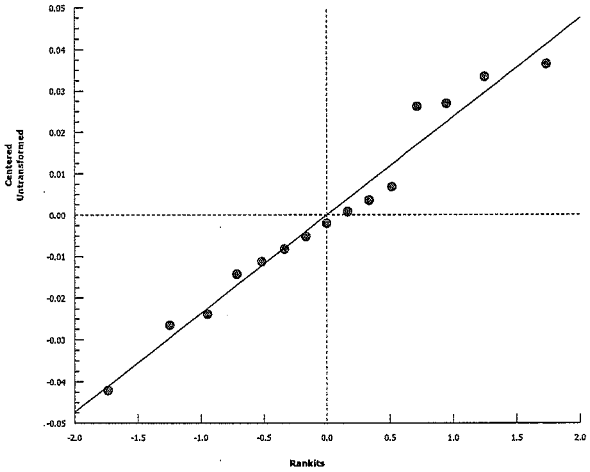
Report Date: 05 Dec-17 11:08 (p 2 of 2)
Test Code: 171052 | 17-2296-8735

Hyalella 14-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	01-8339-2184	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	05 Dec-17 11:08	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Graphics





Analyst:________ QA:________ Dec-5/17

CETIS Analytical Report

Report Date:	28 Nov-17 15:47 (p 1 of 2)
Test Code:	171052 | 17-2296-8735

Hyalella 14-d Survival and Growth Sediment Test — **Nautilus Environmental**

Analysis ID:	05-9680-4235	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	28 Nov-17 15:46	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Batch ID:	20-6218-0957	**Test Type:**	Growth-Survival (~~10~~ 14d) EC	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/33	**Diluent:**	Reconstituted Water
Ending Date:	27 Oct-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	14d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	2-9d

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	25.4%	

Williams Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
LWC		LMC	0.9914	1.86	0.033	8	>0.05	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.0007757707	0.0007757707	1	0.983	0.3505	Non-Significant Effect
Error	0.006313807	0.0007892259	8			
Total	0.007089578		9			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Variance Ratio F	2.231	23.15	0.4560	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.954	0.7411	0.7160	Normal Distribution

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
LMC	5	0.1123	0.08481	0.1397	0.107	0.08573	0.1456	0.009884	19.69%	0.0%
LWC	5	0.1299	0.08888	0.1709	0.1333	0.08778	0.1662	0.01476	25.42%	-15.69%

Mean Dry Weight-mg Detail

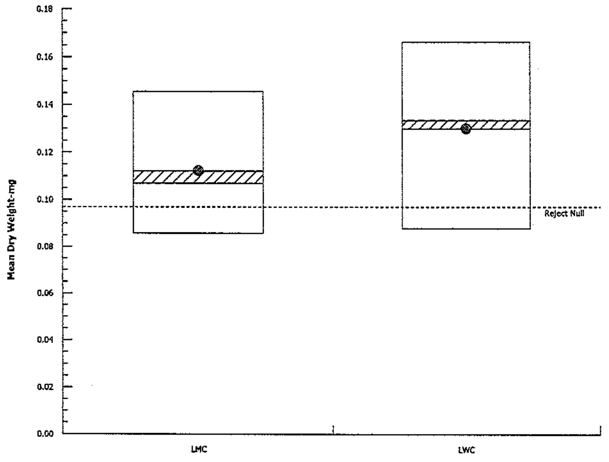
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
LMC	0.107	0.104	0.119	0.1456	0.08573
LWC	0.156	0.08778	0.1333	0.1662	0.106

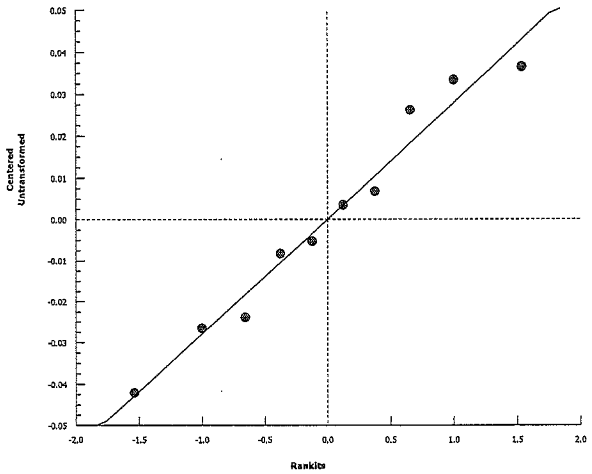
Analyst: EC QA: Nov 28/17

Hyalella 14-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	05-9680-4235	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	28 Nov-17 15:46	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Graphics





Analyst:________ QA:________

Nov 28/17

Client : Minnow
W.O.: 171052
Date see below

Table of PKa values

	TDS (mg/L)			Salinity (g/kg)		
Temperature (°C)	*0*	*250*	*2000*	*10*	*20*	*30*
12	9.662	9.699	9.754	9.788	9.819	9.837
15	9.564	9.601	9.655	9.688	9.719	9.737
18	9.465	9.502	9.557	9.588	9.619	9.636
20	9.401	**9.438**	9.492	9.523	9.554	9.571
22		**9.391**				
23	9.307	**9.344**	9.398	9.426	9.459	9.476
25	9.246	9.283	9.337	9.366	9.397	9.414

unionized ammonia must be <0.2mg/L

Sample ID	Temperature (C)	pH	Salinity (ppt)	Total Ammonia as N (mg/L)	pKa	Unionized Ammonia (mg/L N)
LWC	22.0	7.~~8~~ 7	0	0.27	**9.391**	**0.01**
LWC	22.0	7.8	0	1.00	**9.391**	**0.03**
LWC	22.0	7.9	0	0.40	**9.391**	**0.01**
LWC	22.0	8.1	0	0.10	**9.391**	**0.00**
LWC	22.0	7.9	0	0.10	**9.391**	**0.00**
LWC	22.0	7.9	0	0.20	**9.391**	**0.01**
LWC	22.0	7.9	0	0.07	**9.391**	**0.00**

Nov 28, 2017

Nautilus Environmental
Water Quality Data For Ammonia

Client : Minnow

Work Order No: 171052

Species : Hyallela azteca

Sample Type: Overlying ammonia

Date Measured: Oct 13, 16, 18, 20, 23, 25, 27/17

Date	Sample ID	Temperature (°C)	pH	Total Ammonia as N (mg/L)	Unionized Ammonia (mg/L)	Tech. Init.
EL Oct13/17	LWC	22.0	7.7	0.27	0.01	EC
Oct16/17	LWC	22.0	7.8	EL ~~0.10~~ 1.0	0.03	EL
Oct18/17	LWC	22.0	EL ~~8~~ 7.9	0.4	0.01	EL
Oct20/17	LWC	22.0	8.1	0.1	0.00	EL
Oct23/17	LWC	22.0	7.9	ML7 ~~0.0~~ 0.1	0.00	ML7
Oct25/17	LWC	22.0	7.9	0.2	0.01	ML7
Oct27/17	LWC	22.0	7.9	0.07	0.00	EL

Ammonia Salicylate Lot #: A7150

Ammonia Cyanurate Lot #: A7130

Comments:

Reviewed by:

Date Reviewed: Nov 28, 2017

Client: Minnow

W.O.#: 171052 & 171051

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Day 0 Sample ID	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
Hyal Lab	Oct 13/17	Oct 18/17	50	2.9	3.0	56	100①	1.8	180	AWZ
control Day 0	↓	↓	↓				↓			↓
LMC				4.8	4.9	94		2.2	220	
LWC	↓	↓	↓	4.5	4.6	88	↓	2.4	240	↓

Notes: ① Diluted to 100mL w DI

Reviewed by:

Date Reviewed: Nov. 28, 2017

Client: Minnow

W.O.#: 171052

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Day 14 Sample ID	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/LCaCO$_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L CaCO$_3$)	Technician
Contrl	Oct 27/17	Oct 27/17	50	2.6	2.7	50	50	6.1	122	AWZ
	↓	↓								↓
LML	↓	↓	50	14.6	14.9	286	100①	AWZ ~~2.7~~ 4.5	450	↓
	↓	↓								↓
LWL	↓	↓	50	7.7	7.9	150	100①	2.7	270	↓

Notes: ① Diluted to 100mL w DI

Reviewed by:

Date Reviewed: Nov. 28, 2017

Sediment Description Data Sheet

Client: Minnow
Work Order No.: 171051 & 171052

Date: Oct 12/17
Test Organism: *Hyalella azteca* + Chironomus dilutus

Sample ID	Grain Size	Colour	Odour	Debris	Other	Initials
Control Sediment	Sand	grey	–	–	–	EC
LMC-5	Clay	Brown	–	Some branches	–	EC
LMC-4	Clay	Brown	–	Some branches	–	EC
LMC-3	Clay/Silk	Brown	–	Some branches	–	EC
LMC-2	~~Cl~~ Clay	Brown	–	Some branches	–	EC
LMC-1	Clay/Silk	Brown	–	Some branches	–	EC
LWC-5	Clay	Brown	–	Some branches + leaves + Roots	–	EC
LWC-4	Clay	Brown	–	Some branches	–	EC
LWC-3	Clay	Brown	–	Some branches	–	EC
LWC-2	Silk/Clay	Brown	–	Some branches	–	EC
LWC-1	Silk/Clay	Brown	–	Some branches.	–	EC

Reviewed by:

Date Reviewed: Nov. 28, 2017

APPENDIX B – *Chironomus dilutus* Toxicity Test Data

Chironomus dilutus Sediment Test Summary Sheet

Client: Minnow
Work Order No.: 171051

Start Date: Oct 13/17
Set up by: Ev

Sample Information:

Sample ID: Various (See below)
Sample Date: Sept 20, 21 / 2017
Date Received: Sept 28/17
Sample Volume: 1X 500mL per sample

Test Organism Information:

Species: *C. dilutus*
Supplier: Aquatic Biosystems, CO
Date received: Oct 13/17
Age or size (Day 0): 3rd in-star

① indicates there is a significant survival difference as compared to Control sediment.

② indicates there is a significant survival difference as compared to LWC (reference site).

③ indicates there is a significant Dry weight difference as compared to LWC.

KCl Reference Toxicant Results:

Reference Toxicant ID: CT63
Stock Solution ID: n/a
Date Initiated: Oct 13/17

96-h LC50 (95% CL): 2.9 (2.1 - 4.0) g/L KCl

96-h LC50 Reference Toxicant Mean and Range: 4.8 (2.7 - 8.7) g/L KCl CV (%): 34

Test Results:

Sample ID	Survival ± SD (%)	Average Dry Wt. ± SD (mg)
Control Sediment	86.0 ± 8.9~~0~~ Ev	1.22 ± 0.25
LMC	② ① 48.0 ± 38.3	③ 1.57 ± 0.32
LWC	90.0 ± 17.3	1.92 ± 0.24
	±	±
	±	±
	±	±
	±	±

Reviewed by:

Date reviewed: November 28, 2017

Version 1.1; Issued May 19, 2017

Nautilus Environmental Company Inc.

P1/2

10-d Chironomid Sediment Toxicity Test Data Sheet
Freshwater Sediment 10-d Water Quality

Client: Minnow
W.O #: 171051

Start Date: Oct 13/17
Termination Date: Oct 23/17
CER #: 6
Test Organism: *Chironomus dilutus*

Temperature (°C)

Sample ID	Day 0	1	2	3	4	5	6	7	8	9	10
Control	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
LMC	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
LWC (ref)	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0	22.0
	X EL										
Technician Initials	EL	EL	MKJ	EL	EL	EL	AWT	EL	K	MM	MKJ

Thermometer: 6

Conductivity (µS)

Sample ID	Day 0	1	2	3	4	5	6	7	8 ①	9	10
Control	397	411	415	417	436	430	459	454	498	514	529
LMC	461	492	538	548	547	574	576 AW	~~625~~ 600	634	② ~~698~~	737
LWC	403	400	415	420	415	422	430	429	~~420~~	434	440
Technician Initials	EL	EL	MKJ	EL	EL	EL	EL	EL	K	MM	MKJ

①514
678
430

②698

Conductivity meter/probe: 1 / 1

Comments:

Reviewed by:

Date Reviewed: November 28, 2017

P2/2

10-d Chironomid Sediment Toxicity Test Data Sheet

Freshwater Sediment 10-d Water Quality

Client: Minnow
W.O. #: 171051

Start Date: Oct 13/17
Termination Date: Oct 23/17
CER #: 6
Test Organism: *Chironomus dilutus*

Dissolved oxygen (mg/L)

Sample ID	Day										
	0	1	2	3	4	5	6	7	8	9	10
Control	8.2	8.1	8.2	7.9	8.0	8.0	8.3	8.2	8.2	8.0	8.0
LMC	8.1	8.2	8.0	7.8	8.1	8.1	8.3	8.1	8.1	8.2	7.8
LWC (ref)	8.2	8.0	8.0	7.9	8.0	8.1	8.3	8.2	8.0	8.0	7.8
Technician Initials	EL	EL	MLT	EL	EL	EL	AWT	EL	K	WML	MLT

DO meter/probe: 1 / 1

pH

① 7.8
② 8.2
③ 7.7

Sample ID	Day										
	0	1	2	3	4	5	6	7	8	9	10
Control	7.6	7.5	7.5	7.5	7.6	7.5	7.7	~~8.3~~ ①	7.7	7.8	7.8
LMC	7.9	7.9	7.8	7.8	8.0	8.0	8.1	AWT ~~8.3~~ ②	8.3	8.2	8.2
LWC	7.7	7.7	7.7	7.8	7.9	7.9	7.7	~~8.3~~ ③	7.7	7.5	7.8
Technician Initials	EL	EL	MLT	EL	EL	EL	AWT	EL	K	WML	MLT

pH meter/probe: 1 / 1

Light meter: LH1

Light intensity (Lux): 510 - 810

Comments:

Reviewed by:

Date Reviewed: November 28, 2017

10-d Chironomid Sediment Toxicity Test Data Sheet

Freshwater Sediment 10-d Survival and Weight

Client: Minnow
W.O. #: 171051
Sample ID: Various

Start Date: Oct 13/17
Termination Date: Oct ~~27~~ 23/17
Test Organism: *Chironomus dilutus*
Balance: 1

Sample ID	Min Pan No. Blue	Rep	No. alive	No. dead	No. missing	Initials	Pan weight (mg)	Pan + organism (mg)	No. weighed	Initials
Control Sediment	1	A	9	0	1	MLT	1016.96	1026.39	9	EL
	2	B	9	0	1	↓	1018.89	1029.44	9	↓
	3	C	7②	0	3	↓	1027.26	1038.95	7	↓
	4	D	9	0	1	↓	1028.93	1038.77	9	↓
	5	E	9	0	1	↓	1035.27	1045.47	9	↓
LMC-~~5~~ 1	6	A	2①	0	8	KJL	1032.24	1034.64	2	↓
LMC-~~4~~ 2	7	B	5①	0	5	↓	1027.53	103~~3~~4.60	5	↓
LMC-~~3~~ 3	8	C	8①	0	2	↓	1011.74	1025.86	8	↓
LMC-~~2~~ 4	9	D	0 ①③	0	10	↓	1034.40	—	~~9~~ 0	↓
LMC-~~1~~ 5	10	E	9	0	1	↓	1031.19	1048.25	9	↓
LWC-~~5~~ 1	11	A	10	0	0	MLT	1021.92	1038.86	10	↓
LWC-~~4~~ 2	12	B	9	0	1	↓	1028.89	1044.51	9	↓
LWC-~~3~~ 3	13	C	10	0	0	↓	1040.68	1063.61	10	↓
LWC-~~2~~ 4	14	D	11	0	0	↓	1021.20	1042.30	11	↓
LWC-~~1~~ 5	15	E	6①	0	4	KJL	1024.89	1036.80	6	↓
		A								
		B								
		C								
		D								
		E								

Comments: ① checked by MLT ② checked by KJL ③ jar marked as seeded
Reweighed on Pan#2 : 1029.88 mg. Pan#4 : 1038.88 mg

Reviewed by:

Date Reviewed: November 28, 2017

CETIS Summary Report

Report Date: 21 Nov-17 14:55 (p 1 of 1)
Test Code: 171051 | 11-2980-0764

Chironomus 10-d Survival and Growth Sediment Test — **Nautilus Environmental**

Batch ID:	05-3681-5362	**Test Type:**	Growth-Survival (10d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	23 Oct-17	**Species:**	Chironomus dilutus	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	3rd instar

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control SED	03-7657-6483	13 Oct-17	13 Oct-17	NA		
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control SED	Sediment Sample	Minnow Environmental	Control Sediment		
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

10d Survival Rate Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control SED	5	0.86	0.7489	0.9711	0.7	0.9	0.04	0.08944	10.4%	0.0%
LMC	5	0.48	0.003939	0.9561	0	0.9	0.1715	0.3834	79.88%	44.19%
LWC	5	0.9	0.6849	1	0.6	1	0.07746	0.1732	19.25%	-4.65%

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
Control SED	5	1.223	0.908	1.539	1.048	1.67	0.1136	0.2539	20.76%	0.0%
LMC	4	1.569	1.061	2.076	1.2	1.896	0.1595	0.319	20.33%	-28.23%
LWC	5	1.925	1.628	2.222	1.694	2.293	0.1068	0.2389	12.41%	-57.37%

10d Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	0.9	0.9	0.7	0.9	0.9
LMC	0.2	0.5	0.8	0	0.9
LWC	1	0.9	1	1	0.6

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	1.048	1.172	1.67	1.093	1.133
LMC	1.2	1.414	1.765		1.896
LWC	1.694	1.736	2.293	1.918	1.985

10d Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	9/10	9/10	7/10	9/10	9/10
LMC	2/10	5/10	8/10	0/10	9/10
LWC	10/10	9/10	10/10	11/11	6/10

NOV 28/17

Analyst: Ec QA:

CETIS Analytical Report

Report Date:	21 Nov-17 14:49 (p 1 of 3)
Test Code:	171051 | 11-2980-0764

Chironomus 10-d Survival and Growth Sediment Test

Nautilus Environmental

Analysis ID:	19-5778-6453	**Endpoint:**	10d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:48	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	05-3681-5362	**Test Type:**	Growth-Survival (10d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	23 Oct-17	**Species:**	Chironomus ~~tentans~~ Ec dilutus	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	3rd instar

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control SED	03-7657-6483	13 Oct-17	13 Oct-17	NA		
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control SED	Sediment Sample	Minnow Environmental	Control Sediment		
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
Control SED		LMC	4.772E-05	<0.0001	Exact	Significant Effect
Control SED		LWC	1	1.0000	Exact	Non-Significant Effect

Data Summary

Sample Code		NR	R	NR + R	Prop NR	Prop R	%Effect
Control SED	Negative Contr	43	7	50	0.86	0.14	0.0%
LMC		24	26	50	0.48	0.52	44.19%
LWC		46	5	51	0.902	0.09804	-4.88%

10d Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	0.9	0.9	0.7	0.9	0.9
LMC	0.2	0.5	0.8	0	0.9
LWC	1	0.9	1	1	0.6

10d Survival Rate Binomials

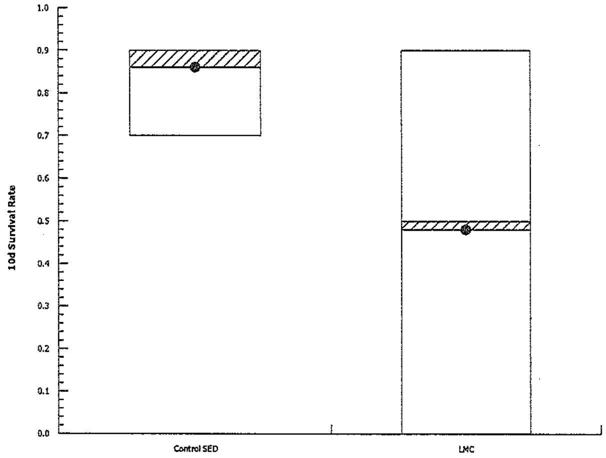
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	9/10	9/10	7/10	9/10	9/10
LMC	2/10	5/10	8/10	0/10	9/10
LWC	10/10	9/10	10/10	11/11	6/10

Nov 28/17

Analyst: Ec QA:

Analysis ID:	19-5778-6453	**Endpoint:**	10d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:48	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Graphics



Analyst: EL QA: NOV·28/17

CETIS Analytical Report

Report Date:	21 Nov-17 14:55 (p 1 of 1)
Test Code:	171051 | 11-2980-0764

Chironomus 10-d Survival and Growth Sediment Test

Nautilus Environmental

Analysis ID:	01-4065-3068	**Endpoint:**	10d Survival Rate	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:54	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	05-3681-5362	**Test Type:**	Growth-Survival (10d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	23 Oct-17	**Species:**	Chironomus dilutus	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	3rd instar

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	Test Result
Untransformed		C > T	NA	NA	

Fisher Exact/Bonferroni-Holm Test

Sample	vs	Sample	Test Stat	P-Value	P-Type	Decision(α:5%)
LWC		LMC	3.286E-06	<0.0001	Exact	Significant Effect

Data Summary

Sample Code		NR	R	NR + R	Prop NR	Prop R	%Effect
LMC		24	26	50	0.48	0.52	46.78%
LWC	Reference Sed	46	5	51	0.902	0.09804	0.0%

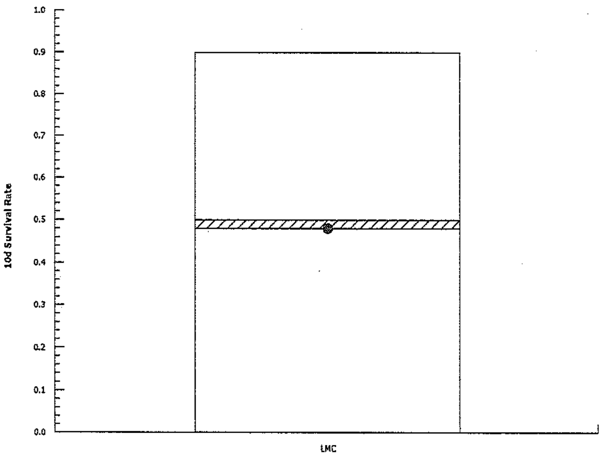
10d Survival Rate Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
LMC	0.2	0.5	0.8	0	0.9
LWC	1	0.9	1	1	0.6

10d Survival Rate Binomials

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
LMC	2/10	5/10	8/10	0/10	9/10
LWC	10/10	9/10	10/10	11/11	6/10

Graphics



Analyst: Ec QA: Nov 28/17

CETIS Analytical Report

Report Date:	21 Nov-17 14:49 (p 1 of 4)
Test Code:	171051 | 11-2980-0764

Chironomus 10-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	14-1972-3414	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:48	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Batch ID:	05-3681-5362	**Test Type:**	Growth-Survival (10d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	23 Oct-17	**Species:**	Chironomus ~~tentans~~ EC dilutus	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	3rd instar

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
Control SED	03-7657-6483	13 Oct-17	13 Oct-17	NA		
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
Control SED	Sediment Sample	Minnow Environmental	Control Sediment		
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	26.2%	

Williams Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
Control SED		LMC	-1.919	1.796	0.323	7	>0.05	CDF	Non-Significant Effect
		LWC	-3.203	1.889	0.321	8	>0.05	CDF	Non-Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.231467	0.6157336	2	8.557	0.0057	Significant Effect
Error	0.7914933	0.07195394	11			
Total	2.02296		13			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	0.2896	9.21	0.8652	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9287	0.8239	0.2925	Normal Distribution

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
Control SED	5	1.223	0.908	1.539	1.133	1.048	1.67	0.1136	20.76%	0.0%
LMC	4	1.569	1.061	2.076	1.589	1.2	1.896	0.1595	20.33%	-28.23%
LWC	5	1.925	1.628	2.222	1.918	1.694	2.293	0.1068	12.41%	-57.37%

Mean Dry Weight-mg Detail

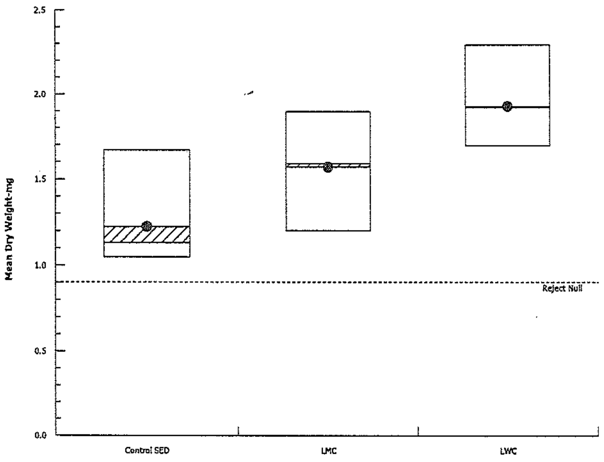
Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
Control SED	1.048	1.172	1.67	1.093	1.133
LMC	1.2	1.414	1.765	1.896	
LWC	1.694	1.736	2.293	1.918	1.985

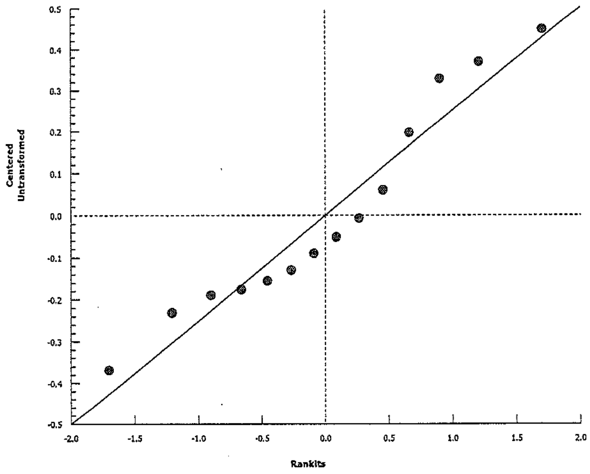
Nov 28/17

Analyst: EC QA:

Analysis ID:	14-1972-3414	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:48	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Graphics





Analyst: EL QA: Nov 28/17

CETIS Analytical Report

Report Date:	21 Nov-17 14:55 (p 1 of 2)
Test Code:	171051 | 11-2980-0764

Chironomus 10-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	17-7050-8428	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:54	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Batch ID:	05-3681-5362	**Test Type:**	Growth-Survival (10d)	**Analyst:**	Eric Cheung
Start Date:	13 Oct-17	**Protocol:**	EC/EPS 1/RM/32	**Diluent:**	Reconstituted Water
Ending Date:	23 Oct-17	**Species:**	Chironomus dilutus	**Brine:**	
Duration:	10d 0h	**Source:**	Aquatic Biosystems, CO	**Age:**	3rd instar

Sample Code	Sample ID	Sample Date	Receive Date	Sample Age	Client Name	Project
LMC	12-3392-1475	20 Sep-17	28 Sep-17 10:30	23d 0h (11 °C)	Minnow	
LWC	10-6552-7572	24 Sep-17	28 Sep-17 10:30	19d 0h (11 °C)		

Sample Code	Material Type	Sample Source	Station Location	Latitude	Longitude
LMC	Sediment Sample	Minnow Environmental	LMC		
LWC	Sediment Sample	Minnow Environmental	LWC		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	Test Result
Untransformed	NA	C > T	NA	NA	18.2%	

Williams Multiple Comparison Test

Sample Code	vs	Sample Code	Test Stat	Critical	MSD	DF	P-Value	P-Type	Decision(α:5%)
LWC		LMC	1.925	1.895	0.351	7	<0.05	CDF	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.2824385	0.2824385	1	3.705	0.0956	Non-Significant Effect
Error	0.5335545	0.07622208	7			
Total	0.815993		8			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Variance Ratio F	1.783	24.26	0.5791	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9485	0.7007	0.6736	Normal Distribution

Mean Dry Weight-mg Summary

Sample Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
LMC	4	1.569	1.061	2.076	1.589	1.2	1.896	0.1595	20.33%	0.0%
LWC	5	1.925	1.628	2.222	1.918	1.694	2.293	0.1068	12.41%	-22.73%

Mean Dry Weight-mg Detail

Sample Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
LMC	1.2	1.414	1.765	1.896	
LWC	1.694	1.736	2.293	1.918	1.985

Analyst: EC QA: Nov 28/17

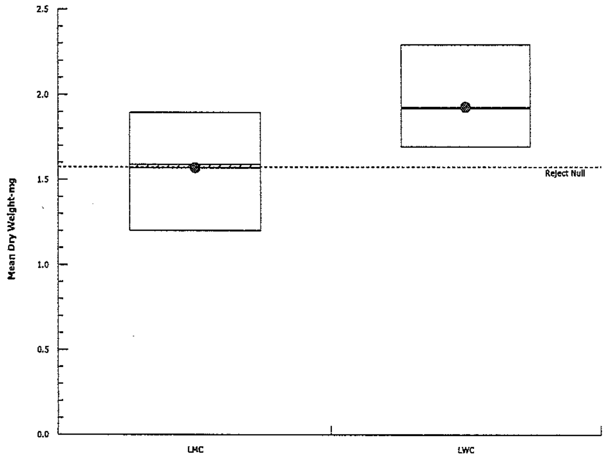
CETIS Analytical Report

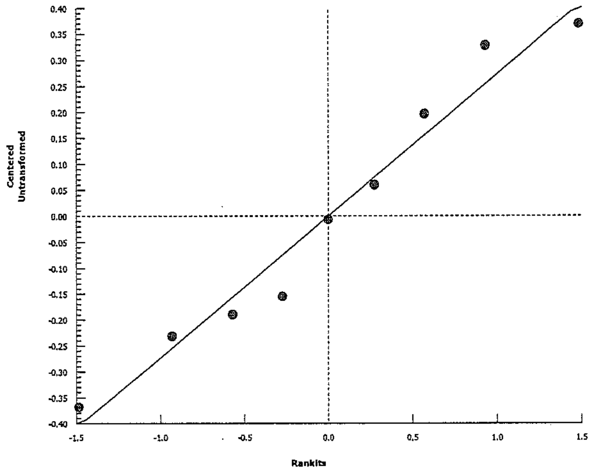
Report Date: 21 Nov-17 14:55 (p 2 of 2)
Test Code: 171051 | 11-2980-0764

Chironomus 10-d Survival and Growth Sediment Test **Nautilus Environmental**

Analysis ID:	17-7050-8428	**Endpoint:**	Mean Dry Weight-mg	**CETIS Version:**	CETISv1.8.7
Analyzed:	21 Nov-17 14:54	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Graphics





Nov-28/17

Analyst: w QA:

Client: Minnow

W.O.#: 171051

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Day 6 Sample ID	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
	Oct 23/17	Oct 23/17								
Control			50	2.2	2.3	42	10 ①	2.6	260	AIP
LWC				3.3	3.5	62		1.8	180	
LMC	↓	↓	↓	7.5	7.7	146	↓	3.2	320	↓

Notes: ① Diluted to 100 mL w/ DI water

Reviewed by:

Date Reviewed: Nov. 28, 2017

APPENDIX C – Analytical Chemistry

NAUTILUS ENVIRONMENTAL
ATTN: Eric Cheung
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 13-OCT-17
Report Date: 20-OCT-17 15:50 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L2007162
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2007162-1	L2007162-2	L2007162-3		
	Description	Water	Water	Water		
	Sampled Date	13-OCT-17	13-OCT-17	13-OCT-17		
	Sampled Time	10:35	10:35	10:35		
	Client ID	LMC	LWC	CONTROL		
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Ammonia, Total (as N) (mg/L)	0.0836	0.335	0.137		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L2007162-COFC

US
NTAL

TESTING LOCATION (Please Circle)

Burnaby ●
8664 Commerce Court
Burnaby, British Columbia, Canada
V5A 4N7
Phone 604.420.8773

Calgary ○
#4, 6125 12 Street SE
Calgary, Alberta, Canada
T2H 2K1
Phone 403.253.7121

Chain of Custody

Date Oct13,17 Page 1 of 1

Report to:

Company Nautilus Environmental
Address 8664 Commerce Court
City/Prov/PC Burnaby, BC
Contact Eric Cheung
Phone 604-420-8773
Email eric@nautilusenvironmental.ca

Invoice To:

Company (same)
Address
City/Prov/PC
Contact
Phone
Email (same) + lise@nautilusenvironmental.ca
PO No.

Sample Collection By:

Sample Type: Grab ○ OR Composite ○

ANALYSES REQUIRED

	SAMPLE ID	DATE (DD/MM/YY)	TIME	MATRIX	# OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)	COMMENTS	overlying ammonia										Receipt Temperature (°C)
1	LMC	13/10/17	1035h	water	1x125mL		☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
2	LWC	↓	↓	↓	↓		☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
3	Control	13/10/17	1035h	water	1x125mL		☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	
4							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
5							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
6							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
7							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
8							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
9							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
10							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

SPECIAL INSTRUCTIONS/COMMENTS (CLIENT)

SAMPLE RECEIPT DETAILS (LABORATORY)

1. Total No. of Containers		**4. Ice Present in Cooler?**	**Y / N**
2. Courier		**5. Seal Present?**	**Y / N**
3. Good Condition?	**Y / N**	**6. Initials Present on Seal?**	**Y / N**

SAMPLE DESCRIPTION AND COMMENTS (LABORATORY)

15°C

RELINQUISHED BY (CLIENT)

Eric Cheung
(Printed Name) (Signature)
Nautilus Environmental Oct13/17 1730h
(Company) (Date DD/MM/YY and Time)

RECEIVED BY (LABORATORY)

Michelle
(Printed Name) (Signature)
Oct 13 18:3
(Company) (Date DD/MM/YY and Time)

Our liability is limited to the cost of the test requested. The test results only relate to the sample as received. No liability in whole or in part is assumed for the collection, handling, or transport of the sample, application or interpretation of the test data or results in part or in whole.

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Form 020; Version 1.2; Revised by CC 2016/10/06

NAUTILUS ENVIRONMENTAL
ATTN: Eric Cheung
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 27-OCT-17
Report Date: 06-NOV-17 12:47 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L2014712
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

H McKenzie

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2014712-1	L2014712-2	L2014712-3		
	Description	Water	Water	Water		
	Sampled Date	23-OCT-17	23-OCT-17	23-OCT-17		
	Sampled Time					
	Client ID	LMC	LWC	CONTROL		
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Ammonia, Total (as N) (mg/L)	0.123	0.882	0.682		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Ammonia, Total (as N)	MS-B	L2014712-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

NAUTILUS
ENVIRONMENTAL

TESTING LOCATION (Please Circle)

Burnaby ●
8664 Commerce Court
Burnaby, British Columbia, Canada
V5A 4N7
Phone 604.420.8773

Calgary ○
#4, 6125 12 Street SE
Calgary, Alberta, Canada
T2H 2K1
Phone 403.253.7121

Chain of Custody

Date Oct23,17 Page 1 of 1

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/Prov/PC	Burnaby, BC
Contact	Eric Cheung
Phone	604-420-8773
Email	eric@nautilusenvironmental.ca

Invoice To:

Company	(same)
Address	
City/Prov/PC	
Contact	
Phone	
Email	(same) + lise@nautilusenvironmental.ca
PO No.	

Sample Collection By:

Sample Type: **Grab** ○ OR **Composite** ○

ANALYSES REQUIRED

	SAMPLE ID	DATE (DD/MM/YY)	TIME	MATRIX	# OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)	COMMENTS	overlying ammonia										Receipt Temperature (°C)
1	LMC	23/10/17		water	1x125mL		✓										
2	LWC	↓		↓	↓		✓										
3	Control	↓		↓	↓		✓										
4																	
5																	
6																	
7																	
8																	
9																	
10																	

L2014712-COFC

SPECIAL INSTRUCTIONS/COMMENTS (CLIENT)

SAMPLE RECEIPT DETAILS (LABORATORY)

1. Total No. of Containers		**4. Ice Present in Cooler?**	Y / N
2. Courier		**5. Seal Present?**	Y / N
3. Good Condition?	Y / N	**6. Initials Present on Seal?**	Y / N

SAMPLE DESCRIPTION AND COMMENTS (LABORATORY)

12.6°C

RELINQUISHED BY (CLIENT)

Mimi Tran (Printed Name)

(Signature)

Nautilus Environmental (Company)

23/10/17 @ 1515h (Date DD/MM/YY and Time)

RECEIVED BY (LABORATORY)

TP (Printed Name)

(Signature)

(Company)

Oct 27 18:20 (Date DD/MM/YY and Time)

Our liability is limited to the cost of the test requested. The test results only relate to the sample as received. No liability in whole or in part is assumed for the collection, handling, or transport of the sample, application or interpretation of the test data or results in part or in whole.

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Form 020; Version 1.2; Revised by CC 2016/10/06

NAUTILUS ENVIRONMENTAL
ATTN: Eric Cheung
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 27-OCT-17
Report Date: 06-NOV-17 12:41 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L2014711
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2014711-1 Water 27-OCT-17 LMC	L2014711-2 Water 27-OCT-17 LWC	L2014711-3 Water 27-OCT-17 CONTROL		
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Ammonia, Total (as N) (mg/L)	0.0661	0.0906	1.92		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Ammonia, Total (as N)	MS-B	L2014711-1, -2, -3

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

NAUTILUS
ENVIRONMENTAL

TESTING LOCATION (Please Circle)

Burnaby ●
8664 Commerce Court
Burnaby, British Columbia, Canada
V5A 4N7
Phone 604.420.8773

Calgary ○
#4, 6125 12 Street SE
Calgary, Alberta, Canada
T2H 2K1
Phone 403.253.7121

Chain of Custody

Date Oct27,17 Page 1 of 1

Report to:

Company	Nautilus Environmental
Address	8664 Commerce Court
City/Prov/PC	Burnaby, BC
Contact	Eric Cheung
Phone	604-420-8773
Email	eric@nautilusenvironmental.ca

Invoice To:

Company	(same)
Address	
City/Prov/PC	
Contact	
Phone	
Email	(same) + lise@nautilusenvironmental.ca
PO No.	

Sample Collection By:

Sample Type: Grab ○ OR Composite ○

	SAMPLE ID	**DATE (DD/MM/YY)**	**TIME**	**MATRIX**	**# OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)**	**COMMENTS**	**ANALYSES REQUIRED** overlying ammonia										**Receipt Temperature (°C)**
1	LMC	27/10/17		water	1x125mL		✓	☐	☐	☐	☐	☐	☐	☐	☐	☐	
2	LWC	↓		↓	↓		✓	☐	☐	☐	☐	☐	☐	☐	☐	☐	
3	Control	↓		↓	↓		✓	☐	☐	☐	☐	☐	☐	☐	☐	☐	
4							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
5							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
6							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
7							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
8							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
9							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	
10							☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

L2014711-COFC

SPECIAL INSTRUCTIONS/COMMENTS (CLIENT)

SAMPLE RECEIPT DETAILS (LABORATORY)

1. Total No. of Containers		**4. Ice Present in Cooler?**	**Y / N**
2. Courier		**5. Seal Present?**	**Y / N**
3. Good Condition?	**Y / N**	**6. Initials Present on Seal?**	**Y / N**

SAMPLE DESCRIPTION AND COMMENTS (LABORATORY)

12.6 °C

RELINQUISHED BY (CLIENT)

Mimi Tran
(Printed Name) (Signature)

Nautilus Environmental
(Company)

27/10/17 @ 1600h
(Date DD/MM/YY and Time)

RECEIVED BY (LABORATORY)

TP
(Printed Name) (Signature)

(Company)

Oct 27 18:20
(Date DD/MM/YY and Time)

Our liability is limited to the cost of the test requested. The test results only relate to the sample as received. No liability in whole or in part is assumed for the collection, handling, or transport of the sample, application or interpretation of the test data or results in part or in whole.

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Form 020; Version 1.2; Revised by CC 2016/10/06

APPENDIX D – Chain-of-Custody Forms

Nautilus Environmental

4340 Vandever Ave.
San Diego, CA 92120
Phone 858.587.7333
Fax 858.587.3961

WO # 171051
171052

Chain of Custody

Date________ Page__ of __

Sample Collection By:

Report to:

Company Minnow Environmental Inc.
Address 101-1025 Hillside Ave
City/State/Zip Victoria, BC, V8T 2A2
Contact Lisa Bowron
Phone 250-595-1627 x21
Email lbowron@minnow.ca

Invoice To:

Company Minto Explorations Ltd.
Address Suite 2100-510 West Georgia Street
City/State/Zip Vancouver, BC, V6B 0M3
Contact Cindy Keehn
Phone 604-684-8894
Email ckeehn@capstonemining.com

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	10 day Chironomus dilutus	14 day Hyalella azteca									Receipt Temperature (°C)
1	LMC-5	20-Sep-17		Sediment	500ml (clean) glass jar	1		X	X									11.0
2	LMC-4	20-Sep-17				1		X	X									
3	LMC-3	21-Sep-17				1		X	X									
4	LMC-2	21-Sep-17				1		X	X									
5	LMC-1	21-Sep-17				1		X	X									
6	LWC-5	24-Sep-17				1		X	X									
7	LWC-4	24-Sep-17				1		X	X									
8	LWC-3	24-Sep-17				1		X	X									
9	LWC-2	24-Sep-17				1		X	X									
10	LWC-1	24-Sep-17				1		X	X									

PROJECT INFORMATION

Client:	**Minnow Environmental Inc**
PO No.:	
Shipped Via:	

SAMPLE RECEIPT

Total No. of Containers	10
Received Good Condition?	*
Matches Test Schedule?	Y

SPECIAL INSTRUCTIONS/COMMENTS:

* sample LMC - jars 1 and 3 arrived broken, contents were intact and been transfered to new ~~contr~~ jars. NY

RELINQUISHED BY (CLIENT)

(Signature) Lisa Bowron (Time) 7:30am
(Printed Name) Lisa Bowron (Date) 27-Sep-17
(Company) Minnow Environmental

RELINQUISHED BY (COURIER)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (~~COURIER~~) Laboratory NY

(Signature) NY (Time) 10:30.
(Printed Name) Nau Yamamoto (Date) Sept 28/17
(Company) Nautilus

RECEIVED BY (~~LABORATORY~~)

(Signature) (Time)
(Printed Name) (Date)
(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

END OF REPORT

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 27-SEP-17
Report Date: 17-NOV-17 16:15 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1998303

Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT
C of C Numbers:	1 of 2, 2 of 2
Legal Site Desc:	

Can Dang
Senior Account Manager

Grouping	Analyte	L1998303-1	L1998303-2	L1998303-3	L1998303-4	L1998303-5
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	21-SEP-17	21-SEP-17	22-SEP-17	22-SEP-17	22-SEP-17
	Sampled Time					
	Client ID	LMC-5	LMC-4	LBC-5	LBC-4	LBC-3
TISSUE						
Physical Tests	% Moisture (%)	76.1	75.5	56.1	74.4	65.5
Metals	Aluminum (Al)-Total (mg/kg wwt)	415	695	1730	664	1010
	Antimony (Sb)-Total (mg/kg wwt)	0.0214	0.0229	0.0379	0.0351	0.0351
	Arsenic (As)-Total (mg/kg wwt)	0.567	0.608	2.99	1.42	1.35
	Barium (Ba)-Total (mg/kg wwt)	33.2	39.5	31.7	18.2	33.0
	Beryllium (Be)-Total (mg/kg wwt)	0.0183	0.0275	0.0953	0.0399	0.0439
	Bismuth (Bi)-Total (mg/kg wwt)	0.0049	0.0073	0.0838	0.0381	0.0581
	Boron (B)-Total (mg/kg wwt)	1.09	1.48	0.79	0.36	0.49
	Cadmium (Cd)-Total (mg/kg wwt)	0.0715	0.0744	0.287	0.213	0.254
	Calcium (Ca)-Total (mg/kg wwt)	657	666	1650	728	1160
	Cesium (Cs)-Total (mg/kg wwt)	0.0384	0.0655	0.301	0.171	0.166
	Chromium (Cr)-Total (mg/kg wwt)	2.07	2.70	4.53	3.81	2.58
	Cobalt (Co)-Total (mg/kg wwt)	0.490	0.693	1.69	0.733	0.870
	Copper (Cu)-Total (mg/kg wwt)	7.50	7.86	6.90	5.90	6.71
	Iron (Fe)-Total (mg/kg wwt)	929	1290	3370	1530	1780
	Lead (Pb)-Total (mg/kg wwt)	0.263	0.362	1.30	0.726	0.822
	Lithium (Li)-Total (mg/kg wwt)	0.38	0.68	1.93	0.65	1.01
	Magnesium (Mg)-Total (mg/kg wwt)	435	571	1490	546	751
	Manganese (Mn)-Total (mg/kg wwt)	180	169	176	87.5	219
	Mercury (Hg)-Total (mg/kg wwt)	0.0083	0.0058	0.0106	0.0094	0.0103
	Molybdenum (Mo)-Total (mg/kg wwt)	0.204	0.173	0.199	0.141	0.264
	Nickel (Ni)-Total (mg/kg wwt)	1.66	2.50	4.05	1.99	2.27
	Phosphorus (P)-Total (mg/kg wwt)	1700	1490	948	1270	1500
	Potassium (K)-Total (mg/kg wwt)	2400	2690	988	1240	1480
	Rubidium (Rb)-Total (mg/kg wwt)	0.819	0.917	2.02	1.34	1.23
	Selenium (Se)-Total (mg/kg wwt)	0.450	0.450	0.207	0.194	0.497
	Sodium (Na)-Total (mg/kg wwt)	587	602	344	501	444
	Strontium (Sr)-Total (mg/kg wwt)	7.36	6.93	15.1	7.59	10.2
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	0.0050	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00398	0.00580	0.0150	0.00861	0.00944
	Tin (Sn)-Total (mg/kg wwt)	0.041	0.036	0.068	0.097	0.052
	Uranium (U)-Total (mg/kg wwt)	0.0995	0.137	0.285	0.250	0.480
	Vanadium (V)-Total (mg/kg wwt)	2.26	3.21	7.02	4.17	5.06
	Zinc (Zn)-Total (mg/kg wwt)	35.2	31.4	22.5	22.0	26.0
	Zirconium (Zr)-Total (mg/kg wwt)	0.773	0.715	1.51	0.936	0.922

	Sample ID	L1998303-6	L1998303-7	L1998303-8	L1998303-9	L1998303-10
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	22-SEP-17	22-SEP-17	23-SEP-17	23-SEP-17	23-SEP-17
	Sampled Time					
	Client ID	LBC-2	LBC-1	LWC-5	LWC-4	LWC-3
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	61.1	93.1	64.6	65.5	71.2
Metals	Aluminum (Al)-Total (mg/kg wwt)	836	189	655	326	852
	Antimony (Sb)-Total (mg/kg wwt)	0.0456	0.0115	0.0224	0.0171	0.0181
	Arsenic (As)-Total (mg/kg wwt)	1.37	0.525	0.483	0.369	0.464
	Barium (Ba)-Total (mg/kg wwt)	19.6	6.90	14.7	12.1	18.1
	Beryllium (Be)-Total (mg/kg wwt)	0.0494	0.0111	0.0526	0.0269	0.0657
	Bismuth (Bi)-Total (mg/kg wwt)	0.0529	0.0145	0.0062	0.0031	0.0057
	Boron (B)-Total (mg/kg wwt)	0.42	<0.20	0.43	0.31	0.38
	Cadmium (Cd)-Total (mg/kg wwt)	0.195	0.142	0.111	0.295	0.166
	Calcium (Ca)-Total (mg/kg wwt)	851	292	802	615	813
	Cesium (Cs)-Total (mg/kg wwt)	0.206	0.0555	0.0899	0.0465	0.0862
	Chromium (Cr)-Total (mg/kg wwt)	2.64	0.948	4.92	2.17	5.94
	Cobalt (Co)-Total (mg/kg wwt)	0.897	0.246	0.802	0.608	1.30
	Copper (Cu)-Total (mg/kg wwt)	6.81	2.11	5.87	6.92	6.58
	Iron (Fe)-Total (mg/kg wwt)	1910	355	1700	685	1990
	Lead (Pb)-Total (mg/kg wwt)	0.833	0.189	0.412	0.186	0.420
	Lithium (Li)-Total (mg/kg wwt)	1.00	0.16	0.63	0.25	0.67
	Magnesium (Mg)-Total (mg/kg wwt)	832	176	608	521	1040
	Manganese (Mn)-Total (mg/kg wwt)	114	34.2	68.2	77.1	110
	Mercury (Hg)-Total (mg/kg wwt)	0.0107	0.0040	0.0150	0.0131	<0.010
	Molybdenum (Mo)-Total (mg/kg wwt)	0.223	0.0505	0.178	0.233	0.218
	Nickel (Ni)-Total (mg/kg wwt)	2.12	0.757	3.00	1.76	5.73
	Phosphorus (P)-Total (mg/kg wwt)	1830	454	1690	2600	1280
	Potassium (K)-Total (mg/kg wwt)	1640	440	1400	2160	982
	Rubidium (Rb)-Total (mg/kg wwt)	1.78	0.661	1.32	1.77	1.38
	Selenium (Se)-Total (mg/kg wwt)	0.234	0.086	0.384	0.686	0.315
	Sodium (Na)-Total (mg/kg wwt)	570	188	575	874	495
	Strontium (Sr)-Total (mg/kg wwt)	7.84	3.41	7.43	5.83	8.83
	Tellurium (Te)-Total (mg/kg wwt)	0.0042	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00915	0.00311	0.00643	0.00440	0.00615
	Tin (Sn)-Total (mg/kg wwt)	0.069	0.056	0.099	0.082	0.080
	Uranium (U)-Total (mg/kg wwt)	0.148	0.0624	0.190	0.0814	0.225
	Vanadium (V)-Total (mg/kg wwt)	4.63	0.858	4.51	1.60	4.38
	Zinc (Zn)-Total (mg/kg wwt)	24.3	7.80	35.6	39.3	22.6
	Zirconium (Zr)-Total (mg/kg wwt)	1.05	0.262	0.980	0.539	1.50

	Sample ID	L1998303-11	L1998303-12	L1998303-13	L1998303-14	L1998303-15
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	24-SEP-17	24-SEP-17	23-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time					
	Client ID	LWC-2	LWC-1	LWC-3X	LMC-3	LMC-2
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	71.5	55.4	61.7	64.6	75.6
Metals	Aluminum (Al)-Total (mg/kg wwt)	582	1030	862	661	178
	Antimony (Sb)-Total (mg/kg wwt)	0.0175	0.0267	0.0190	0.0326	0.0168
	Arsenic (As)-Total (mg/kg wwt)	0.835	0.756	0.530	0.706	0.215
	Barium (Ba)-Total (mg/kg wwt)	26.3	25.6	24.3	34.5	27.1
	Beryllium (Be)-Total (mg/kg wwt)	0.0402	0.101	0.0810	0.0420	0.0086
	Bismuth (Bi)-Total (mg/kg wwt)	0.0051	0.0096	0.0072	0.0088	0.0024
	Boron (B)-Total (mg/kg wwt)	0.38	0.51	0.41	0.97	3.16
	Cadmium (Cd)-Total (mg/kg wwt)	0.0437	0.118	0.160	0.0938	0.124
	Calcium (Ca)-Total (mg/kg wwt)	409	1190	985	1130	566
	Cesium (Cs)-Total (mg/kg wwt)	0.0701	0.166	0.120	0.0669	0.0149
	Chromium (Cr)-Total (mg/kg wwt)	2.50	4.88	5.13	6.01	0.810
	Cobalt (Co)-Total (mg/kg wwt)	0.779	1.48	1.10	0.714	0.327
	Copper (Cu)-Total (mg/kg wwt)	5.82	5.83	5.78	9.33	7.04
	Iron (Fe)-Total (mg/kg wwt)	1120	2770	1990	1500	401
	Lead (Pb)-Total (mg/kg wwt)	0.290	0.794	0.509	0.527	0.264
	Lithium (Li)-Total (mg/kg wwt)	0.45	1.29	0.84	0.61	0.15
	Magnesium (Mg)-Total (mg/kg wwt)	599	1070	766	586	410
	Manganese (Mn)-Total (mg/kg wwt)	155	137	161	179	97.7
	Mercury (Hg)-Total (mg/kg wwt)	0.0051	0.0061	<0.014	0.0089	0.0031
	Molybdenum (Mo)-Total (mg/kg wwt)	0.285	0.333	0.269	0.330	0.332
	Nickel (Ni)-Total (mg/kg wwt)	2.86	4.82	3.62	2.83	1.24
	Phosphorus (P)-Total (mg/kg wwt)	1690	1790	1390	2060	1810
	Potassium (K)-Total (mg/kg wwt)	2670	1580	986	2140	3370
	Rubidium (Rb)-Total (mg/kg wwt)	0.889	1.74	1.61	1.22	0.815
	Selenium (Se)-Total (mg/kg wwt)	0.309	0.414	0.476	0.646	0.279
	Sodium (Na)-Total (mg/kg wwt)	516	582	382	742	539
	Strontium (Sr)-Total (mg/kg wwt)	4.65	12.5	9.82	13.1	6.45
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00463	0.00946	0.00712	0.00637	0.00161
	Tin (Sn)-Total (mg/kg wwt)	0.033	0.163	0.082	0.040	<0.020
	Uranium (U)-Total (mg/kg wwt)	0.134	0.440	0.502	0.143	0.113
	Vanadium (V)-Total (mg/kg wwt)	2.88	6.96	5.12	3.04	1.06
	Zinc (Zn)-Total (mg/kg wwt)	26.2	23.7	29.1	33.7	54.5
	Zirconium (Zr)-Total (mg/kg wwt)	0.722	1.57	1.25	0.975	0.071

	Sample ID	L1998303-16				
	Description	Tissue				
	Sampled Date	26-SEP-17				
	Sampled Time					
	Client ID	LMC-1				
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	70.3				
Metals	Aluminum (Al)-Total (mg/kg wwt)	785				
	Antimony (Sb)-Total (mg/kg wwt)	0.0273				
	Arsenic (As)-Total (mg/kg wwt)	0.731				
	Barium (Ba)-Total (mg/kg wwt)	49.1				
	Beryllium (Be)-Total (mg/kg wwt)	0.0302				
	Bismuth (Bi)-Total (mg/kg wwt)	0.0085				
	Boron (B)-Total (mg/kg wwt)	1.68				
	Cadmium (Cd)-Total (mg/kg wwt)	0.0866				
	Calcium (Ca)-Total (mg/kg wwt)	709				
	Cesium (Cs)-Total (mg/kg wwt)	0.0764				
	Chromium (Cr)-Total (mg/kg wwt)	2.91				
	Cobalt (Co)-Total (mg/kg wwt)	0.777				
	Copper (Cu)-Total (mg/kg wwt)	9.29				
	Iron (Fe)-Total (mg/kg wwt)	1870				
	Lead (Pb)-Total (mg/kg wwt)	0.446				
	Lithium (Li)-Total (mg/kg wwt)	0.72				
	Magnesium (Mg)-Total (mg/kg wwt)	624				
	Manganese (Mn)-Total (mg/kg wwt)	163				
	Mercury (Hg)-Total (mg/kg wwt)	0.0039				
	Molybdenum (Mo)-Total (mg/kg wwt)	0.255				
	Nickel (Ni)-Total (mg/kg wwt)	2.63				
	Phosphorus (P)-Total (mg/kg wwt)	1880				
	Potassium (K)-Total (mg/kg wwt)	2970				
	Rubidium (Rb)-Total (mg/kg wwt)	1.08				
	Selenium (Se)-Total (mg/kg wwt)	0.475				
	Sodium (Na)-Total (mg/kg wwt)	657				
	Strontium (Sr)-Total (mg/kg wwt)	7.21				
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040				
	Thallium (Tl)-Total (mg/kg wwt)	0.00697				
	Tin (Sn)-Total (mg/kg wwt)	0.033				
	Uranium (U)-Total (mg/kg wwt)	0.170				
	Vanadium (V)-Total (mg/kg wwt)	4.72				
	Zinc (Zn)-Total (mg/kg wwt)	36.8				
	Zirconium (Zr)-Total (mg/kg wwt)	0.920				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-WET-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (WET)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

MET-WET-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (WET)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on wet weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MOISTURE-BIOPSY-VA	Tissue	Moisture Content (low weight) in tissue	Puget Sound WQ Authority, Apr 1997

This analysis is carried out gravimetrically by drying the sample at <60 deg. C for a minimum of three days.

MOISTURE-MICR-VA	Tissue	Moisture in Tissue	Puget Sound WQ Authority, Apr 1997

This analysis is carried out gravimetrically by drying the sample at <60 deg. C.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 of 2	2 of 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS

Chain of Custody / Analyti
Canada Toll Free: 1 8
www.alsglobal.

L1998303-COFC

COC #

Page 1 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21 Fax: (250) 595-1625
Invoice To	Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Exploration Ltd
Contact:	Cindy Keehn
Address:	Suite 2100 - 510 West Georgia St., Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2180
Lab Work Order # (lab use only)	

Report Format / Distribution

☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information

Job #: Minnow Project~~[illegible]~~
PO / AFE:
LSD:
Quote #: Q51327

ALS Contact: Jerry Holzbecher
Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS		**See Complete Quote #Q51327									Number of Containers
	LMC-5	20-Sep-17		Tissue	X	X	X		X									1
	LMC-4	20-Sep-17			X	X	X		X									1
	LCC 5	22-Sep-17			X	X	X		X									1
	LBC-4	22-Sep-17			X	X	X		X									1
	LBC-3	22-Sep-17			X	X	X		X									1
	LBC-2	22-Sep-17			X	X	X		X									1
	LBC-1	22-Sep-17			X	X	X		X									1
	LWC-5	23-Sep-17			X	X	X		X									1
	LWC-4	23-Sep-17			X	X	X		X									1
	LWC-3	23-Sep-17			X	X	X		X									1
	LWC-2	24-Sep-17			X	X	X		X									1
	LWC-1	24-Sep-17			X	X	X		X									1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Benthic samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Sep-17			Sept 29/17	12:15	2 °C				

Sep 28/17 10:28 AM 3°C

GENF 20.00 Front

ALS Environmental

Chain of Custody / Analytica
Canada Toll Free: 1 80
www.alsglobal.c

L1998303-COFC

COC # ______

Page 2 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21 Fax: (250) 595-1625
Invoice To	Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Exploration Ltd
Contact:	Cindy Keehn
Address:	Suite 2100 - 510 West Georgia St., Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2180
Lab Work Order # (lab use only)	[redacted]

Report Format / Distribution

☑ Standard ☐ Other

☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca

Email 2: pstecko@minnow.ca

Email 3:

Client / Project Information

Job #: Minnow Project

PO / AFE:

LSD:

Quote #: Q51327

ALS Contact: Jerry ~~S[illegible]~~ Holzbecher

Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)

○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT

○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT

○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS		**See Complete Quote #Q51327								Number of Containers
[redacted]	LWC-3X	23-Sep-17		Tissue	X	X	X		X								1
[redacted]	LMC-3	26-Sep-17		|	X	X	X		X								1
[redacted]	LMC-2	26-Sep-17		|	X	X	X		X								1
[redacted]	LMC-1	26-Sep-17		|	X	X	X		X								1
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Benthic samples

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
	27-Sep-17			Sept 27/17	12:15	2 °C				

GENF 20.00 Front

LAURIE SEPT 28/17 10:25 A.M. 3°C.

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 27-SEP-17
Report Date: 17-NOV-17 16:40 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1998305

Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT
C of C Numbers:	1 of 2, 2 of 2
Legal Site Desc:	

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1998305-1	L1998305-2	L1998305-3	L1998305-4	L1998305-5
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	21-SEP-17	21-SEP-17	22-SEP-17	22-SEP-17	22-SEP-17
	Sampled Time					
	Client ID	LMC-4	LMC-5	LBC-5	LBC-4	LBC-3
TISSUE						
Physical Tests	% Moisture (%)	69.5	62.2	81.5	56.8	57.3
Metals	Aluminum (Al)-Total (mg/kg wwt)	1840	2830	2540	3950	4660
	Antimony (Sb)-Total (mg/kg wwt)	0.084	0.055	0.0364	0.0353	0.0409
	Arsenic (As)-Total (mg/kg wwt)	3.49	3.14	3.07	4.88	4.38
	Barium (Ba)-Total (mg/kg wwt)	290	177	43.2	68.7	84.2
	Beryllium (Be)-Total (mg/kg wwt)	0.095	0.110	0.115	0.179	0.183
	Bismuth (Bi)-Total (mg/kg wwt)	<0.040 DLA	0.034	0.116	0.538	0.134
	Boron (B)-Total (mg/kg wwt)	9.7	11.4	0.89	0.76	1.23
	Cadmium (Cd)-Total (mg/kg wwt)	0.210	0.130	0.0433	0.0617	0.0605
	Calcium (Ca)-Total (mg/kg wwt)	3400	5180	1530	2610	3330
	Cesium (Cs)-Total (mg/kg wwt)	0.166	0.236	0.595	0.777	0.751
	Chromium (Cr)-Total (mg/kg wwt)	5.71	7.16	5.76	9.14	11.9
	Cobalt (Co)-Total (mg/kg wwt)	7.97	5.46	1.82	3.37	3.53
	Copper (Cu)-Total (mg/kg wwt)	14.4	15.9	5.44	8.55	7.60
	Iron (Fe)-Total (mg/kg wwt)	4790	6500	4430	8050	8920
	Lead (Pb)-Total (mg/kg wwt)	1.23	1.85	1.80	3.06	2.85
	Lithium (Li)-Total (mg/kg wwt)	<2.0 DLA	2.5	1.94	3.57	3.49
	Magnesium (Mg)-Total (mg/kg wwt)	1430	1840	1310	2420	2640
	Manganese (Mn)-Total (mg/kg wwt)	5160	2610	196	214	237
	Mercury (Hg)-Total (mg/kg wwt)	0.0076	0.0107	0.0088	0.0089	0.0081
	Molybdenum (Mo)-Total (mg/kg wwt)	0.58	0.387	0.170	0.269	0.268
	Nickel (Ni)-Total (mg/kg wwt)	10.2	9.53	4.90	8.26	8.84
	Phosphorus (P)-Total (mg/kg wwt)	681	649	220	458	562
	Potassium (K)-Total (mg/kg wwt)	1190	1000	393	472	531
	Rubidium (Rb)-Total (mg/kg wwt)	2.43	3.19	2.99	4.14	4.23
	Selenium (Se)-Total (mg/kg wwt)	0.90	0.76	0.067	0.065	0.067
	Sodium (Na)-Total (mg/kg wwt)	<80 DLA	99	87.8	125	157
	Strontium (Sr)-Total (mg/kg wwt)	51.1	41.6	15.2	23.4	25.2
	Tellurium (Te)-Total (mg/kg wwt)	<0.080 DLA	<0.040 DLA	0.0090	0.0156	0.0107
	Thallium (Tl)-Total (mg/kg wwt)	0.0241	0.0268	0.0279	0.0384	0.0378
	Tin (Sn)-Total (mg/kg wwt)	<0.40 DLA	<0.20 DLA	0.083	0.115	0.125
	Uranium (U)-Total (mg/kg wwt)	0.194	0.208	0.272	0.456	0.451
	Vanadium (V)-Total (mg/kg wwt)	11.9	14.7	10.2	18.4	22.4
	Zinc (Zn)-Total (mg/kg wwt)	22.4	20.7	12.8	21.9	22.4
	Zirconium (Zr)-Total (mg/kg wwt)	1.31	1.71	1.97	2.81	2.96

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998305-6	L1998305-7	L1998305-8	L1998305-9	L1998305-10
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	23-SEP-17	23-SEP-17	23-SEP-17	23-SEP-17	24-SEP-17
	Sampled Time					
	Client ID	LWC-5	LWC-4	LWC-3	LWC-3X	LWC-2
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	59.3	45.1	59.7	72.4	52.0
Metals	Aluminum (Al)-Total (mg/kg wwt)	4450	6640	5350	3630	5160
	Antimony (Sb)-Total (mg/kg wwt)	0.0208	0.0154	0.0153	0.0147	0.0179
	Arsenic (As)-Total (mg/kg wwt)	2.00	2.15	1.85	1.27	2.21
	Barium (Ba)-Total (mg/kg wwt)	57.7	83.7	69.0	49.7	72.9
	Beryllium (Be)-Total (mg/kg wwt)	0.233	0.303	0.258	0.169	0.257
	Bismuth (Bi)-Total (mg/kg wwt)	0.0241	0.0414	0.0292	0.0208	0.0309
	Boron (B)-Total (mg/kg wwt)	1.18	1.36	1.18	1.11	1.25
	Cadmium (Cd)-Total (mg/kg wwt)	0.0630	0.0654	0.0547	0.0412	0.0531
	Calcium (Ca)-Total (mg/kg wwt)	2860	4000	3240	2250	3130
	Cesium (Cs)-Total (mg/kg wwt)	0.536	0.786	0.586	0.453	0.599
	Chromium (Cr)-Total (mg/kg wwt)	14.2	19.9	15.8	10.7	16.3
	Cobalt (Co)-Total (mg/kg wwt)	4.94	5.85	4.88	3.13	5.32
	Copper (Cu)-Total (mg/kg wwt)	6.48	8.31	6.89	5.03	7.28
	Iron (Fe)-Total (mg/kg wwt)	10000	11500	9550	6280	10900
	Lead (Pb)-Total (mg/kg wwt)	2.01	2.87	2.22	1.52	2.20
	Lithium (Li)-Total (mg/kg wwt)	3.62	5.54	4.44	2.97	4.24
	Magnesium (Mg)-Total (mg/kg wwt)	3160	4460	3560	2270	3870
	Manganese (Mn)-Total (mg/kg wwt)	281	300	262	222	290
	Mercury (Hg)-Total (mg/kg wwt)	0.0086	0.0094	0.0086	0.0063	0.0076
	Molybdenum (Mo)-Total (mg/kg wwt)	0.501	0.161	0.146	0.103	0.187
	Nickel (Ni)-Total (mg/kg wwt)	14.3	16.9	13.7	8.89	15.8
	Phosphorus (P)-Total (mg/kg wwt)	474	642	501	359	555
	Potassium (K)-Total (mg/kg wwt)	461	551	443	344	491
	Rubidium (Rb)-Total (mg/kg wwt)	4.38	6.25	4.90	3.50	4.88
	Selenium (Se)-Total (mg/kg wwt)	0.107	0.120	0.116	0.111	0.126
	Sodium (Na)-Total (mg/kg wwt)	176	185	162	108	167
	Strontium (Sr)-Total (mg/kg wwt)	25.4	36.2	29.9	21.1	27.8
	Tellurium (Te)-Total (mg/kg wwt)	0.0077	0.0076	0.0071	<0.0040	0.0080
	Thallium (Tl)-Total (mg/kg wwt)	0.0276	0.0408	0.0313	0.0238	0.0304
	Tin (Sn)-Total (mg/kg wwt)	0.138	0.168	0.128	0.101	0.147
	Uranium (U)-Total (mg/kg wwt)	0.455	0.473	0.416	0.266	0.394
	Vanadium (V)-Total (mg/kg wwt)	22.4	26.5	22.3	14.9	26.0
	Zinc (Zn)-Total (mg/kg wwt)	26.7	28.9	23.1	15.4	24.0
	Zirconium (Zr)-Total (mg/kg wwt)	4.41	5.32	4.62	3.18	4.59

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998305-11	L1998305-12	L1998305-13	L1998305-14	L1998305-15
	Description	Tissue	Tissue	Tissue	Tissue	Tissue
	Sampled Date	24-SEP-17	25-SEP-17	25-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time					
	Client ID	LWC-1	LBC-2	LBC-1	LMC-3	LMC-2
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	58.7	67.0	67.4	55.3	60.8
Metals	Aluminum (Al)-Total (mg/kg wwt)	6650	2440	4630	2890	6680
	Antimony (Sb)-Total (mg/kg wwt)	0.0175	0.0429	0.0481	<0.050 DLA	0.0280
	Arsenic (As)-Total (mg/kg wwt)	2.36	3.39	4.37	3.02	3.91
	Barium (Ba)-Total (mg/kg wwt)	88.8	70.0	76.9	245	144
	Beryllium (Be)-Total (mg/kg wwt)	0.330	0.123	0.179	0.123	0.226
	Bismuth (Bi)-Total (mg/kg wwt)	0.0402	0.108	0.189	<0.050 DLA	0.0611
	Boron (B)-Total (mg/kg wwt)	1.96	1.37	1.33	<5.0 DLA	2.56
	Cadmium (Cd)-Total (mg/kg wwt)	0.0773	0.0451	0.0621	0.203	0.103
	Calcium (Ca)-Total (mg/kg wwt)	3840	1800	2960	3400	4830
	Cesium (Cs)-Total (mg/kg wwt)	0.815	0.521	0.804	0.248	0.535
	Chromium (Cr)-Total (mg/kg wwt)	18.8	7.41	10.8	5.8	14.9
	Cobalt (Co)-Total (mg/kg wwt)	5.77	2.25	3.20	9.27	5.38
	Copper (Cu)-Total (mg/kg wwt)	9.00	5.21	7.54	17.1	20.4
	Iron (Fe)-Total (mg/kg wwt)	11400	7270	7820	7670	11900
	Lead (Pb)-Total (mg/kg wwt)	2.71	1.97	2.90	1.73	3.01
	Lithium (Li)-Total (mg/kg wwt)	5.66	2.05	3.41	2.6	5.51
	Magnesium (Mg)-Total (mg/kg wwt)	4310	1470	2480	1920	3220
	Manganese (Mn)-Total (mg/kg wwt)	387	205	247	5810	1220
	Mercury (Hg)-Total (mg/kg wwt)	0.0122	0.0060	0.0120	0.0079	0.0254
	Molybdenum (Mo)-Total (mg/kg wwt)	0.164	0.194	0.263	0.45	0.305
	Nickel (Ni)-Total (mg/kg wwt)	17.0	5.32	8.53	11.6	13.6
	Phosphorus (P)-Total (mg/kg wwt)	561	321	457	458	555
	Potassium (K)-Total (mg/kg wwt)	557	366	512	590	828
	Rubidium (Rb)-Total (mg/kg wwt)	6.39	2.60	4.32	3.37	6.32
	Selenium (Se)-Total (mg/kg wwt)	0.151	0.067	0.065	<0.50 DLA	0.498
	Sodium (Na)-Total (mg/kg wwt)	169	124	153	<100 DLA	108
	Strontium (Sr)-Total (mg/kg wwt)	37.6	15.4	25.8	50.7	47.4
	Tellurium (Te)-Total (mg/kg wwt)	0.0078	0.0085	0.0145	<0.10 DLA	0.0120
	Thallium (Tl)-Total (mg/kg wwt)	0.0422	0.0267	0.0390	0.031	0.0562
	Tin (Sn)-Total (mg/kg wwt)	0.160	0.103	0.127	<0.50 DLA	0.161
	Uranium (U)-Total (mg/kg wwt)	0.431	0.578	0.471	0.244	0.371
	Vanadium (V)-Total (mg/kg wwt)	25.6	19.5	18.8	15.3	24.3
	Zinc (Zn)-Total (mg/kg wwt)	27.8	14.3	21.4	26.0	29.4
	Zirconium (Zr)-Total (mg/kg wwt)	5.36	2.29	2.99	1.3	4.85

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1998305-16				
	Description	Tissue				
	Sampled Date	26-SEP-17				
	Sampled Time					
	Client ID	LMC-1				
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	67.0				
Metals	Aluminum (Al)-Total (mg/kg wwt)	3990				
	Antimony (Sb)-Total (mg/kg wwt)	0.0277				
	Arsenic (As)-Total (mg/kg wwt)	2.66				
	Barium (Ba)-Total (mg/kg wwt)	116				
	Beryllium (Be)-Total (mg/kg wwt)	0.141				
	Bismuth (Bi)-Total (mg/kg wwt)	0.0339				
	Boron (B)-Total (mg/kg wwt)	3.29				
	Cadmium (Cd)-Total (mg/kg wwt)	0.0915				
	Calcium (Ca)-Total (mg/kg wwt)	4020				
	Cesium (Cs)-Total (mg/kg wwt)	0.338				
	Chromium (Cr)-Total (mg/kg wwt)	8.95				
	Cobalt (Co)-Total (mg/kg wwt)	3.83				
	Copper (Cu)-Total (mg/kg wwt)	15.3				
	Iron (Fe)-Total (mg/kg wwt)	7320				
	Lead (Pb)-Total (mg/kg wwt)	1.81				
	Lithium (Li)-Total (mg/kg wwt)	3.21				
	Magnesium (Mg)-Total (mg/kg wwt)	2010				
	Manganese (Mn)-Total (mg/kg wwt)	1130				
	Mercury (Hg)-Total (mg/kg wwt)	0.0082				
	Molybdenum (Mo)-Total (mg/kg wwt)	0.247				
	Nickel (Ni)-Total (mg/kg wwt)	9.01				
	Phosphorus (P)-Total (mg/kg wwt)	441				
	Potassium (K)-Total (mg/kg wwt)	667				
	Rubidium (Rb)-Total (mg/kg wwt)	3.94				
	Selenium (Se)-Total (mg/kg wwt)	0.494				
	Sodium (Na)-Total (mg/kg wwt)	89.6				
	Strontium (Sr)-Total (mg/kg wwt)	37.1				
	Tellurium (Te)-Total (mg/kg wwt)	0.0099				
	Thallium (Tl)-Total (mg/kg wwt)	0.0329				
	Tin (Sn)-Total (mg/kg wwt)	0.118				
	Uranium (U)-Total (mg/kg wwt)	0.283				
	Vanadium (V)-Total (mg/kg wwt)	15.4				
	Zinc (Zn)-Total (mg/kg wwt)	19.6				
	Zirconium (Zr)-Total (mg/kg wwt)	3.14				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-WET-CVAFS-N-VA	Tissue	Mercury in Tissue by CVAFS (WET)	EPA 200.3, EPA 245.7

This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

HG-WET-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (WET)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

MET-WET-CCMS-N-VA	Tissue	Metals in Tissue by CRC ICPMS (WET)	EPA 200.3/6020A

This method is conducted following British Columbia Lab Manual method "Metals in Animal Tissue and Vegetation (Biota) - Prescriptive". Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with addition of hydrogen peroxide. Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MET-WET-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (WET)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on wet weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

MOISTURE-MICR-VA	Tissue	Moisture in Tissue	Puget Sound WQ Authority, Apr 1997

This analysis is carried out gravimetrically by drying the sample at <60 deg. C.

MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	Puget Sound WQ Authority, Apr 1997

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 of 2 2 of 2

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytic
Canada Toll Free: 1 8
www.alsglobal.

L1998305-COFC

COC #

Page 1 of 2

Report To		**Report Format / Distribution**	
Company:	Minnow Environmental Inc.	☑ Standard ☐ Other	
Contact:	Lisa Bowron	☑ PDF ☑ Excel ☐ Digital ☐ Fax	
Address:	101 - 1025 Hillside Ave. Victoria, BC	Email 1:	lbowron@minnow.ca
		Email 2:	pstecko@minnow.ca
Phone:	(250)595-1627 x21 Fax: (250) 595-1625	Email 3:	
Invoice To	Same as Report ? ☐ Yes ☑ No	**Client / Project Information**	
Hardcopy of Invoice with Report?	☑ Yes ☐ No	Job #:	Minnow Project
Company:	Minto Explorations Ltd	PO / AFE:	
Contact:	Cindy Keehn	LSD:	
Address:	Suite 2100 - 510 West Georgia St., Vancouver, BC		
Phone:	604-684-8894 Fax: 604-688-2180	Quote #:	Q51327
Lab Work Order # (lab use only)	[redacted]	ALS Contact:	Jerry ~~Salam Worku~~ Holzbecher
		Sampler:	Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS			**See Complete Quote #Q51327							Number of Containers
[redacted]	LMC-4	21-Sep-17		Tissue	X	x	x			x							1
[redacted]	LMC-5	21-Sep-17			x	x	x			x							1
[redacted]	LBC-5	22-Sept-17			x	x	x			x							1
[redacted]	LBC-4	22-Sept-17			x	x	x			x							1
[redacted]	LBC-3	22-Sep-17			x	x	x			x							1
[redacted]	LWC-5	23-Sep-17			x	x	x			x							1
[redacted]	LWC-4	23-Sep-17			x	x	x			x							1
[redacted]	LWC-3	23-Sep-17			x	x	x			x							1
[redacted]	LWC-3x	23-Sep-17			x	x	x			x							1
[redacted]	LWC-2	24-Sep-17			x	x	x			x							1
[redacted]	LWC-1	24-Sep-17			x	x	x			x							1
[redacted]	LBC-2	25-Sep-17			x	x	x			x							1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Periphyton samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Lisa Bowron	27-Sep-17		D	Sept 27/17	12:15.	1 °C				

Laurie Sept 28/17. 10:25 A.M 3°C.

GENF 20.00 Front

ALS Environmental

Chain of Custody / Analytica
Canada Toll Free: 1 80
www.alsglobal.c

L1998305-COFC

COC # ______

Page 2 of 2

Report To
Company: Minnow Environmental Inc.
Contact: Lisa Bowron
Address: 101 - 1025 Hillside Ave.
Victoria, BC
Phone: (250)595-1627 x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report? ☑ Yes ☐ No
Company: Minto Explorations Ltd
Contact: Cindy Keehn
Address: Suite 2100 - 510 West Georgia St., Vancouver, BC
Phone: 604-684-8894 Fax: 604-688-2180

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information
Job #: Minnow Project
PO / AFE:
LSD:

Quote #: Q51327

Service Requested (Rush for routine analysis subject to availability)
● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Lab Work Order # (lab use only) [redacted]

ALS Contact: Jerry ~~Selam Worku~~ Holzbecher
Sampler: Lisa Bowron

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS			**See Complete Quote #Q51327							Number of Containers
[redacted]	LBC-1	25-Sep-17		Tissue	X	X	X			X							1
[redacted]	LMC-3	26-Sep-17		|	X	X	X			X							1
[redacted]	~~[illegible]~~ LMC-2	26-Sep-17		|	X	X	X			X							1
[redacted]	LMC-1	26-Sep-17		|	X	X	X			X							1
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	
[redacted]																	

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Periphyton samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 27-Sep-17 ~~17-Sep-14~~	Time (hh-mm) ~~12:20~~	Received by:	Date: Sept 27/17	Time: 12:15.	Temperature: / °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

Carrie Sept 28/17 10:25 AM 2°C

GENF 20.00 Front

APPENDIX D

PERIPHYTON COMMUNITY DATA

Tables

Laboratory Reports

APPENDIX D

PERIPHYTON COMMUNITY DATA

Tables

Table D.1: Density (cells/cm^2) of Periphyton Community Sampled at Lower Wolverine Creek and Lower Minto Creek, Minto Mine WUL, 2017

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposed)				
		LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Sample Date											
Group	Genera and species										
Cyanophyte	Phormidium autumnale Agardh	1,507	-	-	345	-	345	2,756	144	-	574
	Heteroleibeinia profunda Komarek	-	-	-	-	-	20,844	4,479	6,460	38,760	42,205
	Homoeothrix varians Komarek & Kalina	-	-	-	-	-	15,159	-	5,168	42,205	8,900
	Pseudoanabaena sp.	-	-	-	-	3,445	-	-	-	-	-
	Chamaesiphon incrustans Smith	-	-	-	-	-	4,479	1,723	1,436	57,709	24,691
Chlorophyte	Closteriopsis sp.	-	-	431	-	-	-	-	-	-	-
	Stigeoclonium sp.	-	-	3,445	-	-	-	-	-	-	-
	Ulothrix zonata Kutzing	-	2,584	-	-	2,153	-	-	-	-	-
Diatoms	Cymbella lapponica	-	-	-	689	-	-	-	-	-	-
	Achnanthes minutissima Kutzing	2,584	1,507	6,460	3,962	8,398	6,718	20,844	17,227	2,297	20,385
	Eucocconeis sp.	-	-	-	-	215	-	-	-	-	-
	Diatoma mesodon Grun.	215	646	646	-	-	-	-	-	-	-
	Encyonema silesiacum (Bleisch) D.G. Mann	215	1,938	1,938	1,206	1,723	1,895	2,756	1,148	-	-
	Navicula radiosa Kutzing	-	-	-	-	-	-	172	-	-	287
	Cocconies disculus Schum.	431	646	-	-	431	172	-	-	1,723	-
	Anomoenies vitrea Ross	1,077	1,077	646	345	-	1,895	1,034	1,148	287	-
	Navicula exigua (Greg.) Muller	-	-	-	-	646	1,206	3,101	1,436	1,723	-
	Fragilaria capucina Grunow	9,475	14,858	17,011	12,920	11,843	3,962	4,307	5,312	1,723	287
	Diatoma vulgare Bory	24,978	26,270	24,548	22,739	29,716	-	-	-	-	-
	Gomphonema minutum	2,369	215	215	345	215	172	2,239	144	1,148	7,465
	Navicula pupula Kutzing	-	-	-	-	-	-	-	861	-	-
	Meridion circulare Agardh	646	861	431	689	-	-	-	574	-	-
	Cymbella minuta Kutzing	-	-	-	-	-	345	1,034	861	6,891	-
	Synedra ulna (Nitzsch) Ehrenberg	-	431	-	-	-	-	-	-	-	287
	Cymbella prostrata (Berkeley) Cleve	-	-	-	172	-	-	-	-	-	-
	Frustulia rhomboides (Ehrenberg) de Toni	-	215	-	-	-	-	-	-	-	-
	Nitzschia filiformis (W. Smith) Hustedt	-	431	-	172	1,077	-	2,584	861	-	574
	Didymosphenia geminata Schmidt	-	-	215	-	-	-	-	-	-	287
	Nitzschia palea (Kutzing) W. Smith	646	1,292	431	-	1,292	1,206	3,618	2,010	1,148	287
	Hannaea arcus Patrick	-	-	-	345	-	-	-	-	-	-
Red Algae	Audouinella / Chantransia stage. Red alga	-	-	-	-	-	12,575	14,643	7,178	-	2,871

Table D.2: **Biomass (µg/cm^2) of Periphyton Community Sampled at Lower Wolverine Creek and Lower Minto Creek, Minto Mine WUL, 2017**

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposed)				
		LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Sample Date											
Group	Genera and species										
Cyanophyte	Phormidium autumnale Agardh	6.0	-	-	1.3	-	0.92	7.5	0.43	-	1.4
	Heteroleibeinia profunda Komarek	-	-	-	-	-	2.6	0.48	0.69	3.5	5.2
	Homoeothrix varians Komarek & Kalina	-	-	-	-	-	6.9	-	2.4	20	4.3
	Pseudoanabaena sp.	-	-	-	-	0.025	-	-	-	-	-
	Chamaesiphon incrustans Smith	-	-	-	-	-	0.12	0.048	0.040	2.2	0.75
Chlorophyte	Closteriopsis sp.	-	-	4.2	-	-	-	-	-	-	-
	Stigeoclonium sp.	-	-	3.8	-	-	-	-	-	-	-
	Ulothrix zonata Kutzing	-	32	-	-	27	-	-	-	-	-
Diatoms	Cymbella lapponica	-	-	-	1.7	-	-	-	-	-	-
	Achnanthes minutissima Kutzing	0.19	0.12	0.51	0.32	0.67	0.53	1.7	1.3	0.18	1.6
	Eucocconeis sp.	-	-	-	-	0.99	-	-	-	-	-
	Diatoma mesodon Grun.	0.90	2.7	2.7	-	-	-	-	-	-	-
	Encyonema silesiacum (Bleisch) D.G. Mann	0.25	2.3	2.3	1.4	2.0	2.2	3.5	1.4	-	-
	Navicula radiosa Kutzing	-	-	-	-	-	-	0.32	-	-	0.49
	Cocconies disculus Schum.	0.69	0.99	-	-	0.69	0.27	-	-	2.7	-
	Anomoenies vitrea Ross	0.37	0.37	0.21	0.11	-	0.63	0.33	0.38	0.097	-
	Navicula exigua (Greg.) Muller	-	-	-	-	0.31	0.53	2.9	0.84	0.97	-
	Fragilaria capucina Grunow	12	20	22	7.6	16	5.1	5.5	6.6	2.1	0.33
	Diatoma vulgare Bory	5.9	6.2	5.9	5.6	7.0	-	-	-	-	-
	Gomphonema minutum	1.1	0.097	0.094	0.15	0.094	0.078	0.55	0.070	0.52	3.4
	Navicula pupula Kutzing	-	-	-	-	-	-	-	1.2	-	-
	Meridion circulare Agardh	0.69	0.90	0.46	0.74	-	-	-	0.93	-	-
	Cymbella minuta Kutzing	-	-	-	-	-	0.13	0.37	0.32	2.1	-
	Synedra ulna (Nitzsch) Ehrenberg	-	1.9	-	-	-	-	-	-	-	0.70
	Cymbella prostrata (Berkeley) Cleve	-	-	-	2.9	-	-	-	-	-	-
	Frustulia rhomboides (Ehrenberg) de Toni	-	1.0	-	-	-	-	-	-	-	-
	Nitzschia filiformis (W. Smith) Hustedt	-	0.052	-	0.01	0.076	-	0.25	0.081	-	0.069
	Didymosphenia geminata Schmidt	-	-	8.6	-	-	-	-	-	-	11
	Nitzschia palea (Kutzing) W. Smith	1.6	3.4	1.1	-	3.1	2.0	5.7	2.8	2.1	0.52
	Hannaea arcus Patrick	-	-	-	0.21	-	-	-	-	-	-
Red Algae	Audouinella / Chantransia stage. Red alga	-	-	-	-	-	8.8	11	4.8	-	2.1

Table D.3: **Summary Statistics for Periphyton Density (cells/cm^2) Collected at Lower Wolverine Creek and Lower Minto Creek Stations, Minto Mine WUL, 2017**

Sample Location		**Lower Wolverine Creek (Reference)**					**Lower Minto Creek (Exposed)**				
		Mean	Median	Minimum	Maximum	Standard Deviation	Mean	Median	Minimum	Maximum	Standard Deviation
Group	**Genera and species**										
Cyanophyte	Phormidium autumnale Agardh	926	926	345	1,507	-	955	459	144	2,756	1,214
	Heteroleibeinia profunda Komarek	-	-	-	-	-	22,550	20,844	4,479	42,205	17,589
	Homoeothrix varians Komarek & Kalina	-	-	-	-	-	17,858	12,030	5,168	42,205	16,746
	Pseudoanabaena sp.	3,445	3,445	3,445	3,445	-	-	-	-	-	-
	Chamaesiphon incrustans Smith	-	-	-	-	-	18,007	4,479	1,436	57,709	24,206
Chlorophyte	Closteriopsis sp.	431	431	431	431	-	-	-	-	-	-
	Stigeoclonium sp.	3,445	3,445	3,445	3,445	-	-	-	-	-	-
	Ulothrix zonata Kutzing	2,369	2,369	2,153	2,584	-	-	-	-	-	-
Diatoms	Cymbella lapponica	689	689	689	689	-	-	-	-	-	-
	Achnanthes minutissima Kutzing	4,582	3,962	1,507	8,398	2,825	13,494	17,227	2,297	20,844	8,466
	Eucocconeis sp.	215	215	215	215	-	-	-	-	-	-
	Diatoma mesodon Grun.	502	646	215	646	249	-	-	-	-	-
	Encyonema silesiacum (Bleisch) D.G. Mann	1,404	1,723	215	1,938	729	1,933	1,895	1,148	2,756	805
	Navicula radiosa Kutzing	-	-	-	-	-	230	230	172	287	-
	Cocconies disculus Schum.	502	431	431	646	124	947	947	172	1,723	-
	Anomoenies vitrea Ross	786	861	345	1,077	358	1,091	1,091	287	1,895	658
	Navicula exigua (Greg.) Muller	646	646	646	646	-	1,866	1,579	1,206	3,101	850
	Fragilaria capucina Grunow	13,221	12,920	9,475	17,011	2,875	3,118	3,962	287	5,312	2,055
	Diatoma vulgare Bory	25,650	24,978	22,739	29,716	2,601	-	-	-	-	-
	Gomphonema minutum	672	215	215	2,369	950	2,234	1,148	144	7,465	3,048
	Navicula pupula Kutzing	-	-	-	-	-	861	861	861	861	-
	Meridion circulare Agardh	657	668	431	861	177	574	574	574	574	-
	Cymbella minuta Kutzing	-	-	-	-	-	2,283	947	345	6,891	3,086
	Synedra ulna (Nitzsch) Ehrenberg	431	431	431	431	-	287	287	287	287	-
	Cymbella prostrata (Berkeley) Cleve	172	172	172	172	-	-	-	-	-	-
	Frustulia rhomboides (Ehrenberg) de Toni	215	215	215	215	-	-	-	-	-	-
	Nitzschia filiformis (W. Smith) Hustedt	560	431	172	1,077	466	1,340	861	574	2,584	1,087
	Didymosphenia geminata Schmidt	215	215	215	215	-	287	287	287	287	-
	Nitzschia palea (Kutzing) W. Smith	915	969	431	1,292	444	1,654	1,206	287	3,618	1,256
	Hannaea arcus Patrick	345	345	345	345	-	-	-	-	-	-
Red Algae	Audouinella / Chantransia stage. Red alga	-	-	-	-	-	9,317	9,877	2,871	14,643	5,326

Table D.4: Summary Statistics for Periphyton Biomass ($\mu g/cm^2$) Collected at Lower Wolverine Creek and Lower Minto Creek Stations, Minto Mine WUL, 2017

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposed)				
		Mean	Median	Minimum	Maximum	Standard Deviation	Mean	Median	Minimum	Maximum	Standard Deviation
Group	**Genera and species**										
Cyanophyte	Phormidium autumnale Agardh	3.6	3.6	1.3	6.0	-	2.6	1.2	0.43	7.5	3.3
	Heteroleibeinia profunda Komarek	-	-	-	-	-	2.5	2.6	0.48	5.2	2.0
	Homoeothrix varians Komarek & Kalina	-	-	-	-	-	8.5	5.6	2.4	20	8.1
	Pseudoanabaena sp.	0.025	0.025	0.025	0.025	-	-	-	-	-	-
	Chamaesiphon incrustans Smith	-	-	-	-	-	0.64	0.12	0.040	2.2	0.94
Chlorophyte	Closteriopsis sp.	4.2	4.2	4.2	4.2	-	-	-	-	-	-
	Stigeoclonium sp.	3.8	3.8	3.8	3.8	-	-	-	-	-	-
	Ulothrix zonata Kutzing	30	30	27	32	-	-	-	-	-	-
Diatoms	Cymbella lapponica	1.7	1.7	1.7	1.7	-	-	-	-	-	-
	Achnanthes minutissima Kutzing	0.36	0.32	0.12	0.67	0.23	1.1	1.3	0.18	1.7	0.67
	Eucocconeis sp.	0.99	0.99	0.99	0.99	-	-	-	-	-	-
	Diatoma mesodon Grun.	2.1	2.7	0.90	2.7	1.0	-	-	-	-	-
	Encyonema silesiacum (Bleisch) D.G. Mann	1.7	2.0	0.25	2.3	0.86	2.4	2.2	1.4	3.5	1.0
	Navicula radiosa Kutzing	-	-	-	-	-	0.40	0.40	0.32	0.49	-
	Cocconies disculus Schum.	0.79	0.69	0.69	0.99	0.18	1.5	1.5	0.27	2.7	-
	Anomoenies vitrea Ross	0.26	0.29	0.11	0.37	0.13	0.36	0.36	0.097	0.63	0.22
	Navicula exigua (Greg.) Muller	0.31	0.31	0.31	0.31	-	1.3	0.91	0.53	2.9	1.1
	Fragilaria capucina Grunow	15	16	7.6	22	5.7	3.9	5.1	0.33	6.6	2.6
	Diatoma vulgare Bory	6.1	5.9	5.6	7.0	0.55	-	-	-	-	-
	Gomphonema minutum	0.30	0.097	0.094	1.1	0.43	0.92	0.52	0.070	3.4	1.4
	Navicula pupula Kutzing	-	-	-	-	-	1.2	1.2	1.2	1.2	-
	Meridion circulare Agardh	0.70	0.72	0.46	0.90	0.18	0.93	0.93	0.93	0.93	-
	Cymbella minuta Kutzing	-	-	-	-	-	0.73	0.35	0.13	2.1	0.92
	Synedra ulna (Nitzsch) Ehrenberg	1.9	1.9	1.9	1.9	-	0.70	0.70	0.70	0.70	-
	Cymbella prostrata (Berkeley) Cleve	2.9	2.9	2.9	2.9	-	-	-	-	-	-
	Frustulia rhomboides (Ehrenberg) de Toni	1.0	1.0	1.0	1.0	-	-	-	-	-	-
	Nitzschia filiformis (W. Smith) Hustedt	0.047	0.052	0.012	0.076	0.032	0.13	0.081	0.069	0.25	0.10
	Didymosphenia geminata Schmidt	8.6	8.6	8.6	8.6	-	11	11	11	11	-
	Nitzschia palea (Kutzing) W. Smith	2.3	2.4	1.1	3.4	1.1	2.6	2.1	0.52	5.7	1.9
	Hannaea arcus Patrick	0.21	0.21	0.21	0.21	-	-	-	-	-	-
Red Algae	Audouinella / Chantransia stage. Red alga	-	-	-	-	-	6.8	6.8	2.1	11	4.1

Table D.5: Presence/Absence of Periphyton Taxa at Lower Wolverine Creek and Lower Minto Creek, Minto Mine WUL, 2017

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposed)				
		LWC-1	**LWC-2**	**LWC-3**	**LWC-4**	**LWC-5**	**LMC-1**	**LMC-2**	**LMC-3**	**LMC-4**	**LMC-5**
Group	**Genera and species**										
Cyanophyte	Phormidium autumnale Agardh	1	0	0	1	0	1	1	1	0	1
	Heteroleibeinia profunda Komarek	0	0	0	0	0	1	1	1	1	1
	Homoeothrix varians Komarek & Kalina	0	0	0	0	0	1	0	1	1	1
	Pseudoanabaena sp.	0	0	0	0	1	0	0	0	0	0
	Chamaesiphon incrustans Smith	0	0	0	0	0	1	1	1	1	1
Chlorophyte	Closteriopsis sp.	0	0	1	0	0	0	0	0	0	0
	Stigeoclonium sp.	0	0	1	0	0	0	0	0	0	0
	Ulothrix zonata Kutzing	0	1	0	0	1	0	0	0	0	0
Diatoms	Cymbella lapponica	0	0	0	1	0	0	0	0	0	0
	Achnanthes minutissima Kutzing	1	1	1	1	1	1	1	1	1	1
	Eucocconeis sp.	0	0	0	0	1	0	0	0	0	0
	Diatoma mesodon Grun.	1	1	1	0	0	0	0	0	0	0
	Encyonema silesiacum (Bleisch) D.G. Mann	1	1	1	1	1	1	1	1	0	0
	Navicula radiosa Kutzing	0	0	0	0	0	0	1	0	0	1
	Cocconies disculus Schum.	1	1	0	0	1	1	0	0	1	0
	Anomoenies vitrea Ross	1	1	1	1	0	1	1	1	1	0
	Navicula exigua (Greg.) Muller	0	0	0	0	1	1	1	1	1	0
	Fragilaria capucina Grunow	1	1	1	1	1	1	1	1	1	1
	Diatoma vulgare Bory	1	1	1	1	1	0	0	0	0	0
	Gomphonema minutum	1	1	1	1	1	1	1	1	1	1
	Navicula pupula Kutzing	0	0	0	0	0	0	0	1	0	0
	Meridion circulare Agardh	1	1	1	1	0	0	0	1	0	0
	Cymbella minuta Kutzing	0	0	0	0	0	1	1	1	1	0
	Synedra ulna (Nitzsch) Ehrenberg	0	1	0	0	0	0	0	0	0	1
	Cymbella prostrata (Berkeley) Cleve	0	0	0	1	0	0	0	0	0	0
	Frustulia rhomboides (Ehrenberg) de Toni	0	1	0	0	0	0	0	0	0	0
	Nitzschia filiformis (W. Smith) Hustedt	0	1	0	1	1	0	1	1	0	1
	Didymosphenia geminata Schmidt	0	0	1	0	0	0	0	0	0	1
	Nitzschia palea (Kutzing) W. Smith	1	1	1	0	1	1	1	1	1	1
	Hannaea arcus Patrick	0	0	0	1	0	0	0	0	0	0
Red Algae	Audouinella / Chantransia stage. Red alga	0	0	0	0	0	1	1	1	0	1
	Total	**11**	**14**	**12**	**12**	**12**	**14**	**14**	**16**	**11**	**13**

APPENDIX D

PERIPHYTON COMMUNITY DATA

Laboratory Reports

PERIPHYTON COMMUNITY ANALYSIS

PROVIDED BY:

PLANKTON R US INC.

(WINNIPEG, MB)

Epilithic algal density (cells/cm2) for **Minto WUL Monitoring 2017 - (Project 1739)**
(for Lisa Minnow Environmental Inc.)

R = QAQC recount

Project	Location	Date	Cyanobacteria	Chlorophyte	Diatom	Red Algae	Total
			cells/cm^2	cells/cm^2	cells/cm^2	cells/cm^2	cells/cm^2
1739	LMC - 1	26-Sep-17	40827	0	17571	12575	70973
1739	LMC - 2	26-Sep-17	8958	0	41688	14643	65289
1739	LMC - 3	26-Sep-17	13207	0	31582	7178	51967
1739	LMC - 4	21-Sep-17	138674	0	16939	0	155613
1739	LMC - 5	21-Sep-17	76371	0	29859	2871	109101
1739	LMC - 5R	21-Sep-17	79242	0	28424	4594	112260
1739	LWC - 1	24-Sep-17	1507	0	42636	0	44143
1739	LWC - 2	24-Sep-17	0	2584	50388	0	52972
1739	LWC - 3	23-Sep-17	0	3876	52541	0	56417
1739	LWC - 4	23-Sep-17	345	0	43583	0	43928
1739	LWC - 5	23-Sep-17	3445	2153	55556	0	61154

Epilithic algal biomass (µg/cm2) for **Minto WUL Monitoring 2017 - (Project 1739)**
(for Lisa Minnow Environmental Inc.)

R = QAQC recount

Project	Location	Date	Cyanobacteria	Chlorophyte	Diatom	Red Algae	Total
			µg/cm^2	µg/cm^2	µg/cm^2	µg/cm^2	µg/cm^2
1739	LMC - 1	26-Sep-17	10.46	0	11.43	8.85	30.74
1739	LMC - 2	26-Sep-17	8.01	0	21.01	11.29	40.30
1739	LMC - 3	26-Sep-17	3.54	0	15.84	4.81	24.19
1739	LMC - 4	21-Sep-17	26.15	0	10.78	0	36.93
1739	LMC - 5	21-Sep-17	11.65	0	18.60	2.12	32.37
1739	LMC - 5R	21-Sep-17	14.59	0	18.98	3.39	36.96
1739	LWC - 1	24-Sep-17	5.97	0	23.82	0	29.79
1739	LWC - 2	24-Sep-17	0	32.47	39.81	0	72.28
1739	LWC - 3	23-Sep-17	0	8.01	43.67	0	51.68
1739	LWC - 4	23-Sep-17	1.28	0	20.71	0	21.99
1739	LWC - 5	23-Sep-17	0.03	27.06	30.68	0	57.76

Epilithic algal species data **for Minto WUL Monitoring 2017 - (Project 1739)** (for Lisa Minnow Environmental Inc.)

**** 1st number in species code = group 1=cyanophyte 2=chlorophyte 5=diatoms 8= red algae**
**** total daily biomass is sum of all species on a date**

Project	Location	Date	Species Code	Speceis name	density cells/cm^2	biomass µg/cm^2	length µ	width µ	cell volume µ^3
1739	LMC - 1	26-Sep-17	1122	Phormidium autumnale Agardh	345	0.92	94.00	6.00	2657.80
1739	LMC - 1	26-Sep-17	1131	Heteroleibeinia profunda Komarek	20844	2.55	39.00	2.00	122.50
1739	LMC - 1	26-Sep-17	1223	Chamaesiphon incrustans Smith	4479	0.12	5.90	3.00	27.80
1739	LMC - 1	26-Sep-17	1239	Homoeothrix varians Komarek & Kalina	15159	6.87	60.00	3.10	452.90
1739	LMC - 1	26-Sep-17	5311	Cymbella minuta Kutzing	345	0.13	15.10	8.00	379.50
1739	LMC - 1	26-Sep-17	5702	Achnanthes minutissima Kutzing	6718	0.53	19.00	4.00	79.60
1739	LMC - 1	26-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1895	2.23	30.00	10.00	1178.10
1739	LMC - 1	26-Sep-17	5873	Gomphonema minutum	172	0.08	27.00	8.00	452.40
1739	LMC - 1	26-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	1206	1.96	62.00	10.00	1623.20
1739	LMC - 1	26-Sep-17	5875	Cocconies disculus Schum.	172	0.27	30.00	14.00	1539.40
1739	LMC - 1	26-Sep-17	5882	Anomoenies vitrea Ross	1895	0.63	35.00	6.00	329.90
1739	LMC - 1	26-Sep-17	5910	Navicula exigua (Greg.) Muller	1206	0.53	26.00	8.00	435.60
1739	LMC - 1	26-Sep-17	5916	Fragilaria capucina Grunow	3962	5.08	136.00	6.00	1281.80
1739	LMC - 1	26-Sep-17	8001	Audouinella / Chantransia stage. Red alga	12575	8.85	21.00	8.00	703.70
1739	LMC - 2	26-Sep-17	1122	Phormidium autumnale Agardh	2756	7.48	96.00	6.00	2714.30
1739	LMC - 2	26-Sep-17	1131	Heteroleibeinia profunda Komarek	4479	0.48	34.00	2.00	106.80
1739	LMC - 2	26-Sep-17	1223	Chamaesiphon incrustans Smith	1723	0.05	5.90	3.00	27.80
1739	LMC - 2	26-Sep-17	5311	Cymbella minuta Kutzing	1034	0.37	14.40	8.00	361.90
1739	LMC - 2	26-Sep-17	5702	Achnanthes minutissima Kutzing	20844	1.66	19.00	4.00	79.60
1739	LMC - 2	26-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	2756	3.46	32.00	10.00	1256.60
1739	LMC - 2	26-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	2584	0.25	41.00	3.00	96.60
1739	LMC - 2	26-Sep-17	5870	Navicula radiosa Kutzing	172	0.32	71.00	10.00	1858.80
1739	LMC - 2	26-Sep-17	5873	Gomphonema minutum	2239	0.55	26.00	6.00	245.00
1739	LMC - 2	26-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	3618	5.68	60.00	10.00	1570.80
1739	LMC - 2	26-Sep-17	5882	Anomoenies vitrea Ross	1034	0.33	34.00	6.00	320.40
1739	LMC - 2	26-Sep-17	5910	Navicula exigua (Greg.) Muller	3101	2.86	55.00	8.00	921.50
1739	LMC - 2	26-Sep-17	5916	Fragilaria capucina Grunow	4307	5.52	136.00	6.00	1281.80
1739	LMC - 2	26-Sep-17	8001	Audouinella / Chantransia stage. Red alga	14643	11.29	23.00	8.00	770.70
1739	LMC - 3	26-Sep-17	1122	Phormidium autumnale Agardh	144	0.43	106.00	6.00	2997.10
1739	LMC - 3	26-Sep-17	1131	Heteroleibeinia profunda Komarek	6460	0.69	34.00	2.00	106.80
1739	LMC - 3	26-Sep-17	1223	Chamaesiphon incrustans Smith	1436	0.04	5.90	3.00	27.80
1739	LMC - 3	26-Sep-17	1239	Homoeothrix varians Komarek & Kalina	5168	2.38	61.00	3.10	460.40
1739	LMC - 3	26-Sep-17	5311	Cymbella minuta Kutzing	861	0.32	14.90	8.00	374.50
1739	LMC - 3	26-Sep-17	5702	Achnanthes minutissima Kutzing	17227	1.32	18.30	4.00	76.70
1739	LMC - 3	26-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1148	1.40	31.00	10.00	1217.40
1739	LMC - 3	26-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	861	0.08	40.00	3.00	94.20
1739	LMC - 3	26-Sep-17	5873	Gomphonema minutum	144	0.07	29.00	8.00	485.90
1739	LMC - 3	26-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	2010	2.79	53.00	10.00	1387.50
1739	LMC - 3	26-Sep-17	5882	Anomoenies vitrea Ross	1148	0.38	35.00	6.00	329.90
1739	LMC - 3	26-Sep-17	5887	Navicula pupula Kutzing	861	1.15	51.00	10.00	1335.20
1739	LMC - 3	26-Sep-17	5910	Navicula exigua (Greg.) Muller	1436	0.84	35.00	8.00	586.40
1739	LMC - 3	26-Sep-17	5916	Fragilaria capucina Grunow	5312	6.56	131.00	6.00	1234.60
1739	LMC - 3	26-Sep-17	5986	Meridion circulare Agardh	574	0.93	62.00	10.00	1623.20
1739	LMC - 3	26-Sep-17	8001	Audouinella / Chantransia stage. Red alga	7178	4.81	20.00	8.00	670.20
1739	LMC - 4	21-Sep-17	1131	Heteroleibeinia profunda Komarek	38760	3.53	29.00	2.00	91.10
1739	LMC - 4	21-Sep-17	1223	Chamaesiphon incrustans Smith	57709	2.23	6.40	3.40	38.70
1739	LMC - 4	21-Sep-17	1239	Homoeothrix varians Komarek & Kalina	42205	20.39	64.00	3.10	483.10
1739	LMC - 4	21-Sep-17	5311	Cymbella minuta Kutzing	6891	2.10	15.00	7.20	305.40
1739	LMC - 4	21-Sep-17	5702	Achnanthes minutissima Kutzing	2297	0.18	18.60	4.00	77.90
1739	LMC - 4	21-Sep-17	5873	Gomphonema minutum	1148	0.52	27.00	8.00	452.40
1739	LMC - 4	21-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	1148	2.07	69.00	10.00	1806.40
1739	LMC - 4	21-Sep-17	5875	Cocconies disculus Schum.	1723	2.74	31.00	14.00	1590.70
1739	LMC - 4	21-Sep-17	5882	Anomoenies vitrea Ross	287	0.10	36.00	6.00	339.30
1739	LMC - 4	21-Sep-17	5910	Navicula exigua (Greg.) Muller	1723	0.97	33.60	8.00	563.00
1739	LMC - 4	21-Sep-17	5916	Fragilaria capucina Grunow	1723	2.09	129.00	6.00	1215.80
1739	LMC - 5	21-Sep-17	1122	Phormidium autumnale Agardh	574	1.40	86.00	6.00	2431.60
1739	LMC - 5	21-Sep-17	1131	Heteroleibeinia profunda Komarek	42205	5.21	39.30	2.00	123.50
1739	LMC - 5	21-Sep-17	1223	Chamaesiphon incrustans Smith	24691	0.75	6.40	3.00	30.20
1739	LMC - 5	21-Sep-17	1239	Homoeothrix varians Komarek & Kalina	8900	4.30	64.00	3.10	483.10
1739	LMC - 5	21-Sep-17	5523	Synedra ulna (Nitzsch) Ehrenberg	287	0.70	260.00	6.00	2450.40
1739	LMC - 5	21-Sep-17	5702	Achnanthes minutissima Kutzing	20385	1.62	19.00	4.00	79.60
1739	LMC - 5	21-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	574	0.07	51.00	3.00	120.20
1739	LMC - 5	21-Sep-17	5870	Navicula radiosa Kutzing	287	0.49	65.00	10.00	1701.70
1739	LMC - 5	21-Sep-17	5873	Gomphonema minutum	7465	3.38	27.00	8.00	452.40
1739	LMC - 5	21-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	287	0.52	69.00	10.00	1806.40
1739	LMC - 5	21-Sep-17	5880	Didymosphenia geminata Schmidt	287	11.49	118.00	36.00	40036.50
1739	LMC - 5	21-Sep-17	5916	Fragilaria capucina Grunow	287	0.33	121.00	6.00	1140.40
1739	LMC - 5	21-Sep-17	8001	Audouinella / Chantransia stage. Red alga	2871	2.12	22.00	8.00	737.20
1739	LMC - 5R	21-Sep-17	1122	Phormidium autumnale Agardh	1148	2.79	86.00	6.00	2431.60
1739	LMC - 5R	21-Sep-17	1131	Heteroleibeinia profunda Komarek	44789	5.53	39.30	2.00	123.50
1739	LMC - 5R	21-Sep-17	1223	Chamaesiphon incrustans Smith	23256	0.70	6.40	3.00	30.20
1739	LMC - 5R	21-Sep-17	1239	Homoeothrix varians Komarek & Kalina	10049	5.57	61.00	3.40	553.80
1739	LMC - 5R	21-Sep-17	5702	Achnanthes minutissima Kutzing	18375	1.46	19.00	4.00	79.60
1739	LMC - 5R	21-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	861	0.10	51.00	3.00	120.20
1739	LMC - 5R	21-Sep-17	5873	Gomphonema minutum	6604	2.99	27.00	8.00	452.40
1739	LMC - 5R	21-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	574	1.04	69.00	10.00	1806.40
1739	LMC - 5R	21-Sep-17	5875	Cocconies disculus Schum.	861	1.37	31.00	14.00	1590.70
1739	LMC - 5R	21-Sep-17	5880	Didymosphenia geminata Schmidt	287	11.49	118.00	36.00	40036.50
1739	LMC - 5R	21-Sep-17	5882	Anomoenies vitrea Ross	574	0.19	36.00	6.00	339.30
1739	LMC - 5R	21-Sep-17	5916	Fragilaria capucina Grunow	287	0.33	121.00	6.00	1140.40
1739	LMC - 5R	21-Sep-17	8001	Audouinella / Chantransia stage. Red alga	4594	3.39	22.00	8.00	737.20
1739	LWC - 1	24-Sep-17	1122	Phormidium autumnale Agardh	1507	5.97	140.00	6.00	3958.40
1739	LWC - 1	24-Sep-17	5702	Achnanthes minutissima Kutzing	2584	0.19	18.00	4.00	75.40
1739	LWC - 1	24-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	215	0.25	30.00	10.00	1178.10
1739	LWC - 1	24-Sep-17	5860	Diatoma vulgare Bory	24978	5.88	25.00	6.00	235.60
1739	LWC - 1	24-Sep-17	5873	Gomphonema minutum	2369	1.07	27.00	8.00	452.40
1739	LWC - 1	24-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	646	1.62	96.00	10.00	2513.30
1739	LWC - 1	24-Sep-17	5875	Cocconies disculus Schum.	431	0.69	31.00	14.00	1590.70
1739	LWC - 1	24-Sep-17	5882	Anomoenies vitrea Ross	1077	0.37	36.00	6.00	339.30
1739	LWC - 1	24-Sep-17	5890	Diatoma mesodon Grun.	215	0.90	40.00	20.00	4188.80
1739	LWC - 1	24-Sep-17	5916	Fragilaria capucina Grunow	9475	12.14	136.00	6.00	1281.80

Epilithic algal species data **for Minto WUL Monitoring 2017 - (Project 1739)** (for Lisa Minnow Environmental Inc.)

**** 1st number in species code = group 1=cyanophyte 2=chlorophyte 5=diatoms 8= red algae**
**** total daily biomass is sum of all species on a date**

Project	Location	Date	Species Code	Speceis name	density cells/cm^2	biomass µg/cm^2	length µ	width µ	cell volume µ^3
1739	LWC - 1	24-Sep-17	5986	Meridion circulare Agardh	646	0.69	41.00	10.00	1073.40
1739	LWC - 2	24-Sep-17	2511	Ulothrix zonata Kutzing	2584	32.47	40.00	20.00	12566.40
1739	LWC - 2	24-Sep-17	5523	Synedra ulna (Nitzsch) Ehrenberg	431	1.88	260.00	8.00	4356.30
1739	LWC - 2	24-Sep-17	5547	Frustulia rhomboides (Ehrenberg) de Toni	215	1.05	86.00	12.00	4863.20
1739	LWC - 2	24-Sep-17	5702	Achnanthes minutissima Kutzing	1507	0.12	19.00	4.00	79.60
1739	LWC - 2	24-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1938	2.28	30.00	10.00	1178.10
1739	LWC - 2	24-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	431	0.05	51.00	3.00	120.20
1739	LWC - 2	24-Sep-17	5860	Diatoma vulgare Bory	26270	6.24	25.20	6.00	237.50
1739	LWC - 2	24-Sep-17	5873	Gomphonema minutum	215	0.10	27.00	8.00	452.40
1739	LWC - 2	24-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	1292	3.38	100.00	10.00	2618.00
1739	LWC - 2	24-Sep-17	5875	Cocconies disculus Schum.	646	0.99	30.00	14.00	1539.40
1739	LWC - 2	24-Sep-17	5882	Anomoenies vitrea Ross	1077	0.37	36.00	6.00	339.30
1739	LWC - 2	24-Sep-17	5890	Diatoma mesodon Grun.	646	2.71	40.00	20.00	4188.80
1739	LWC - 2	24-Sep-17	5916	Fragilaria capucina Grunow	14858	19.74	141.00	6.00	1328.90
1739	LWC - 2	24-Sep-17	5986	Meridion circulare Agardh	861	0.90	40.00	10.00	1047.20
1739	LWC - 3	23-Sep-17	2234	Closteriopsis sp.	431	4.22	111.00	15.00	9807.70
1739	LWC - 3	23-Sep-17	2954	Stigeoclonium sp.	3445	3.79	14.00	10.00	1099.60
1739	LWC - 3	23-Sep-17	5702	Achnanthes minutissima Kutzing	6460	0.51	19.00	4.00	79.60
1739	LWC - 3	23-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1938	2.28	30.00	10.00	1178.10
1739	LWC - 3	23-Sep-17	5860	Diatoma vulgare Bory	24548	5.85	25.30	6.00	238.40
1739	LWC - 3	23-Sep-17	5873	Gomphonema minutum	215	0.09	26.00	8.00	435.60
1739	LWC - 3	23-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	431	1.13	100.00	10.00	2618.00
1739	LWC - 3	23-Sep-17	5880	Didymosphenia geminata Schmidt	215	8.62	118.00	36.00	40036.50
1739	LWC - 3	23-Sep-17	5882	Anomoenies vitrea Ross	646	0.21	34.00	6.00	320.40
1739	LWC - 3	23-Sep-17	5890	Diatoma mesodon Grun.	646	2.71	40.00	20.00	4188.80
1739	LWC - 3	23-Sep-17	5916	Fragilaria capucina Grunow	17011	21.80	136.00	6.00	1281.80
1739	LWC - 3	23-Sep-17	5986	Meridion circulare Agardh	431	0.46	41.00	10.00	1073.40
1739	LWC - 4	23-Sep-17	1122	Phormidium autumnale Agardh	345	1.28	131.00	6.00	3703.90
1739	LWC - 4	23-Sep-17	5702	Achnanthes minutissima Kutzing	3962	0.32	19.30	4.00	80.80
1739	LWC - 4	23-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1206	1.42	30.00	10.00	1178.10
1739	LWC - 4	23-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	172	0.01	51.00	2.30	70.60
1739	LWC - 4	23-Sep-17	5860	Diatoma vulgare Bory	22739	5.57	26.00	6.00	245.00
1739	LWC - 4	23-Sep-17	5865	Cymbella prostrata (Berkeley) Cleve	172	2.91	89.00	22.00	16915.90
1739	LWC - 4	23-Sep-17	5871	Cymbella lapponica	689	1.70	94.00	10.00	2460.90
1739	LWC - 4	23-Sep-17	5873	Gomphonema minutum	345	0.15	26.00	8.00	435.60
1739	LWC - 4	23-Sep-17	5882	Anomoenies vitrea Ross	345	0.11	33.00	6.00	311.00
1739	LWC - 4	23-Sep-17	5916	Fragilaria capucina Grunow	12920	7.58	140.00	4.00	586.40
1739	LWC - 4	23-Sep-17	5917	Hannaea arcus Patrick	345	0.21	64.00	6.00	603.20
1739	LWC - 4	23-Sep-17	5986	Meridion circulare Agardh	689	0.74	41.00	10.00	1073.40
1739	LWC - 5	23-Sep-17	1077	Pseudoanabaena sp.	3445	0.03	2.10	2.10	7.30
1739	LWC - 5	23-Sep-17	2511	Ulothrix zonata Kutzing	2153	27.06	40.00	20.00	12566.40
1739	LWC - 5	23-Sep-17	5702	Achnanthes minutissima Kutzing	8398	0.67	19.00	4.00	79.60
1739	LWC - 5	23-Sep-17	5726	Eucocconeis sp.	215	0.99	40.00	21.00	4618.10
1739	LWC - 5	23-Sep-17	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1723	2.03	30.00	10.00	1178.10
1739	LWC - 5	23-Sep-17	5857	Nitzschia filiformis (W. Smith) Hustedt	1077	0.08	51.00	2.30	70.60
1739	LWC - 5	23-Sep-17	5860	Diatoma vulgare Bory	29716	7.00	25.00	6.00	235.60
1739	LWC - 5	23-Sep-17	5873	Gomphonema minutum	215	0.09	26.00	8.00	435.60
1739	LWC - 5	23-Sep-17	5874	Nitzschia palea (Kutzing) W. Smith	1292	3.08	91.00	10.00	2382.40
1739	LWC - 5	23-Sep-17	5875	Cocconies disculus Schum.	431	0.69	31.00	14.00	1590.70
1739	LWC - 5	23-Sep-17	5910	Navicula exigua (Greg.) Muller	646	0.31	29.00	8.00	485.90
1739	LWC - 5	23-Sep-17	5916	Fragilaria capucina Grunow	11843	15.74	141.00	6.00	1328.90

APPENDIX E

BENTHIC INVERTEBRATE COMMUNITY DATA

Figures and Tables

Laboratory Reports

APPENDIX E

BENTHIC INVERTEBRATE COMMUNITY DATA

Figures and Tables

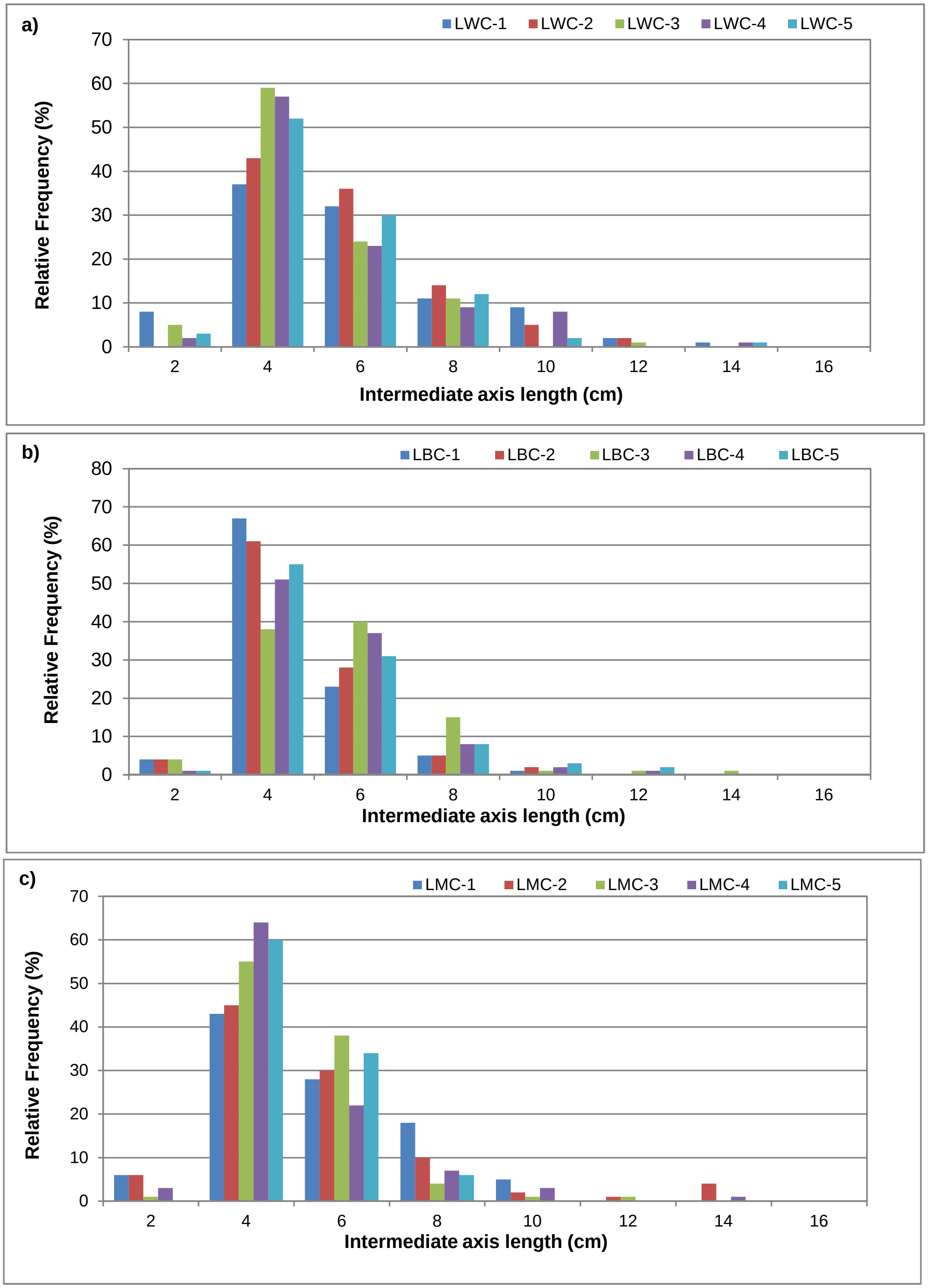


Figure E.1: **Intermediate Axis Length of 100 Rocks Measured at Five Benthic Stations in a) Lower Wolverine Creek, b) Lower Big Creek, and c) Lower Minto Creek**

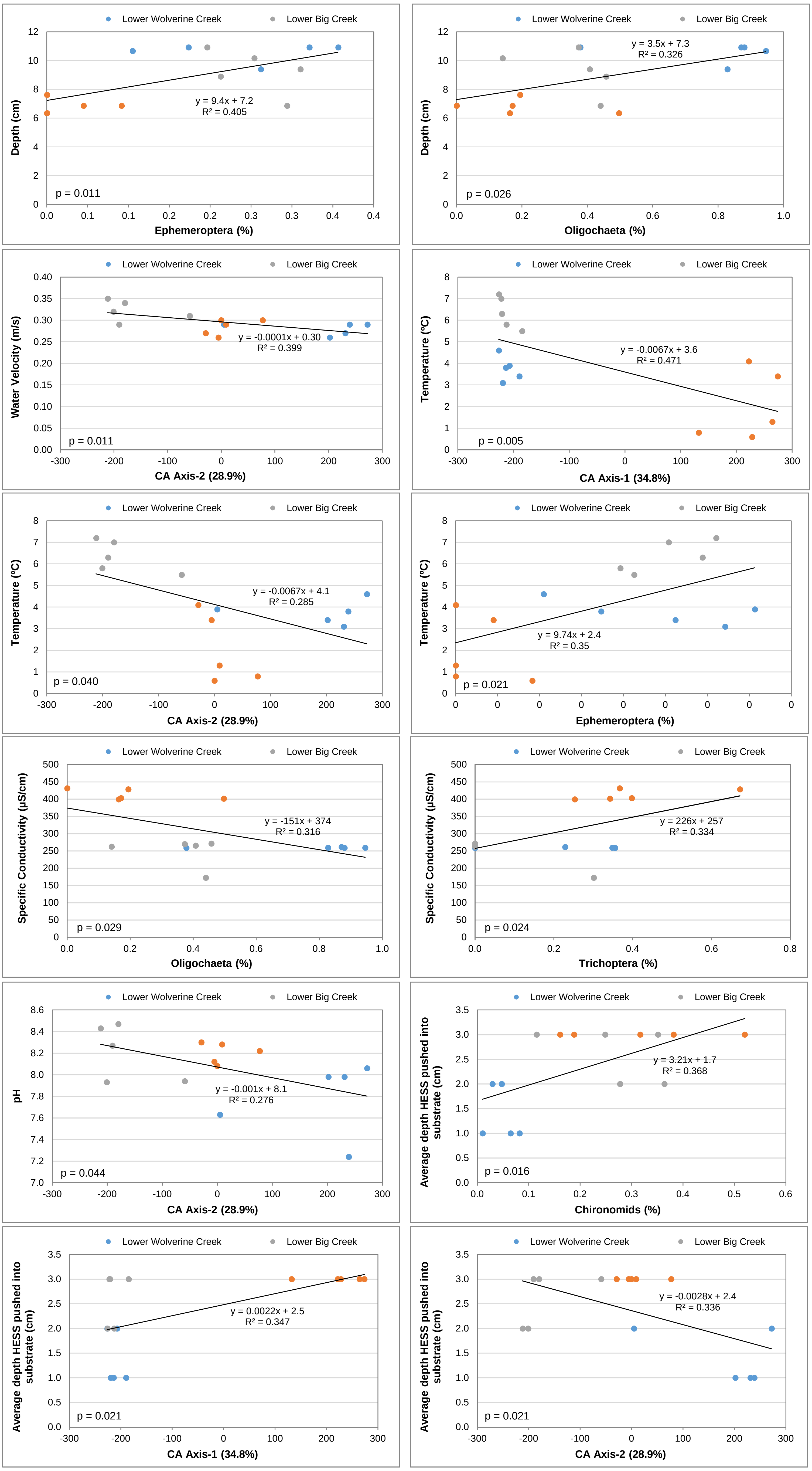


Figure E.2: **Scatterplots of Relationships ($p < 0.050$) between Selected Benthic Invertebrate Environmental Measurements and Biological Endpoints, Minto Mine WUL, 2017**

Table E.1: Benthic Invertebrates (Organisms per Sample) Collected by Hess Sampler and Screened Through a 500 µm Sieve, Minto Mine WUL, 2017

Invertebrate	**Lower Wolverine Creek (Reference)**					**Lower Big Creek (Reference)**					**Lower Minto Creek (Exposed)**				
	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Phylum: Arthropoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order: Collembola	-	-	-	-	-	-	-	-	-	3	-	-	1	1	1
Family: Hypogastruridae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Family: Onychiuridae	-	-	-	-	-	-	-	-	-	-	20	2	-	-	-
Subphylum: Hexapoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Class: Insecta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order: Ephemeroptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Ameletidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ameletus	-	-	-	-	-	1	1	1	1	-	-	-	1	-	-
Family: Baetidae	1	-	-	3	1	-	1	-	5	3	-	-	3	-	-
Acentrella	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Baetis	1	-	1	1	-	4	8	5	-	3	-	-	-	-	1
Baetis tricaudatus	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Family: Ephemerellidae	2	-	-	2	-	-	-	1	3	-	-	-	-	-	-
Drunella doddsii	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-
Drunella spinifera	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Ephemerella	1	-	-	-	1	-	-	1	1	-	-	-	-	-	-
Ephemerella aurivillii	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Family: Heptageniidae	5	5	1	1	7	8	6	13	3	2	-	-	-	-	-
Order: Plecoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Capniidae	4	4	4	17	20	69	44	115	144	71	-	-	7	8	7
Family: Chloroperlidae	-	-	1	5	-	-	2	-	7	-	-	-	-	-	-
Sweltsa	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-
Family: Nemouridae	-	1	-	-	-	2	-	-	-	1	228	2	133	55	175
Nemoura	1	2	-	1	3	-	-	2	1	5	106	6	90	16	39
Zapada	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Zapada cinctipes	-	-	-	3	2	-	-	3	-	-	-	-	-	-	-
Family: Perlodidae	1	-	-	1	2	-	-	-	-	-	-	-	-	-	1
Cultus	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Isoperla	-	-	-	7	9	-	-	1	-	-	-	-	-	-	-
Kogotus	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-
Family: Taeniopterygidae	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Taenionema	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Order: Trichoptera	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Family: Apataniidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Apatania	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
Family: Glossosomatidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Glossosoma	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Family: Hydropsychidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydropsyche	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Family: Limnephilidae	-	-	1	-	-	-	-	1	-	-	1	-	9	35	4
Dicosmoecus	-	-	-	-	-	-	-	-	-	-	1	1	2	3	5
Ecclisomyia	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-
Family: Rhyacophilidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rhyacophila	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Order: Diptera	-	-	-	-	1	-	-	-	1	-	1	1	-	-	-

Notes: Dash represents zero taxa or no taxa identified to that taxonomic level.

Table E.1: Benthic Invertebrates (Organisms per Sample) Collected by Hess Sampler and Screened Through a 500 µm Sieve, Minto Mine WUL, 2017

Invertebrate	Lower Wolverine Creek (Reference)					Lower Big Creek (Reference)					Lower Minto Creek (Exposed)				
	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Family: Ceratopogonidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Culicoides	-	-	-	-	-	-	-	-	-	-	-	-	10	1	2
Monohelea	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Family: Chironomidae	1	2	2	1	3	10	14	3	14	4	-	-	-	-	-
Subfamily: Chironominae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tribe: Chironomini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Saetheria	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Stictochironomus	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Tribe: Tanytarsini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Micropsectra	-	-	-	-	7	-	-	-	2	6	1	-	6	1	2
Rheotanytarsus	-	-	-	-	-	15	10	8	8	6	-	-	-	-	-
Stempellina	-	-	-	-	2	1	-	1	-	-	-	-	-	-	-
Subfamily: Diamesinae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tribe: Diamesini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diamesa	-	-	-	-	-	2	1	3	14	-	-	-	-	-	-
Pagastia	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-
Pseudodiamesa	-	-	-	1	5	-	-	-	-	-	1	-	2	-	-
Subfamily: Orthocladiinae	-	-	-	1	-	-	-	-	1	1	-	-	6	-	-
Brillia	-	1	-	-	-	-	-	1	-	1	23	1	1	-	-
Cricotopus	-	-	-	-	-	-	-	-	-	-	15	4	2	9	101
Eukiefferiella	-	-	-	-	-	-	-	2	2	1	36	31	104	20	79
Heterotrissocladius	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
Hydrosmittia	-	-	-	-	-	2	-	-	1	1	-	-	-	-	-
Krenosmittia	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Limnophyes	-	-	-	-	-	2	-	-	2	-	1	1	5	1	1
Metriocnemus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Orthocladius	-	2	6	-	1	34	41	9	41	16	1	-	7	2	-
Parakiefferiella	-	-	-	-	-	1	-	-	-	1	-	-	15	2	4
Paraphaenocladius	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pseudosmittia	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Rheocricotopus	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Rheosmittia	-	-	-	-	-	-	-	-	5	4	-	-	-	-	-
Tvetenia	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Subfamily: Tanypodinae	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Tribe: Pentaneurini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Thienemannimyia group	-	-	-	-	1	1	2	-	-	1	-	-	4	-	-
Family: Empididae	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-
Chelifera/Metachela	-	-	-	-	1	1	-	2	3	-	-	-	-	-	-
Clinocera	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Clinocerinae Unknown Genus A	-	-	3	3	3	1	-	1	1	-	-	-	-	-	-
Neoplasta	-	-	1	1	3	7	-	4	-	1	2	2	1	-	1
Trichoclinocera	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Wiedemannia	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Family: Muscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnophora	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Notes: Dash represents zero taxa or no taxa identified to that taxonomic level.

Table E.1: Benthic Invertebrates (Organisms per Sample) Collected by Hess Sampler and Screened Through a 500 µm Sieve, Minto Mine WUL, 2017

Invertebrate	**Lower Wolverine Creek (Reference)**					**Lower Big Creek (Reference)**					**Lower Minto Creek (Exposed)**				
	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Family: Psychodidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pericoma/Telmatoscopus	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Family: Simuliidae	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Prosimulium/Helodon	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-
Family: Stratiomyidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemotelus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Family: Tipulidae	-	-	-	1	-	-	-	-	-	-	-	-	2	1	1
Antocha	-	-	-	-	-	-	1	-	-	-	3	-	1	1	1
Dicranota	1	1	-	1	2	1	-	1	9	2	4	-	19	11	15
Hesperoconopa	-	-	1	1	-	-	-	-	7	-	-	-	-	-	-
Rhabdomastix	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tipula	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Order: Hemiptera	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Order: Lepidoptera	-	-	1	-	1	-	-	2	-	-	-	-	-	-	-
Order: Hymenoptera	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
Subphylum: Chelicerata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Class: Arachnida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order: Trombidiformes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Feltriidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Feltria	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Family: Hygrobatidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Atractides	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Hygrobates	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Lebertiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lebertia	1	-	-	-	1	4	1	-	1	-	-	-	-	-	-
Family: Sperchontidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sperchon	-	-	-	-	-	-	2	-	-	-	21	3	26	11	49
Order: Sarcoptiformes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order: Oribatida	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
Phylum: Mollusca	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Class: Bivalvia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order: Veneroida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Pisidiidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pisidium	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Phylum: Annelida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Subphylum: Clitellata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Class:Oligochaeta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Order: Lumbriculida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Lumbriculidae	75	50	244	9	277	4	30	43	33	37	13	18	14	5	-
Rhynchelmis	-	-	-	-	-	-	1	4	14	-	-	-	-	2	-
Order: Tubificida	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Family: Enchytraeidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Enchytraeus	-	-	-	-	-	1	16	3	-	-	-	-	-	-	-
Family: Naididae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nais	-	-	-	-	-	25	2	7	7	4	-	-	-	-	-
Subfamily: Tubificinae with hair chaetae	-	1	-	-	-	-	-	-	-	-	-	-	2	-	-
Subfamily: Tubificinae without hair chaetae	-	-	-	-	-	1	-	-	-	-	10	-	-	-	4
Totals:	**97**	**73**	**273**	**63**	**368**	**202**	**187**	**243**	**338**	**177**	**490**	**73**	**480**	**186**	**498**

Notes: Dash represents zero taxa or no taxa identified to that taxonomic level.

Table E.2: **Benthic Invertebrate Community Metrics by Station for Samples Collected by Hess Sampler, Minto Mine WUL, 2017**

Area	Station	Density (organisms/m^2)	Number of Taxa	BC Distance to LWC Median	BC Distance to LBC Median	BC Distance to Combined Reference Median	Simpson's Diversity [a]	Simpson's Evenness [a]	Ephemeroptera (%)	Plecoptera (%)	Trichoptera (%)	EPT (%)	Chironomids (%)	Oligochaeta (%)	CA Axis-1 (34.8%)	CA Axis-2 (28.9%)
Lower Wolverine Creek (Reference)	LWC-1	97	13	0.91	0.90	0.89	0.40	0.13	10	7.2	0	18	1.0	77	-220	231
	LWC-2	73	12	0.89	0.89	0.80	0.52	0.17	6.8	9.6	0	16	8.2	68	-190	202
	LWC-3	273	16	0.94	0.93	0.90	0.20	0.078	1.1	2.6	1.5	5.1	2.9	89	-227	272
	LWC-4	63	16	0.90	0.79	0.65	0.87	0.48	13	56	1.6	70	4.8	14	-207	4.7
	LWC-5	366	25	0.92	0.88	0.86	0.42	0.069	3.0	11	0.27	14	6.5	76	-214	239
Lower Big Creek (Reference)	LBC-1	202	26	0.94	0.24	0.66	0.82	0.21	6.4	36	0	42	35	2.0	-222	-180
	LBC-2	187	19	0.96	0.23	0.67	0.83	0.30	9.6	25	0	34	36	17	-226	-212
	LBC-3	243	27	0.95	0.30	0.70	0.73	0.14	8.6	51	0.82	60	12	19	-221	-191
	LBC-4	338	27	0.93	0.34	0.76	0.77	0.16	3.8	46	0	49	28	14	-213	-201
	LBC-5	177	22	0.87	0.37	0.56	0.78	0.21	4.5	44	0	48	25	21	-185	-59
Lower Minto Creek (Exposed)	LMC-1	490	17	0.26	0.98	0.89	0.52	0.12	0	68	0.41	69	16	2.7	264	8.5
	LMC-2	73	11	0.68	0.98	0.63	0.73	0.34	0	11	1.4	12	52	25	132	77
	LMC-3	480	28	0.20	0.94	0.83	0.73	0.13	0.83	48	2.5	51	32	2.9	228	-0.39
	LMC-4	186	16	0.43	0.89	0.70	0.79	0.29	0	42	20	63	19	3.8	222	-29
	LMC-5	498	20	0.24	0.96	0.87	0.74	0.19	0.20	45	1.8	47	38	0	274	-5.7

[a] Calculated as recommended by Environment Canada 2012.

Table E.3: Statistical Comparisons of Benthic Invertebrate Community Characteristics Among Areas, Minto Mine WUL, 2017

Endpoint	Overall 3-group Comparison			Post-hoc comparisons			Observed Effect Size (Group 1 - Group 2) /SD pooled
	Data Transformation	Test	Test p-value	Groups		Test P-value	
				Group 1	Group 2		
Density (Individuals/m^2)	none	ANOVA	0.208	LMC	LWC	-	1.3
					LBC	-	0.86
				LWC	LBC	-	0.41
Number of Taxa	none	ANOVA	0.080	LMC	LWC	0.813	0.42
					LBC	0.213	-1.2
				LWC	LBC	0.078	1.6
EPT (%)	none	ANOVA	0.161	LMC	LWC	-	1.3
					LBC	-	0.079
				LWC	LBC	-	1.2
Chironomids (%)	none	ANOVA	0.003	LMC	LWC	0.004	2.8
					LBC	0.800	0.44
				LWC	LBC	0.013	2.3
Oligochaeta (%)	square root	ANOVA	0.001	LMC	LWC	0.001	-3.4
					LBC	0.389	-0.93
				LWC	LBC	0.010	-2.4
BC Distance to LWC Median	-	Kruskal-Wallis	0.006	LMC	LWC	0.028	-
					LBC	0.002	-
				LWC	LBC	0.358	-
BC Distance to LBC Median	none	ANOVA	<0.001	LMC	LWC	0.105	1.5
					LBC	<0.001	13
				LWC	LBC	<0.001	-12
BC Distance to Combined Reference Median	none	ANOVA	0.077	LMC	LWC	0.847	-0.4
					LBC	0.192	1.3
				LWC	LBC	0.078	-1.7
Simpson's Diversity	-	Kruskal-Wallis	0.105	LMC	LWC	-	-
					LBC	-	-
				LWC	LBC	-	-
Simpson's Evenness	log	ANOVA	0.555	LMC	LWC	-	0.67
					LBC	-	0.022
				LWC	LBC	-	0.65
CA Axis-1 (34.8%)	-	Kruskal-Wallis	0.009	LMC	LWC	0.011	-
					LBC	0.006	-
				LWC	LBC	0.832	-
CA Axis-2 (28.9%)	none	ANOVA	<0.001	LMC	LWC	0.007	-2.6
					LBC	0.007	2.6
				LWC	LBC	<0.001	-5.2

▨ Highlighted values indicate significance at the *p* < 0.10 level.

🟦 Effect size magnitude > 2 relative to both reference areas.

Note: Observed effect size = (group 1 mean - group 2 mean)/pooled standard deviation.

Table E.4: Correspondence Analysis Axes Results and Station Scores Using Benthic Invertebrate Abundances at the Lowest Practical Level of Taxonomic Resolution

	CA Axis-1 (34.8%)	CA Axis-2 (28.9%)
Eigenvalue	0.843	0.700
Relative Inertia (%)	34.8	28.9
Monte Carlo p-value	0.001	0.001
LWC-1	-220	231
LWC-2	-190	202
LWC-3	-227	272
LWC-4	-207	4.7
LWC-5	-214	239
LBC-1	-222	-180
LBC-2	-226	-212
LBC-3	-221	-191
LBC-4	-213	-201
LBC-5	-185	-59
LMC-1	264	8.5
LMC-2	132	77
LMC-3	228	-0.39
LMC-4	222	-29
LMC-5	274	-5.7

Table E.5: Pearson Correlation of Station Correspondence Analysis (CA) Axes Scores with Benthic Taxa

Invertebrate	CA Axis-1 (34.8%)		CA Axis-2 (28.9%)	
	Pearson r-value	p-value	Pearson r-value	p-value
Collembola	0.094	0.740	-0.136	0.629
Ameletus	-0.217	0.436	-0.735	0.002
Baetis	-0.496	0.060	-0.535	0.040
Ephemerella	-0.345	0.208	-0.194	0.489
Heptageniidae	-0.650	0.009	-0.258	0.353
Capniidae	-0.475	0.074	-0.705	0.003
Chloroperlidae	-0.289	0.297	-0.067	0.813
Nemoura	0.829	0.000	-0.033	0.907
Zapada cinctipes	-0.336	0.220	-0.056	0.844
Isoperla	-0.286	0.301	0.281	0.311
Dicosmoecus	0.601	0.018	-0.073	0.796
Culicoides	0.502	0.056	-0.030	0.916
Micropsectra	0.087	0.759	0.122	0.666
Rheotanytarsus	-0.471	0.077	-0.766	0.001
Stempellina	-0.334	0.223	0.058	0.836
Diamesa	-0.271	0.328	-0.492	0.063
Pseudodiamesa	-0.033	0.908	0.358	0.190
Subfamily Orthocladiinae	0.265	0.339	-0.109	0.698
Brillia	0.432	0.108	0.000	1.000
Cricotopus	0.556	0.031	-0.029	0.918
Eukiefferiella	0.828	0.000	-0.029	0.919
Hydrosmittia	-0.321	0.244	-0.481	0.069
Limnophyes	0.457	0.086	-0.302	0.273
Orthocladius	-0.432	0.108	-0.694	0.004
Parakiefferiella	0.517	0.049	-0.067	0.814
Thienemannimyia group	0.082	0.771	-0.228	0.414
Chelifera/Metachela	-0.380	0.162	-0.464	0.081
Clinocerinae Unknown Genus A	-0.492	0.062	0.306	0.267
Neoplasta	-0.148	0.598	-0.253	0.363
Antocha	0.717	0.003	-0.151	0.592
Dicranota	0.692	0.004	-0.166	0.555
Hesperoconopa	-0.254	0.362	-0.290	0.294
Lepidoptera	-0.343	0.210	0.064	0.821
Lebertia	-0.384	0.158	-0.302	0.274
Sperchon	0.813	0.000	-0.054	0.848
Lumbriculidae	-0.342	0.212	0.731	0.002
Rhynchelmis	-0.323	0.240	-0.653	0.008
Enchytraeus	-0.254	0.361	-0.451	0.091
Nais	-0.341	0.214	-0.545	0.036
Tubificinae without hair chaetae	0.555	0.032	-0.043	0.878

▨ Indicates absolute r-values > 0.50.

🟦 Indicates p-value < 0.05.

Table E.6: Intermediate Axis Length and Embeddedness of 100 Rocks Washed during Hess Sampling at Benthic Invertebrate Stations, Minto Mine WUL, 2017

Rock Number	Lower Wolverine Creek (Reference)									
	LWC-1		LWC-2		LWC-3		LWC-4		LWC-5	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	11.7		7.0		4.2		8.2		13.7	
2	8.2		4.0		5.8		9.0		3.5	
3	5.2		4.2		5.0		4.2		4.2	
4	12.7		3.6		7.5		9.1		4.7	
5	4.5		7.1		7.6		7.2		8.1	
6	7.2		9.8		3.9		3.7		5.0	
7	2.7		5.0		5.3		6.7		4.5	
8	3.9		4.1		3.7		4.3		7.3	
9	4.0		11.2		6.4		6.3		2.6	
10	8.2	0	5.3	0	7.0	0	4.5	0	7.2	0
11	9.3		5.2		5.4		3.2		5.1	
12	5.4		4.8		4.1		2.5		4.2	
13	7.3		4.6		3.4		2.0		6.0	
14	3.4		4.2		5.4		3.0		4.1	
15	3.6		4.7		4.0		10.0		7.1	
16	4.4		5.0		3.2		2.4		4.5	
17	4.6		7.4		2.2		2.6		3.1	
18	2.3		5.1		4.5		2.2		5.0	
19	3.5		5.8		2.0		3.4		5.2	
20	4.4	25	10.1	25	2.6	50	4.8	0	6.5	0
21	3.0		5.0		2.1		3.7		4.7	
22	4.2		5.7		2.4		5.5		9.1	
23	5.0		6.2		3.2		2.2		5.1	
24	8.6		4.3		3.0		5.7		7.0	
25	3.7		3.2		2.3		3.6		4.4	
26	3.3		3.0		2.0		2.8		7.2	
27	3.5		3.9		3.0		3.3		2.4	
28	5.6		2.8		3.6		3.5		2.9	
29	4.2		4.1		4.1		4.5		3.1	
30	4.6	50	2.2	50	2.3	0	6.6	0	2.5	50
31	4.6		8.0		3.8		4.4		4.0	
32	6.7		4.9		5.2		3.7		4.0	
33	4.9		6.6		4.1		12.1		4.7	
34	2.5		4.6		2.3		3.6		6.6	
35	1.9		6.0		3.2		3.5		3.9	
36	3.3		4.3		3.0		2.1		3.5	
37	7.4		3.7		2.3		2.3		3.9	
38	3.2		4.8		3.7		2.6		3.4	
39	3.5		5.3		10.4		3.0		2.1	
40	5.5	0	2.2	0	4.2	25	3.7	0	3.5	0
41	3.8		8.2		6.2		2.4		7.5	
42	2.4		4.2		3.3		7.0		4.7	
43	4.1		3.8		7.4		2.5		7.3	
44	2.8		3.6		6.7		3.0		3.2	
45	8.1		5.2		4.3		2.7		4.6	
46	4.5		5.6		6.5		4.6		3.0	
47	5.0		6.5		3.1		4.1		5.1	
48	6.0		3.1		4.6		3.1		6.1	
49	8.8		2.3		4.1		1.9		7.2	
50	2.0	0	6.8		7.2	0	9.7	25	4.3	0
51	10.1		9.7		3.4		2.8		4.5	
52	6.6		7.1		4.9		2.2		5.9	
53	4.8		3.2		2.1		5.3		3.6	
54	5.6		2.1		3.4		2.8		3.2	
55	1.9		3.8		1.9		7.5		2.4	
56	2.1		9.7		5.2		7.5		3.3	
57	1.9		2.6		2.9		3.5		2.7	
58	2.8		6.6		2.7		5.0		3.2	
59	3.7		3.2		3.6		7.2		6.6	
60	5.5	25	3.8	0	3.1	25	3.0	0	6.0	25
61	3.7		6.7		2.3		4.2		4.4	
62	3.6		4.6		2.5		3.2		5.4	
63	3.8		5.9		3.2		2.6		5.1	
64	2.2		7.8		2.0		2.3		4.6	
65	4.5		5.3		2.0		2.5		5.5	
66	2.0		4.9		3.2		2.5		5.5	
67	3.6		4.9		2.7		2.5		3.0	
68	1.9		5.0		3.0		6.9		3.8	
69	2.0		7.7		2.9		3.2		3.0	
70	3.7	25	6.9	25	4.2	75	4.2	0	3.8	0
71	4.5		3.1		4.0		3.3		3.1	
72	2.2		2.3		5.1		4.0		3.9	
73	3.1		4.0		3.7		4.0		4.6	
74	2.2		3.5		5.4		2.1		3.6	
75	1.9		3.2		2.7		8.1		2.0	
76	8.3		2.7		3.0		9.1		2.1	
77	6.7		2.5		4.7		5.5		2.7	
78	5.0		4.3		3.8		5.8		2.5	
79	7.6		5.2		2.8		4.6		3.6	
80	4.9	0	9.7	0	3.4	0	3.7	25	2.6	0
81	2.3		2.7		3.0		8.5		3.5	
82	5.0		4.6		6.6		5.1		2.8	
83	6.8		3.3		4.2		2.1		2.6	
84	10.0		3.4		2.3		2.9		2.8	
85	6.6		3.3		3.0		6.0		2.7	
86	2.2		3.5		2.7		4.0		3.9	
87	8.6		2.7		3.6		3.3		2.6	
88	5.1		3.6		2.2		2.3		2.0	
89	5.6		4.8		4.1		5.8		2.3	
90	6.2	0	2.5	25	2.6	0	3.1	0	2.5	25
91	5.6		3.3		2.9		3.0		2.0	
92	5.1		4.5		6.7		3.3		3.5	
93	4.3		3.7		5.0		4.1		3.0	
94	4.2		3.0		3.3		2.9		3.0	
95	2.5		3.0		2.9		3.9		5.0	
96	2.5		3.7		3.8		3.5		2.5	
97	3.6		3.4		2.9		3.3		3.2	
98	3.0		3.3		2.6		4.7		2.6	
99	6.6		3.3		3.1		3.5		3.3	
100	3.8	25	4.0	25	2.2	0	4.7	0	2.6	25
Minimum	**1.9**		**2.1**		**1.9**		**1.9**		**2.0**	
Maximum	**12.7**		**11.2**		**10.4**		**12.1**		**13.7**	
Mean	**4.8**		**4.8**		**3.9**		**4.3**		**4.3**	
Geometric mean	**4.3**		**4.5**		**3.6**		**3.9**		**4.0**	
Median	**4.4**	**13**	**4.3**	**25**	**3.4**	**0**	**3.7**	**0**	**3.9**	**0**

Note: intermediate axis length is the second longest axis on a rock. Embeddedness refers to how deeply the rock is surrounded or buried by other substrate.

Table E.6: Intermediate Axis Length and Embeddedness of 100 Rocks Washed during Hess Sampling at Benthic Invertebrate Stations, Minto Mine WUL, 2017

Rock Number	Lower Big Creek (Reference)									
	LBC-1		LBC-2		LBC-3		LBC-4		LBC-5	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	6.9		7.0		7.0		5.2		7.1	
2	7.3		5.7		4.9		4.4		5.5	
3	8.9		5.6		2.1		3.0		5.3	
4	2.6		5.9		6.9		3.3		3.5	
5	2.4		4.5		4.2		2.6		5.0	
6	5.8		4.9		2.6		4.1		4.2	
7	5.5		5.4		6.5		5.0		3.5	
8	3.9		3.6		6.4		2.1		3.6	
9	2.0		8.2		3.7		2.6		7.4	
10	3.6	0	2.3	25	5.4	0	3.0	0	3.5	0
11	5.2		3.3		13.3		4.4		3.8	
12	3.3		5.2		6.7		3.6		5.2	
13	4.4		2.0		4.3		4.1		3.5	
14	2.0		2.6		6.0		5.1		9.3	
15	5.0		3.7		3.5		5.1		3.2	
16	3.7		8.5		6.0		3.6		4.3	
17	4.0		4.6		5.6		2.7		4.2	
18	3.4		2.6		2.7		6.5		4.3	
19	3.1		2.2		2.7		4.7		3.2	
20	3.7	50	2.7	25	6.6	0	4.6	50	3.5	25
21	6.7		6.0		4.3		5.2		2.9	
22	3.1		3.9		7.4		2.7		3.4	
23	3.5		3.3		8.9		4.1		2.2	
24	2.5		3.1		5.7		2.5		4.4	
25	5.2		2.9		4.7		2.5		3.8	
26	3.6		4.3		3.7		10.1		2.0	
27	2.2		3.6		3.0		5.0		3.6	
28	5.2		3.8		4.6		2.3		2.4	
29	2.9		5.5		3.2		4.5		2.8	
30	7.9	25	2.0	0	5.2	25	3.0	0	2.3	25
31	3.3		5.0		4.5		2.6		4.5	
32	4.5		5.2		5.5		2.5		4.2	
33	3.6		2.5		7.7		3.1		6.2	
34	3.7		3.1		5.0		3.8		5.6	
35	3.0		4.5		5.1		2.6		10.4	
36	3.1		3.6		5.0		5.3		2.7	
37	3.5		4.2		7.4		2.5		6.5	
38	3.2		3.5		2.6		3.8		4.8	
39	6.6		3.1		4.1		5.4		7.6	
40	3.2	0	3.3	0	3.4	0	4.5	25	5.8	0
41	3.3		4.3		5.2		4.2		3.2	
42	4.2		5.5		4.3		5.1		5.0	
43	3.4		2.8		4.8		5.0		4.2	
44	5.0		3.1		2.7		2.8		3.2	
45	3.5		2.6		6.1		4.0		5.5	
46	2.8		5.3		4.5		3.0		3.3	
47	3.1		3.6		2.8		3.0		4.1	
48	3.7		4.8		2.1		2.8		3.3	
49	4.9		7.8		4.3		2.6		2.3	
50	3.1		2.9	25	4.0	0	9.9	0	4.1	0
51	2.6		3.0		3.5		3.9		10.1	
52	3.5		4.0		2.5		4.2		5.5	
53	3.6		3.8		2.2		3.1		6.9	
54	4.5		4.2		6.2		2.7		3.1	
55	4.5		5.0		4.2		2.9		5.8	
56	4.9		2.5		2.7		3.7		8.5	
57	3.1		4.5		5.4		2.7		4.1	
58	4.9		3.0		5.6		3.1		2.2	
59	2.6		2.5		7.0		4.0		3.4	
60	5.3	0	2.5	25	5.0	50	3.8	0	5.5	25
61	3.0		2.6		5.6		3.5		3.0	
62	3.4		2.7		5.1		7.1		3.8	
63	4.5		3.6		4.2		6.2		4.7	
64	3.0		3.5		5.7		2.8		4.1	
65	5.1		6.2		3.0		3.5		3.6	
66	1.3		3.9		7.6		6.2		2.6	
67	3.7		3.6		5.3		9.3		2.9	
68	2.1		3.0		5.1		7.6		2.6	
69	2.8		3.6		4.2		3.7		4.9	
70	2.7	0	3.5	0	3.4	0	2.8	25	2.3	25
71	3.1		2.8		6.2		1.9		8.5	
72	4.1		3.7		5.6		3.5		3.9	
73	5.1		3.0		2.2		7.7		2.8	
74	3.0		2.5		3.4		4.0		3.3	
75	3.9		2.5		2.6		7.0		2.9	
76	4.2		3.2		4.7		3.1		3.2	
77	2.8		2.3		3.0		3.3		2.7	
78	2.6		5.0		6.0		5.1		2.6	
79	2.5		3.2		2.0		2.6		2.8	
80	3.3	25	3.2	0	2.4	0	5.2	0	2.6	0
81	2.4		2.7		2.4		6.5		2.5	
82	3.0		3.3		1.9		3.1		4.0	
83	2.0		3.1		2.0		4.6		2.5	
84	4.0		5.5		3.1		5.5		2.5	
85	4.2		2.0		4.3		4.3		2.2	
86	3.3		3.4		3.5		4.9		4.7	
87	2.6		2.0		2.2		5.8		4.6	
88	3.0		2.9		6.2		3.5		6.5	
89	2.4		2.6		2.0		3.5		6.1	
90	2.5	0	3.2	25	3.2	0	3.1	0	3.6	0
91	2.2		4.7		4.0		4.2		3.3	
92	3.3		3.9		3.4		5.2		5.6	
93	3.5		6.5		3.5		4.4		4.5	
94	2.6		4.7		3.1		4.6		2.3	
95	2.6		2.5		3.3		4.4		4.3	
96	4.4		4.1		10.5		4.5		2.3	
97	2.7		3.8		4.5		4.5		2.8	
98	2.7		2.4		5.5		4.8		2.7	
99	3.4		5.0		3.7		3.7		2.7	
100	2.7	50	6.4	50	3.6	25	4.1	50	2.8	0
Minimum	**1.3**		**2.0**		**1.9**		**1.9**		**2.0**	
Maximum	**8.9**		**8.5**		**13.3**		**10.1**		**10.4**	
Mean	**3.7**		**3.9**		**4.6**		**4.2**		**4.2**	
Geometric mean	**3.5**		**3.7**		**4.2**		**3.9**		**3.9**	
Median	**3.4**	**0**	**3.6**	**25**	**4.3**	**0**	**4.0**	**0**	**3.6**	**0**

Note: intermediate axis length is the second longest axis on a rock. Embeddedness refers to how deeply the rock is surrounded or buried by other substrate.

Table E.6: Intermediate Axis Length and Embeddedness of 100 Rocks Washed during Hess Sampling at Benthic Invertebrate Stations, Minto Mine WUL, 2017

Rock Number	Lower Minto Creek (Exposed)									
	LMC-1		LMC-2		LMC-3		LMC-4		LMC-5	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	8.0		16.9		5.8		12.2		2.9	
2	4.7		13.2		3.3		7.2		3.4	
3	3.3		7.4		4.8		3.0		3.5	
4	6.7		10.6		7.0		4.5		5.1	
5	3.6		5.5		7.1		4.3		3.6	
6	5.0		5.1		3.4		4.2		6.2	
7	8.0		3.9		3.8		4.0		3.7	
8	8.1		3.1		4.9		3.0		4.8	
9	2.5		13.8		4.9		3.7		4.7	
10	6.6	25	5.5	0	2.4	0	3.3	0	2.2	0
11	3.9		3.7		3.9		4.8		2.7	
12	5.4		4.0		4.5		3.8		4.8	
13	4.7		5.2		7.1		9.1		6.1	
14	5.7		5.6		4.9		2.6		5.7	
15	3.1		3.9		6.0		2.4		4.6	
16	1.9		3.0		5.1		5.7		4.7	
17	3.2		6.0		2.5		4.0		4.9	
18	6.8		4.2		2.3		1.9		5.3	
19	3.4		3.6		2.9		2.4		5.7	
20	6.4	50	4.4	50	2.5	0	9.8	25	3.0	25
21	2.5		3.3		6.8		3.6		3.4	
22	3.5		4.6		4.9		4.3		3.1	
23	6.1		2.4		2.6		3.1		3.2	
24	7.5		7.0		3.6		3.3		5.2	
25	3.8		3.1		5.1		7.3		3.0	
26	3.5		2.6		3.9		9.0		4.7	
27	6.0		7.0		4.1		4.3		5.2	
28	5.1		8.6		2.8		2.0		4.4	
29	7.2		4.1		5.1		3.7		2.9	
30	4.2	0	8.2	0	3.6	0	4.0	25	7.5	0
31	3.4		4.7		5.4		2.6		3.9	
32	5.0		6.3		3.6		6.2		3.6	
33	5.7		5.7		3.3		4.5		5.5	
34	3.1		5.2		5.3		3.5		4.0	
35	4.1		4.4		10.2		2.7		5.3	
36	3.1		1.9		4.2		3.5		5.0	
37	7.1		2.9		2.0		3.7		3.5	
38	3.2		2.3		2.8		2.0		3.6	
39	2.5		2.1		3.7		2.5		4.8	
40	2.0	25	2.3	25	4.7	0	3.6	50	4.3	25
41	2.7		3.8		4.2		2.8		2.7	
42	4.2		3.3		4.6		2.9		5.3	
43	5.5		4.2		4.6		6.0		3.0	
44	4.2		3.1		5.7		4.0		5.7	
45	4.1		2.6		3.3		2.9		2.3	
46	8.9		1.9		3.7		3.5		3.2	
47	3.5		3.9		2.2		2.6		3.7	
48	7.1		3.8		3.6		4.1		8.0	
49	4.3		3.5		5.6		7.9		4.1	
50	2.0	25	3.5	25	3.5	25	2.5	50	2.6	25
51	4.0		4.9		4.0		4.1		4.1	
52	3.1		3.0		3.3		3.2		3.2	
53	4.9		2.0		3.8		5.0		3.2	
54	2.9		4.2		4.1		3.0		4.0	
55	4.7		4.6		4.5		2.5		4.5	
56	5.2		5.2		4.1		4.0		5.1	
57	7.1		2.6		5.6		4.4		3.1	
58	6.1		3.8		4.6		3.1		5.2	
59	4.0		2.2		2.4		3.3		4.0	
60	6.5	50	3.0	0	4.4	0	2.8	0	5.5	0
61	4.5		3.2		3.6		2.6		4.6	
62	3.9		2.4		3.0		4.1		4.0	
63	1.9		4.6		4.0		3.3		3.5	
64	6.3		3.9		2.6		3.0		3.6	
65	3.0		2.6		2.2		4.5		4.1	
66	7.5		2.0		2.2		7.6		3.6	
67	9.5		1.9		6.0		6.2		2.8	
68	4.8		1.9		8.8		3.8		2.7	
69	7.1		3.1		3.9		2.2		3.3	
70	3.4	25	3.9	25	3.4	25	3.5	50	5.2	25
71	3.2		3.3		5.4		3.2		4.2	
72	3.0		2.6		4.9		3.4		2.8	
73	3.1		2.9		4.3		2.6		3.7	
74	3.0		3.2		3.8		3.2		4.5	
75	3.6		2.8		4.7		4.2		3.1	
76	4.4		3.7		4.2		3.0		4.6	
77	8.7		6.0		2.6		6.6		4.0	
78	3.7		3.5		2.9		3.7		3.9	
79	4.4		5.0		4.1		3.4		3.1	
80	3.7	0	3.6	50	4.2	0	4.2	25	3.2	25
81	3.5		5.1		2.1		5.4		2.6	
82	2.9		4.0		2.9		3.3		3.5	
83	2.4		4.1		3.7		4.0		3.1	
84	2.7		3.5		4.0		2.7		3.4	
85	1.9		5.5		2.9		3.3		2.9	
86	1.9		8.0		4.3		4.8		3.5	
87	2.8		6.5		3.5		3.0		3.0	
88	5.4		7.8		4.0		3.8		3.7	
89	6.0		6.0		3.1		5.3		3.3	
90	3.8	0	6.0	25	3.2	50	4.4	25	3.4	25
91	3.4		13.1		3.5		2.7		2.5	
92	8.0		12.5		2.9		2.8		4.8	
93	5.4		7.0		2.4		2.8		2.8	
94	4.0		5.1		2.7		3.7		6.7	
95	8.2		6.2		4.7		4.5		3.7	
96	5.7		4.8		3.4		3.7		2.2	
97	5.0		17.0		4.0		3.2		4.0	
98	4.0		6.3		5.0		2.9		6.6	
99	4.0		4.8		3.1		2.5		2.9	
100	2.5	0	3.8	0	3.0	0	3.0	0	2.9	50
Minimum	**1.9**		**1.9**		**2.0**		**1.9**		**2.2**	
Maximum	**9.5**		**17.0**		**10.2**		**12.2**		**8.0**	
Mean	**4.6**		**4.9**		**4.1**		**4.0**		**4.0**	
Geometric mean	**4.3**		**4.3**		**3.9**		**3.7**		**3.9**	
Median	**4.1**	**25**	**4.0**	**25**	**3.9**	**0**	**3.6**	**25**	**3.7**	**25**

Note: intermediate axis length is the second longest axis on a rock. Embeddedness refers to how deeply the rock is surrounded or buried by other substrate.

APPENDIX E

BENTHIC INVERTEBRATE COMMUNITY DATA

Laboratory Reports

BENTHIC INVERTEBRATE COMMUNITY ANALYSIS

PROVIDED BY:

CORDILLERA CONSULTING

(SUMMERLAND, BC)

Cordillera
Consulting

Project: Minto WUL 2017

Minnow Environmental (BC), Lisa Bowron
Sue Salter
suesalter@cordilleraconsulting.ca
250-494-7553

Site:	LMC	LMC	LMC	LMC	LMC	LBC	LBC	LBC	LBC	LBC	LWC	LWC	LWC	LWC	LWC
Sample:	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Sample Collection Date:	26-Sep-17	26-Sep-17	26-Sep-17	21-Sep-17	21-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	24-Sep-17	24-Sep-17	23-Sep-17	23-Sep-17	23-Sep-17
CC#:	CC181283	CC181284	CC181285	CC181286	CC181287	CC181288	CC181289	CC181290	CC181291	CC181292	CC181293	CC181294	CC181295	CC181296	CC181297
Sieve Size:	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	0	0	1	1	1	0	0	0	0	3	0	0	0	0	0
| Family: Hypogastruridae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
| Family: Onychiuridae	20	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	0	0	1	0	0	1	1	1	1	0	0	0	0	0	0
| Family: Baetidae	0	0	3	0	0	0	1	0	5	3	1	0	0	3	1
Acentrella	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Baetis	0	0	0	0	1	4	8	5	0	3	1	0	1	1	0
Baetis tricaudatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
| Family: Ephemerellidae	0	0	0	0	0	0	0	1	3	0	2	0	0	2	0
Drunella doddsii	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Drunella spinifera	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Ephemerella	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1
Ephemerella aurivillii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
| Family: Heptageniidae	0	0	0	0	0	8	6	13	3	2	5	5	1	1	7
| Order: Plecoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Capniidae	0	0	7	8	7	69	44	115	144	71	4	4	4	17	20
| Family: Chloroperlidae	0	0	0	0	0	0	2	0	7	0	0	0	1	5	0
Sweltsa	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0
| Family: Nemouridae	228	2	133	55	175	2	0	0	0	1	0	1	0	0	0
Nemoura	106	6	90	16	39	0	0	2	1	5	1	2	0	1	3
Zapada	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Zapada cinctipes	0	0	0	0	0	0	0	3	0	0	0	0	0	3	2
| Family: Perlodidae	0	0	0	0	1	0	0	0	0	0	1	0	0	1	2
Cultus	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0

Site:	LMC	LMC	LMC	LMC	LMC	LBC	LBC	LBC	LBC	LBC	LWC	LWC	LWC	LWC	LWC
Sample:	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Sample Collection Date:	26-Sep-17	26-Sep-17	26-Sep-17	21-Sep-17	21-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	24-Sep-17	24-Sep-17	23-Sep-17	23-Sep-17	23-Sep-17
CC#:	CC181283	CC181284	CC181285	CC181286	CC181287	CC181288	CC181289	CC181290	CC181291	CC181292	CC181293	CC181294	CC181295	CC181296	CC181297
Sieve Size:	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Isoperla	0	0	0	0	0	0	0	1	0	0	0	0	0	7	9
Kogotus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Taenionema	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
| Order: Trichoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
| Family: Apataniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apatania	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
| Family: Glossosomatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glossosoma	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsyche	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Limnephilidae	1	0	9	35	4	0	0	1	0	0	0	0	1	0	0
Dicosmoecus	1	1	2	3	5	0	0	0	0	0	0	0	0	0	0
Ecclisomyia	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
| Family: Rhyacophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophila	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
| Order: Diptera	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Culicoides	0	0	10	1	2	0	0	0	0	0	0	0	0	0	0
Monohelea	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
| Family: Chironomidae	0	0	0	0	0	10	14	3	14	4	1	2	2	1	3
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Chironomini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saetheria	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Stictochironomus	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	1	0	6	1	2	0	0	0	2	6	0	0	0	0	7
Rheotanytarsus	0	0	0	0	0	15	10	8	8	6	0	0	0	0	0
Stempellina	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diamesa	0	0	0	0	0	2	1	3	14	0	0	0	0	0	0
Pagastia	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
Pseudodiamesa	1	0	2	0	0	0	0	0	0	0	0	0	0	1	5
| Subfamily: Orthocladiinae	0	0	6	0	0	0	0	0	1	1	0	0	0	1	0
Brillia	23	1	1	0	0	0	0	1	0	1	0	1	0	0	0
Cricotopus	15	4	2	9	101	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	36	31	104	20	79	0	0	2	2	1	0	0	0	0	0
Heterotrissocladius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3

Site:	LMC	LMC	LMC	LMC	LMC	LBC	LBC	LBC	LBC	LBC	LWC	LWC	LWC	LWC	LWC
Sample:	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Sample Collection Date:	26-Sep-17	26-Sep-17	26-Sep-17	21-Sep-17	21-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	24-Sep-17	24-Sep-17	23-Sep-17	23-Sep-17	23-Sep-17
CC#:	CC181283	CC181284	CC181285	CC181286	CC181287	CC181288	CC181289	CC181290	CC181291	CC181292	CC181293	CC181294	CC181295	CC181296	CC181297
Sieve Size:	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hydrosmittia	0	0	0	0	0	2	0	0	1	1	0	0	0	0	0
Krenosmittia	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Limnophyes	1	1	5	1	1	2	0	0	2	0	0	0	0	0	0
Metriocnemus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Orthocladius	1	0	7	2	0	34	41	9	41	16	0	2	6	0	1
Parakiefferiella	0	0	15	2	4	1	0	0	0	1	0	0	0	0	0
Paraphaenocladius	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Pseudosmittia	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Rheocricotopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Rheosmittia	0	0	0	0	0	0	0	0	5	4	0	0	0	0	0
Tvetenia	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
| Subfamily: Tanypodinae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
| Tribe: Pentaneurini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thienemannimyia group	0	0	4	0	0	1	2	0	0	1	0	0	0	0	1
| Family: Empididae	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0
Chelifera/ Metachela	0	0	0	0	0	1	0	2	3	0	0	0	0	0	1
Clinocera	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Clinocerinae Unknown Genus A	0	0	0	0	0	1	0	1	1	0	0	0	3	3	3
Neoplasta	2	2	1	0	1	7	0	4	0	1	0	0	1	1	3
Trichoclinocera	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wiedemannia	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
| Family: Muscidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Limnophora	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Psychodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pericoma/Telmatoscopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
| Family: Simuliidae	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Prosimulium/Helodon	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
| Family: Stratiomyidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemotelus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
| Family: Tipulidae	0	0	2	1	1	0	0	0	0	0	0	0	0	1	0
Antocha	3	0	1	1	1	0	1	0	0	0	0	0	0	0	0
Dicranota	4	0	19	11	15	1	0	1	9	2	1	1	0	1	2
Hesperoconopa	0	0	0	0	0	0	0	0	7	0	0	0	1	1	0
Rhabdomastix	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Tipula	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Hemiptera	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lepidoptera	0	0	0	0	0	0	0	2	0	0	0	0	1	0	1
| Order: Hymenoptera	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Site:	LMC	LMC	LMC	LMC	LMC	LBC	LBC	LBC	LBC	LBC	LWC	LWC	LWC	LWC	LWC
Sample:	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Sample Collection Date:	26-Sep-17	26-Sep-17	26-Sep-17	21-Sep-17	21-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	24-Sep-17	24-Sep-17	23-Sep-17	23-Sep-17	23-Sep-17
CC#:	CC181283	CC181284	CC181285	CC181286	CC181287	CC181288	CC181289	CC181290	CC181291	CC181292	CC181293	CC181294	CC181295	CC181296	CC181297
Sieve Size:	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
| Class: Arachnida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Feltriidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Feltria	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atractides	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	0	0	0	4	1	0	1	0	1	0	0	0	1
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	21	3	26	11	49	0	2	0	0	0	0	0	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Oribatida	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Veneroida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Pisidiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pisidium	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	13	18	14	5	0	4	30	43	33	37	75	50	244	9	277
Rhynchelmis	0	0	0	2	0	0	1	4	14	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Enchytraeus	0	0	0	0	0	1	16	3	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nais	0	0	0	0	0	25	2	7	7	4	0	0	0	0	0
| Subfamily: Tubificinae with ha	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0
| Subfamily: Tubificinae without	10	0	0	0	4	1	0	0	0	0	0	0	0	0	0
All others	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Totals:	**490**	**73**	**480**	**186**	**498**	**202**	**187**	**243**	**339**	**177**	**97**	**73**	**273**	**63**	**368**

Site:	LMC	LMC	LMC	LMC	LMC	LBC	LBC	LBC	LBC	LBC	LWC	LWC	LWC	LWC	LWC
Sample:	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Sample Collection Date:	26-Sep-17	26-Sep-17	26-Sep-17	21-Sep-17	21-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	22-Sep-17	24-Sep-17	24-Sep-17	23-Sep-17	23-Sep-17	23-Sep-17
CC#:	CC181283	CC181284	CC181285	CC181286	CC181287	CC181288	CC181289	CC181290	CC181291	CC181292	CC181293	CC181294	CC181295	CC181296	CC181297
Sieve Size:	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Taxa present but not included:															
Terrestrials	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
| Class: Maxillipoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Copepoda	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Totals:	**3**	**1**	**2**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**0**	**2**

Project: Minto WUL 2017

Minnow Environmental (BC), Lisa Bowron
Sue Salter
suesalter@cordilleraconsulting.ca
250-494-7553

Site - LBC, Sample - LBC-4, CC# - CC181291, Percent sampled = 100%, Sieve size = 500

Rheotanytarsus	Larvae	8	
Stictochironomus	Larvae	2	
Micropsectra	Larvae	2	
Chironomidae	Pupa	14	
Diptera	Pupa	1	
Eukiefferiella	Larvae	2	
Limnophyes	Larvae	2	
Orthocladiinae	Juvenile/Damaged	1	
Diamesa	Larvae	14	
Orthocladius	Larvae	41	
Rheosmittia	Larvae	5	
Tvetenia	Larvae	1	
Chelifera/ Metachela	Larvae	3	
Wiedemannia	Larvae	1	
Hesperoconopa	Larvae	7	
Dicranota	Larvae	9	
Ameletus	Larvae	1	
Baetidae	Juvenile/Damaged	5	
Heptageniidae	Juvenile/Damaged	3	
Ephemerellidae	Juvenile/Damaged	3	
Ephemerella	Larvae	1	
Sweltsa	Larvae	2	
Capniidae	Juvenile/Damaged	144	
Chloroperlidae	Juvenile/Damaged	7	
Lebertia	Adult	1	
Lumbriculidae	None	33	
Nemoura	Larvae	1	
All others	None	1	1 fish present
Rhynchelmis	None	14	
Nais	None	7	
Pisidium	None	1	
Hydrosmittia	Larvae	1	
Clinocerinae Unknown Genus A	Larvae	1	
Total:		**339**	

Cordillera
Consulting

Project: Minto WUL 2017

Minnow Environmental (BC), Lisa Bowron
Sue Salter
suesalter@cordilleraconsulting.ca
250-494-7553

	Total Recovered	Total from Sample	Percent Efficiency
Site - QC, Sample - QC 1, CC# - CC181286, Percent sampled = 100%, Sieve size = 500			
Trombidiformes	1		
Total:	**1**	**186**	**99%**
Site - QC, Sample - QC 2, CC# - CC181294, Percent sampled = 100%, Sieve size = 500			
No Invertebrates Found	0		
Total:	**0**	**73**	**100%**

Appendix L – Minto Creek Fish Monitoring Program Review and Recommendations

capstone
MINTO MINE

Minto Mine
Fisheries Monitoring Program
2017 Summary Report

January 2018

Table of Contents

List of Figures

List of Tables

1 Introduction

Minto Explorations Ltd. (MEL), a wholly owned subsidiary of Capstone Mining Corp., owns and operates the Minto Mine, a high-grade copper mine, located approximately 240 km northwest of Whitehorse, Yukon Territory (Figure 1). The project is located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R6A, and is centered at approximately 62°37’N latitude and 137°15’W longitude. The Minto Mine commenced commercial operation in October 2007 and is permitted to conduct mining and milling operations at a rate of 4,200 tonnes of ore per day (tpd). Some of the Minto ore deposits (copper/gold/silver) currently being mined are located in the upper reaches of the Minto Creek watershed approximately 12 km to the west of the Minto Creek confluence with the Yukon River (Figure 2). MEL is required, under the terms of its water use license #QZ14-031 (Amendment 1), to conduct an aquatic environmental monitoring program, of which, this fisheries monitoring program in Minto Creek is a component. This current report provides details of the monitoring conducted during the open water season in 2017 and the results of the work undertaken. This program was carried out under DFO Scientific Collection Licence number XR 154 2017.

Figure 1: Project Location

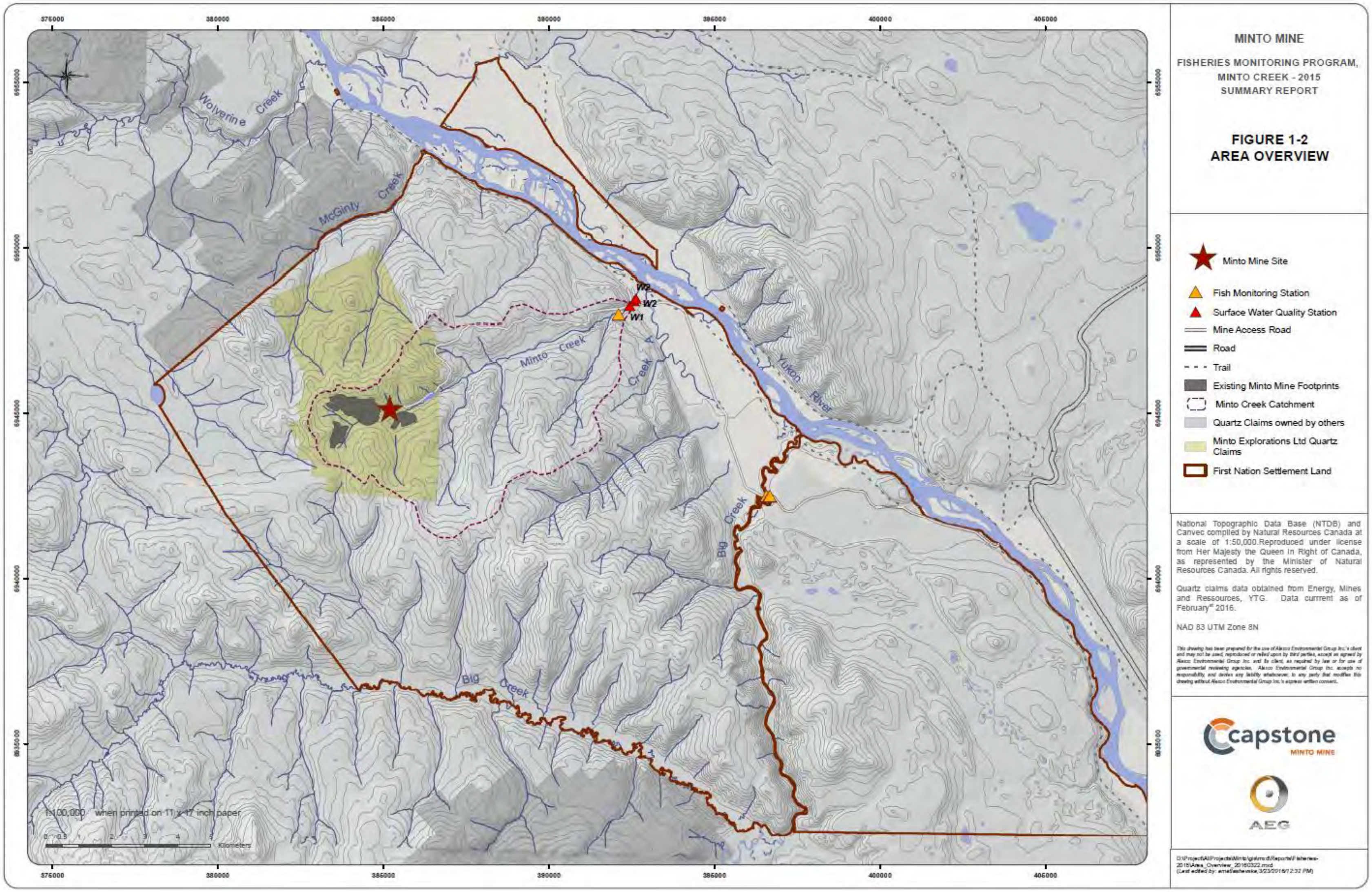


Figure 2: Project Overview

2 Previous Studies

Numerous studies on fisheries and fish habitat have been conducted over the recent history of the Minto Mine. These studies are summarized chronologically in Table 1, below.

Table 1: Minto Creek Fish Investigations

Year	Months	Purpose of Study	Conducted by
1994	June, August, September	Baseline Collection	Hallam Knight Piesold (HKP)
2006	September	Baseline Collection	Access Consulting Group (ACG)
2007	May, June, August, September	Environmental Effects Monitoring Study Design Development	ACG / Minnow Environmental (Minnow)
2008	June, September	Environmental Effects Monitoring, Cycle I	ACG / Minnow
2009	June, July	Monitoring	ACG
2009	September, October	Fish Re-location	ACG
2010	June - October	Juvenile Chinook Salmon Mark-recapture program, compliance Monitoring	ACG
2011	July - October	Environmental Effects Monitoring Cycle II, Compliance Monitoring	ACG, Minnow
2011	July, August	EEM Cycle II – Growth Trials	ACG, Minnow
2012	May - September	Compliance Monitoring Se in tissue study	ACG, MEL (Minto Exploration Ltd.)
2013-2015	May - October	Compliance Monitoring	ACG/AEG, MEL
2016	June - September	Compliance Monitoring	MEL, AEG
2017	June – September	Compliance Monitoring	MEL

Attempts to collect fish in lower Minto Creek while conducting the Phase 1 Metal Mining Effluent Regulation, Environmental Effects Monitoring (EEM) study in 2008 resulted in the capture of no fish during the month of June and very few fish during the month of September. This is consistent with the findings of previous fish investigations conducted in the creek (HKP 1994; R&D 2006, 2007). Fish use of Minto Creek is transient and likely short-lived, as has been found in other non-natal chinook rearing creeks (Walker 1976; Scrivener et al. 1994).

The majority of fish using the system are juvenile chinook salmon (*Onchoryhnchus tshawytscha*), as determined by the above investigations. Other species that have been found in the creek in low numbers include round whitefish (*Prosopium cylindraceum*), Arctic grayling (*Thymallus arcticus*), Slimy sculpin (*Cottus cognatus*) and Burbot (*Lota lota*). Of these, only slimy sculpin have been captured on a regular basis.

Juvenile chinook salmon (JCS) have never been encountered in the creek before July and their numbers tend to peak in late August or early September. Moreover, the mark-recapture investigation conducted in 2010 on JCS indicates that use of the creek is transient. The majority of JCS using the system stay in the creek for about two to three weeks or less.

A summary of past fish sampling results in Minto Creek is presented in Table 2.

Table 2: Summary of Fish captures in Minto Creek between 2008 and 2016

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
2008	Backpack Electrofishing	796 secs	Catch	#	1	0
			CPUE	Fish/min	0.075	0
	Baited Gee Minnow Trapping	28.6 days	Catch	#	18	0
			CPUE	Fish/day	0.63	0
2009*	Baited Gee Minnow Trapping	28.6 days	Catch	#	136	142
			CPUE	Fish/day	4.76	4.97
2010	Baited Gee Minnow Trapping	145.9 days	Catch	#	2293	2307
			CPUE	Fish/day	15.72	15.81
2011	Baited Gee Minnow Trapping	71 days	Catch	#	12	29
			CPUE	Fish/day	0.17	0.41
2012	Backpack Electrofishing	1051 secs	Catch	#	0	4
			CPUE	Fish/min	0	0.23
	Baited Gee Minnow Trapping	43 days	Catch	#	3	6
			CPUE	Fish/day	0.07	0.14
2013	Backpack Electrofishing	3402 secs	Catch	#	0	4
			CPUE	Fish/min	0	0.07
	Baited Gee Minnow Trapping	62.5 days	Catch	#	121	7
			CPUE	Fish/day	1.94	0.11
2014	Baited Gee Minnow Trapping	70.2 days	Catch	#	151	3
			CPUE	Fish/day	2.15	0.04
2015	Baited Gee Minnow Trapping	67.3 days	Catch	#	6	0
			CPUE	Fish/day	0.089	0
2016	Baited Gee Minnow Trapping	69.3 days	Catch	#	6	0
			CPUE	Fish/day	0.086	0

JCS presence in Minto creek was observed to be influenced by mine water discharge. During non-discharge periods, and prior to operations (baseline), numbers of JCS and other species of fish in the system were found to be very low. In contrast, during the two major discharge events (2009 and 2010), numbers of JCS were 20 to 30 times higher in the system (see Table 3 below), indicating that they may have been attracted into the system as a likely result of a more consistent temperature and flow regime associated with mine water discharge. Numbers of other species of fish during discharge events did not increase. It is important to note however, that numbers of other species using the system has been consistently very low, prior to mine development and during operations.

Table 3: Maximum Catch per Unit Effort (CPUE) of Juvenile Chinook Salmon in Minto Creek using baited Minnow traps 1994-2017

Year	Month	JCS – CPUE (#fish/trap-day)*	Minto Creek Conditions
1994	September	0	Pre-development – no discharge
2008	September	0.9	Operational – no discharge
2009	September/October	20.0	Discharge
2010	August	30.0	Discharge
2011	September	0.43	No discharge – high TSS contribution from tributary
2012	September	0.19	No discharge – high TSS contribution from tributary
2013	October	5.01	Operational – no discharge
2014	September	5.05	Operational – no discharge
2015	July	0.30	Operational – no discharge
2016	July	0.30	Operational – no discharge
2017	June-September	0.00	Discharge only during June trapping

**CPUE calculated for actual 24-hr period (rather than nominal 24-hr period)*

Minto Creek does not provide preferred spawning habitat for fish because it completely freezes during winter months with no flow in lower Minto Creek. Accordingly, there is no evidence of spawning in Minto Creek (HKP 1994; R&D 2006, 2007), nor is there traditional knowledge indicating spawning occurring in the system (HKP 1994). Lower Minto Creek is also subject to low or zero flow conditions during periods in the summer when a portion (or all) of the flow sometimes infiltrates the ground, preventing the establishment of resident fish populations in this section of the stream. A natural barrier to fish passage exists at approximately km 1.2 upstream in Minto Creek from the Yukon River, therefore limiting fish use upstream of the barrier. This barrier is largely comprised of organic debris and can be considered to be temporary as it will likely degrade over time, although it has been consistently observed since it was first characterized in 2010. Sampling effort has been applied upstream of the barrier during every sampling event since 2010 and resulted in no fish capture. New temporary barriers may also be established in any given year and could occur both upstream and further downstream of the current barrier location. The canyon located upstream of the current barrier however, is a permanent barrier to fish passage due to its high gradient, thus limiting fish habitat to the lower 2.0 km of the system.

Water temperatures tend to remain cooler in Minto Creek than in the Yukon River. This likely deters fish, in particular JCS, from entering the system until creek temperatures approach or equilibrate with the Yukon River. Minto Creek is subject to large diurnal fluctuations in temperature (up to 5°C or more) throughout the open water season. This daily variation is not ideal for fish and may limit their interest in using the creek for rearing.

Creek bottom substrate is comprised mostly of fines (silt/sand) with limited cobble/gravel sections which are more desirable for fish. In addition, significant input of suspended solids from a tributary in 2011 and 2012 may have further limited the use of the system by JCS during those years.

Bottom substrate at the mouth of Minto Creek and at the Yukon River confluence consists primarily of silt and mud which is not considered suitable substrate for salmonid spawning (grayling, salmon etc.). Aerial surveys for spawning fish were conducted in 2011, 2012, 2013 and 2014, and no adult fish were observed spawning in the vicinity of the Minto Creek/Yukon River confluence. No signs were present during the surveys that this area is used for spawning (such as redds or carcasses).

Starting in 2012, the compliance monitoring program included sampling efforts in Big Creek, which serves as a reference site. The same fish species as in Minto Creek were generally observed in Big Creek, and the CPUE has normally been slightly higher in Big Creek. Table 4 summarizes fish captures in Big Creek from 2012 to 2016.

Table 4: Summary of Fish captures in Big Creek in 2012 to 2016

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
2012	Backpack Electrofishing	273 secs	Catch	#	1	23
			CPUE	Fish/min	0.22	5.05
	Baited Gee Minnow Trapping	11.8 days	Catch	#	7	2
			CPUE	Fish/day	0.59	0.17
2013	Backpack Electrofishing	911 secs	Catch	#	0	27
			CPUE	Fish/min	0	1.78
	Baited Gee Minnow Trapping	14.8 days	Catch	#	19	2
			CPUE	Fish/day	1.28	0.14
2014	Baited Gee Minnow Trapping	16.4 days	Catch	#	96	3
			CPUE	Fish/day	5.86	0.18
2015	Baited Gee Minnow Trapping	17.1 days	Catch	#	58	5
			CPUE	Fish/day	3.39	0.15
2016	Baited Gee Minnow Trapping	22.2	Catch	#	51	11
			CPUE	Fish/day	2.30	0.49

3 Objectives

The objectives of the 2017 Fisheries Monitoring Program were to monitor, assess and characterize fish usage in Minto Creek during the open water season, and to provide data for the interpretation of the potential role and influence of the Minto Mine on the fish community. The 2017 fisheries program was a continuation of the previous year's components and targeted all species that have previously been encountered, as well as any new species. As part of the monitoring program since 2012, assessments at Big Creek were made concurrently with sampling in Minto Creek, to compare fish use in a neighboring system relative to Minto Creek. Fish monitoring studies were conducted in support of the requirements of Water Use License QZ14-031.

4 Methodology

4.1 Fish Monitoring

Fish monitoring of Minto Creek and Big Creek was conducted monthly during open water season, from June to September 2017, at trapping sites consistent with the 2010 mark-recapture study and the 2011 to 2016 fish monitoring programs (Figure 3). Capture effort included the use of Gee-type Minnow traps with 0.635 cm wire mesh size, baited with Yukon River origin chinook salmon roe. A total of 9 to 20 minnow traps were set during each sampling event in Minto Creek, depending on water levels and availability of pools and backwater areas. Four traps were set during each event in Big Creek, in the vicinity of the Minto access road bridge.

All fish captured were identified, enumerated and measured for fork length or total length (± 1 mm), inspected for abnormalities, and released in the vicinity of their trapping location. JCS were also weighed (± 0.01g) prior to being released.

Additional supporting information collected included:

- photo-documentation of the creek,
- water level readings at station W1 staff gauge,
- in situ water parameters in Minto Creek, Big Creek and the Yukon River - temperature, dissolved oxygen, conductivity, pH, ORP,
- flow discharge measured at W1, and
- weather conditions at time of sampling.

Continuous temperature loggers (TidbiT) were deployed in the Yukon River and Big Creek for the duration of the project, however ice formation in early October on Big creek had removed the Tidbit from its location and it could not be recovered. A Levelogger recorded continuous temperature and stage in Minto Creek. Supporting variables also included monitoring of the previously identified fish barrier (1.2 km upstream of the Yukon River confluence) and/or any new barriers that may have developed.

Selected photographs documenting field activities and site conditions are presented in Appendix A.

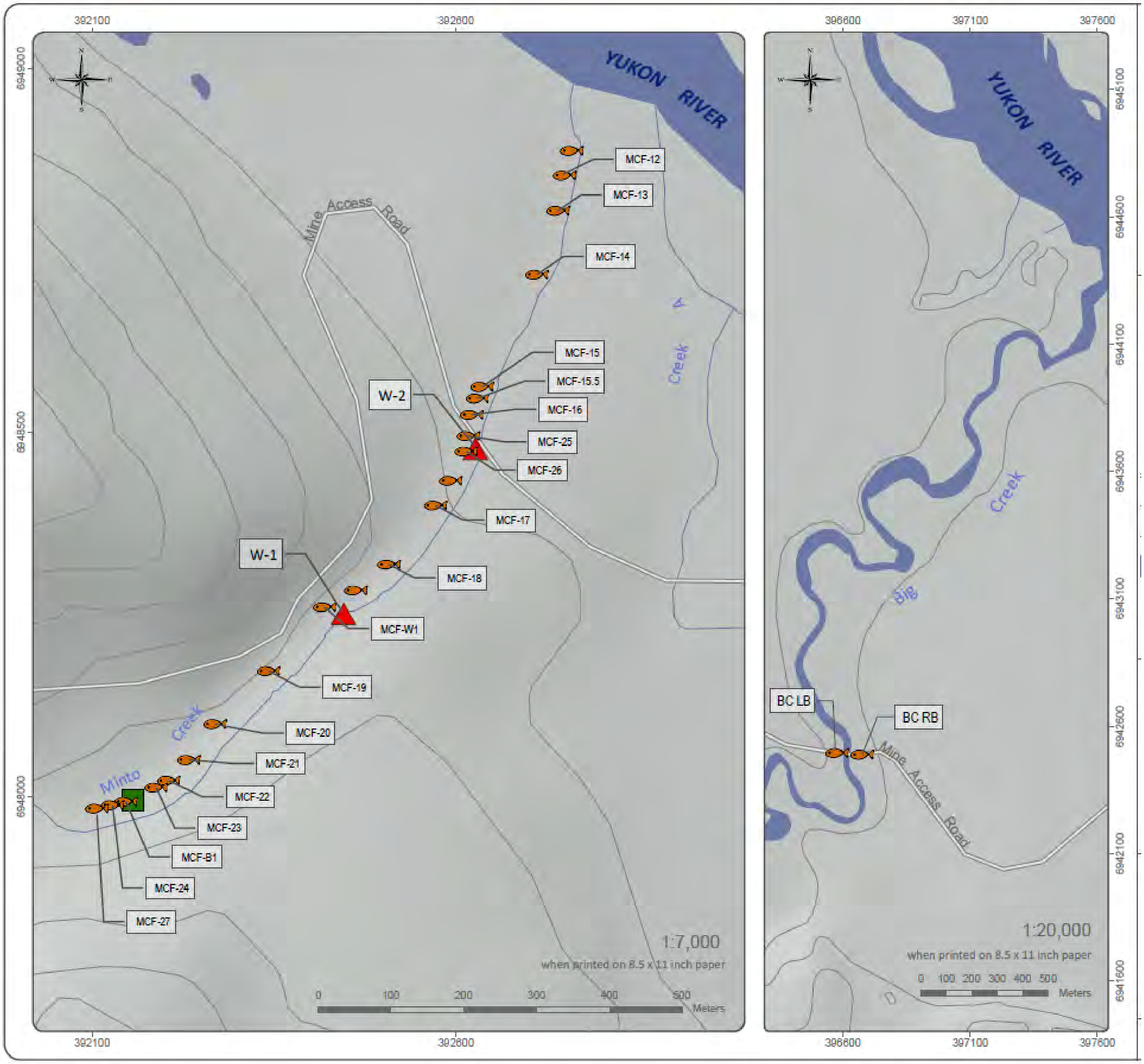


Figure 3: Minto Creek and Big Creek Fisheries Monitoring stations

5 Results

The following sections present the fisheries statistics and effort in Minto Creek and Big Creek between June and September 2017.

5.1 Fish Usage and Distribution

5.1.1 Minto Creek

Minto Creek was assessed monthly between June and September 2017. No fish were captured in Minto Creek in 2017. A portion of Minto Creek was found to be dry during the fish monitoring event in July and August 2017, which could have played an important role in preventing fish movement up and down Minto Creek. The following table (Table 5) presents the effort applied and the summary of fish capture in Minto Creek in 2017.

Table 5: Summary Statistics of Minnow Trapping in Minto Creek

Month	Effort (trap-hours)	Effort(trap-days)	Juvenile Chinook Salmon (*Onchoryhnchus tshawytscha*)	
			Results	CPUE*
June	320	13.3	0	0
July	140	5.8	0	0
August	272.4	11.4	0	0
September	306.6	12.8	0	0
Total	1039	43.3	0	0

** CPUE = fish/trap-day (for actual 24-hr period)*

5.1.2 Big Creek

Fisheries sampling effort in Big Creek was initiated in June, and conducted monthly until September, concurrent with sampling in Minto Creek, resulting in the capture of 35 fish, 27 of which were JCS. JCS were captured in all but the June sampling event in 2017, with highest numbers (11) captured in August. In addition, six (6) slimy sculpin and two (2) Burbot were captured during the 2017 sampling season.

The average catch per unit effort for JCS in Big Creek was 0.090 JCS/trap-day and was highest in August (0.165 JCS/trap-day). In comparison, the average JCS CPUE (June to September) in 2016 was higher at 0.747 JCS/trap-day and was as high as 1.288 JCS/trap-day in July 2016. The following table (Table 6) presents the effort undertaken and the resulting fish capture in Big Creek in 2017.

Due to unknown circumstances during the evening of the July 19th sampling session, 1 of the 6 JCS caught in Big Creek was dead upon retrieval (see Appendix A).

Table 6: Summary Statistics of Minnow Trapping in Big Creek in 2017

Month	**Effort (trap-hours)**	**Effort (trap-days)**	**Juvenile Chinook Salmon (*Onchoryhnchus tshawytscha*)**		**Slimy Sculpin (*Cottus cognatus*)**		**Burbot (*Lota lota*)**	
			Results	**CPUE***	**Results**	**CPUE***	**Results**	**CPUE***
June	93	3.9	0	0	4	0.395	0	0
July	69	2.9	6**	0.087	0	0	1	0.015
August	66.6	2.8	11	0.165	1	0.015	0	0
September	92.4	3.9	10	0.108	1	0.015	1	0.011
Total	320	13.5	27	0.084	6	0.019	2	0.006

**CPUE = fish/trap-day (for actual 24-hr period)*
**One JCS found deceased upon trap retrieval

Figure 4 presents a comparison between monthly JCS capture and CPUE in Minto Creek and Big Creek for 2017.

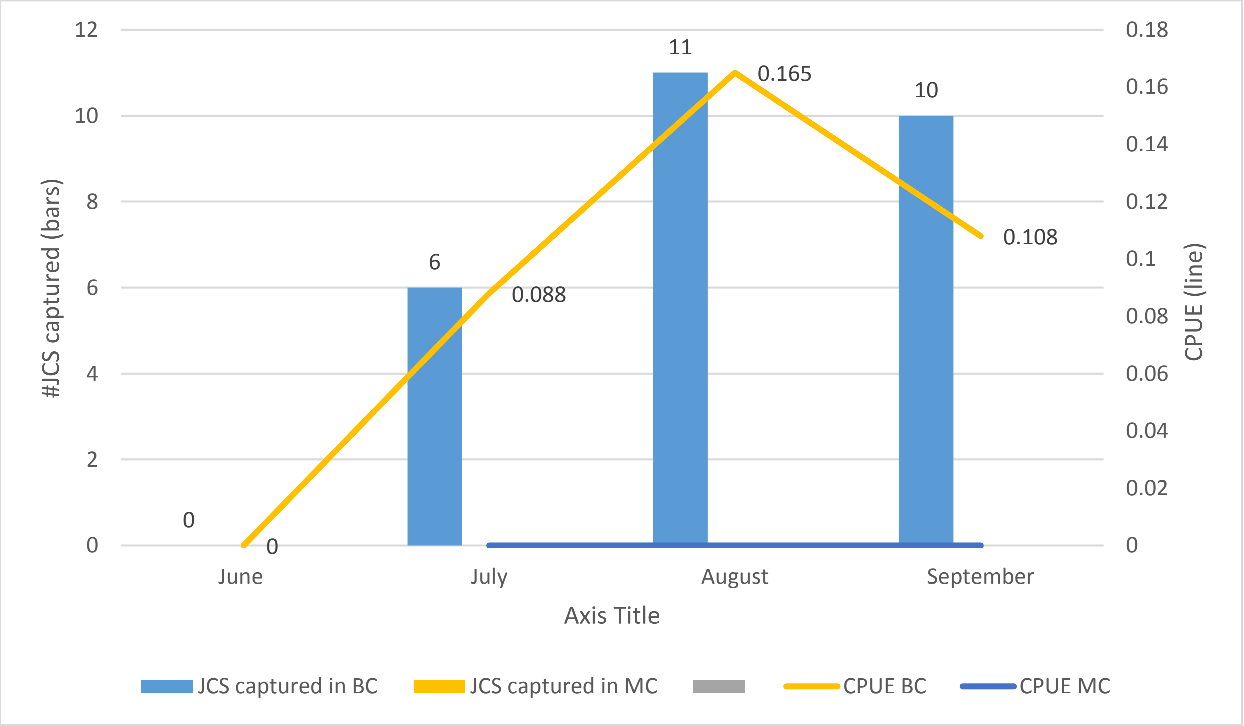


Figure 4: Monthly JCS capture in Minto Creek and Big Creek, 2017

5.2 Fish Metrics

Fork lengths of JCS captured in Big Creek ranged from 48 to 85 mm and their weights ranged from 2.07 to 9.72 g. There was a notable difference between the JCS lengths and widths during each sampling event. The JCS observed in July were smaller than the JCS captured in September. The lengths and weights observed throughout the season were consistent with 0+ aged fish (young of year).

Figure 5 presents the monthly averages for both creeks. Individual results for all fish captured are presented in Appendix B.

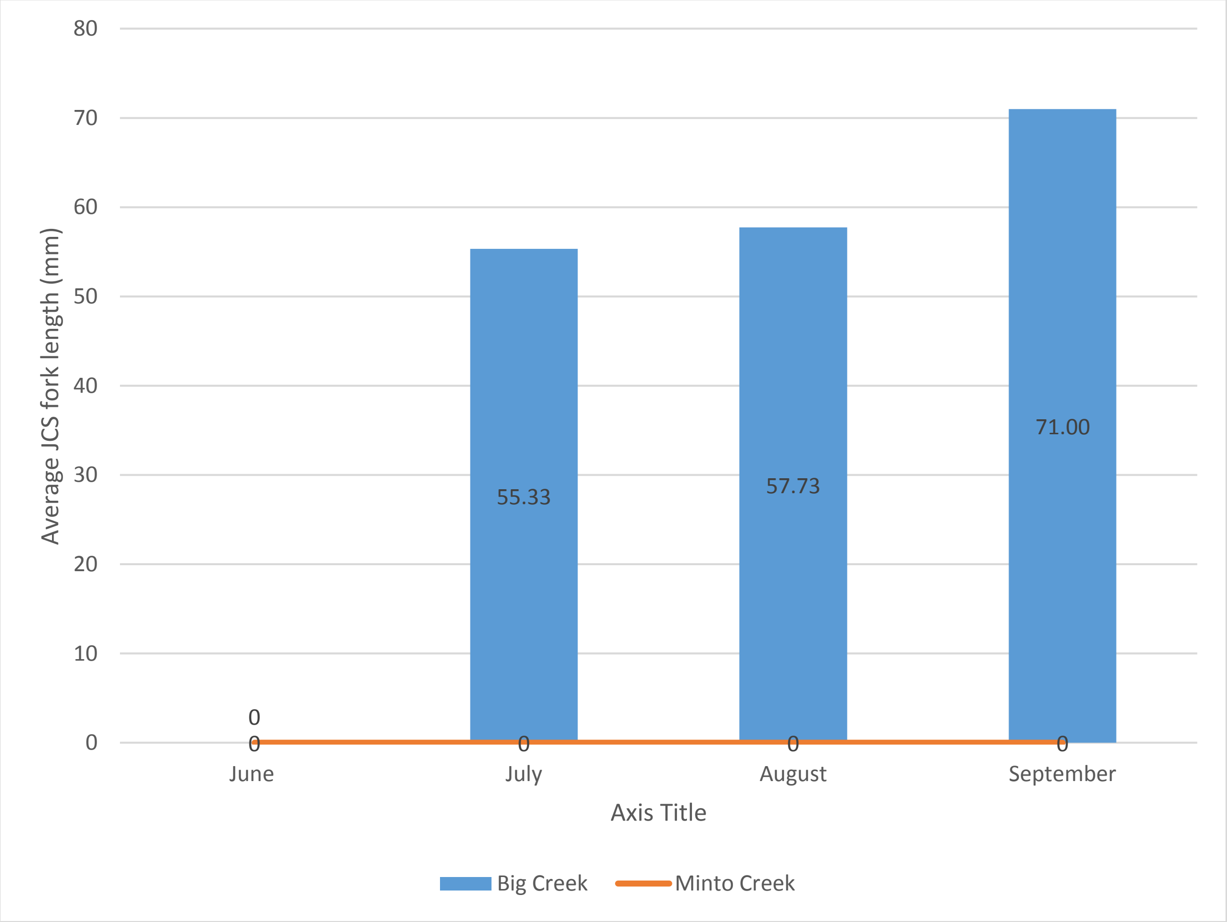


Figure 5: Average JCS length (fork) in Big Creek, 2017

5.3 Water Quality Parameters

In situ data was collected in Minto Creek at station W2, and Big Creek (bridge) during each site visit and results are summarized in Table 7. In situ data was also collected at the Yukon River (W4) during the June, July and September sampling events. In situ parameters were collected with a YSI Professional Plus multimeter, which was calibrated prior to each trip.

Table 7: In situ data from Minto Creek, Big Creek, and Yukon River, 2017

Site	Date	Time	Temperature (˚C)	Dissolved Oxygen (%)	Dissolved Oxygen (m/L)	Specific Conductance (µS/cm)	pH
Minto Creek	19-Jul-17	15:57	9.6	94.5	10.83	359.2	7.36
	16-Aug-17	14:50	6.7	100.6	12.27	379	7.5
	26-Sep-17	9:45	1.3	87.4	12.31	360.1	7.6
Big Creek	9-Jun-17	14:55	13	97.6	10.34	151.8	7.12
	19-Jul-17	16:27	12.8	101.1	10.69	173	7.36
	16-Aug-17	16:55	11.8	106.3	11.61	188.6	7.69
	26-Sep-17	15:05	3.5	100.8	13.38	177.3	7.76
Yukon River	9-Jun-17	15:30	14.2	105.3	10.75	119.2	7.42
	19-Jul-17	17:11	15	90.9	9.13	150.5	7.16
	26-Sep-17	14:50	8.3	94.8	11.14	158.1	8.03

Tidbit water temperature loggers were deployed in the Yukon River at station W4 (between the barge landing and the mouth of Minto Creek) and in Big Creek (near the bridge) during the open water season, while a continuous logger located at W1 records the water temperature and stage of lower Minto Creek.

Due to ice formation in early October 2017, the Tidbit logger at Big Creek was unable to be retrieved. The water temperature data for Big Creek was collected with a YSI Professional Plus multimeter during each of the sampling events.

Figure 6 presents the two temperature curves. This figure indicates that the temperatures of Minto Creek is generally colder than that of the Yukon River. The average difference in water temperature over this period between the Yukon River and Big Creek was 2.79°C, while the difference between Big Creek and Minto Creek was 5.29°C.

The 2017 data record does not indicate that the water temperature of Minto Creek equilibrated with that of the Yukon River during the 2017 open water season, although this has occasionally been observed to happen for a short period in June in the past. In 2013 for example, the maximum water temperature observed in Minto Creek was 15.7°C in late June, at which time the temperature of the Yukon River was very similar. In 2014 and 2015 however, the water temperature in Minto Creek did not exceed 10.6°C and 9.7°C respectively, and did not reach equilibrium with the Yukon River. In 2017 the maximum water temperature observed in Minto Creek was 13.1 °C.

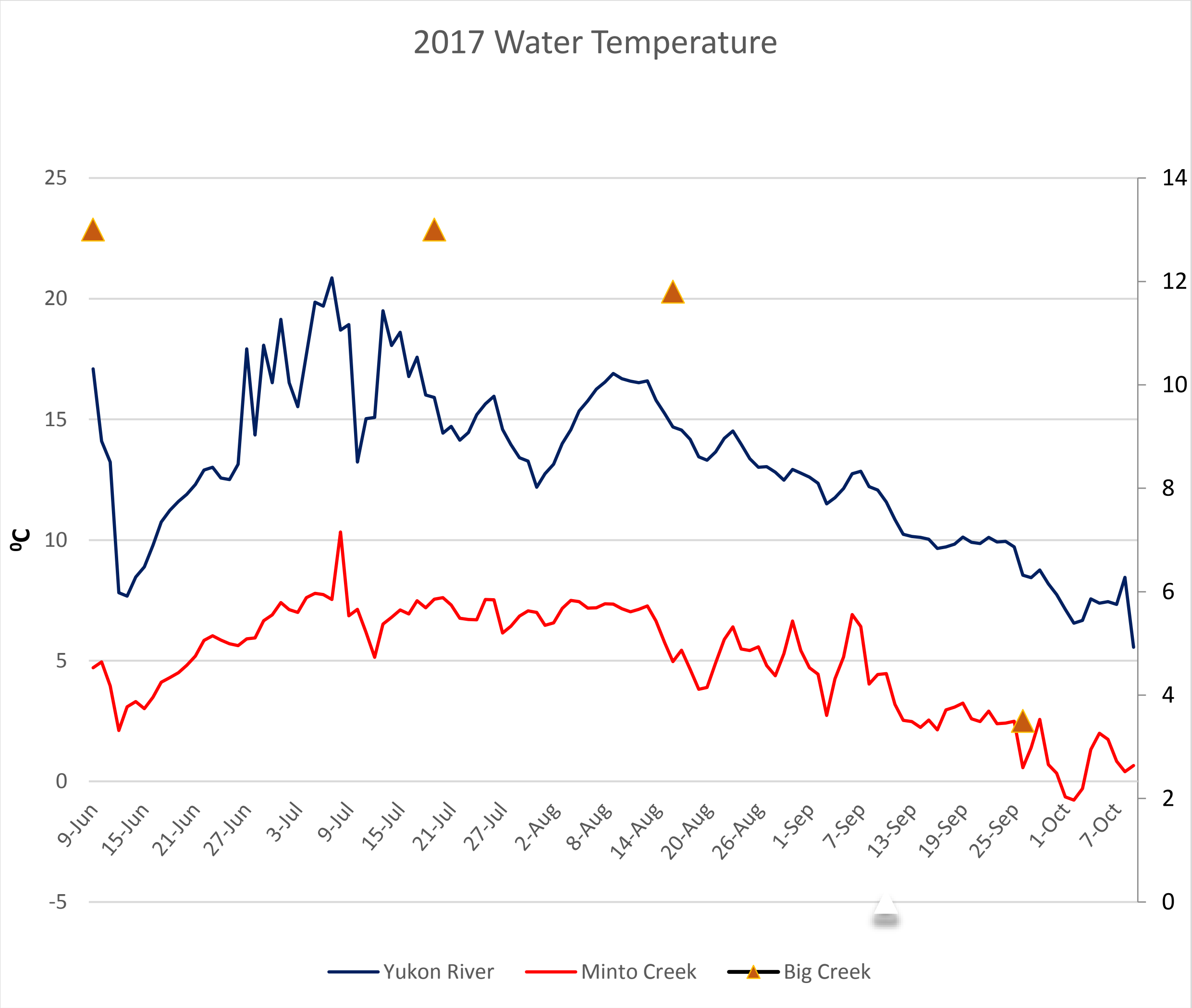


Figure 6: Water Temperature, Minto Creek and Yukon River, 2017

Turbidity in Minto Creek was noted to be higher in June due to a significant rain event. Figure 7 presents Total Suspended Solids (TSS) values measured at W2 from June 6th to September 26th, 2017; the dotted line indicates the decreasing trend.

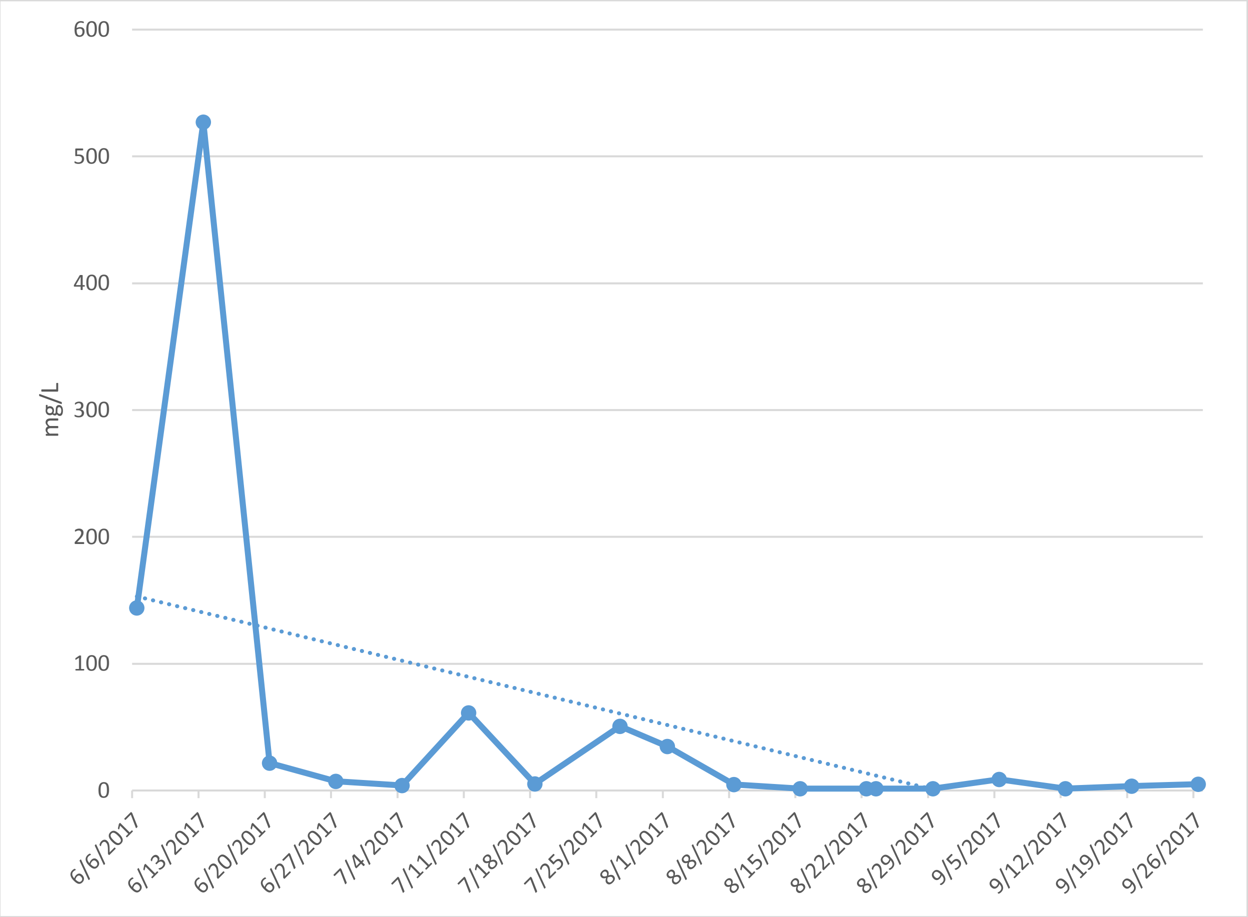


Figure 7: Total Suspended Solids (mg/L) measured at W2 in 2017

W2 TSS records for the open water season from 2011 to 2017 are presented in Figure 8 for comparison.

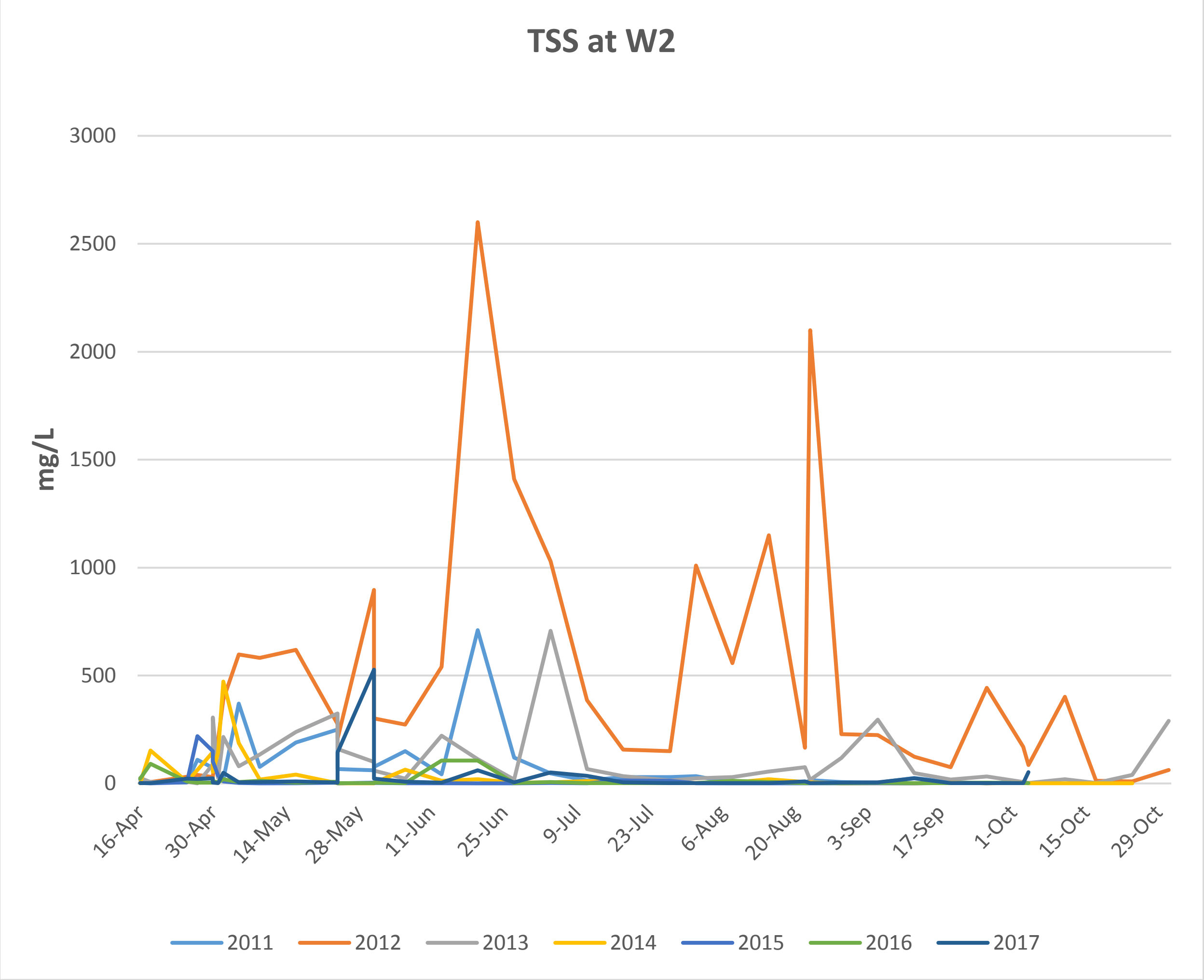


Figure 8: Total Suspended Solids (mg/L) measured at W2 during open water, 2011 to 2017

5.4 Stage and Discharge

The staff gauge located at W1 in Minto Creek was read during each trip, and discharge was measured at W1 with a Marsh McBirney Flo-Mate electromagnetic flow meter or a with a Hach FH950 electromagnetic flow meter. A continuously logging water level recorder is also located at W1.

Water levels and discharge for Minto Creek and Big Creek are presented in Table 8 below, for dates when fisheries surveys occurred. Big Creek values were obtained through the Water Survey of Canada on-line database (Water Survey Canada, 2017) and are subject to change as they have not yet been validated by Water Survey Canada.

Table 8: Stage and Discharge in Minto Creek and Big Creek, 2017

Date	Time (PDT)	Minto Creek		Big Creek	
		Stage (m)	Discharge (m^3/s)	Stage (m)	Discharge (m^3/s)
6/9/2017	17:00	0.270	0.040	6.329	14.8
7/19/2017	15:42	0.117	0.005	6.377	17.4
8/16/2017	15:15	0.122	0.006	6.186	8.21
9/26/2017	14:18	0.146	0.009	6.166	7.43

Figure 9 displays the continuous record available from April to early October in Minto Creek.

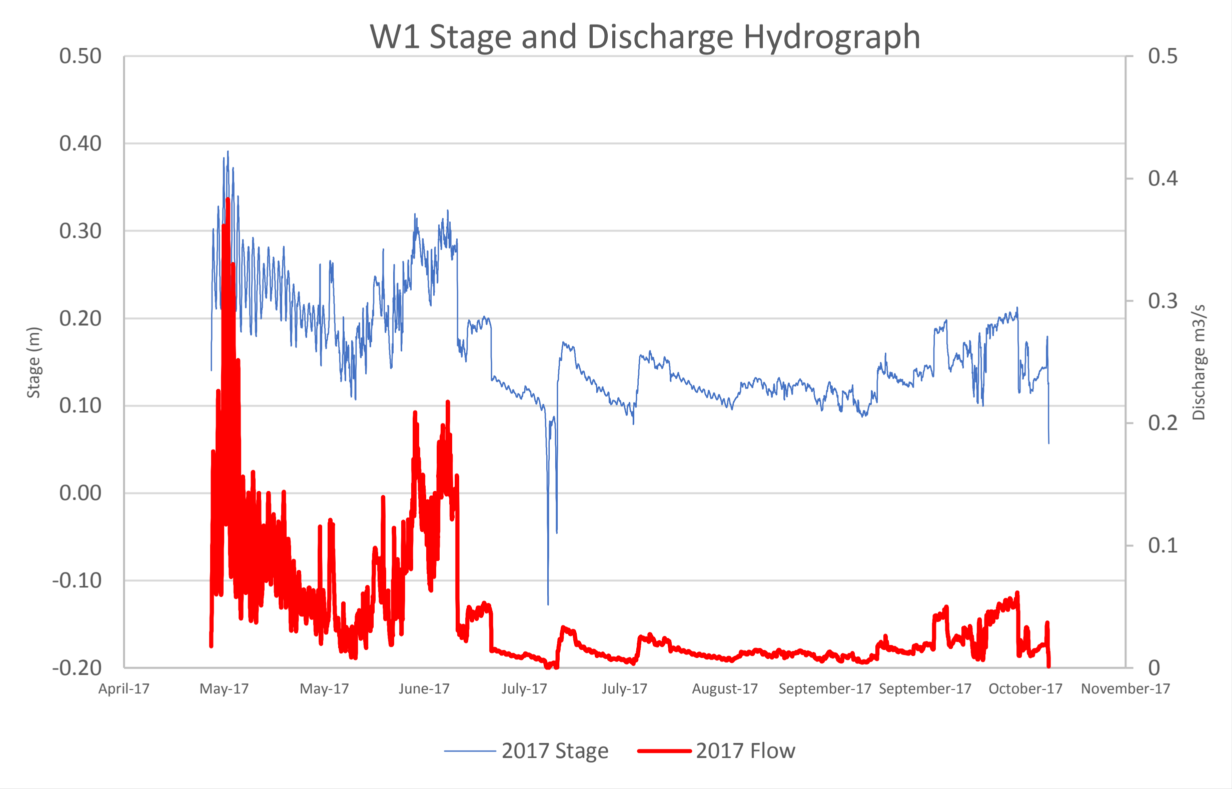


Figure 9 Stage and discharge in Minto Creek at monitoring station W1, 2017

The Big Creek hydrometric station (Water Survey of Canada station ID # 09AH003) is located downstream of the Minto access road bridge, near its confluence with the Yukon River, at the following coordinates: 62° 34' 07'' N; 137° 00' 58'' W. It records continuous water level and discharge. Figure 10 presents data from June to October 2017.

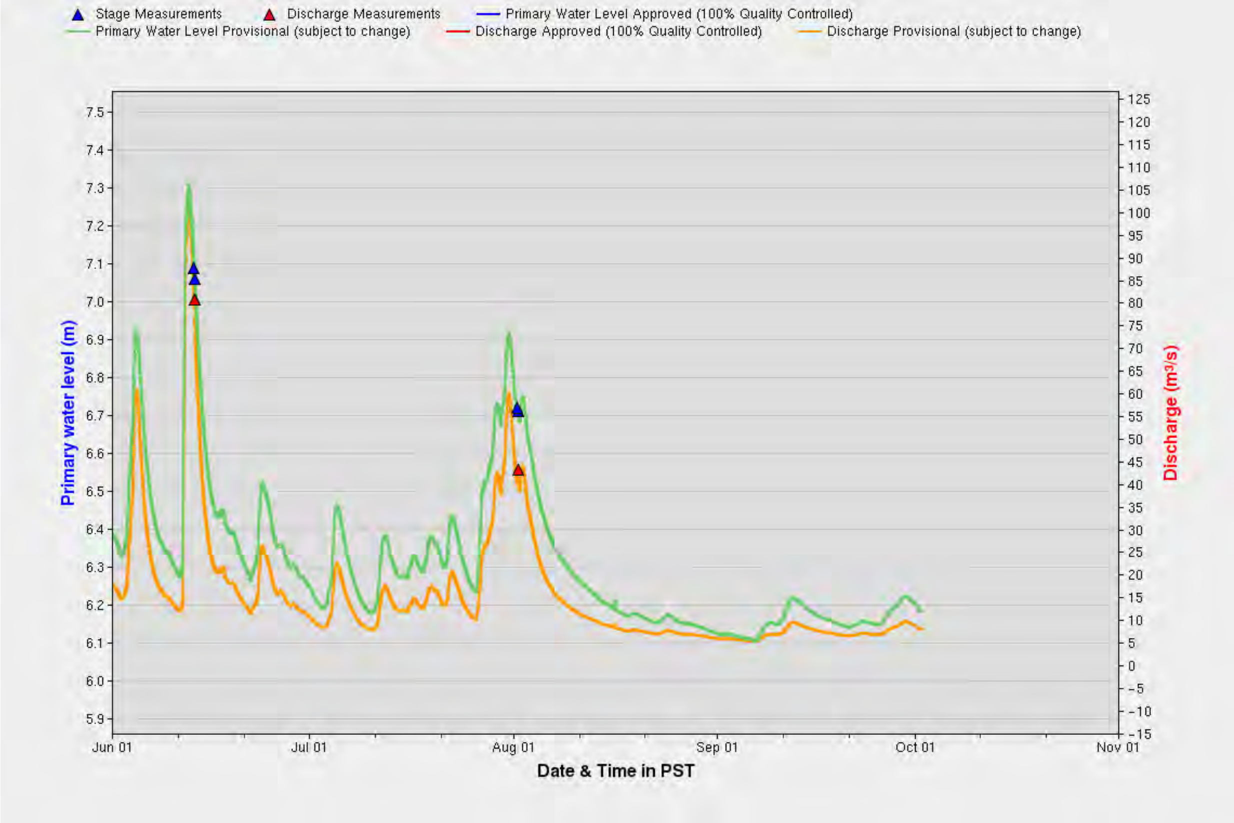


Figure 10: Water Level Discharge in Big Creek 2017 (Source: Water Survey of Canada, 2017)

5.5 Fish Barrier

The fish barrier located approximately 1.2 km upstream of the Yukon River (MCF-B1 on Figure 3), which was documented in previous years, was re-confirmed in 2017. Another fish barrier exists approximately 200m downstream of MCF-B1 at MCF-21. Fish use upstream of the barriers, which consists of a log jam (Figure 11), was assessed by setting traps upstream of it during each sampling event. No fish were captured upstream of the barrier during 2017.

Figure 11: Fish Barrier and Minnow Trap at MCF-B1

Figure 12: Fish barrier at MCF-21

6 Discussion

A section of lower Minto Creek (downstream of MCF-14) was dry during the July and August 2017 sampling events, preventing fish movement up the system. The period which this section of the creek was going dry is unknown, however this could have occurred on other occasions throughout the summer.

In 2017, no JCS were captured in Minto Creek during all sampling events. This may be related in part to the higher water temperatures observed in Big Creek and the lower temperatures observed in Minto Creek during this season. More generally this supports previous findings that JCS do not tend to enter Minto Creek (or Big Creek) until the water temperature has equilibrated with that of the Yukon River or reached a minimum threshold temperature, which was not observed in 2017.

The highest JCS catch per unit effort (CPUE) was observed in August in Big Creek. Figure 12 shows the CPUE trends since 2008 for JCS (Minnow trapping only) in Minto Creek and since 2012 in Big Creek. The average CPUE in Minto Creek has shown some variability since 2008 but has generally been relatively low. One exception is the year 2010 where the average CPUE in Minto Creek was 15.7 JCS/trap-day and some trapping events returned over 400 JCS. Those high numbers are thought to be associated with mine water discharge occurring throughout the open water season in Minto Creek that year (ACG, 2010), the more consistent temperature and flow regimes possibly acting as attractants to fish.

No fish were caught in Minto Creek in 2017. This could be explained by a section of the lower creek going dry in July and August, preventing fish movement up or down the creek, combined with a relatively low temperature profile in 2017. In some years, water temperature of Minto Creek and Yukon River reach equilibrium for a short period in June, however this did not happen from 2014 to 2017. In 2017, Minto Creek's maximum water temperature stayed below 11°C, whereas the Yukon River minimum temperature largely stayed above 11°C throughout the summer. The colder temperature profile of Minto Creek in 2017 may have deterred the movement of JCS into the system.

In Big Creek, the average CPUE for 2017 was the lowest recording since 2012. The CPUE was generally higher in Big Creek than in Minto Creek, except in 2013 where it was the opposite. A higher CPUE in Big Creek than in Minto Creek could be explained by the fact that Big Creek is a larger system, with a higher water temperature, generally providing better rearing conditions for JCS. The CPUE has also been noted as following the same trend within both Minto Creek and Big Creek since 2008.

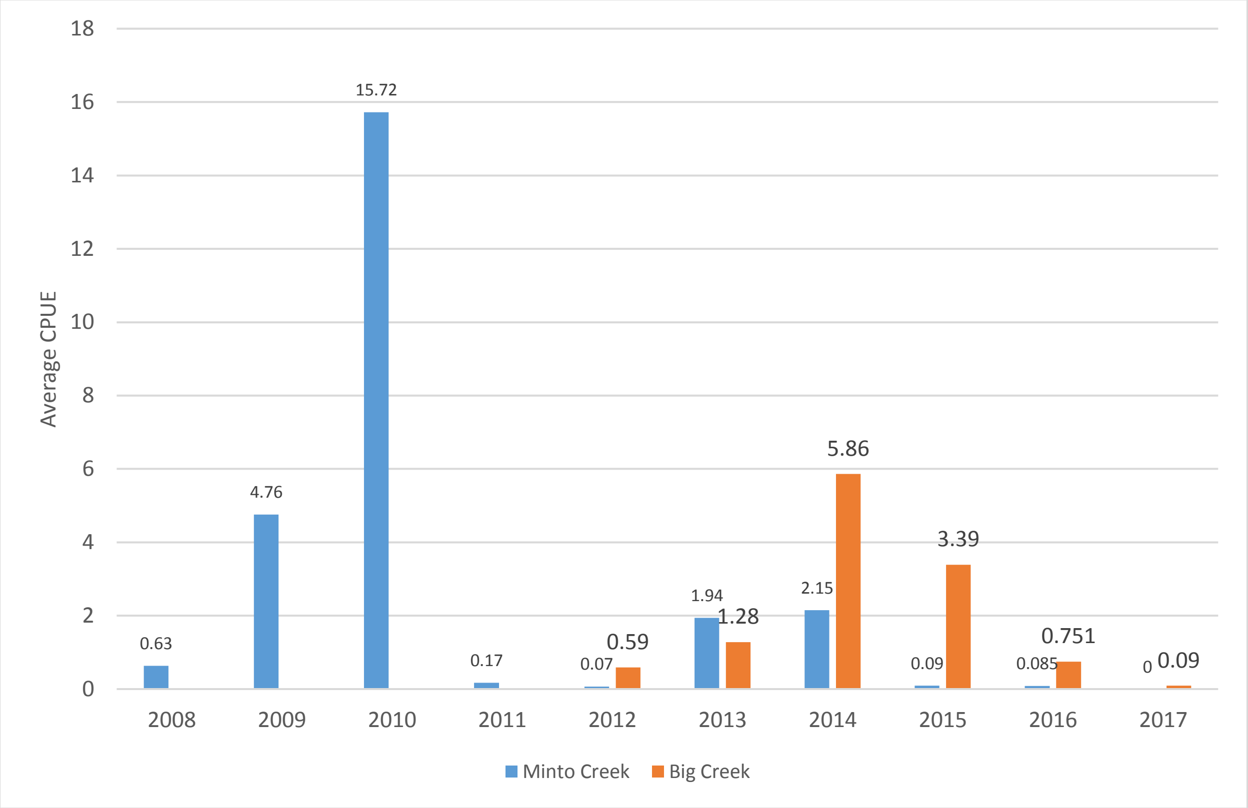


Figure 13: JCS Average CPUE, Minnow Trapping, Minto Creek (2008-2017), and Big Creek (2012-2017)

In 2009 and 2010, the mine was discharging water throughout the open water season into Minto Creek, causing higher and more consistent flow and temperature regimes in lower Minto Creek, conditions which may have been more attractive to JCS. Mine water discharge only occurred during spring freshet from 2012 to 2015 and no discharge occurred in 2011. In 2016 the new permitted discharge rate (Q_{EFF}), as per the WUL QZ14-031, was calculated as follows:

a) Initial discharge rate: $1/3\ (Q_{MC}+Q_{RO})\geq Q_{EFF\text{-}c}$
b) Rate after discharge has commenced: $1/3\ (Q_{MC}+Q_{RO}\ -Q_{EFF\text{-}M})\geq Q_{EFF\text{-}c}$

Where:

Q_{MC} = daily flow rate in Lower Minto Creek (represented by either W1 or MC1),
Q_{RO} = daily flow rate of discharged from the RO
$Q_{EFF\text{-}M}$ = measured daily rate of discharge from mine site
$Q_{EFF\text{-}C}$ = calculated rate of water discharge from mine site

In 2017 Minto mine was discharging throughout the open water season. However, this year's discharge was at much lower rates than in 2009 and 2010 because of the new discharge formula.

Following a forest fire in 2010, more sediment entered Minto Creek through runoff in 2011 and 2012, thereby increasing turbidity. A small landslide was also documented by Minto personnel in an upstream tributary in May 2012, likely contributing to high TSS levels observed downstream. The elevated turbidity may have deterred fish from entering Minto Creek. Average TSS values at W2 in 2016 were the lowest since 2011, with the highest being observed in 2012 (see Appendix C for details). Average TSS values at W2 in 2017 were the lowest since 2011, with the highest being observed in 2012 (see Figure 8 for details). Turbidity and TSS did not likely influence fish presence or absence in Minto Creek in 2017 as values remained low throughout the season.

The natural fish barrier identified in Minto Creek in previous years was again confirmed in 2017, as well as a second natural fish barrier 200m downstream. Therefore, the area of usable fish habitat in Minto Creek is limited to the lower 1 km of the creek.

Aerial surveys for spawning fish were carried out in the vicinity of the Minto Creek/Yukon River confluence from 2010 to 2014 and no spawning activity was ever observed or suspected. Bottom substrate in the confluence area consists primarily of silt and mud which is not suitable substrate for salmon spawning.

7 References

Capstone Mining (MEL), 2015. *Fisheries Monitoring Program – Minto Creek, 2016 Summary Report*.

Alexco Environmental Group (AEG), 2015. *Fisheries Monitoring Program – Minto Creek, 2015 Summary Report*.

Access Consulting Group, 2014a. *Fisheries Monitoring Program – Minto Creek, 2014 Summary Report*.

Access Consulting Group, 2014b. *Fisheries Monitoring Program – Minto Creek, 2013 Summary Report*.

Access Consulting Group, 2013. *Fisheries Monitoring Program – Minto Creek, 2012 Summary Report*.

Access Consulting Group, 2011. *Fisheries Monitoring Program – Minto Creek, 2011 Summary Report*.

Access Consulting Group. 2010. *Juvenile Chinook Salmon Mark/Recapture Study Minto Creek, 2010,– Draft Report.*

Access Consulting Group (Access). 2009. *Minto Creek Fish Relocation Project. September 29 – October 2, 2009; October 12 – 14, 2009.* Letter Report.

B.C. Fisheries Information Service Branch for the Resource Inventory Committee. 2001. *Fish and Fish Habitat Inventory: Standards and Procedures. Version 2.0*. April 2001.

Hallam Knight Piesold Ltd. 1994. *Minto Project, Initial Environmental Evaluation, Supporting Volume II, Environmental Setting*. Prepared for Minto Explorations Ltd. May 1994.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2009. *Environmental Effects Monitoring First Interpretive Report, Minto Project, Yukon Territory*. Prepared for Minto Explorations Ltd. January 2009.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2012. *Minto Mine Cycle 2 Environmental Effects Monitoring*. Prepared for Minto Explorations Ltd. January 2012

R&D Environmental. 2006. *Fisheries Assessment of Minto Creek,* September 2006. Prepared for the Access Consulting Group.

R&D Environmental. 2007. *Fisheries Assessment of Minto Creek, May, June and August 2007*. Prepared for the Access Consulting Group.

Water Survey of Canada. 2015. *BIG CREEK NEAR THE MOUTH [YT] (09AH003). Real-time data* - subject to change. Copyright Environment Canada (2015).

http://wateroffice.ec.gc.ca/report/report_e.html?type=realTime&stn=09AH003

Appendix A - 2017 Photo Log

June 2017 Big Creek

June 2017 Big Creek

June 2017 Slimy Sculpin Big Creek

June 2017 MCF21

July 2017 Deceased JCS at Big creek

July 2017 Juvenile Burbot (Big Creek)

July 2017 BC2

July 2017 MCF-14 dry

July 2017 MCF-12 dry

August 2017 fish barrier @ MCF-21

August 2017 JCS from Big creek

August 2017 MCF-15 Fish Trap

August 2017 Slimy Sculpin at Big creek

September 2017 JCS at Big Creek

September 2017 BC2 fish trap

September 2017 Burbot at Big Creek

Appendix B - Fish Data, Minto Creek and Big Creek, 2017

Fish Data

Date	Location	Location Code	Samplers	Species	Length (mm)	Weight (g)	Fate	Sex	Maturity	Age
2017/Jun/10	Big Creek	BC1	SR/SB	CCG	53	2.09	Released (good)	Unknown	Immature	Juvenile
2017/Jun/10	Big Creek	BC2	SR/SB	CCG	52	2.01	Released (good)	Unknown	Immature	Juvenile
2017/Jun/10	Big Creek	BC2	SR/SB	CCG	59	3.31	Released (good)	Unknown	Immature	Juvenile
2017/Jun/10	Big Creek	BC2	SR/SB	CCG	56	1.63	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC1	CH/CP	CH	48	2.07	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC1	CH/CP	CH	51	2.22	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC2	CH/CP	CH	63	3.32	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC2	CH/CP	BB	148	21.64	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC3	CH/CP	CH	55	2.73	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC3	CH/CP	CH	55	2.72	Released (good)	Unknown	Immature	Juvenile
2017/Jul/20	Big Creek	BC3	CH/CP	CH	60	3.73	Deceased	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	59	3.42	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	52	2.48	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	61	3.87	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	58	3.2	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	51	2.35	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	51	2.51	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	68	4.59	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	65	4.5	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	55	3.68	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC1	CH/CP	CH	57	3.48	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC4	CH/CP	CCG	48	1.05	Released (good)	Unknown	Immature	Juvenile
2017/Aug/17	Big Creek	BC4	CH/CP	CH	58	2.93	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC1	CH/EB	CCG	35	0.72	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC1	CH/EB	CH	78	6.45	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC1	CH/EB	CH	59	2.62	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC3	CH/EB	CH	80	5.34	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC3	CH/EB	CH	71	4.79	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC3	CH/EB	CH	73	5.74	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC3	CH/EB	CH	85	9.72	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC3	CH/EB	CH	73	5.96	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC4	CH/EB	BB	101	7.39	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC4	CH/EB	CH	65	5.1	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC4	CH/EB	CH	64	4.17	Released (good)	Unknown	Immature	Juvenile
2017/Sep/25	Big Creek	BC4	CH/EB	CH	62	3.96	Released (good)	Unknown	Immature	Juvenile

Data Summary

ID	Licence Or Ref. No.	Corporation	Sampler Or Data Collectors	Collection Date (YYYY-MMM-DD)	Waterbody Name	Wateshed Code	Waterbody ID (Lakes)	Upper Latitude (Decimal Degree eg. 62.82527)	Upper Longitude (Decimal Degree eg. -137.62750)	Lower Latitude	Lower Longitude	Species (see look-up tab)	Lifestage	Number Captured	Number Retained	Number Of Incidental Mortalities	Capture Method	Effort	Unit of Measure	Comments
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Shelby Black Shaun Roberts	2017/Jun/10	Big Creek	80080623801957		62.598706	-137.013264			CCG	juvenile	4	0	0	MT	92	hr	4 traps
XR154-2017-2	XR154-2017-2	Capstone Mining Corp.	Shelby Black Shaun Roberts	2017/Jun/10	Minto Creek	800803912		62.65442	-137.0929558			n/a	n/a	0	0	0	MT	320	hr	14 traps
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Colin Prentice	2017/Jul/20	Big Creek	80080623801957		62.598706	-137.013264			BB	juvenile	1	0		MT	68.55	hr	3 traps
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Colin Prentice	2017/Jul/20	Big Creek	80080623801957		62.65442	-137.0929558			CH	juvenile	6	0	1	MT	68.55	hr	3 traps
XR154-2017-2	XR154-2017-2	Capstone Mining Corp.	Chris Harry Colin Prentice	2017/Jul/20	Minto Creek	800803912		62.65442	-137.0929558			n/a	n/a	0	0	0	MT	139.9	hr	6 traps placed
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Colin Prentice	2017/Aug/17	Big Creek	80080623801957		62.598706	-137.013264			CH	juvenile	11	0	0	MT	66.6	hr	3 traps
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Colin Prentice	2017/Aug/17	Big Creek	80080623801957		62.598706	-137.013264			CCG	juvenile	1	0	0	MT	66.6	hr	3 traps
XR154-2017-2	XR154-2017-2	Capstone Mining Corp.	Chris Harry Colin Prentice	2017/Aug/17	Minto Creek	800803912		62.65442	-137.0929558			n/a	n/a	0	0	0	MT	272.4	hr	12 traps placed
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Emilie Bouchard	2017/Sep/25	Big Creek	80080623801957		62.598706	-137.013264			CCG	juvenile	1	0	0	MT			4 traps placed
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Emilie Bouchard	2017/Sep/25	Big Creek	80080623801957		62.598706	-137.013264			BB	juvenile	1	0	0	MT			4 traps placed
XR154-2017-1	XR154-2017-1	Capstone Mining Corp.	Chris Harry Emilie Bouchard	2017/Sep/25	Big Creek	80080623801957		62.598706	-137.013264			CH	juvenile	10	0	0	MT			4 traps placed
XR154-2017-1	XR154-2017-2	Capstone Mining Corp.	Chris Harry Emilie Bouchard	2017/Sep/25	Minto Creek	800803912		62.65442	-137.0929558			n/a	n/a							

Net Times

Site	Date Set	Set	Date Pulled	Pulled	Net Time
BC1	6/9/2017	14:55	6/10/2017	14:06	23
BC2	6/9/2017	15:00	6/10/2017	14:12	23
BC3	6/9/2017	15:10	6/10/2017	14:22	23
BC4	6/9/2017	15:15	6/10/2017	14:25	23
MCF12	6/9/2017	15:50	6/10/2017	14:48	23
MCF13	6/9/2017	15:55	6/10/2017	14:50	23
MCF14	6/9/2017	16:00	6/10/2017	14:54	23
MCF15	6/9/2017	16:18	6/10/2017	15:06	23
MCF16	6/9/2017	16:30	6/10/2017	15:09	23
MCF26	6/9/2017	16:35	6/10/2017	15:20	23
MCF17	6/9/2017	16:40	6/10/2017	16:31	24
MCF18	6/9/2017	16:50	6/10/2017	16:25	24
MCF W1	6/9/2017	16:55	6/10/2017	16:26	24
MCF19	6/9/2017	17:20	6/10/2017	16:17	23
MCF20	6/9/2017	17:25	6/10/2017	16:13	23
MCF21	6/9/2017	17:30	6/10/2017	16:10	23
MCF22	6/9/2017	17:34	6/10/2017	15:34	22
MCF23	6/9/2017	17:35	6/10/2017	15:36	22
BC1	7/19/2017	16:29	7/20/2017	15:33	23.1
BC2	7/19/2017	16:22	7/20/2017	15:03	22.7
BC3	7/19/2017	16:25	7/20/2017	15:13	22.8
MCF15	7/19/2017	14:24	7/20/2017	13:46	23.4
MCF17	7/19/2017	14:35	7/20/2017	14:00	23.4
MCF20	7/19/2017	14:49	7/20/2017	14:44	23.9
MCF22	7/19/2017	15:00	7/20/2017	14:23	23.4
MCF B1	7/19/2017	15:18	7/20/2017	14:17	23.0
MCF24	7/19/2017	15:24	7/20/2017	14:14	22.8
MCF14	8/16/2017	14:41	8/17/2017	13:14	22.5
MCF15	8/16/2017	14:33	8/17/2017	13:39	23.1
MCF16	8/16/2017	14:30	8/17/2017	13:41	23.2
MCF17	8/16/2017	15:15	8/17/2017	14:36	23.3
MCF18	8/16/2017	15:19	8/17/2017	14:31	23.2
MCF19	8/16/2017	15:30	8/17/2017	14:36	23.1
MCF20	8/16/2017	15:40	8/17/2017	14:25	22.7
MCF21	8/16/2017	16:08	8/17/2017	14:15	22.1
MCF22	8/16/2017	15:45	8/17/2017	14:21	22.6
MCF-B1	8/16/2017	16:15	8/17/2017	15:03	22.8

Site	Date Set	Set	Date Pulled	Pulled	Net Time
MCF24	8/16/2017	16:23	8/17/2017	14:13	21.8
MCF27	8/16/2017	16:27	8/17/2017	14:15	21.8
BC1	8/16/2017	16:55	8/17/2017	15:03	22.1
BC2	8/16/2017	16:57	8/17/2017	15:09	22.2
BC3	8/16/2017	17:00	8/17/2017	15:15	22.2
MCF12	9/25/2017	14:06	9/26/2017	9:26	19.3
MCF13	9/25/2017	14:11	9/26/2017	9:28	19.3
MCF14	9/25/2017	14:15	9/26/2017	9:32	19.3
MCF15	9/25/2017	14:23	9/26/2017	9:39	19.3
MCF25	9/25/2017	14:27	9/26/2017	13:39	23.2
MCF27	9/25/2017	14:51	9/26/2017	13:50	23.0
MCF24	9/25/2017	14:56	9/26/2017	13:54	23.0
MCF-B1	9/25/2017	15:00	9/26/2017	13:57	23.0
MCF-22	9/25/2017	15:09	9/26/2017	14:02	22.9
MCF-21	9/25/2017	15:14	9/26/2017	14:07	22.9
MCF-20	9/25/2017	15:18	9/26/2017	14:10	22.9
MCF-18	9/25/2017	15:31	9/26/2017	14:27	22.9
MCF-17	9/25/2017	15:37	9/26/2017	14:32	22.9
MCF-26	9/25/2017	15:41	9/26/2017	14:34	22.9
BC1	9/25/2017	15:58	9/26/2017	14:56	23.0
BC2	9/25/2017	16:02	9/26/2017	15:09	23.1
BC3	9/25/2017	16:05	9/26/2017	15:13	23.1
BC4	9/25/2017	16:08	9/26/2017	15:17	23.2

Monthly Report Tables

August

Site	# Traps	Date and Time In	Date and Time Out	Soak Time (hrs)	Results	Species	Length (mm)	Weight (g)
BC1	1	8/16/2017 16:55	8/17/2017 15:03	22.1	10	CH	59	3.42
						CH	52	2.48
						CH	61	3.87
						CH	58	3.2
						CH	51	2.35
						CH	51	2.51
						CH	68	4.59
						CH	65	4.5
						CH	55	3.68
						CH	57	3.48
BC3	1	8/16/2017 17:00	8/17/2017 15:15	22.2	2	CCG	48	1.05
						CH	58	2.93

Site	# Traps	Date and Time In	Date and Time Out	Soak Time	Results
MCF14	1	8/16/2017 14:41	8/17/2017 13:14	22.5	0
MCF15	1	8/16/2017 14:33	8/17/2017 13:39	23.1	0
MCF16	1	8/16/2017 14:30	8/17/2017 13:41	23.2	0
MCF17	1	8/16/2017 15:15	8/17/2017 14:36	23.3	0
MCF18	1	8/16/2017 15:19	8/17/2017 14:31	23.2	0
MCF19	1	8/16/2017 15:30	8/17/2017 14:36	23.1	0
MCF20	1	8/16/2017 15:40	8/17/2017 14:25	22.7	0
MCF21	1	8/16/2017 16:08	8/17/2017 14:15	22.1	0
MCF22	1	8/16/2017 15:45	8/17/2017 14:21	22.6	0
MCF-B1	1	8/16/2017 16:15	8/17/2017 15:03	22.8	0
MCF24	1	8/16/2017 16:23	8/17/2017 14:13	21.8	0
MCF27	1	8/16/2017 16:27	8/17/2017 14:15	21.8	0

Site	Date	Time	Water Temp (°C)	DO (%)	DO (mg/L)	pH	ORP (mV)
Big Creek (BC1)	8/16/2017	16:55	11.8	106.3	11.61	7.69	160.9
Minto Creek (W2)	8/16/2017	14:50	6.7	100.6	12.27	7.5	182.2

Date	Time	Water Level (m)	Discharge (m3/s)
8/16/2017	15:15	0.122	0.006

September

Site	# Traps	Date and Time In	Date and Time Out	Soak Time (hrs)	Results	Species	Length (mm)	Weight (g)
BC1	1	9/25/2017 15:58	9/25/2017 14:56	23	3	CCG	35	0.72
						CH	78	6.45
						CH	59	2.62
BC3	1	9/25/2017 16:05	9/26/2017 15:13	23.1	5	CH	80	5.34
						CH	71	4.79
						CH	73	5.74
						CH	85	9.72
						CH	73	5.96
BC4	1	9/25/2017 16:08	9/26/2017 15:17	23.2	4	BB	101	7.39
						CH	65	5.1
						CH	64	4.17
						CH	62	3.96

Site	# Traps	Date and Time In	Date and Time Out	Soak Time	Results
MCF12	1	9/25/2017 14:06	9/26/2017 9:26	19.3	0
MCF13	1	9/25/2017 14:06	9/26/2017 9:28	19.3	0
MCF14	1	9/25/2017 14:06	9/26/2017 9:32	19.3	0
MCF15	1	9/25/2017 14:06	9/26/2017 9:39	19.3	0
MCF25	1	9/25/2017 14:27	9/26/2017 13:39	23.2	0
MCF27	1	9/25/2017 14:51	9/26/2017 13:50	23.0	0
MCF24	1	9/25/2017 14:56	9/26/2017 13:54	23.0	0
MCF-B1	1	9/25/2017 15:00	9/26/2017 13:57	23.0	0
MCF-22	1	9/25/2017 15:09	9/26/2017 14:02	22.9	0
MCF-21	1	9/25/2017 15:14	9/26/2017 14:07	22.9	0
MCF-20	1	9/25/2017 15:18	9/26/2017 14:10	22.9	0
MCF-18	1	9/25/2017 15:31	9/26/2017 14:27	22.9	0
MCF-17	2	9/25/2017 15:37	9/26/2017 14:32	22.9	0
MCF-26	3	9/25/2017 16:02	9/26/2017 15:09	22.9	0

Site	Date	Time	Water Temp (^{o}C)	DO (%)	DO (mg/L)	pH	ORP (mV)
Big Creek (BC1)	9/26/2017	15:05	3.5	100.8	13.38	7.76	207.7
Minto Creek (W2)	9/26/2017	14:50	1.3	87.4	12.31	7.6	192.6
Yukon River (W4)	9/26/2017	9:45	8.3	94.8	11.14	8.03	203.9

Date	Time	Water Level (m)	Discharge (m3/s)
9/26/2017	14:18	0.146	0.009

CPUE

Month	Total net times MC	Total net times BC	CH Caught BC	CH Caught MC	CCG caught BC	CCG caught MC	BB Caught BC	BB Caught MC	CH CPUE BC	CH CPUE MC	CCG CPUE BC	CCG CPUE MC	BB CPUE BC	BB CPUE MC
June	320	93	0	0	4	0	0		0			0		
July	140	69	6	0	0	0	1		0.087527352	0	0		0.014587892	
August	272.4	66.6	11	0	1	0	0	0	0.165165165	0	0.015015015	0	0	0
September	306.6	92.4	10	0	1	0	1	0	0.108225108	0	0.010822511	0	0.010822511	0
									0.090229406	0	0.008612509	0	0.008470134	0

Appendix M – Copper Toxicity in Turbid Flow Report (Minnow)

minnow environmental inc.
A Trinity Consultants Company

January 31, 2018

Mr. Ryan Herbert
Environmental Manager
Capstone Mining Corporation - Minto Mine
PO Box 11
Whitehorse Central PO
Whitehorse, Yukon, Y1A 2V3

Dear Mr. Herbert,

Re: Turbid Flow Water Toxicity Testing to Verify the Minto Mine Water Quality Objective for Copper in Minto Creek

This brief letter report provides a summary and interpretation of the results of toxicity testing undertaken to verify the Minto Mine's water quality objective (WQO) for copper in lower Minto Creek. As required under the Minto Mine Water Use Licence (WUL; QZ14-031), turbid flow conditions were tested (on a sample collected in early May 2017).

Background

In August 2015, the Yukon Water Board (YWB) issued an amended WUL to the Minto Mine that included a WQO of 20 µg/L dissolved copper when dissolved organic carbon (DOC) concentrations exceed 10 mg/L and 13 µg/L dissolved copper when DOC concentrations are 10 mg/L or lower[1] (YWB 2015). The amended WUL also included Clause 105 stipulating that "the licensee shall complete the study generally described in the document entitled Study Plan for Evaluating the Toxicity of Copper to Selected Aquatic Organisms in Minto Creek Water Version 3 and shall submit the results to the Board by March 31, 2017 for Review and Approval." The Study Plan (Appendix A) was designed by MacDonald Environmental Sciences Limited (MESL) and reviewed by Minnow Environmental Inc. (Minnow) prior to a YWB public hearing in March 2015.

The Study Plan was designed to determine if the WQO is protective of sensitive organisms and endpoints (survival, growth, and reproduction) under a range of water quality conditions. The Study Plan includes laboratory testing with site water collected during clear and turbid flow

---

[1] WQOs apply at Station W2 in lower Minto Creek when water is flowing at the mine site (Stations W15 and W35) and apply to water leaving the site at Station W16 when there is no flow at Stations W15 and W35 (see Figure 1 for station locations). The former condition is the focus of this document, as WQOs are intended to be protective of lower Minto Creek.

conditions. Clear flow is defined as flowing water with less than 25 mg/L total suspended solids (TSS) and turbid flow as flowing water with greater than 25 mg/L TSS.

Minto's WQO for copper was based on evaluations which identified high background copper concentrations and high concentrations of DOC (approximately 12 mg/L, on average) which is known to limit the bioavailability and toxicity of copper. Minto's WQO for copper was based on a combination of background concentration characterization (e.g., Minnow 2009), toxicity testing in site water (e.g., Minnow 2009), application of scientific literature-based quantitative relationships between copper toxicity and DOC, biotic ligand modelling (e.g., Minnow 2009, 2013, 2014) and testing of potential effects to fish olfaction (Kennedy et al. 2012). The WQO was supported through the Yukon Environmental and Socio-economic Assessment Board (YESAB) environmental assessment, when independent evaluation suggested that 40 µg/L could potentially be used as the WQO for copper in lower Minto Creek (Ecometrix 2014).

In late September 2015, copper toxicity testing was conducted under clear flow conditions. A downward revision of WQO was unnecessary since there were no endpoints for which the 20th percentile effect concentration was below 20 µg/L and the 20 µg/L (or lower) copper concentration treatments also differed significantly from the laboratory control (Minnow 2016).

Methods

Site water for turbid flow testing was collected on May 5th 2017 from lower Minto Creek (W2) and the water storage pond (WSP; W16; Figure 1). The original decision path developed for the Study Plan implementation guided the timing of collection (Figure 2; Minnow 2015). Appropriate turbid flow conditions did not occur in 2016 (due, at least in part, to a mild snow melt/spring freshet). The water collected on May 5th 2017 arrived at the Nautilus Environmental (Nautilus) toxicity testing laboratory (Calgary, AB) on May 12th, 2017. A 3:1 ratio of Minto Creek water to effluent (W2:W16) was mixed at the laboratory. This ratio mimics the expected ratio at maximum effluent discharge. In accordance with the Study Plan (Appendix A) and standard protocols (Appendix B - Nautilus 2017), four long-term (i.e., chronic) static-renewal toxicity tests were completed:

- a 48-h rotifer (*Brachionus calyciflorus*) toxicity test (intrinsic rate of population increase);
- a 21-d cladoceran (*Daphnia magna*) toxicity test (survival, reproduction);
- a 32-d fathead minnow (*Pimephales promelas*) toxicity test (hatching success, total post-hatch survival, overall survival, length, and biomass); and

- a 42-d amphipod (*Hyalella azteca*) toxicity test (survival, growth[2], and reproduction).

Mixed site water was spiked with copper at the following nominal copper concentrations: 5, 10, 20, 40, 80, and 160 µg/L (Appendix B - Nautilus 2017). Each test evaluated the six exposure concentrations, an un-spiked mixed site water control, and a laboratory control. Dissolved and total copper concentrations were measured in all test vessels on a weekly basis. Major ions (calcium, magnesium, potassium, sodium, sulphate, and chloride) and alkalinity were measured in the site and laboratory control waters, and DOC was measured in the mixed site water control (Appendix B – Nautilus 2017).

Lethal concentrations (LC) or inhibitory concentrations (IC) were determined for all 13 endpoints associated with the four toxicity tests. All LC and IC values were calculated at the 10th, 20th, and 50th percentiles (Appendix B – Nautilus 2017). Mean survival, growth, and/or reproduction associated with each treatment was statistically contrasted with the laboratory control. Criteria for interpreting suitability of the WQO were defined a-priori (MESL 2015). The WQO for copper is considered protective if 20th percentile effect concentrations (LC20 and IC20) are greater than 20 µg/L and endpoints (i.e., survival, growth, and/or reproduction) associated with copper concentrations of 20 µg/L (and lower) do not differ significantly from those of the control ($p = 0.05$; Appendix A). Conversely, if one or more of the 20th percentile effect concentrations is less than or equal to 20 µg/L and that endpoint (or those endpoints) associated with copper concentrations of 20 µg/L (or lower) also differ significantly from the control ($p = 0.05$), the WQO would be revised downward to establish a level protective of aquatic organisms in site water (Appendix A).

Results

The mean concentration of DOC in mixed test waters collected on May 5, 2017 (29.1 ± 3.0 mg/L) was higher than 10 mg/L, and therefore the objective of 20 µg/L of dissolved copper would apply as outlined in Minto's WUL.

Evaluation of toxicity test results as reported in Appendix B (Nautilus 2017) indicated that the 20th percentile effect concentrations were well above the SSWQO of 20 µg/L dissolved copper for 12 of 13 endpoints (Table 1 and Figure 3). The IC20 for "intrinsic rate of population increase" of *B. calyciflorus* was 150 µg/L dissolved copper (161 µg/L total; Table 1). Only the highest exposure concentration (168 µg/L dissolved copper; 180 µg/L total) resulted in a growth rate significantly lower than the laboratory control (Appendix B – Nautilus 2017). *D. magna* survival and reproduction LC20s and IC20s were greater than the highest concentration tested

---

[2] Survival and growth of *Hyalella azteca* were evaluated after 28-days and after 42-days

(nominally 160 µg/L and measured as 149 µg/L dissolved copper and 167 µg/L total copper) and neither survival nor reproduction in any treatment differed from the laboratory control (Table 1). Similarly, all five endpoints for *P. promelas* yielded LC20 or IC20 values greater than the highest concentration tested (nominally 160 µg/L and measured as either 144 µg/L or 158 µg/L dissolved copper and 168 µg/L or 170 µg/L total copper) and neither survival nor growth in any treatment differed from the laboratory control (Table 1). *H. azteca* survival LC20 was also greater than the highest concentration tested in 28-day and in 42-day exposures, and there were no significant differences between any of the treatments and the laboratory control (Table 1; Appendix B – Nautilus 2017). The IC20 for *H. azteca* biomass was 97.0 µg/L dissolved copper (106 µg/L total) in the 28-day exposure and 96.6 µg/L dissolved copper (102 µg/L total) in the 42-day exposure (Table 1). The only treatment that differed significantly from the laboratory control (over both exposure durations) was the nominal 160 µg/L treatment (measured as 154 µg/L dissolved and 167 µg/L total in the 28-day exposure and 160 µg/L dissolved and 169 µg/L total in the 42-day exposure; Table 1; Appendix B – Nautilus 2017).

The reproductive endpoint in the 42-day test of *H. azteca* was the most sensitive endpoint and was the only endpoint (as reported in Appendix B – Nautilus 2017) with a reported IC20 lower than the SSWQO of 20 µg/L (Table 1 and Figure 3). Despite good *H. azteca* survival and growth at nominal copper concentrations up to approximately 80 µg/L (measured as 86.4 µg/L dissolved copper and 92.7 µg/L total copper), the IC20 for the *H. azteca* reproductive endpoint was <14.9 µg/L dissolved copper (<17.5 µg/L total copper) and mean reproduction was significantly lower than that associated with the laboratory control (Table 2; Figure 4). Reproductive output associated with all exposure concentrations were significantly lower than the laboratory control with the exception of the nominal 5 µg/L treatment (19.8 µg/L dissolved copper and 22.3 µg/L total copper; Figure 4).

Expression of the IC20 as a "<" (Table 1; Appendix B – Nautilus 2017) prompted a review of the test data and the associated statistical analysis. Review of the test data (Appendix B – Nautilus 2017) and statistical examination of the data (Appendix C) revealed three primary issues contributing to the "<" result: 1) extreme reproductive output associated with two of eight laboratory control organisms (43, 30, 16, 12, 12, 11, 11, and 7 neonates); 2) an unusual dose-response curve (e.g., reproductive output in the nominal 5 µg/L treatment was higher than that of the site control, reproductive output in the nominal 20 µg/L treatment was greater than that of the 10 µg/L treatment; Figure 4); and 3) strong heterogeneity of variance that violated the assumptions of the log-linear regression model applied in the data analysis. Re-analysis was conducted to address some of these issues (Table 2; Appendix C). The approach addressed the leveraging effect of the two unusually high reproductive outputs by basing analysis upon the median lab control (12 neonates per organism versus a leveraged mean of 17.8 neonates per organism), identified and eliminated on outlier (associated with the nominal 10 µg/L treatment), and eliminated the violation of the assumption of homogeneity of variance by data transformation (Appendix C). The regression models with the best overall fit indicated IC20 values for *H. azteca* reproduction of 27.6 µg/L dissolved copper and 30.1 µg/L total copper (Figure 5; Appendix C).

Comparisons to Clear Flow Toxicity Testing

The concentration of DOC was substantially higher during turbid flow conditions (29.1 ± 3.0 mg/L) than during clear flow conditions (9.2 ± 0.5 mg/L). During clear flow conditions, the only endpoints with effect concentrations lower than 20 µg/L were survival of *D. magna* and reproduction of *H. azteca*. Neither of these endpoints differed significantly from the laboratory control at the 20 µg/L exposure concentration (or lower). During turbid flow conditions, survival of *D. magna* was not impacted by even the highest test concentration (149 µg/L dissolved copper), a substantial difference from the LC20 observed during clear flow testing (18.3 µg/L dissolved copper). The difference is consistent with amelioration of copper toxicity by DOC (e.g., Grosell 2012). The difference between clear- and turbid-flow IC20 values for *H. azteca* reproduction was much smaller than for *D. magna* survival (27.6 µg/L dissolved copper in turbid-flow testing versus 17.6 µg/L copper in clear-flow testing). Reproduction is typically highly correlated with biomass (e.g., Ivey et al. 2016), and was 2.5-times more sensitive than biomass in the clear water testing and 3.5-times more sensitive than biomass in the turbid water testing. Similarly, sensitivity of the *H. azteca* reproduction endpoint was almost identical to that of *D. magna* survival in clear water testing, but was 5.4-times more sensitive in turbid water testing. Although the reproductive endpoint in *H. a*zteca tests is known to be among the more variable test endpoints, this suggests that *H. azteca* reproduction may not respond to concentrations of copper and DOC in the same manner as *D. magna* survival.

Conclusion and Closure

As defined in the Study Plan (Appendix A), the SSWQO for copper (20 µg/L dissolved copper when DOC is greater than 10 mg/L) would be considered protective of aquatic organisms in site water if the reported 20th percentile effect concentrations are greater than 20 µg/L and copper concentrations of 20 µg/L (and lower) also do not differ significantly from the control. This was the case for all endpoints in the clear flow testing (sample collected on September 28th 2015; Minnow 2017) and in turbid flow testing (sample collected May 5th 2017). Specifically, in the clear flow testing, two 20th percentile endpoints were less than 20 µg/L dissolved copper (the LC20 for *D. magna* [18.3 µg/L dissolved copper] and the IC20 for *H. azteca* reproduction

[17.6 µg/L dissolved copper]), but neither differed significantly from the laboratory control (Minnow 2016). In the turbid flow testing, all lowest 20th percentile effect endpoints were greater than 20 µg/L dissolved copper (the lowest IC20 value [by far] was for reproduction in the 42-day test of *H. azteca* [27.6 µg/L dissolved copper]). Therefore, the SSWQO for copper, as defined in Minto's Water Use Licence (WUL), appears to be protective of the aquatic life of Minto Creek.

Sincerely,
Minnow Environmental Inc.

Pierre Stecko, M.Sc., EP, RPBio
Senior Aquatic Scientist

References

Ecometrix (Ecometrix Inc.). 2014. Minto Creek Phase V/VI: Review of the Copper Bio-Ligand Model (BLM) and Review of Discharge Limits for Water Releases from the Mine Site. Memorandum to Adam Wrench (Yukon Environmental and Socio-economic Assessment Board) from Lynnae Dudley, Bruce Rodgers, Don Hart and Goran Ivanis. March 17, 2014.

Grosell, M. 2012. Copper. In: C.M. Wood, A.P. Farrell and C.J. Brauner (eds.). Homeostasis and Toxicology of Essential Metals. Elsevier / Academic Press, New York. pp. 53-133.

Ivey, C.D., C.G. Ingersoll, W.G. Brumbaugh, E. Hammer, D.R. Mount, J.R. Hockett, T.J. Norberg-King, D.J. Soucek and L. Taylor. 2016. Using an Inter-Laboratory Study to Revise Methods for Conducting 10-d to 42-d Water or Sediment Tests with *Hyalella Azteca*. Environ. Toxicol. Chem. 35(10): 2439-2447.

Kennedy, C.J., P. Stecko, B. Truelson and D. Petkovich. 2012. Dissolved Organic Carbon Modulates the Effects of Copper on Olfactory-Mediated Behaviors of Chinook Salmon. Environ. Toxicol. Chem. 31(10): 2281-2288.

MESL (MacDonald Environmental Sciences Ltd.). 2015. Water Licence Amendment: Phase V/VI Expansion of Mining – Minto Mine – Review. Letter from Don MacDonald to Chief Kevin McGinty (Selkirk First Nation), January 30, 2015.

Minnow (Minnow Environmental Inc.). 2009. Evaluation of the Background Water Quality of Minto Creek and Options for the Derivation of Site-Specific Water Quality Objectives. Report Prepared for Access Consulting Group and Minto Explorations Ltd. April 2009.

Minnow (Minnow Environmental Inc.). 2013. Minto Mine WUL Clause 94 – Water Quality Standard for Copper. Letter Report from Pierre Stecko to Jennie Gjertsen (Minto Explorations Ltd). March 29, 2013.

Minnow (Minnow Environmental Inc.). 2014. Application of Chronic Biotic Ligand Models (BLM) for Copper to the Predicted Water Quality of Minto Creek. Letter Report from Pierre Stecko to Martin Haefele (Capstone Mining Corporation). March 5, 2014.

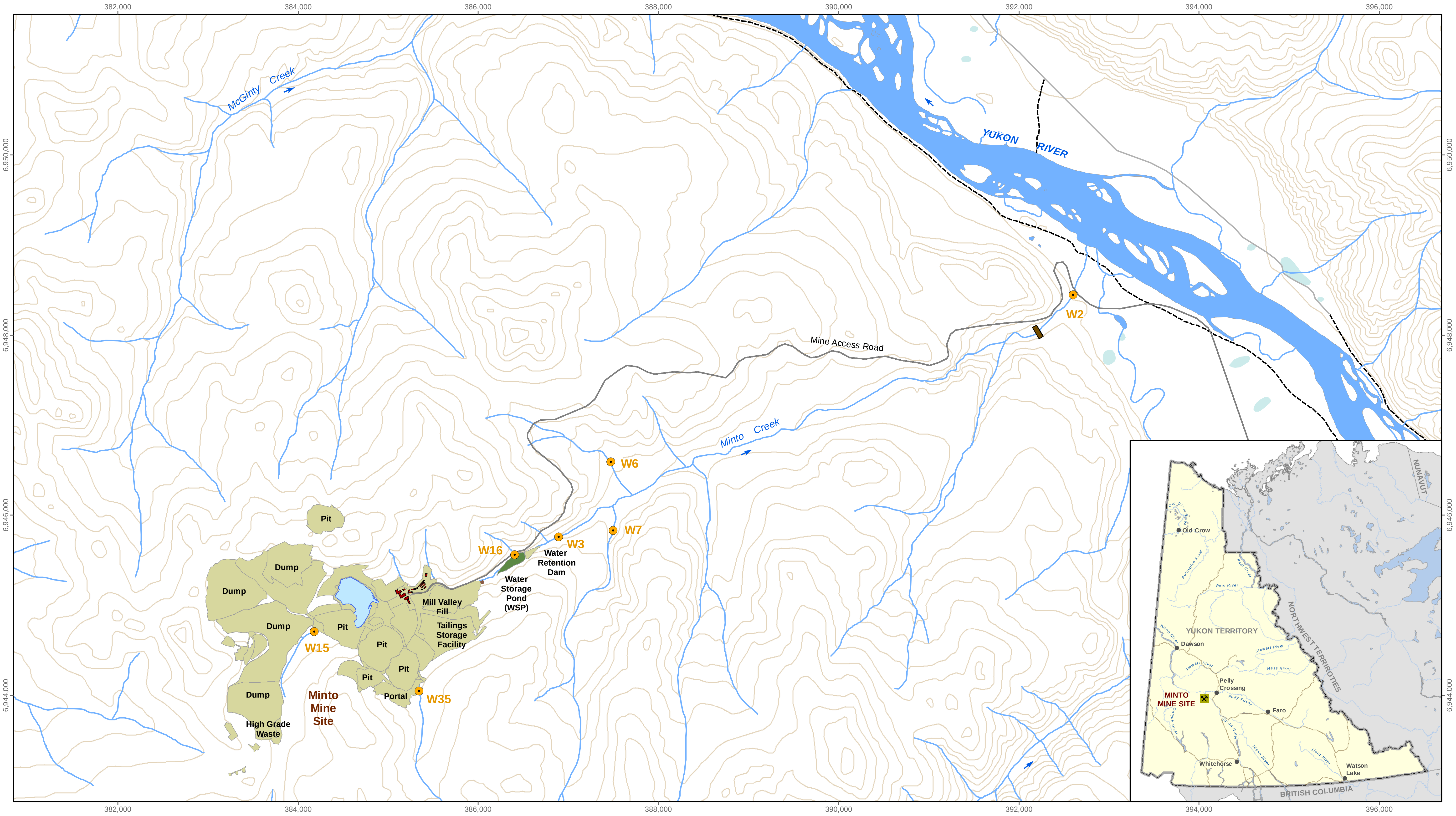
Minnow (Minnow Environmental Inc.). 2015. Expanded Study Plan for Evaluating the Toxicity of Copper to Selected Organisms in Minto Creek Water – DRAFT. Procedure Document prepared for the Minto Mine. August 2015.

Minnow (Minnow Environmental Inc.). 2016. Clear Flow Water Toxicity Testing to Verify the Minto Mine Water Quality Objective for Copper on Minto Creek. Letter Report from Pierre Stecko to Ryan Herbert (Minto Mine). May 2016.

Nautilus (Nautilus Environmental Inc.). 2017. Copper Toxicity Testing for Minto Creek. Report prepared for Minnow Environmental Inc. November 2017.

YWB (Yukon Water Board). 2015. Minto Mine Type A Water Use Licence Number QZ14-031. Issued to Minto Explorations Ltd. August 2015.

FIGURES



LEGEND

- ● Water Quality Station
- ▬ Fish Barrier
- 🟩 Water Storage Pond
- ▨ Mine Footprint
- ▭ Main Pit Lake
- 🟥 Building

0 0.5 1 2
km

N
W E
S

Projection: North American Datum 1983 UTM Zone 8U
Reproduced under licence from Her Majesty the Queen in Right of Canada, Department of Natural Resources Canada. All rights reserved.

Location and Layout of the Minto Mine

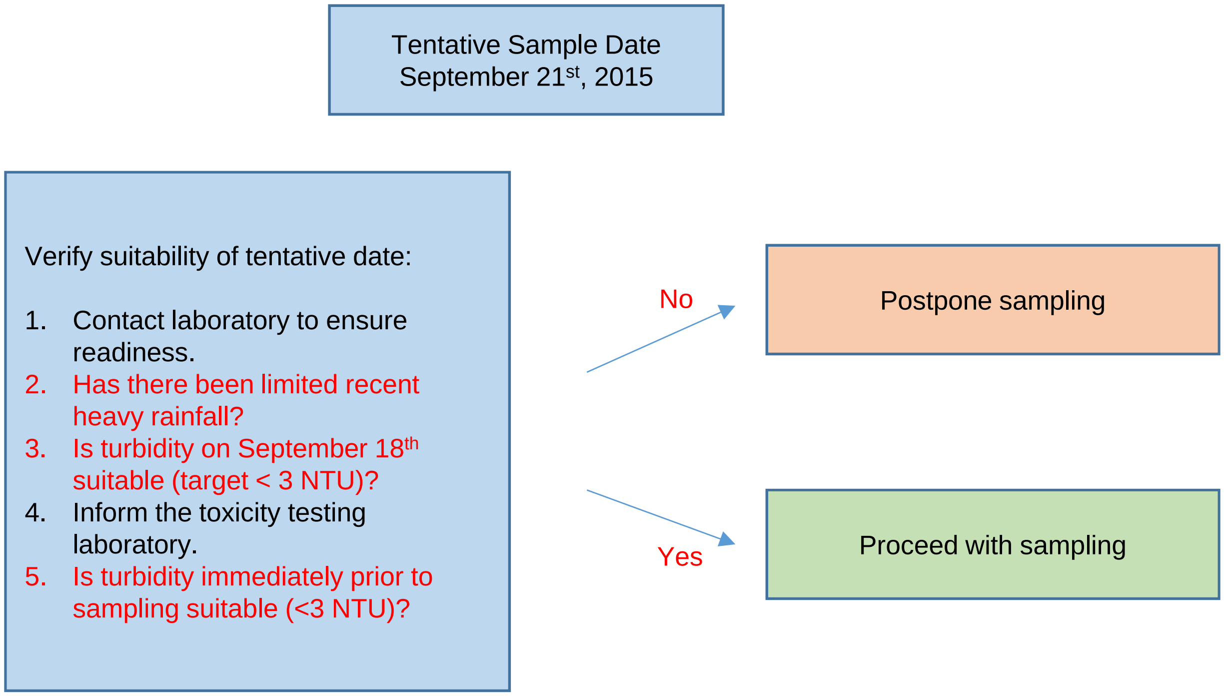
Date January 2018
Project 157202.0072

minnow environmental inc.

Figure 1

Document Path: S:\Projects\157202\157202.0072 Minto - Verification of Cu WQO\gis mapping\Memo - Turbid Conditions\0072 - Figure 1 Location and Layout - W16 Station.mxd

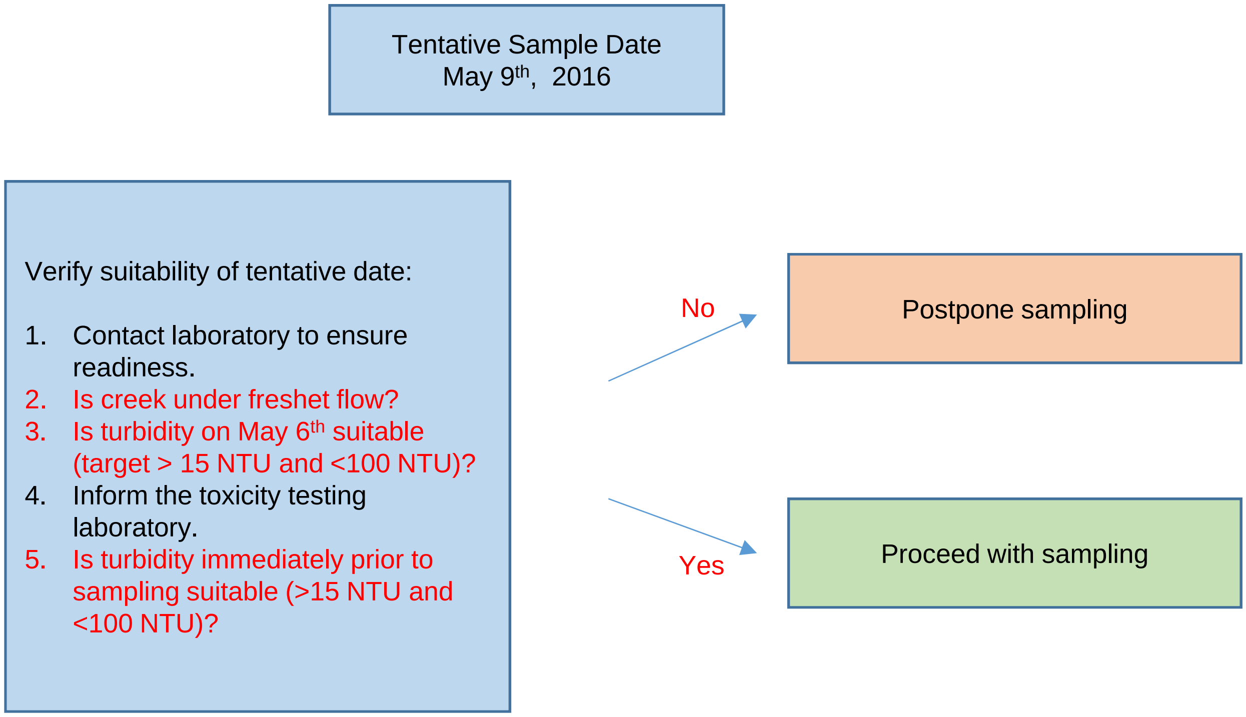
a: **Clear flow conditions (< 25 mg/L TSS)**


Tentative Sample Date
September 21st, 2015

Verify suitability of tentative date:

1. Contact laboratory to ensure readiness.
2. Has there been limited recent heavy rainfall?
3. Is turbidity on September 18th suitable (target < 3 NTU)?
4. Inform the toxicity testing laboratory.
5. Is turbidity immediately prior to sampling suitable (<3 NTU)?

b: **Turbid flow conditions (> 25 mg/L TSS)**


Tentative Sample Date
May 9th, 2016

Verify suitability of tentative date:

1. Contact laboratory to ensure readiness.
2. Is creek under freshet flow?
3. Is turbidity on May 6th suitable (target > 15 NTU and <100 NTU)?
4. Inform the toxicity testing laboratory.
5. Is turbidity immediately prior to sampling suitable (>15 NTU and <100 NTU)?

Figure 2: **Original Decision Path for when to Sample under a) Clear Flow (< 25 mg/L Total Suspended Solids [TSS]); and b) Turbid Flow (> 25 mg/L TSS)**

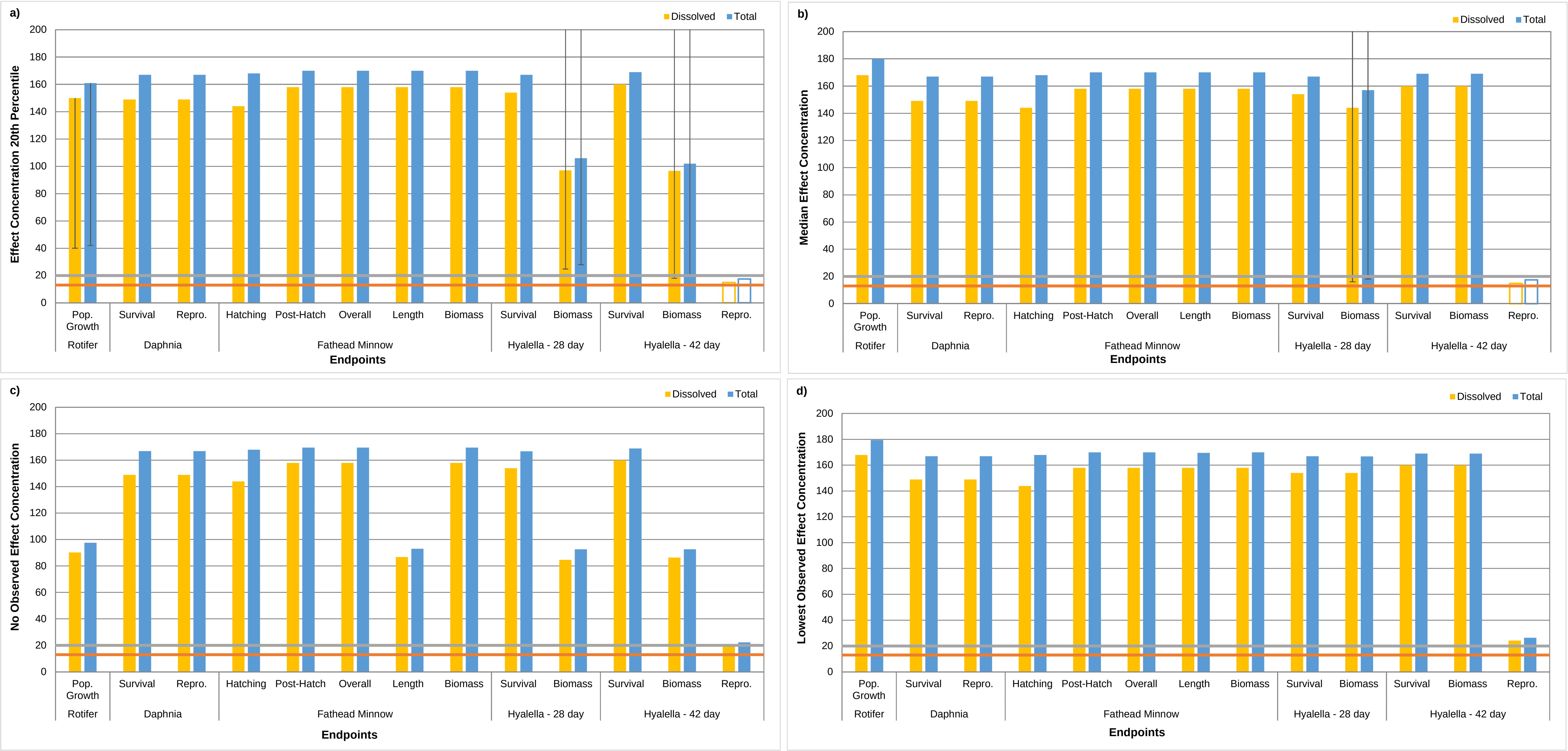


Figure 3: Copper Concentrations (Dissolved and Total) from Sub-lethal Toxicity Tests of Minto Creek Water under Turbid Flow (May 5, 2017): a) 20th Percentile Effect Concentrations; b) Median Effect Concentrations; c) No Observed Effect Concentrations; and d) Lowest Observed Effect Concentrations

Notes: Pop. Growth = Population Growth; Repro. = Reproduction; Hatching = Hatching Success; Post-Hatch = Post-Hatch Survival; Overall = Overall Survival; Rotifer = *Brachionus calyciflorus*; Daphnia = *Daphnia magna*; FHM = *Pimephales promelas*; Hyalella = *Hyalella azteca.*
Orange lines represent Water Quality Objective of 13 µg/L when dissolved organic carbon (DOC) ≤ 10 mg/L.
Grey lines represent Water Quality Objective of 20 µg/L when dissolved organic carbon (DOC) > 10 mg/L.
Hollow bars represent endpoints reported as "less than" ("<") values.

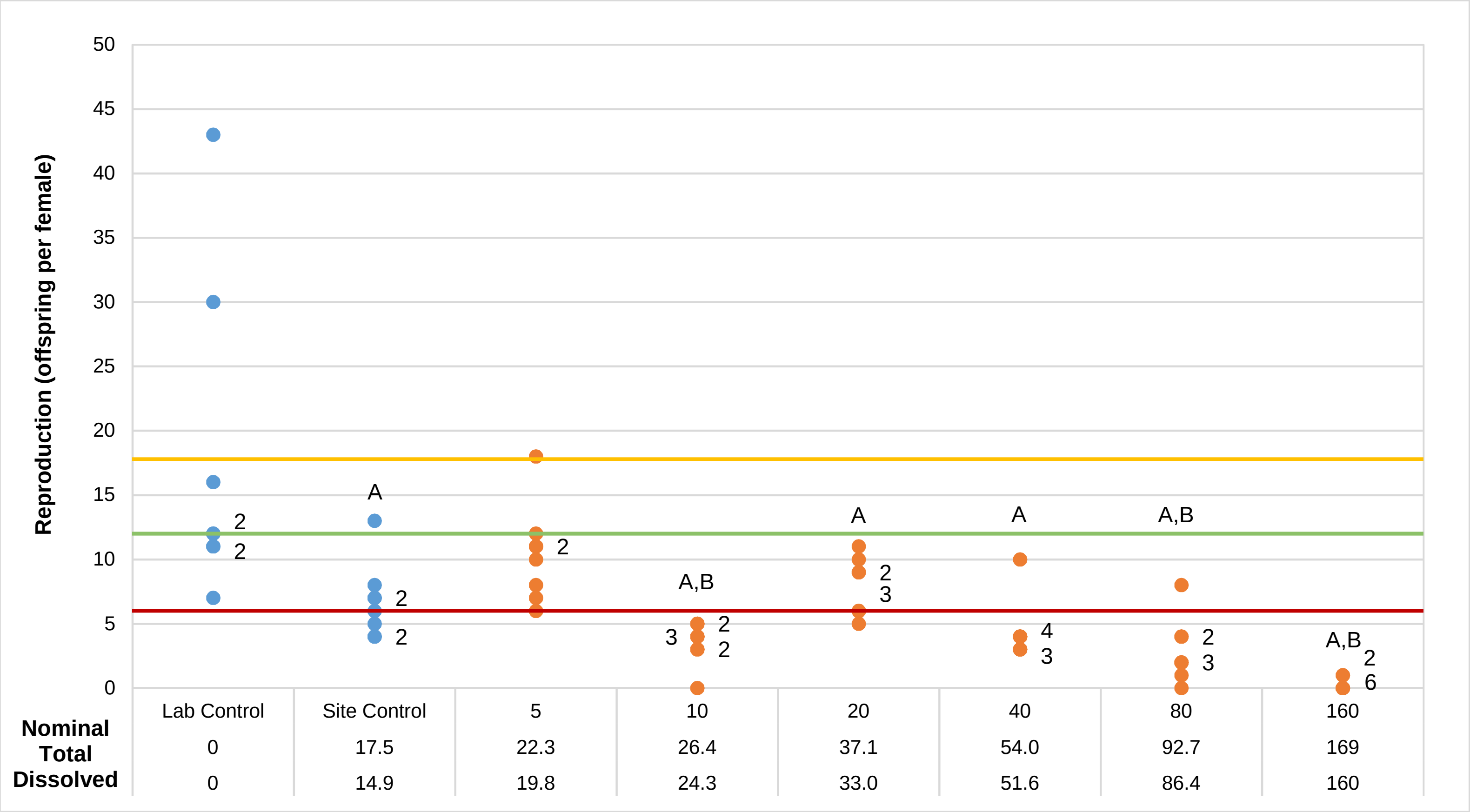


Figure 4: **Reproduction Results of *Hyalella azteca* 42 day Test During Turbid Flow Conditions**

Notes: Letters represent significant differences between spiked copper samples (orange) and controls (blue). A represents a significant difference from the laboratory control and B represents a significant difference from the site control.

Red solid line represents the laboratory control performance criteria of 6 offspring per female (Nautilus 2017).

Green solid line represents the laboratory control median (12.0 offspring per female).

Yellow solid line represents the laboratory control mean (17.8 offspring per female).

Numbers beside dots indicate number of replicates (n=8) with same result.

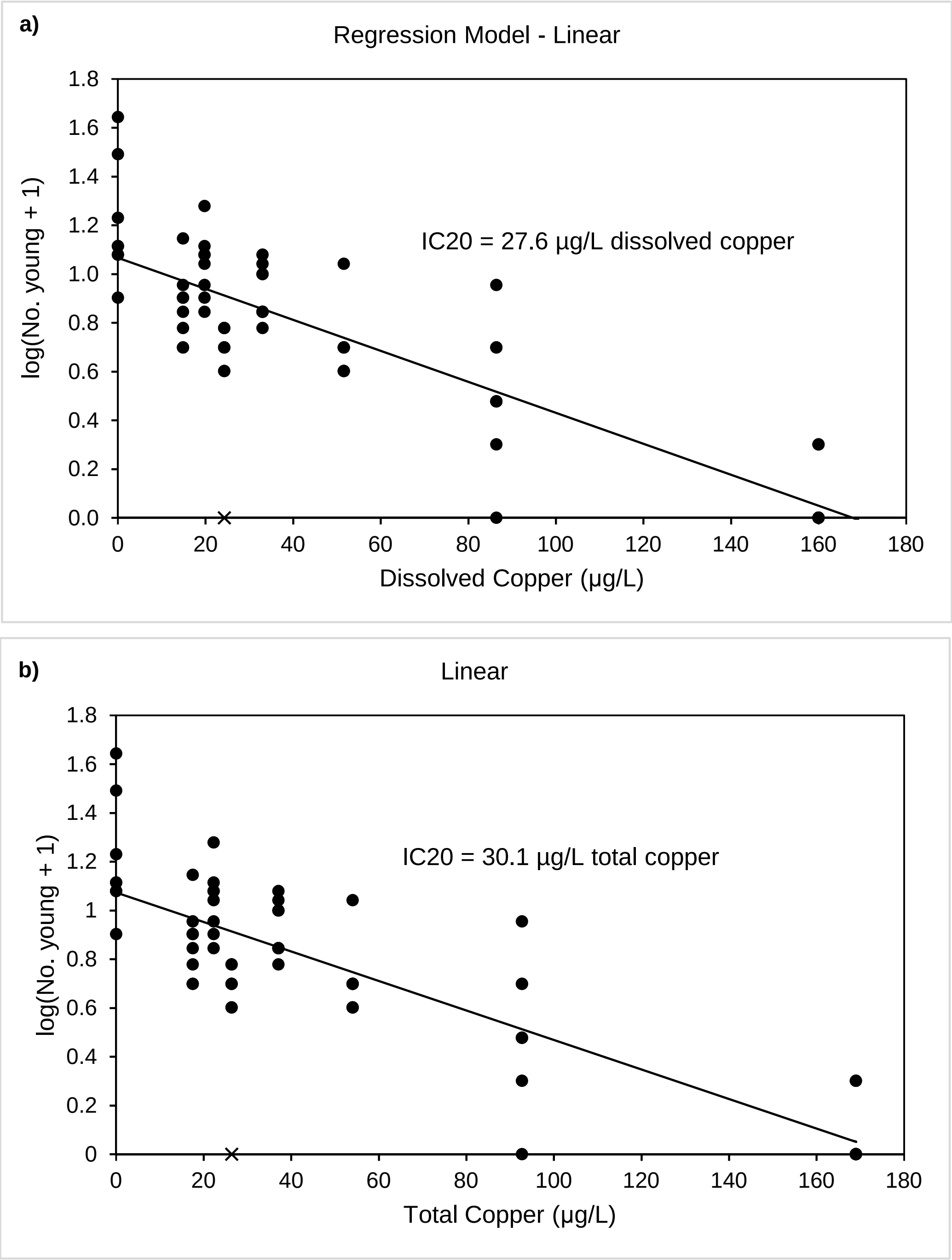


Figure 5: Scatterplots and Best-Fit Regression Models for *Hyallela azteca* 42-d Reproduction versus Concentration: a) Dissolved Copper; b) Total Copper, Minto Creek Turbid Flow, May 5th 2017

Notes: outliers removed from analysis denoted by an ×

TABLES

Table 1: **Results of Turbid Flow Toxicity Testing of Dissolved and Total Copper (µg/L) as Reported in Appendix B (Nautilus 2017)** [a]

Organism	Endpoint	Dissolved Copper (µg/L)						Total Copper (µg/L)					
		LC20	LC50	IC20	IC50	NOEC	LOEC	LC20	LC50	IC20	IC50	NOEC	LOEC
Brachionus calyciflorus - 48 hour	Population Growth Rate	-	-	150 (110-NC)	> 168	90	168	-	-	161 (119-NC)	> 180	98	180
Daphnia magna - 21 day	Survival	> 149	> 149	-	-	149	> 149	> 167	> 167	-	-	167	> 167
	Reproduction	-	-	> 149	> 149	149	> 149	-	-	> 167	> 167	167	> 167
Pimephales promelas - 32 day	Hatching Success	> 144	> 144	-	-	144	> 144	> 168	> 168	-	-	168	> 168
	Post-hatch Survival	> 158	> 158	-	-	158	> 158	> 170	> 170	-	-	170	> 170
	Overall Survival	> 158	> 158	-	-	158	> 158	> 170	> 170	-	-	170	> 170
	Length	-	-	> 158	> 158	87	158	-	-	> 170	> 170	93	170
	Biomass	-	-	> 158	> 158	158	> 158	-	-	> 170	> 170	170	> 170
Hyalella azteca - 28 day	Survival	> 154	> 154	-	-	154	> 154	> 167	> 167	-	-	167	> 167
	Biomass	-	-	97 (72.2-116)	144 (128-163)	85	154	-	-	106 (78-126)	157 (139-177)	93	167
Hyalella azteca - 42 day	Survival	> 160	> 160	-	-	160	> 160	> 169	> 169	-	-	169	> 169
	Biomass	-	-	96.6 (78.6-115)	> 160	86	160	-	-	102 (81.6-122)	> 169	93	169
	Reproduction	-	-	< 14.9	< 14.9	20	24	-	-	< 17.5	< 17.5	22	26

[a] Water sample collected on May 5th, 2017.

🟧 Endpoint value is lower than 13 µg/L (the water quality objective [WQO] applicable at dissolved organic carbon [DOC] ≤ 10 mg/L).

🟦 Endpoint value is lower than 20 µg/L (the water quality objective [WQO] applicable at dissolved organic carbon [DOC] > 10 mg/L).

Table 2: Evaluation of Turbid Flow Toxicity Testing of Dissolved and Total Copper (µg/L) Relative to Pre-Defined Criteria [a]

Organism	Endpoint	Criterion 1 [b]				Criterion 2 [c]								
		LC20 or IC20 (Measured Concentrations)				Copper Treatment								
		Dissolved Copper (µg/L)		Total Copper (µg/L)		Site Control (Nominal) 14 - 20 µg/L (Dissolved) 17 - 24 µg/L (Total)			5 µg/L (Nominal) 18 - 25 µg/L (Dissolved) 21 - 28 µg/L (Total)			10 µg/L (Nominal) 23 - 30 µg/L (Dissolved) 26 - 34 µg/L (Total)		
		Mean	EC20 < 20 µg/L?	Mean	EC20 < 20 µg/L?	Mean ± SD	p value	Significant Difference?	Mean ± SD	p value	Significant Difference?	Mean ± SD	p value	Significant Difference?
Brachionus calyciflorus - 48 hour	Population Growth Rate	150	NO	161	NO	0.67 ± 0.09	0.890	NO	0.78 ± 0.09	1.000	NO	0.82 ± 0.11	1.000	NO
Daphnia magna - 21 day	Survival	> 149	NO	> 167	NO	100	1.000	NO	90	1.000	NO	100	1.000	NO
	Reproduction	> 149	NO	> 167	NO	117 ± 19	1.000	NO	113 ± 14	1.000	NO	114 ± 39	1.000	NO
Pimephales promelas - 32 day	Hatching Success	> 144	NO	> 168	NO	95 ± 6.4	0.753	NO	97 ± 3.9	0.875	NO	100 ± 0	0.987	NO
	Post-hatch Survival	> 158	NO	> 170	NO	74 ± 26	> 0.050	NO	90 ± 8.5	> 0.050	NO	88 ± 6.4	> 0.050	NO
	Overall Survival	> 158	NO	> 170	NO	70 ± 25	0.118	NO	87 ± 5.4	0.726	NO	88 ± 6.3	0.818	NO
	Length	> 158	NO	> 170	NO	9.9 ± 0.8	0.985	NO	9.1 ± 0.1	0.172	NO	9.1 ± 0.1	0.150	NO
	Biomass	> 168	NO	> 170	NO	1.01 ± 0.04	0.550	NO	0.95 ± 0.18	0.303	NO	0.93 ± 0.07	0.230	NO
Hyalella azteca - 28 day	Survival	> 154	NO	> 167	NO	94 ± 7.9	0.908	NO	93 ± 7.8	0.826	NO	92 ± 7.1	0.567	NO
	Biomass	97	NO	106	NO	0.69 ± 0.10	0.778	NO	0.68 ± 0.07	0.718	NO	0.78 ± 0.08	0.998	NO
Hyalella azteca - 42 day	Survival	> 160	NO	> 169	NO	86 ± 11	0.884	NO	85 ± 11	0.820	NO	85 ± 14	0.849	NO
	Biomass	97	NO	102	NO	0.92 ± 0.16	0.973	NO	0.94 ± 0.13	0.992	NO	0.92 ± 0.11	0.972	NO
	Reproduction	< 14.9	YES	< 17.5	YES	6.8 ± 2.9	0.025	YES	10.4 ± 3.7	0.374	NO	3.5 ± 1.6	< 0.001	NO
	Reproduction [d]	27.6	NO	30.1	NO	6.8 ± 2.9	0.025	YES	10.4 ± 3.7	0.374	NO	3.5 ± 1.6	< 0.001	NO

[a] Water sample collected on May 5th, 2017.

[b] 20th percentile effect concentration relative to 20 µg/L.

[c] Concentrations not significantly different from control.

[d] Re-analysis to address the leveraging effect of extreme reproduction in two laboratory control replication and a violation of the assumption of equality of variance.

🟧	Endpoint value is lower than 13 µg/L (the water quality objective [WQO] applicable at dissolved organic carbon [DOC] ≤ 10 mg/L).
🟦	Endpoint value is lower than 20 µg/L (the water quality objective [WQO] applicable at dissolved organic carbon [DOC] > 10 mg/L).
▨	p value < 0.050.

Table 2: **Evaluation of Turbid Flow Toxicity Testing of Dissolved and Total Copper (µg/L) Relative to Pre-Defined Criteria** [a]

Organism	Endpoint	Criterion 2 [c]											
		Copper Treatment											
		20 µg/L (Nominal) 31 - 39 µg/L (Dissolved) 36 - 44 µg/L (Total)			**40 µg/L (Nominal)** 49 - 56 µg/L (Dissolved) 53 - 63 µg/L (Total)			**80 µg/L (Nominal)** 84 - 90 µg/L (Dissolved) 93 - 98 µg/L (Total)			**160 µg/L (Nominal)** 149 - 168 µg/L (Dissolved) 167 - 180 µg/L (Total)		
		Mean ± SD	p value	Significant Difference?	Mean ± SD	p value	Significant Difference?	Mean ± SD	p value	Significant Difference?	Mean ± SD	p value	Significant Difference?
Brachionus calyciflorus - 48 hour	Population Growth Rate	0.90 ± 0.07	1.000	NO	0.85 ± 0.06	1.000	NO	0.78 ± 0.09	1.000	NO	0.50 ± 0.11	0.040	YES
Daphnia magna - 21 day	Survival	100	1.000	NO	90	1.000	NO	100	1.000	NO	100	1.000	NO
	Reproduction	115 ± 11	1.000	NO	119 ± 17	1.000	NO	141 ± 16	1.000	NO	128 ± 16	1.000	NO
Pimephales promelas - 32 day	Hatching Success	100 ± 0	0.987	NO	98 ± 3.3	0.955	NO	90 ± 13	0.327	NO	97 ± 6.7	0.891	NO
	Post-hatch Survival	85 ± 14	> 0.050	NO	90 ± 3.7	> 0.050	NO	83 ± 8.5	> 0.050	NO	93 ± 0.5	> 0.050	NO
	Overall Survival	85 ± 14	0.708	NO	88 ± 3.3	0.801	NO	75 ± 15	0.184	NO	90 ± 6.7	0.887	NO
	Length	9.4 ± 0.2	0.627	NO	9.1 ± 0.1	0.130	NO	9.0 ± 0.7	0.096	NO	8.7 ± 0.3	0.009	YES
	Biomass	1.06 ± 0.13	0.741	NO	0.97 ± 0.10	0.382	NO	1.00 ± 0.30	0.514	NO	0.92 ± 0.17	0.216	NO
Hyalella azteca - 28 day	Survival	88 ± 11	0.376	NO	97 ± 4.9	0.984	NO	98 ± 4.5	0.994	NO	85 ± 9.1	0.050	NO
	Biomass	0.77 ± 0.07	0.996	NO	0.67 ± 0.09	0.662	NO	0.63 ± 0.06	0.296	NO	0.32 ± 0.04	< 0.001	NO
Hyalella azteca - 42 day	Survival	80 ± 11	0.433	NO	93 ± 7	0.996	NO	91 ± 8	0.990	NO	76 ± 14	0.211	NO
	Biomass	0.89 ± 0.10	0.918	NO	0.95 ± 0.10	0.996	NO	0.74 ± 0.16	0.085	NO	0.49 ± 0.15	< 0.001	NO
	Reproduction	7.8 ± 2.3	0.008	YES	4.4 ± 2.3	0.001	YES	2.9 ± 2.5	0.001	YES	0.3 ± 0.5	0.001	YES
	Reproduction [d]	7.8 ± 2.3	0.008	YES	4.4 ± 2.3	0.001	YES	2.9 ± 2.5	0.001	YES	0.3 ± 0.5	0.001	YES

[a] Water sample collected on May 5th, 2017.

[b] 20th percentile effect concentration relative to 20 µg/L.

[c] Concentrations not significantly different from control.

[d] Re-analysis to address the leveraging effect of extreme reproduction in two laboratory control replication and a violation of the assumption of equality of variance.

🟧	Endpoint value is lower than 13 µg/L (the water quality objective [WQO] applicable at dissolved organic carbon [DOC] ≤ 10 mg/L).
🟦	Endpoint value is lower than 20 µg/L (the water quality objective [WQO] applicable at dissolved organic carbon [DOC] > 10 mg/L).
▨	p value < 0.050.

APPENDIX

APPENDIX A
STUDY PLAN FOR EVALUATING THE TOXICITY OF COPPER TO SELECTED AQUATIC ORGANISMS IN MINTO CREEK WATER – VERSION 3
(MESL 2015)

Attachment 1:

Study Plan for Evaluating the Toxicity of Copper to Selected Aquatic Organisms in Minto Creek Water
Version 3

Prepared by: MESL/PERC, with comments by Minnow Environmental
Version 3 Prepared: January 14, 2015

Purpose: The purpose of this study is to determine if the proposed water quality objective (WQO) for copper in Minto Creek (20 µg/L) would be protective of aquatic organisms.

Approach: The protectiveness of the proposed WQO for copper would be evaluated by conducting a series of laboratory toxicity tests with selected species of fish and invertebrates. A resident species approach could be applied to evaluate the protectiveness of the proposed WQO (which could involve toxicity testing with chinook salmon, slimy sculpin, Yukon floaters, and various crustaceans and/or insect larvae). However, it is more practical to utilize an indicator species approach that involves conducting toxicity tests with a number of commonly-tested fish and invertebrate species that are likely to be representative of sensitive species that utilize aquatic habitats within Minto Creek. Application of this approach would involve:

- Collecting site water (i.e., Minto Creek at W2) during two periods of the hydrological regime (i.e., clear flow; TSS < 25 mg/L; and, turbid flow: TSS $\geq$ 25 mg/L);
- Transporting sufficient quantities of site water to the toxicity testing laboratory to support toxicity testing;
- Spiking site water with copper chloride to achieve five exposure concentrations, as well as a negative control (Lab water), site control (i.e., unspiked site water);
- Conducting a total of four long-term (i.e., chronic) static-renewal toxicity tests to evaluate the effects of copper on aquatic organisms in site water, including:
    1. 42-d toxicity test with the amphipod, *Hyalella azteca* (Endpoints: Survival, growth, and reproduction);

2. 21-d toxicity test with the cladoceran, *Daphnia magna* (Endpoints: Survival and reproduction);
3. 48-h toxicity test with the rotifer, *Brachionus calyciflorus* (Endpoint: Intrinsic rate of population increase); and,
4. 32-d toxicity test with fathead minnows, *Pimephales promelas* (Endpoints: Hatching success, total post-hatch survival, overall survival, and dry weight);

- Conducting a reference toxicity test with each species to confirm that sensitivity is within the expected range;
- Measuring the concentrations of total and dissolved copper in each treatment for each toxicity test at the beginning of the test, the end of the test, and periodically during the test (i.e., depending on when new batches of site water are used and/or when dilution water is prepared. Note our preference would be to have all of the tests conducted with a single batch of homogenized site water);
- Characterizing water quality in each treatment at the beginning of the test, the end of the test, and periodically during the test (i.e., depending on when new batches of site water are used);
- Calculating EC_{10} and EC_{20} values; and,
- Compiling and reporting the results of the toxicity testing program.

Interpretation: The WQO for copper will be considered to be protective if the reported EC_{20} values are greater than 20 µg/L for all tested species and the 20 µg/L treatment does not differ significantly from the control ($p = 0.05$). If one or more of the EC_{20} values is less than or equal to the proposed WQO and the 20 µg/L treatment is significantly impaired relative to control ($p = 0.05$), the WQO would be revised downward to establish a level that is protective of aquatic organisms in site water.

Note: This general approach can be modified to evaluate the protectiveness of the WQOs that have been proposed for all of the COPCs. In this case, site water would be spiked with all of the identified COPCs at levels equivalent to the WQOs (i.e., in site water collected during clear-flow and turbid flow periods).

Note: Add Table of Test Conditions for Each Toxicity Test to complete Study Plan.

APPENDIX B

COPPER TOXICITY TESTING FOR MINTO CREEK

(NAUTILUS 2017)

Copper Toxicity Testing for Minto Creek

W2, W16

Final Report

November 6, 2017

Submitted to: **Minnow Environmental Inc.**
Victoria, BC

TABLE OF CONTENTS

List of Tables

List of Appendices

SIGNATURE PAGE

Report By:
Leila Oosterbroek, BSc
Environmental Scientist

Reviewed By:
James Elphick, RPBio
Environmental Toxicologist

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client and the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

SUMMARY

A summary of sample information and test results from the *Brachionus calyciflorus, Daphnia magna, Pimephales promelas* and *Hyalella azteca* toxicity tests are provided in the tables below for the samples W2 and W16 amended with copper. Testing was initiated for *B. calyciflorus* on May 23, 2017 at the Nautilus Burnaby laboratory. Testing was initiated for *D. magna* on May 24, 2017 and for *P. promelas* and *H. azteca* on May 25, 2017 at the Nautilus Calgary laboratory.

Sample and Test Type Information

Sample ID	W2, W16
Sample collection date	May 5, 2017
Sample receipt date	May 12, 2017
Sample receipt temperature	6°C
Test species	*Brachionus calyciflorus* *Daphnia magna* *Pimephales promelas* *Hyalella azteca*

Summary of Results

Endpoint	Sample ID W2:W16 (3:1 ratio) amended with copper	
	Total copper endpoint (µg/L)	Dissolved copper endpoint (µg/L)
B. calciflorus		
Growth IC20	161 (119-NC)	150 (110-NC)
D. magna		
Survival LC20	>167	>149
Reproduction IC20	>167	>149
P. promelas		
Hatch % EC20	>168	>144
Post Hatch Survival EC20	>170	>158
Overall Survival EC20	>170	>158
Biomass IC20	>170	>158
Length IC20	>170	>158
H. azteca		
28-d Survival LC20	>167	>154
42-d Survival LC20	>169	>160
28-d Biomass IC20	106 (78.0-126)	97.0 (72.2-116)
42-d Biomass IC20	102 (81.6-122)	96.6 (76.8-115)
Reproduction IC20	<17.5	<14.9

1.0 INTRODUCTION

Nautilus Environmental Company Inc. (Nautilus Environmental) conducted sub-lethal toxicity tests for Minnow Environmental Inc. (Minnow Environmental) to investigate the effects of copper in site water collected from Minto Creek by Minto Mine. This investigation was conducted on site water with elevated total suspended solids and the purpose was to determine if the proposed water quality objective for copper in Minto Creek would be protective of aquatic life.

The following sub-lethal toxicity tests were performed:

- 48-hour *Brachionus calyciflorus* population growth test
- 21-day *Daphnia magna* survival and reproduction test
- 32-day *Pimephales promelas* survival and growth test
- 42-day *Hyalella azteca* survival, reproduction and growth test

The *B. calyciflorus* test was performed at the Nautilus Environmental Burnaby, BC location, while all other testing took place at the Nautilus Environmental Calgary, AB location.

2.0 METHODS

Water samples were collected on May 5, 2017 from stations W2 and W16 and were submitted by Minto Mine to Nautilus Environmental in Calgary, AB on May 12, 2017. The samples were delivered in 200-L plastic drums and were received in good condition.

Test water was prepared in the laboratory by mixing the two site waters in a 3:1 ratio of W2:W16. The site water was then amended with copper using a stock solution of copper chloride dihydrate. The nominal concentrations of copper tested were 5, 10, 20, 40, 80 and 160 µg/L. In addition to un-amended site water, laboratory control water was also evaluated in each test. Total and dissolved copper was measured weekly in each test concentration and calcium, magnesium, potassium, sodium, sulfate, chloride and alkalinity were measured in the site and laboratory controls. The site control water was also analyzed weekly for dissolved organic carbon. Chemical analysis was performed by ALS Laboratories.

Testing was conducted following standard protocols that are currently employed in Canada and the United States and are described in further detail below. Statistical analyses for all tests were performed using CETIS (Tidepool Scientific Software, 2015) and are based on average measured total or dissolved copper. Where possible, linear or non-linear regression models were used to calculate point estimates. In cases where the data did not fit these models, linear interpolation of log-transformed data was used.

The *B. calyciflorus* tests followed procedures outlined in Snell and Moffat (1992) and APHA (2012) and are summarized in Table 1. The test was a 48-hour growth test that measured the intrinsic rate of population increase. The test was conducted at 25 ± 1°C and *B. calyciflorus* were fed green algae (*Pseudokirchneriella subcapitata*) at test initiation.

The *D. magna* test followed methods described in ASTM (2012), which are summarized in Table 2. The test involved a 21-day exposure under static-renewal conditions, with solutions being renewed three times per week and survival and reproduction being monitored. The test was conducted at 20 ± 1°C and daphnids were fed a mixture of green algae (*P. subcapitata*) and digested yeast, cerophyll and trout chow (YCT).

The *P. promelas* test followed methods described in USEPA (1996) and ASTM (2013), which are summarized in Table 3. The test evaluated hatch, survival and growth during a 32-day static-renewal exposure, with solutions being renewed daily. The test was conducted at 25 ± 1°C and minnows were fed daily with *Artemia nauplii*. The test used four replicates for each test concentration with 15 eggs in each test container. After 48 hours of exposure, undeveloped eggs in each replicate (i.e., unfertilized eggs) were replaced with eggs contained in two additional sacrificial test containers that were initiated for each test concentration for this purpose.

The *H. azteca* tests followed methods described by USEPA (2000), with modifications described recently by the *Hyalella* Advisory Group, headed by Dr. Chris Ingersoll of USGS. A description of test conditions is provided in Table 4. The test involved a 42 day exposure of 7- to 8-day old organisms using twelve replicates of ten amphipods. Four replicates were terminated at Day 28 to assess biomass and survival, and the remaining eight were continued to Day 42 and were used to evaluate survival, biomass and reproduction. The test organisms were fed a ramped diet of Tetramin and YCT, with increased feeding rates as the test progressed. The test was conducted under static renewal conditions, with one water renewal three times per week. The control and test waters for the *H. azteca* tests contained at least 0.02 mg/L Br and 15 mg/L Cl. Reproduction was assessed on days 35 and 42. On day 42, the number of adult females was evaluated in each replicate so that reproduction could be reported on the basis of the number of female amphipods.

Table 1. **Summary of test conditions: *Brachionus calyciflorus* growth test.**

Test organism	*Brachionus calyciflorus*
Test organism age	< 2 h-post hatch
Test type	Static
Test duration	48 h
Test chamber	Test tube
Test solution volume	12 mL
Test concentrations	Six concentrations, plus site water and laboratory controls
Number of replicates	7
Control water	Moderately-hard reconstituted water (hardness 80-100 mg/L)
Test solution renewal	None
Test temperature	25 ± 1°C
Number of organisms/chamber	6
Feeding	*Pseudokirchneriella subcapitata* at test initiation
Photoperiod	Continuous darkness
Aeration	None
Test protocol	Snell and Moffat (1992); APHA (2012)
Test endpoints	Growth rate (intrinsic rate of population increase; r)
Test acceptability criterion for controls	r ≥ 0.7

Table 2. Summary of test conditions: *Daphnia magna* survival and reproduction test.

Test organism	*Daphnia magna*
Test organism source	In-house culture
Test organism age	<24-h old neonates
Test type	Static-renewal
Test duration	21 days
Test chamber	120-mL plastic cup
Test solution volume	100 mL
Test concentrations	Six concentrations, plus site water and laboratory controls
Number of replicates	10
Control/dilution water	Moderately hard water (hardness 80-100 mg/L $CaCO_3$)
Test solution renewal	Three times weekly
Test temperature	20 ± 2°C
Number of organisms/chamber	1
Feeding	Daily, with *Pseudokirchneriella subcapitata* and digested yeast, cerophyll and trout chow
Light intensity	400 to 800 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	ASTM E1193 – 97
Test endpoints	Survival and reproduction
Test acceptability criterion for controls	≥70% survival; average of ≥60 young per surviving control female
Reference Toxicant	Sodium chloride

Table 3. Summary of test conditions: *Pimephales promelas* early life stage test.

Test organism	*Pimephales promelas*
Test organism age	< 24-h old fertilized eggs
Test type	Static-renewal
Test duration	~32 days
Test chamber	1-L glass jars
Test solution volume	1 L
Test concentrations	Six concentrations, plus site water and laboratory controls
Number of replicates	4
Control water	Dechlorinated tap water amended with 4 mg/L KCl
Test solution renewal	Daily
Test temperature	25 ± 1°C
Number of organisms/chamber	15
Feeding	Twice daily, with *Artemia* nauplii
Light intensity	100 to 600 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None unless required to maintain DO >50% saturation
Test protocol	USEPA (1996); ASTM (2013)
Test endpoints	Survival, hatch, growth
Test acceptability criterion for controls	>66% hatch; ≥70% post-hatch survival

Table 4. Summary of test conditions: *Hyalella azteca* survival, growth and reproduction test.

Test organism	*Hyalella azteca*
Test organism age	7-8 days old
Test type	Static-renewal
Test duration	42 days
Test vessel	375 mL glass container with a 5 cm disc of Nitex for substrate
Test volume	200 mL of water
Test concentrations	Six concentrations, plus site water and laboratory controls
Test replicates	12 test replicates per treatment; 4 terminated at day 28
Number of organisms	10 per replicate
Control water	Borgman's water (Environment Canada 2011) containing >25 mg/L Cl and supplemented with 0.02 mg/L Br.
Test solution renewal	3 x per week
Test temperature	23 ± 1°C
Feeding	1 mL of YCT daily to each container. Tetramin daily, with amounts in each test container increasing weekly: Week 1, 0.25 mg; Week 2, 0.5 mg; Week 3, 1 mg; Week 4, 1 mg; Week 5, 1.5 mg; Week 6, 2.0 mg.
Light intensity	500 to 1000 lux at water surface
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	Modified from US EPA (2000)
Test endpoint	Survival, dry weight, reproduction
Test acceptability criteria for controls	Mean control survival of ≥80% survival, >6 young/female
Reference toxicant	Copper

3.0 RESULTS

The nominal and mean measured concentration are presented in Table 5. The site control was included in the statistical analysis as an additional treatment level due to the concentration of copper that was present.

Table 5. Measured copper concentration for each test species.

Nominal Concentration (µg/L Cu)	Mean measured concentration (total, dissolved µg/L Cu)				
	B. calyciflorus	***D. magna***	***P. promelas***	***H. azteca* – day 28**	***H. azteca* – day 42**
Site Control	23.6, 20.0	16.6, 13.8	18.1, 15.3	17.6, 14.7	17.5, 14.9
5	28.4, 24.6	20.9, 18.0	23.0, 20.1	22.1, 19.1	22.3, 19.8
10	34.0, 30.0	25.6, 22.8	27.0, 24.5	25.9, 23.7	26.4, 24.3
20	43.6, 39.0	35.6, 31.3	37.5, 33.4	35.6, 32.4	37.1, 33.0
40	63.4, 56.4	53.8, 49.0	54.7, 50.9	53.3, 49.7	54.0, 51.6
80	97.6, 90.3	94.2, 83.6	93.1, 86.9	92.7, 84.7	92.7, 86.4
160	180, 168	167, 149	170, 158	167, 154	169, 160

The results of the *B. calyciflorus* test are presented in Table 6. There was an adverse effect observed on the population growth of *B. calyciflorus*, resulting in an IC20 of 161 µg/L total copper.

The results of the *D. magna* test are presented in Table 7. No adverse effects were observed for either survival or reproduction, resulting in endpoints of >167 µg/L total copper for both the LC20 and IC20.

The results of the *P. promelas* test are presented in Tables 8 and 9. No adverse effects were observed on the three survival endpoints in the test (hatch, post hatch survival and overall survival), resulting in an EC20 of >168 µg/L total copper for hatch and >170 µg/L total copper for both post hatch survival and overall survival. The IC20 endpoints for length and biomass were also >170 µg/L total copper. The IC10 reported for biomass is likely an unreliable estimate, as the test was likely not able to statistically detect this level of effect with a reasonable degree of confidence. This is supported by the fact that the NOEC was 169 µg/L and LOEC was >169 µg/L total copper, indicating that there were no statistically significant adverse effects when compared to the laboratory control in any of the concentrations tested.

The results of the *H. azteca* test are presented in Tables 10 and 11. There were no adverse effects observed on survival after 28 and 42 days resulting in LC20 endpoints of >167 and >169 µg/L total copper, respectively. There were adverse effects observed for both biomass and reproduction endpoints. Biomass IC20 endpoints after 28 and 42 days were 106 and 102 µg/L total copper, respectively. The highest test concentration at both time points for biomass was significantly adversely affected when compared to the laboratory control. Reproduction was also adversely affected resulting in an IC20 of <17.5 µg/L total copper; all concentrations, with the exception of 22.3 µg/L total copper, were statistically significantly adversely affected relative to the control.

The low reproduction endpoint observed with *H. azteca* may partially be attributed to the exceptional performance of the laboratory control (average of 17.8 young per female); the site control had an average of 6.8 young per female. Both of these controls met the requirement for control performance of at least 6 offspring per female. It is possible that the difference observed between the two controls reflects random chance, or some influence of differences in water chemistry on the reproductive rate of this species. When the statistical analysis for reproduction was performed in comparison to the site control instead of the laboratory control, the IC20 (and 95% confidence intervals) increased to 33.1 (15.0 – 48.9) µg/L total copper.

Table 6. **Results: *B. calyciflorus* toxicity test using copper.**

Copper Concentration (µg/L)			
Nominal	**Measured Total**	**Measured Dissolved**	**Growth rate (r) (Mean ± SD)**
Lab Control	Lab control	Lab control	0.66 ± 0.10
Site Control	23.6	20.0	0.67 ± 0.09
5	28.4	24.6	0.78 ± 0.09
10	34.0	30.0	0.82 ± 0.11
20	43.6	39.0	0.90 ± 0.07
40	63.4	56.4	0.85 ± 0.06
80	97.6	90.3	0.78 ± 0.09
160	180	168	0.50 ± 0.11 *
Test endpoint (µg/L total copper)			
	IC10 (95% CL)		125 (43-140)
	IC20 (95% CL)		161 (119-NC)
	IC50		>180
Test endpoint (µg/L dissolved copper)			
	IC10 (95% CL)		117 (34-135)
	IC20 (95% CL)		150 (110-NC)
	IC50		>168

SD = Standard deviation, CL = Confidence limits, IC = Inhibition concentration, NC = Not calculable
* statistically significantly adversely affected relative to the control

Table 7. Results: *D. magna* toxicity test using copper.

Copper Concentration (µg/L)			Survival (%)	Reproduction (Mean ± SD)
Nominal	Measured Total	Measured Dissolved		
Lab Control	Lab control	Lab control	100	75 ± 11
Site Control	16.6	13.8	100	117 ± 19
5	20.9	18.0	90	113 ± 14
10	25.6	22.8	100	114 ± 39
20	35.6	31.3	100	115 ± 11
40	53.8	49.0	90	119 ± 17
80	94.2	83.6	100	141 ± 16
160	167	149	100	128 ± 16
Test endpoint (µg/L total copper)				
	LC10		>167	--
	LC20		>167	--
	LC50		>167	--
	IC10		--	>167
	IC20		--	>167
	IC50		--	>167
Test endpoint (µg/L dissolved copper)				
	LC10		>149	--
	LC20		>149	--
	LC50		>149	--
	IC10		--	>149
	IC20		--	>149
	IC50		--	>149

SD = Standard deviation, CL = Confidence limits, IC = Inhibition concentration, NC = Not calculable
* statistically significantly adversely affected relative to the control

Table 8. Results: hatch and survival in the *P. promelas* toxicity test using copper.

Copper Concentration (µg/L)			Hatch (%)** (Mean ± SD)	Post Hatch Survival (%) (Mean ± SD)	Overall Survival (%) (Mean ± SD)
Nominal	Measured Total	Measured Dissolved			
Lab Control	Lab control	Lab control	97 ± 3.9	93 ± 5.4	90 ± 3.8
Site Control	18.1	15.3	95 ± 6.4	74 ± 26	70 ± 25
5	23.0	20.1	97 ± 3.9	90 ± 8.5	87 ± 5.4
10	27.0	24.5	100 ± 0	88 ± 6.4	88 ± 6.3
20	37.5	33.4	100 ± 0	85 ± 14	85 ± 14
40	54.7	50.9	98 ± 3.3	90 ± 3.7	88 ± 3.3
80	93.1	86.9	90 ± 13	83 ± 8.5	75 ± 15
160	170	158	97 ± 6.7	93 ± 0.5	90 ± 6.7
Test endpoint (µg/L total copper)					
	EC10		>168	>170	>170
	EC20		>168	>170	>170
	EC50		>168	>170	>170
Test endpoint (µg/L dissolved copper)					
	EC10 (95% CL)		>144	>158	>158
	EC20 (95% CL)		>144	>158	>158
	EC50 (95% CL)		>144	>158	>158

SD = Standard deviation, CL = Confidence limits, IC = Inhibition concentration, NC = Not calculable

* statistically significantly adversely affected relative to the control

** the measured concentrations of total copper for Hatch were as follows: lab control, 14.0, 19.9, 24.2, 32.9, 51.5, 95.1 and 168 µg/L

** the measured concentrations for dissolved copper for Hatch were as follows: lab control, 12.1, 16.5, 22.3, 29.7, 46.6, 85.0 and 144 µg/L

Table 9. **Results: growth in the *P. promelas* toxicity test using copper.**

Copper Concentration (µg/L)			Length (mm) (Mean ± SD)	Biomass (mg) (Mean ± SD)
Nominal	**Measured Total**	**Measured Dissolved**		
Lab Control	Lab control	Lab control	9.6 ± 0.2	1.10 ± 0.09
Site Control	18.1	15.3	9.9 ± 0.8	1.01 ± 0.04
5	23.0	20.1	9.1 ± 0.1	0.95 ± 0.18
10	27.0	24.5	9.1 ± 0.1	0.93 ± 0.07
20	37.5	33.4	9.4 ± 0.2	1.06 ± 0.13
40	54.7	50.9	9.1 ± 0.1	0.97 ± 0.10
80	93.1	86.9	9.0 ± 0.7	1.00 ± 0.30
160	170	158	8.7 ± 0.3 *	0.92 ± 0.17
Test endpoint (µg/L total copper)				
	IC10 (95% CL)		162 (69 - >170)	15 (<18.1 – >170)
	IC20		>170	>170
	IC50		>170	>170
Test endpoint (µg/L dissolved copper)				
	IC10 (95% CL)		150 (63-287)	13 (<15.3 – >158)
	IC20		>158	>158
	IC50		>158	>158

SD = Standard deviation, CL = Confidence limits, IC = Inhibition concentration, NC = Not calculable
* statistically significantly adversely affected relative to the control

Table 10. 28-d Results: *H. azteca* toxicity test using copper.

Copper Concentration (µg/L)			Survival (%) (Mean ± SD)	Biomass (mg) (Mean ± SD)
Nominal	**Measured Total**	**Measured Dissolved**		
Lab Control	Lab control	Lab control	94 ± 6.7	0.70 ± 0.08
Site Control	17.6	14.7	94 ± 7.9	0.69 ± 0.10
5	22.1	19.1	93 ± 7.8	0.68 ± 0.07
10	25.9	23.7	92 ± 7.1	0.78 ± 0.08
20	35.6	32.4	88 ± 11	0.77 ± 0.07
40	53.8	49.7	97 ± 4.9	0.67 ± 0.09
80	92.7	84.7	98 ± 4.5	0.63 ± 0.06
160	167	154	85 ± 9.1	0.32 ± 0.04 *
Test endpoint (µg/L total copper)				
	LC10		>167	--
	LC20		>167	--
	LC50		>167	--
	IC10 (95% CL)		--	84.2 (31.8 - 105)
	IC20 (95% CL)		--	106 (78.0 – 126)
	IC50 (95% CL)		--	157 (139 - 177)
Test endpoint (µg/L dissolved copper)				
	LC10 (95% CL)		>154	--
	LC20 (95% CL)		>154	--
	LC50 (95% CL)		>154	--
	IC10 (95% CL)		--	76.8 (30.6 - 96.1)
	IC20 (95% CL)		--	97.0 (72.2 - 116)
	IC50 (95% CL)		--	144 (128 - 163)

SD = Standard deviation, CL = Confidence limits, IC = Inhibition concentration, NC = Not calculable
* statistically significantly adversely affected relative to the control

Table 11. 42-d Results: *H. azteca* toxicity test using copper.

Copper Concentration (µg/L)			Survival (%) (Mean ± SD)	Biomass (mg) (Mean ± SD)	Reproduction (Mean± SD)
Nominal	**Measured Total**	**Measured Dissolved**			
Lab Control	Lab control	Lab control	86 ± 9.1	0.88 ± 0.08	17.8 ± 12.3
Site Control	17.5	14.9	86 ± 11	0.92 ± 0.16	6.8 ± 2.9 *
5	22.3	19.8	85 ± 11	0.94 ± 0.13	10.4 ± 3.7
10	26.4	24.3	85 ± 14	0.92 ± 0.11	3.5 ± 1.6 *
20	37.1	33.0	80 ± 11	0.89 ± 0.10	7.8 ± 2.3 *
40	54.0	51.6	93 ± 7	0.95 ± 0.10	4.4 ± 2.3 *
80	92.7	86.4	91 ± 8	0.74 ± 0.16	2.9 ± 2.5 *
160	169	160	76 ± 14	0.49 ± 0.15 *	0.3 ± 0.5 *
Test endpoint (µg/L total copper)					
LC10 (95% CL)			153 (108 – NC)	--	--
LC20			>169	--	--
LC50			>169	--	--
IC10 (95% CL)			--	77.5 (48.0 – 97.6)	<17.5
IC20 (95% CL)			--	102 (81.6 – 122)	<17.5
IC50			--	>169	<17.5
Test endpoint (µg/L dissolved copper)					
LC10 (95% CL)			145 (102 – NC)	--	--
LC20			>160	--	--
LC50			>160	--	--
IC10 (95% CL)			--	72.9 (45.1 – 91.9)	<14.9
IC20 (95% CL)			--	96.6 (76.8 – 115)	<14.9
IC50 (95% CL)			--	>160	<14.9

SD = Standard deviation, CL = Confidence limits, IC = Inhibition concentration, NC = Not calculable
* statistically significantly adversely affected relative to the control

4.0 QA/QC

The health histories of the test organisms used in the exposures were acceptable and met the requirements of the test protocols. The tests met all control acceptability criteria and water quality parameters remained within ranges specified in the protocols throughout the tests. Uncertainty associated with these tests is best described by the standard deviations around the means.

Results of the reference toxicant tests conducted during the testing program are summarized in Table 12. Results for these tests fell within the acceptable range for organism performance of mean and two standard deviations, based on historical results obtained by the laboratory for the *D. magna* and *H. azteca* tests. In the test using *P. promelas,* the reference toxicant results fell outside of the historical range for the test, indicating that the test organisms used for this species may have been more sensitive than usual. The test was reviewed and testing and culturing procedures were considered to have been followed appropriately. The results of the control performance from the test was acceptable. Thus, despite not falling within the two standard deviation historical range, the test with the sample was considered to be a useful measure of sensitivity to copper, particularly since there was no evidence of adverse effects from copper in the test. There were not sufficient historical data with which to prepare a historical reference toxicant range for the *B. calyciflorus* test.

Table 12. Reference toxicant test results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
P. promelas	Survival (LC50): 3.3 g/L NaCl	7.3 (5.4-9.8)	9.6	May 29, 2017
	Biomass (IC25): 2.3 g/L NaCl	4.4 (3.1-6.3)	12	
D. magna	Survival (LC50): 5.4 g/L NaCl	4.9 (4.2-5.8)	5.3	May 31, 2017
B. calyciflorus	Survival (IC50) 1.6 (0.6-2.0) g/L NaCl	NA	NA	May 23, 2107
H. azteca	Survival (LC50): 416 µg/L Cu	631 (251-1259)	33	May 25, 2017

SD = Standard Deviation, CV = Coefficient of Variation, LC = Lethal Concentration, IC = Inhibition Concentration, EC = Effect Concentration, NA = Not Available

5.0 REFERENCES

APHA (American Public Health Association). 2012. Standard Methods for the Examination of Water and Wastewater, 22nd Edition. Section 8420 – Rotifers. Washington, DC, USA.

ASTM. 2004. Standard Guide for Conducting Daphnia magna Life-Cycle Toxicity Tests. Method: E1193 - 97 (Reapproved 2004). In: Annual Book of ASTM Standards. Volume 11.06. Biological Effects and Environmental Fate; Biotechnology, Water and Environmental Technology, American Society for Testing and Materials. Philadelphia, PA.

ASTM. 2013. Standard guide for conducting early life-stage toxicity tests with fishes. E1241-05. 29 pp.

Environment Canada, 2005. Guidance Document on Statistical Methods for Environmental Toxicity Tests. EPS 1/RM/46.

Snell TW. 1992. A 2-d Life Cycle Test with the Rotifer *Brachionus calyciflorus*. Environ Toxicol Chem 11:1249-1257.

Tidepool Scientific Software. 2015. CETIS comprehensive environmental toxicity information system, version 1.9.0.8 Tidepool Scientific Software, McKinleyville, CA.

USEPA. 1996. Ecological Effects Test Guidelines. OPPTS 850.1400 Fish Early-Life Stage Toxicity Test. EPA-712-C-96-121, Public Draft.

USEPA. 2000. Methods for measuring the toxicity and bioaccumulation of sediment-associated contaminants with freshwater invertebrates. EPA 600/R-99/064. March 2000.ASTM. 2013. Standard guide for conducting early life-stage toxicity tests with fishes. E1241-05, 29 p.

APPENDIX A – *Brachionus calyciflorus* Toxicity Test Data

Brachionus calyciflorus Summary Sheet

Client: Calgary Nautilus (Minnow Environmental)
Work Order No.: 170494

Start Date/Time: May 23, 2017 @ 14:00
Test Species: *Brachionus calyciflorus*
Set up by: EMM

Sample Information:

Sample ID: W2:W16 mixture
Sample Date: n/a
Date Received: May 23/17
Sample Volume: W2 - 2 x 2L and W16 - 1 x 2L

Test Organism Information:

Age of young (Day 0): <2 hours

NaCl Reference Toxicant Results:

Reference Toxicant ID: BC04
Stock Solution ID: 17Na02
Date Initiated: May 23/17
48-h IC50 (95% CL): 1.6 (0.6 - 2.0) g/L NaCl

Reference Toxicant Mean ± 2 SD: n/a
Reference Toxicant CV (%): n/a

1 -
Test Results: The resulting IC25 and IC50 values were >179.5 µg/L Cu.
The NOEC and LOEC was 97.6 and 179.5 µg/L Cu, respectively.
1 - endpoints were calculated using laboratory control as the negative control against total copper values.

Reviewed by:

Date reviewed: Sep. 27/17

1/2

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Minnow Environmental
Sample ID: W2:W16 (3:1 mixture)
Work Order No.: 170494

Start Date/Time: May ~~25~~ 23 /17 @ 1400h
Test Organism: *Brachionus calyciflorus*
Set up by: Emm

DO meter: DO-1
pH meter: pH-1
Conductivity meter: C-1

Concentration (µg/L Cu)	Temperature (°C)		Dissolved oxygen (mg/L)		pH		Conductivity (µS/cm)	
	0	48	0	48	0	48	0	48
lab MHW control	24.0	24.0	8.2	8.0	7.9	7.8	354	353
site control (W2:W16)	24.0	24.0	8.1	7.9	7.2	7.1	221	222
5	24.0	24.0	8.1	7.9	7.2	7.2	221	220
10	24.0	24.0	8.0	7.8	7.2	7.2	222	220
20	24.0	24.0	8.0	7.8	7.3	7.2	222	221
40	24.0	24.0	8.1	7.9	7.3	7.2	221	222
Technician Initials	Emm	Emm	Emm	Emm	Emm	Emm	Emm	Emm

	Hardness	Alkalinity
Control	100	72
Highest concentration	N/A	N/A

	Adjustment	Adjusted WQ
Temp (°C)	N/A	N/A
DO (mg/L)	N/A	N/A
pH	N/A	N/A
Cond (µS/cm)	N/A	N/A

Comments: initiated test w/ six organisms per replicate

Reviewed by: June 29/17

2/2

Freshwater Acute
48 Hour Toxicity Test Data Sheet

Client: Minnow Environmental
Sample ID: W2:W16 (3:1 mixture)
Work Order No.: 170494

Start Date/Time: May ~~25~~ 23/17 @ 1400h
Test Organism: *Brachionus calyciflorus*
Set up by: EMM

DO meter: DO-1
pH meter: pH-1
Conductivity meter: C-1

Concentration (µg/L Cu)	Temperature (°C)		Dissolved oxygen (mg/L)		pH		Conductivity (µS/cm)	
	0	48	0	48	0	48	0	48
80	24.0	24.0	8.1	7.8	7.3	7.2	221	220
160	24.0	24.0	8.1	7.8	7.3	7.2	221	220
Technician Initials	EMM	EMM	EMM	EMM	EMM	EMM	EMM	EMM

	Hardness	Alkalinity
Control	100	72
Highest concentration	N/A	N/A

	Adjustment	Adjusted WQ
Temp (°C)	N/A	N/A
DO (mg/L)	N/A	N/A
pH	N/A	N/A
Cond (µS/cm)	N/A	N/A

Comments:

Reviewed by: JCh June 29/17

Freshwater Acute Toxicity Test
B. calyciflorus Survival

May 23/17 to May 25/17

Client: Minnow Environmental
Sample ID: W2:W16 (3:1 Mixture)
Work Order: 170494

Start Date & Time: May 25/17 @ 1400h
Stop Date & Time: May ~~6~~27/17 @ 1400h
Set up by: EMM

(μg/L Cu)

Hrs	Concentration: MHW lab control								Concentration: W2:W16 site control							
	A	B	C	D	E	F	G	Init	A	B	C	D	E	F	G	Init
24	6	→						EMM	6	→						EMM
48	22	28	23	24	28	20	16	EMM	28	22	29	20	18	22	24	EMM

Hrs	Concentration: 5								Concentration: 10							
	A	B	C	D	E	F	G	Init	A	B	C	D	E	F	G	Init
24	6	→						EMM	6	→						EMM
48	30	32	28	28	34	20	29	EMM	20	28	30	32	38	36	38	EMM

Hrs	Concentration: 20								Concentration: 40							
	A	B	C	D	E	F	G	Init	A	B	C	D	E	F	G	Init
24	6	→						EMM	6	→						EMM
48	38	39	28	39	40	38	32	EMM	38	38	30	32	34	28	33	EMM

Sample Description: clear, slightly yellow, odourless
Comments:

Reviewed by: JGn

Date reviewed: June 29/17

Freshwater Acute Toxicity Test
B. calyciflorus Survival

23/17 to 25/17

Client: Minnow
Sample ID: W2:W16 (3:1 mixture)
Work Order: 17CM94

Start Date & Time: May 25/17 @ 1400h
Stop Date & Time: May 27/17 @ 1400h
Set up by: EMM

Hrs	Concentration: 80								Concentration: 160							
	A	B	C	D	E	F	G	Init	A	B	C	D	E	F	G	Init
24	6	→						EMM	6	→						EMM
48	36	30	28	28	31	30	20	EMM	21	19	16	11	20	26	24	EMM

Hrs	Concentration:								Concentration:							
	A	B	C	D	E	F	G	Init	A	B	C	D	E	F	G	Init
24																
48																

Hrs	Concentration:								Concentration:							
	A	B	C	D	E	F	G	Init	A	B	C	D	E	F	G	Init
24																
48																

Sample Description: same as previous page
Comments:

Reviewed by: JGh

Date reviewed: June 29/17

Client: Minnow Environmental

W.O.#: 170494

Hardness and Alkalinity Datasheet

	Alkalinity						Hardness			
Sample ID	Subsample Date	Date Measured	Sample Volume (mL)	(mL) 0.02N HCL/H_2SO_4 used to pH 4.5	(mL) of 0.02N HCL/H_2SO_4 used to pH 4.2	Total Alkalinity (mg/L$CaCO_3$)	Sample Volume (mL)	Volume of 0.01M EDTA Used (mL)	Total Hardness (mg/L $CaCO_3$)	Technician
MHW	May 25/17	May 25/17	50	4.0	4.4	72	50	5.0	100	YML

Notes:

Reviewed by: JBu

Date Reviewed: June 29/17

CETIS Summary Report

Report Date: 27 Sep-17 10:18 (p 1 of 1)
Test Code: 170494 | 15-3040-3260

Rotifer 48-h Life Cycle Test — **Nautilus Environmental**

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	11-5967-1644	**Code:**	451F2F5C	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
14-3261-1670	Growth Rate-r	97.6	179.5	132.4	17.6%		Steel Many-One Rank Sum Test

Point Estimate Summary

Analysis ID	Endpoint	Level	ug/L	95% LCL	95% UCL	TU	Method
07-5016-8812	Growth Rate-r	IC5	110.6	8.325	115.9		Linear Interpolation (ICPIN)
		IC10	125.3	42.67	139.6		
		IC15	141.9	102	N/A		
		IC20	160.8	118.9	N/A		adjusted for homesis
		IC25	>179.5	N/A	N/A		
		IC40	>179.5	N/A	N/A		
		IC50	>179.5	N/A	N/A		
09-4910-7142	Growth Rate-r	IC5	106.3	81.8	108.9		Linear Interpolation (ICPIN)
		IC10	115.8	101.6	122		
		IC15	126.1	113.6	136.5		
		IC20	137.3	124	152.7		
		IC25	149.5	133.3	171.2		
		IC40	>179.5	N/A	N/A		
		IC50	>179.5	N/A	N/A		

Growth Rate-r Summary

C-ug/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
1	Negative Control	7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
23.6		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
28.4		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
34		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
43.6		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
63.4		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
97.6		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
179.5		7	0.5018	0.397	0.6065	0.3031	0.6264	0.04281	0.1133	22.57%	24.43%

Growth Rate-r Detail

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
1	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
23.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
28.4		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
34		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
43.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
63.4		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
97.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
179.5		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: emm QA: Jbh Sep 27/17

CETIS Analytical Report

Report Date:	25 Sep-17 13:11 (p 1 of 2)
Test Code:	170494 | 15-3040-3260

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID:	09-4910-7142	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	25 Sep-17 13:10	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	11-5967-1644	**Code:**	451F2F5C	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper (total)	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	603402	200	Yes	Two-Point Interpolation

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	106.3	81.8	108.9
IC10	115.8	101.6	122
IC15	126.1	113.6	136.5
IC20	137.3	124	152.7
IC25	149.5	133.3	171.2
IC40	>179.5	N/A	N/A
IC50	>179.5	N/A	N/A

Growth Rate-r Summary

			Calculated Variate						
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
1	Negative Control	7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
23.6	Site control	7	0.6717	0.5493	0.7878	0.03253	0.08607	12.81%	-1.17%
28.4		7	0.777	0.602	0.8673	0.03213	0.08501	10.94%	-17.04%
34		7	0.8222	0.602	0.9229	0.04294	0.1136	13.82%	-23.84%
43.6		7	0.8962	0.7702	0.9486	0.02521	0.06671	7.44%	-34.98%
63.4		7	0.8539	0.7702	0.9229	0.0215	0.05688	6.66%	-28.62%
97.6		7	0.7813	0.602	0.8959	0.03388	0.08964	11.47%	-17.67%
179.5		7	0.5018	0.3031	0.6264	0.04281	0.1133	22.57%	24.43%

Growth Rate-r Detail

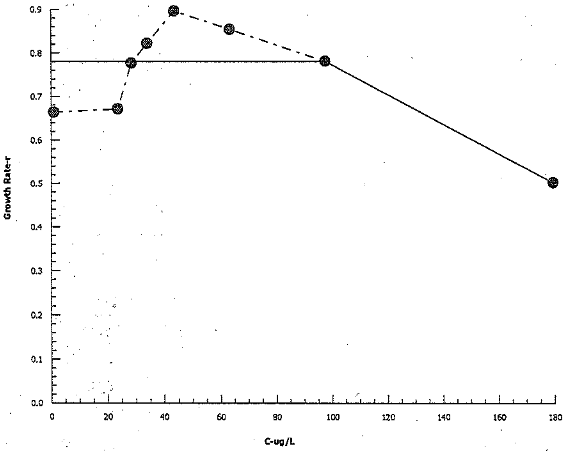
C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
1	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
23.6	Site control	0.7702	0.6496	0.7878	0.602	0.5493	0.6496	0.6931
28.4		0.8047	0.837	0.7702	0.7702	0.8673	0.602	0.7878
34		0.602	0.7702	0.8047	0.837	0.9229	0.8959	0.9229
43.6		0.9229	0.9359	0.7702	0.9359	0.9486	0.9229	0.837
63.4		0.9229	0.9229	0.8047	0.837	0.8673	0.7702	0.8524
97.6		0.8959	0.8047	0.7702	0.7702	0.8211	0.8047	0.602
179.5		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: EMM QA: JGL Sep. 27/17

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID: 09-4910-7142 **Endpoint:** Growth Rate-r **CETIS Version:** CETISv1.8.7
Analyzed: 25 Sep-17 13:10 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Graphics



Analyst: AMM QA: JGK
27/17

CETIS Analytical Report

Report Date: 27 Sep-17 10:15 (p 1 of 2)
Test Code: 170494 | 15-3040-3260

Rotifer 48-h Life Cycle Test — **Nautilus Environmental**

Analysis ID:	07-5016-8812	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 10:15	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	11-5967-1644	**Code:**	451F2F5C	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1672544	200	Yes	Two-Point Interpolation

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	110.6	8.325	115.9
IC10	125.3	42.67	139.6
IC15	141.9	102	N/A
IC20	160.8	118.9	N/A
IC25	>179.5	N/A	N/A
IC40	>179.5	N/A	N/A
IC50	>179.5	N/A	N/A

Growth Rate-r Summary

			Calculated Variate						
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
1	Negative Control	7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
23.6		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
28.4		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
34		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
43.6		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
63.4		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
97.6		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
179.5		7	0.5018	0.3031	0.6264	0.04281	0.1133	22.57%	24.43%

Growth Rate-r Detail

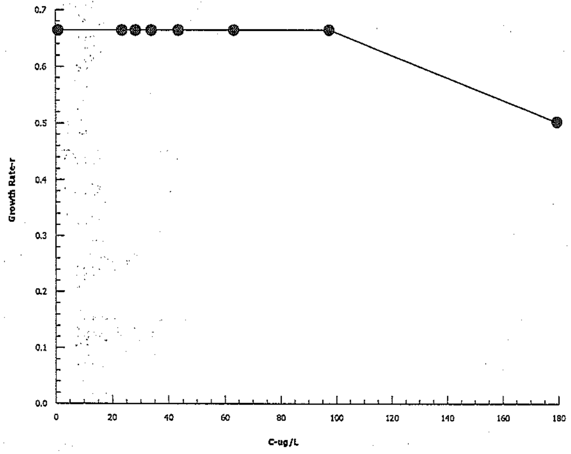
C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
1	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
23.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
28.4		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
34		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
43.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
63.4		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
97.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
179.5		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: EMM QA: JGL Sep. 27/17

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID:	07-5016-8812	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 10:15	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst: EMM QA: JGG 27/17

CETIS Analytical Report

Report Date: 25 Sep-17 13:11 (p 1 of 2)
Test Code: 170494 | 15-3040-3260

Rotifer 48-h Life Cycle Test — **Nautilus Environmental**

Analysis ID:	14-3261-1670	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	25 Sep-17 13:11	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	11-5967-1644	**Code:**	451F2F5C	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper (total)	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Untransformed	NA	C > T	NA	NA	17.6%	97.6	179.5	132.4	

Steel Many-One Rank Sum Test

Control	vs	C-ug/L	Test Stat	Critical	Ties	DF	P-Value	P-Type	Decision(α:5%)
1		23.6	53	34	5	12	0.8904	Asymp	Non-Significant Effect
1		28.4	69.5	34	3	12	0.9999	Asymp	Non-Significant Effect
1		34	70.5	34	3	12	1.0000	Asymp	Non-Significant Effect
1		43.6	76	34	2	12	1.0000	Asymp	Non-Significant Effect
1		63.4	76	34	2	12	1.0000	Asymp	Non-Significant Effect
1		97.6	69.5	34	3	12	0.9999	Asymp	Non-Significant Effect
1		179.5*	33.5	34	2	12	0.0404	Asymp	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.7989955	0.1141422	7	13.9	<0.0001	Significant Effect
Error	0.3942036	0.008212575	48			
Total	1.193199		55			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	4.189	18.48	0.7577	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9322	0.9426	0.0037	Non-normal Distribution

Growth Rate-r Summary

C-ug/L	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
1	Negative Control	7	0.6639	0.5733	0.7546	0.6719	0.4904	0.7702	0.03705	14.77%	0.0%
23.6	sitecontrol	7	0.6717	0.5921	0.7513	0.6496	0.5493	0.7878	0.03253	12.81%	-1.17%
28.4		7	0.777	0.6984	0.8556	0.7878	0.602	0.8673	0.03213	10.94%	-17.04%
34		7	0.8222	0.7172	0.9273	0.837	0.602	0.9229	0.04294	13.82%	-23.84%
43.6		7	0.8962	0.8345	0.9579	0.9229	0.7702	0.9486	0.02521	7.44%	-34.98%
63.4		7	0.8539	0.8013	0.9065	0.8524	0.7702	0.9229	0.0215	6.66%	-28.62%
97.6		7	0.7813	0.6984	0.8642	0.8047	0.602	0.8959	0.03388	11.47%	-17.67%
179.5		7	0.5018	0.397	0.6065	0.4904	0.3031	0.6264	0.04281	22.57%	24.43%

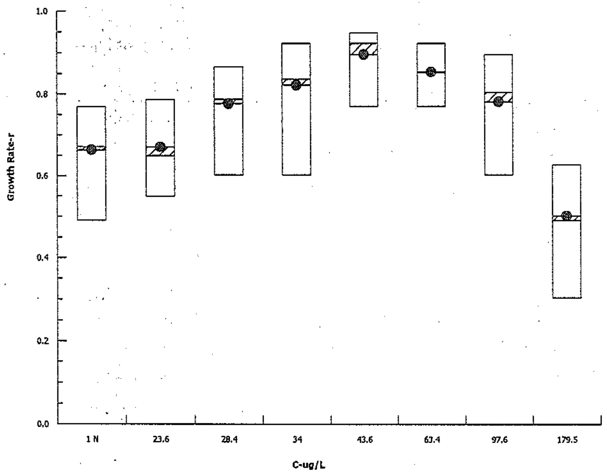
Growth Rate-r Detail

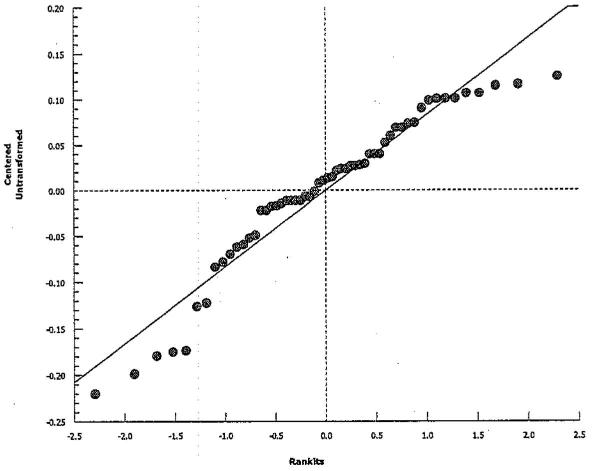
C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
1	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
23.6	Sitecontrol	0.7702	0.6496	0.7878	0.602	0.5493	0.6496	0.6931
28.4		0.8047	0.837	0.7702	0.7702	0.8673	0.602	0.7878
34		0.602	0.7702	0.8047	0.837	0.9229	0.8959	0.9229
43.6		0.9229	0.9359	0.7702	0.9359	0.9486	0.9229	0.837
63.4		0.9229	0.9229	0.8047	0.837	0.8673	0.7702	0.8524
97.6		0.8959	0.8047	0.7702	0.7702	0.8211	0.8047	0.602
179.5		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: EMM QA: JGL [illegible] 27/17

Analysis ID: 14-3261-1670 **Endpoint:** Growth Rate-r **CETIS Version:** CETISv1.8.7
Analyzed: 25 Sep-17 13:11 **Analysis:** Nonparametric-Control vs Treatments **Official Results:** Yes

Graphics





Analyst: emm QA: JGh Sep 27/17

Brachionus calyciflorus Summary Sheet

Client: Calgary Nautilus (Minnow Environmental)
Work Order No.: 170494

Start Date/Time: May 23, 2017 @ 14:00
Test Species: *Brachionus calyciflorus*
Set up by: EMM

Sample Information:

Sample ID: W2:W16 mixture
Sample Date: n/a
Date Received: May 23/17
Sample Volume: W2 - 2 x 2L and W16 - 1 x 2L

Test Organism Information:

Age of young (Day 0): <2 hours

NaCl Reference Toxicant Results:

Reference Toxicant ID: BC04
Stock Solution ID: 17Na02
Date Initiated: May 23/17
48-h IC50 (95% CL): 1.6 (0.6 - 2.0) g/L NaCl

Reference Toxicant Mean ± 2 SD: n/a
Reference Toxicant CV (%): n/a

Test Results[1]:
The resulting IC25 and IC50 values were >168 µg/L Cu.
The NOEC and LOEC was 90.3 and 168.0 µg/L Cu, respectively.
1 - endpoints were calculated using laboratory control as the negative control against dissolved copper values.

Reviewed by: JCh

Date reviewed: Sep.27/17

CETIS Summary Report

Report Date: 27 Sep-17 10:18 (p 1 of 1)
Test Code: 170494(dissolve | 18-9936-5638

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	05-9182-0491	**Code:**	234676CB	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Comparison Summary

Analysis ID	Endpoint	NOEL	LOEL	TOEL	PMSD	TU	Method
16-0667-5684	Growth Rate-r	90.3	168	123.2	17.6%		Steel Many-One Rank Sum Test

Point Estimate Summary

Analysis ID	Endpoint	Level	ug/L	95% LCL	95% UCL	TU	Method
12-8150-0850	Growth Rate-r	IC5	98.51	72.56	101		Linear Interpolation (ICPIN)
		IC10	107.5	91.82	113		
		IC15	117.2	102.8	126.9		
		IC20	127.9	113.8	142.2		
		IC25	139.4	123.7	161.6		
		IC40	>168	N/A	N/A		
		IC50	>168	N/A	N/A		
18-5740-8791	Growth Rate-r	IC5	102.6	5.827	107.3		Linear Interpolation (ICPIN)
		IC10	116.5	33.9	135.3		
		IC15	132.3	91.61	167		adjusted for hormesis
		IC20	150.2	110.3	N/A		
		IC25	>168	N/A	N/A		
		IC40	>168	N/A	N/A		
		IC50	>168	N/A	N/A		

Growth Rate-r Summary

C-ug/L	Control Type	Count	Mean	95% LCL	95% UCL	Min	Max	Std Err	Std Dev	CV%	%Effect
0.3	Negative Control	7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
20		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
24.6		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
30		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
39		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
56.4		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
90.3		7	0.6639	0.5733	0.7546	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
168		7	0.5018	0.397	0.6065	0.3031	0.6264	0.04281	0.1133	22.57%	24.43%

Growth Rate-r Detail

C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
0.3	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
20		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
24.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
30		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
39		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
56.4		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
90.3		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
168		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: emm QA: JGh

CETIS Analytical Report

Report Date: 25 Sep-17 12:48 (p 1 of 2)
Test Code: 170494(dissolve | 18-9936-5638

Rotifer 48-h Life Cycle Test — **Nautilus Environmental**

Analysis ID:	12-8150-0850	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	25 Sep-17 12:47	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	05-9182-0491	**Code:**	234676CB	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper (dissolved)	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	550775	200	Yes	Two-Point Interpolation

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	98.51	72.56	101
IC10	107.5	91.82	113
IC15	117.2	102.8	126.9
IC20	127.9	113.8	142.2
IC25	139.4	123.7	161.6
IC40	>168	N/A	N/A
IC50	>168	N/A	N/A

Growth Rate-r Summary

			Calculated Variate						
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0.3	Negative Control	7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
20	(site control)	7	0.6717	0.5493	0.7878	0.03253	0.08607	12.81%	-1.17%
24.6		7	0.777	0.602	0.8673	0.03213	0.08501	10.94%	-17.04%
30		7	0.8222	0.602	0.9229	0.04294	0.1136	13.82%	-23.84%
39		7	0.8962	0.7702	0.9486	0.02521	0.06671	7.44%	-34.98%
56.4		7	0.8539	0.7702	0.9229	0.0215	0.05688	6.66%	-28.62%
90.3		7	0.7813	0.602	0.8959	0.03388	0.08964	11.47%	-17.67%
168		7	0.5018	0.3031	0.6264	0.04281	0.1133	22.57%	24.43%

Growth Rate-r Detail

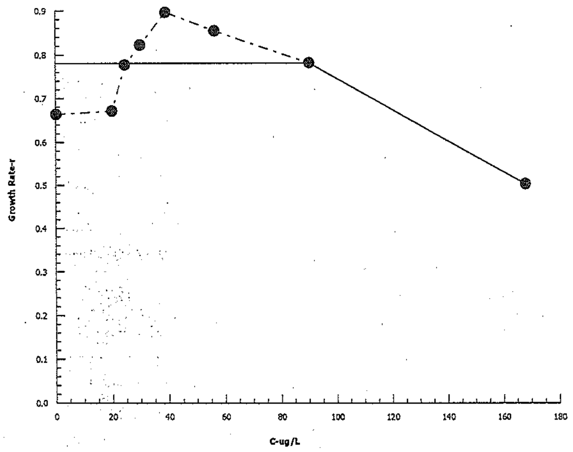
C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
0.3	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
20	(site control)	0.7702	0.6496	0.7878	0.602	0.5493	0.6496	0.6931
24.6		0.8047	0.837	0.7702	0.7702	0.8673	0.602	0.7878
30		0.602	0.7702	0.8047	0.837	0.9229	0.8959	0.9229
39		0.9229	0.9359	0.7702	0.9359	0.9486	0.9229	0.837
56.4		0.9229	0.9229	0.8047	0.837	0.8673	0.7702	0.8524
90.3		0.8959	0.8047	0.7702	0.7702	0.8211	0.8047	0.602
168		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: EMM QA: JGL Sep 27/17

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID:	12-8150-0850	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	25 Sep-17 12:47	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst: AMW QA: JGU Sep 27/17

CETIS Analytical Report

Report Date: 27 Sep-17 10:17 (p 1 of 2)
Test Code: 170494(dissolve | 18-9936-5638

Rotifer 48-h Life Cycle Test | **Nautilus Environmental**

Analysis ID:	18-5740-8791	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 10:16	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	05-9182-0491	**Code:**	234676CB	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1740520	200	Yes	Two-Point Interpolation

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	102.6	5.827	107.3
IC10	116.5	33.9	135.3
IC15	132.3	91.61	167
IC20	150.2	110.3	N/A
IC25	>168	N/A	N/A
IC40	>168	N/A	N/A
IC50	>168	N/A	N/A

Growth Rate-r Summary

			Calculated Variate						
C-ug/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0.3	Negative Control	7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
20		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
24.6		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
30		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
39		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
56.4		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
90.3		7	0.6639	0.4904	0.7702	0.03705	0.09803	14.77%	0.0%
168		7	0.5018	0.3031	0.6264	0.04281	0.1133	22.57%	24.43%

Growth Rate-r Detail

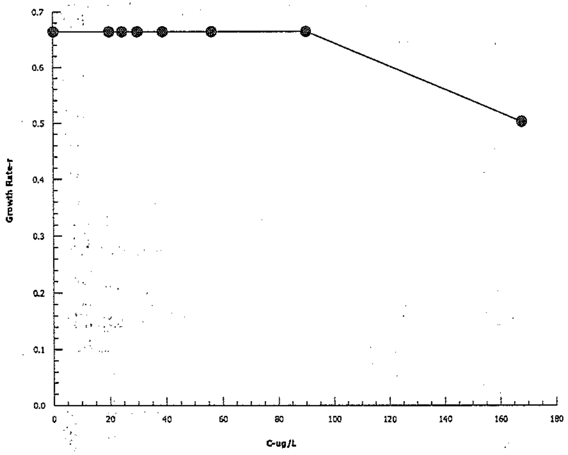
C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
0.3	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
20		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
24.6		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
30		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
39		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
56.4		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
90.3		0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
168		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

Analyst: EMM QA: JCk 27/17

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID:	18-5740-8791	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	27 Sep-17 10:16	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



Analyst: EMM QA: JGk Sep 27/17

CETIS Analytical Report

Report Date:	25 Sep-17 12:48 (p 1 of 2)
Test Code:	170494(dissolve | 18-9936-5638

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID:	16-0667-5684	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	25 Sep-17 12:48	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-8148-8809	**Test Type:**	Rotifer Growth	**Analyst:**	Emma Marus
Start Date:	23 May-17 14:00	**Protocol:**	SNELL/ET&C 11 (1992)	**Diluent:**	
Ending Date:	25 May-17 14:00	**Species:**	Brachionus calyciflorus	**Brine:**	
Duration:	48h	**Source:**	Brine Shrimp Direct	**Age:**	

Sample ID:	05-9182-0491	**Code:**	234676CB	**Client:**	Minnow Environmental
Sample Date:	23 May-17	**Material:**	Copper (dissolved)	**Project:**	
Receive Date:	23 May-17	**Source:**	Minnow Environmental		
Sample Age:	14h (20 °C)	**Station:**	W2/W16		

Data Transform	Zeta	Alt Hyp	Trials	Seed	PMSD	NOEL	LOEL	TOEL	TU
Untransformed	NA	C > T	NA	NA	17.6%	90.3	168	123.2	

Steel Many-One Rank Sum Test

Control	vs	C-ug/L	Test Stat	Critical	Ties	DF	P-Value	P-Type	Decision(α:5%)
0.3		20	53	34	5	12	0.8904	Asymp	Non-Significant Effect
0.3		24.6	69.5	34	3	12	0.9999	Asymp	Non-Significant Effect
0.3		30	70.5	34	3	12	1.0000	Asymp	Non-Significant Effect
0.3		39	76	34	2	12	1.0000	Asymp	Non-Significant Effect
0.3		56.4	76	34	2	12	1.0000	Asymp	Non-Significant Effect
0.3		90.3	69.5	34	3	12	0.9999	Asymp	Non-Significant Effect
0.3		168*	33.5	34	2	12	0.0404	Asymp	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.7989955	0.1141422	7	13.9	<0.0001	Significant Effect
Error	0.3942036	0.008212575	48			
Total	1.193199		55			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance	4.189	18.48	0.7577	Equal Variances
Distribution	Shapiro-Wilk W Normality	0.9322	0.9426	0.0037	Non-normal Distribution

Growth Rate-r Summary

C-ug/L	Control Type	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0.3	Negative Control	7	0.6639	0.5733	0.7546	0.6719	0.4904	0.7702	0.03705	14.77%	0.0%
20	(site control)	7	0.6717	0.5921	0.7513	0.6496	0.5493	0.7878	0.03253	12.81%	-1.17%
24.6		7	0.777	0.6984	0.8556	0.7878	0.602	0.8673	0.03213	10.94%	-17.04%
30		7	0.8222	0.7172	0.9273	0.837	0.602	0.9229	0.04294	13.82%	-23.84%
39		7	0.8962	0.8345	0.9579	0.9229	0.7702	0.9486	0.02521	7.44%	-34.98%
56.4		7	0.8539	0.8013	0.9065	0.8524	0.7702	0.9229	0.0215	6.66%	-28.62%
90.3		7	0.7813	0.6984	0.8642	0.8047	0.602	0.8959	0.03388	11.47%	-17.67%
168		7	0.5018	0.397	0.6065	0.4904	0.3031	0.6264	0.04281	22.57%	24.43%

Growth Rate-r Detail

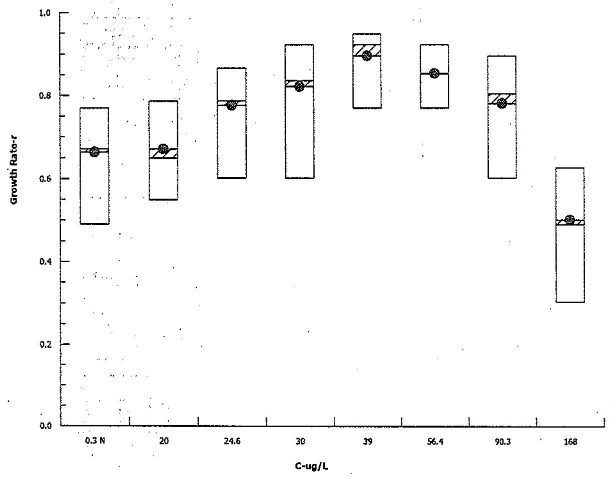
C-ug/L	Control Type	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7
0.3	Negative Control	0.6496	0.7702	0.6719	0.6931	0.7702	0.602	0.4904
20	(site control)	0.7702	0.6496	0.7878	0.602	0.5493	0.6496	0.6931
24.6		0.8047	0.837	0.7702	0.7702	0.8673	0.602	0.7878
30		0.602	0.7702	0.8047	0.837	0.9229	0.8959	0.9229
39		0.9229	0.9359	0.7702	0.9359	0.9486	0.9229	0.837
56.4		0.9229	0.9229	0.8047	0.837	0.8673	0.7702	0.8524
90.3		0.8959	0.8047	0.7702	0.7702	0.8211	0.8047	0.602
168		0.6264	0.5763	0.4904	0.3031	0.602	0.4904	0.4236

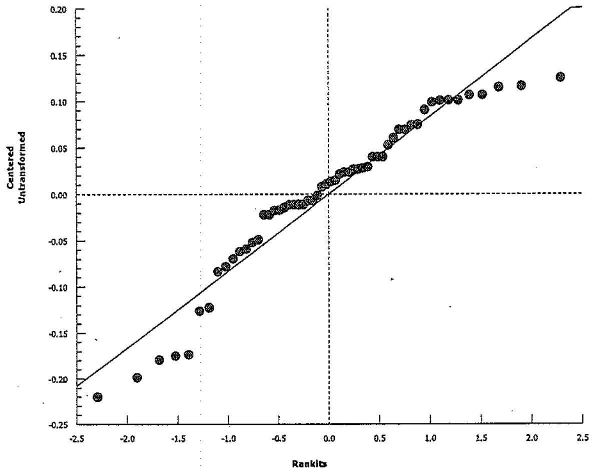
Analyst: EMM QA: JGu Sep 27/17

Rotifer 48-h Life Cycle Test **Nautilus Environmental**

Analysis ID:	16-0667-5684	**Endpoint:**	Growth Rate-r	**CETIS Version:**	CETISv1.8.7
Analyzed:	25 Sep-17 12:48	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Graphics





Analyst: AMW QA: JGG Sep 27/17

APPENDIX B – *Daphnia magna* Toxicity Test Data

Daphnia Bench Sheet

Method 21-d DA

Client MIN100	Sample SP1617-029

Test Log

Date	Day	Time	Technicians	Fed (✓) Feed (Daily)	Comments	Bench Sheet Review
2017/05/24	0	1235	JW/JN	✓	–	SS
17/05/25	1	0830	NM	✓ ~~✓~~	–	JW
2017/05/26	2	1030	JW	✓	–	JN
2017/05/27	3	1240	FW	✓	–	LC
2017/05/28	4	1200	NM	✓	–	SS
2017/05/29	5	1030	FW	✓	–	NM
2017/05/30	6	1000	FW	✓	–	SS
2017/05/31	7	1140	FW/LC	✓	Saw first broods today.	Ca
2017/06/01	8	1040	FW	✓	–	LC
2017/06/02	9	1310	FW	✓	–	Ca
2017/06/03	10	1330	LC	✓	–	FD
2017/06/04	11	1250	FW	✓	–	NM
2017/06/05	12	1030	FW	✓	–	FD
2017/06/06	13	1030	FW	✓	–	FD
2017/06/07	14	1030	FW	✓	–	LC
2017/06/08	15	1400	LC	✓	–	HS
2017/06/09	16	1500	LC	✓	–	SS
2017/06/10	17	0930	LC	✓	–	HS
2017/06/11	18	1145	NM	✓	–	SS
2017/06/12	19	1045	NM	✓	–	HS
2017/06/13	20	1200	FW	✓	–	NM
2017/06/14	21	0945	FW	–	Takedown	HS

Culture

Young jars D1

Jar(s) mortality 7 days prior to test (must be ≤25%) 0%

QA (previous month)

Days to first brood (≤12 days) 7

Average number of young produced (≥15 young) 29.8

Sample

Duration of pre-aeration (rate of 37.5 ± 12.5 mL/min.L-1) –

Hardness adjustment of sample (must be between 25 - 30 mg CaCO3/L) 120-250

Lab Control Water

Day	Pail	Prep Date	Hardness (mg/L)
0	D	05/23	91
2	H	05/24	84
5	G	05/25 23rd	93
7	D	05/29	86
9	G	06/01	89
12	H	06/02	84

Day	Pail	Prep Date	Hardness (mg/L)
14	D	06/04	86
16	E	06/05	83
19	D	06/10	84

Meter/Probe Used: [✓ water] / soil / sample sign-in / products

NAUTILUS
ENVIRONMENTAL

#3, 6125 12th Street SE Calgary, Alberta Canada T2H 2K1
Tel (403) 253-7121 Fax (403) 252-9363 www.nautilusenvironmental.ca

Daphnia Bench Sheet

Client MIN100	Sample SP1617-029

Chemistry (Monday, Wednesday, Friday)

	New Solutions								Old Solutions								
dose (ug/L) day	Lab CTL	Site CTL	5	10	20	40	80	160	Lab CTL	Site CTL	5	10	20	40	80	160	
	pH (units)								**pH (units)**								
0	7.3	6.9	6.9	6.9	7.0	6.9	6.9	7.0	—	—	—	—	—	—	—	—	JN
2	7.5	7.2	7.3	7.2	7.2	7.3	7.5	7.5	7.9	7.8	7.8	7.8	7.8	7.8	7.8	7.8	
5	7.0	7.0	7.0	7.1	7.1	7.1	7.1	7.1	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	
7	7.3	7.0	7.0	7.0	7.1	7.7	7.1	7.1	7.2	7.2	7.2	7.2	7.2	7.3	7.3	7.3	
9	7.3	7.3	7.2	7.2	7.2	7.2	7.3	7.3	7.2	7.4	7.4	7.4	7.5	7.5	7.5	7.5	
12	7.9	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.8	7.9	7.9	7.9	7.9	7.9	7.9	7.9	
14	7.8	7.7	7.7	7.8	7.8	7.5	7.5	7.5	7.8	7.7	7.7	7.7	7.7	7.8	7.8	7.8	
16	7.7	7.6	7.5	7.4	7.4	7.4	7.5	7.4	7.7	7.8	7.8	7.8	7.9	7.9	7.9	7.9	
19	7.9	7.8	7.9	7.9	7.9	7.8	7.9	7.9	8.0	7.9	7.9	8.0	8.0	8.0	8.0	7.9	
21	—	—	—	—	—	—	—	— JW	7.7	7.8	7.8	7.7	7.8	7.8	7.8	7.8	
	conductance (uS/cm)								**conductance (uS/cm)**								
0	324	230	230	231	230	231	230	231	—	—	—	—	—	—	—	—	JN
2	376	242	231	230	229	225	222	229	340	253	235	233	235	243	234	247	
5	319	236	229	229	225	229	229	229	400	266	254	256	250	278	276	283	
7	323	235	233	234	233	234	235	235	368	257	246	246	247	254	255	256	
9	316	247	240	239	238	239	238	239	336	256	246	243	247	267	251	256	
12	332	242	239	239	240	240	238	240	361	267	257	256	270	319	258	273	
14	320	245	242	237	238	239	238	239	319	249	243	244	256	271	252	255	
16	331	246	239	231	237	239	237	236	343	255	249	250	263	265	266	251	
19	337	242	242	238	236	237	239	237	347	261	248	250	254	252	267	239	
21	—	—	—	—	—	—	—	— JW	381	265	263	259	266	270	259	272	
	dissolved oxygen (mg/L)								**dissolved oxygen (mg/L)**								
0	7.7	8.1	8.1	8.1	8.1	8.1	8.1	8.1	—	—	—	—	—	—	—	—	JN
2	7.7	7.8	7.8	7.7	7.7	7.8	7.8	7.7	7.9	7.9	8.0	8.0	8.0	8.1	8.1	8.1	
5	7.5	7.9	7.8	7.8	7.8	7.8	7.9	7.9	7.8	7.9	8.0	8.0	8.0	7.9	8.0	8.0	
7	7.5	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.4	7.6	7.5	7.5	7.4	7.4	7.5	7.5	
9	7.4	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.5	7.5	7.6	7.6	7.6	7.5	7.7	7.7	
12	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.9	7.9	7.9	7.9	7.8	7.9	7.8	
14	7.7	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.6	7.6	7.7	7.6	7.6	7.6	7.8	7.9	
16	7.7	7.8	7.8	7.7	7.7	7.7	7.7	7.8	7.6	7.5	7.6	7.6	7.6	7.6	7.8	7.9	
19	7.5	7.6	7.5	7.6	7.6	7.6	7.6	7.6	7.8	7.7	7.7	7.7	7.6	7.6	7.2	7.2	
21	—	—	—	—	—	—	—	— JW	7.5	7.5	7.6	7.5	7.5	7.6	7.7	7.7	
	temperature (°C)								**temperature (°C)**								
0	19.5	18.7	18.6	18.5	18.4	18.4	18.3	18.3	—	—	—	—	—	—	—	—	JN
2	19.8	20.4	20.5	20.8	20.8	20.7	20.7	20.7	19.6	19.7	19.6	19.6	19.5	18.9	19.0	19.1	
5	20.4	20.4	20.7	20.7	20.7	20.7	20.4	20.4	19.9	19.6	19.6	19.6	19.6	19.6	19.6	19.6	
7	21.0	21.1	21.2	21.2	21.2	21.2	21.2	21.1	21.2	20.6	20.6	20.6	20.5	20.5	20.4	20.4	
9	21.0	21.0	20.9	21.0	21.3	21.0	21.1	21.0	19.9	20.0	20.0	20.0	20.0	19.9	19.9	19.8	
12	19.9	20.5	20.5	20.6	20.5	20.6	20.4	20.4	19.2	19.1	19.2	19.1	19.0	18.9	19.5	19.4	
14	20.7	20.8	20.8	20.9	20.9	20.9	20.8	20.6	19.9	19.8	19.7	19.6	19.5	19.5	19.4	19.4	
16	19.8	19.7	19.7	19.6	19.5	19.5	19.6	19.6	19.7	19.5	19.5	19.3	19.3	19.2	19.2	19.4	
19	20.9	20.8	20.8	20.6	20.6	20.6	20.7	20.8	19.8	19.9	19.9	19.8	19.8	19.6	20.8	20.8	
21	—	—	—	—	—	—	—	— JW	19.5	19.5	19.6	19.6	19.5	19.5	19.5	19.0	

Daphnia Bench Sheet

Client MIN100 | Sample SP1617-029

Biology (#, young produced; 0, no young; blank, dead)

day 1

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2								
3								
4								
5								
6								
7								
8								
9								
10	↓	↓	↓	↓	↓	↓	↓	↓

day 2

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1 A	0	0	0	0	0	0	0	0
2 B								
3 C								
4 D								
5 E								
6 F								
7 G								
8 H								
9 I								
10 J	↓	↓	↓	↓	↓	↓	↓	↓

day 3

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2								
3								
4								
5								
6								
7								
8								
9								
10	↓	↓	↓	↓	↓	↓	↓	↓

day 4

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2								
3								
4								
5								
6								
7								
8								
9								
10	↓	↓	↓	↓	↓	↓	↓	↓

day 5

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2								
3								
4								
5								
6								
7								
8								
9								
10	↓	↓	↓	↓	↓	↓	↓	↓

day 6

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2								
3								
4								
5								
6								
7								
8								
9								
10	↓	↓	↓	↓	↓	↓	↓	↓

day 7

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2								
3								
4								
5								
6		↓						
7		14	↓				↓	
8		0	~~13~~16 rw		↓		14	
9		0	0		13		15	
10	↓	0	0	↓	0	↓	0	↓

day 8

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	10	10	0	16	0	15	12
2		0	0	0	12		0	0
3		16	13	0	0		13	0
4		0	14	14	12		12	0
5		10	13	0	13		0	12
6		*~~[illegible]~~10	0	0	12		12	0
7		0	13	0	0		0	16
8		14	0	0	0		0	~~8~~ – 12 rw
9		14	0	0	0		0	11
10	↓	15	13	~~10~~	14	↓	15	0

*14 rw

13 rw

NAUTILUS
ENVIRONMENTAL

#3, 6125 12th Street SE Calgary, Alberta Canada T2H 2K1
Tel (403) 253-7121 Fax (403) 252-9363 www.nautilusenvironmental.ca

Daphnia Bench Sheet

Client MIN100 | Sample SP1617-029

Biology (#, young produced; 0, no young; blank, dead)

dose (ug/L)	Lab CTL	Site CTL	5	10	20	40	80	160
replicate	day 9							
1 A	9	0	0	0	0	14	0	0
2 B	0	14	20	0	0	15	0	23
3 C	0	0	0	15	0	0	0	18
4 D	0	0	0	0	0	13	0	0
5 E	0	0	0	21	0	0	13	0
6 F	0	0	24	0	0	13	0	0
7 G	0	0	0	19	0	13	0	0
8 H	0	0	0	17	0	0	0	0
9 I	0	0	0	0	0	0	0	0
10 J	0	0	0	0	0	14	0	15
	day 10							
1 A	0	0	0	13	0	0	0	0
2 B	0	0	0	11	0	0	24	0
3 C	0	0	0	0	19	0	0	0
4 D	0	10	0	0	0	0	0	23
5 E	0	0	0	0	0	23	0	0
6 F	0	0	0	27	0	0	16	16
7 G	13	26	0	0	22	0	0	0
8 H	0	0	19	0	18	17	26	0
9 I	0	0	20	18	19	18	25	0
10 J	18	0	0	0	0	0	0	0
	day 11							
1 A	0	17	30	0	23	0	36	26
2 B	12	20	0	0	25	20	0	0
3 C	12	31	28	0	0	20	25	0
4 D	~~11~~ 13 sw	0	26	19	25	0	26	0
5 E	12	19	20	0	27	0	35	23
6 F	13	27	0	0	27	0	~~32~~ 0	0
7 G	0	0	17	0	0	0	~~0~~ 32 sw	20
8 H	9	15	0	0	0	0	0	34
9 I	9	19	0	0	0	0	0	28
10 J	0	19	25	24	31	0	31	27
	day 12							
1 A	13	0	0	0	0	~~21~~ 33 sw	0	0
2 B	0	0	35	0	0	0	0	22*
3 C	0	0	0	30	0	0	0	28
4 D	0	0	0	0	0	26	0	0
5 E	0	0	0	28	0	0	0	0
6 F	0	0	28	0	0	32	0	0
7 G	0	0	0	26	0	28	0	0
8 H	0	0	0	30	0	0	0	0
9 I	0	0	0	0	0	0	0	0
10 J	0	0	0	0	0	26	0	0

Day 12 *160 → very faint neonates

Lab CTL	Site CTL	5	10	20	40	80	160	
day 13								
0	0	0	29	0	0	0	0	
0	0	0	30	0	0	30	0	
0	0	0	0	27	0	0	0	
0	32	0	0	0	0	0	29	
0	0	0	0	0	30	0	0	
0	0	0	30	0	0	33	31	
0	33	0	0	29	0	0	0	
0	0	21	0	26	28	30	0	
0	0	26	23	0	30	29	0	
25	0	0	0	0	0	0	0	
day 14								
0	23	29	0	19	0	39	30	
17	0	0	0	17	0	0	0	
19	33	28	0	0	31	29	0	
16	0	32	17	29	0	29	0	
13	20	24	0	25	0	32	31	
20	26	0	0	32	0	0	0	
19	0	17	0	0	0	29	25	
17	25	0	0	0	0	0	33	
14	①20	0	0	23	0	0	31	
0	19	20	25	27	0	①32	0	
day 15								
20	0	0	0	0	35	0	0	
0	27	31	0	10	37	0	31	
0	0	0	37	0	30	0	34	
0	0	0	0	0	36	0	0	
0	0	0	33	0	0	0	0	
0	0	31	0	0	37	30	0	
0	0	0	30	0	35	0	0	
0	0	0	34	0	0	0	0	
0	0	0	0	0	0	0	0	
0	0	0	0	0	29	0	32	
day 16								Lab Ctl
0	0	0	32	0	0	0	0	0
41	0	0	34	0	0	41	0	0
0 34	0	0	0	30	0	0	0	0
39	31	0	0	0	0	39	32	0
0 38	0	0	0	0	46	0	0	0
0	0	0	33	0	0	0	40	0
0	34	0	0	35	0	0	0	0
38	0	21	0	34	36	38	0	0
34	0	27	36	0	37	34	0	0
0	0	0	0	0	0	0	0	33

LC

NAUTILUS
ENVIRONMENTAL

#3, 6125 12th Street SE Calgary, Alberta Canada T2H 2K1
Tel (403) 253-7121 Fax (403) 252-9363 www.nautilusenvironmental.ca

Daphnia Bench Sheet

Client MIN100 | Sample SP1617-029

Biology (#, young produced; 0, no young; blank, dead)

day 17

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1 A	0	26	~~32~~ 33	0	26	0	38	~~41~~ 43
2 B	18	0	0	0	0	0	0	0
3 C	24	41	26	0	0	35	38	0
4 D	~~22~~ 24	0	23	26	32	0	0	0
5 E	0	0	23	0	33	0	42	29
6 F	0	0	0	0	30	0	0	0
7 G	24	0	24	0	0	0	30	35
8 H	0	28	0	0	0	0	0	34
9 I	14	25	0	0	26	0	0	30
10 J	0	26	~~22~~ 23	35	0	0	37	0

day 18

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2		~~27~~ 28			22	38		0
3		0		26	0	0		32
4		0		0		30		0
5	15	22		37		0		
6	~~0~~ 20	23		0		43		
7	~~20~~ 0	0		0		~~34~~ 35		
8	21	0		33		0		
9	0	0		0		0		
10	0	0		38		37		40

day 19

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	24	0	0	28	0	40	0	0
2	0	0	39	35	0	0	30	20
3	0	0	0	0	30	0	0	0
4		30	0	0	0	0	0	32
5		0	0	0	0	2	0	0
6		0	28	19	0	0	31	31
7		0	0	36	29	0	0	0
8		0	X18	0	32	0	35	0
9		0	29	0	28	X0	31	0
10		0	0	0	0	0	0	0

day 20

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	34	32	0	22	0	43	38
2	30	0	0	0	0	0	0	0
3	29	35	31	0	0	30	38*	0
4	26	0	29	17	28	0	31	0
5	0	29	28	0	30	22	38	21
6	0	0	0	0	32	0	0	0
7	26	37	24	0	0	0	33	37
8	0	34	X	0	0	36	0	28
9	~~12~~ 19 tw	23	0	23	0	X	0	0
10	20	22	~~31~~ 32 tw	0	① 33	0	35	0

* faint

day 21

replicate	Lab CTL	Site CTL	5	10	20	40	80	160
1	0	0	0	0	0	0	0	0
2	0	30	0	0	19	32	0	0
3	0	0	0	0	0	0	0	24
4	0	0	0	0	0	31	0	0
5	30	0	0	0	0	0	0	0
6	19	25	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	22	0	X	26	0	0	0	0
9	0	0	0	0	0	X	0	31
10	0	0	0	32	0	0	0	29

Comments:

20-8 = 34
20-9 = 29 tw

Day 19 death (5-8 + 40-9) → normal mortality observations, nothing stand-out.

CETIS Analytical Report

Report Date: 20 Jul-17 09:21 (p 1 of 2)
Test Code: SP1617-029 DA | 19-7681-6302

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	03-5027-8011	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	20 Jul-17 9:21	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	Not Applicable
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	19-6851-8300	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2069508	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.279	3.306	0.0559	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	>167	n/a	n/a
IC10	>167	n/a	n/a
IC15	>167	n/a	n/a
IC20	>167	n/a	n/a
IC25	>167	n/a	n/a
IC40	>167	n/a	n/a
IC50	>167	n/a	n/a

Reproduction Summary

			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	10	75.1	56	96	3.501	11.07	14.74%	0.00%
16.6		10	116.5	100	156	6.058	19.16	16.44%	-55.13%
20.9		10	113.3	95	134	4.31	13.63	12.03%	-50.87%
25.6		10	114.4	64	176	12.22	38.63	33.77%	-52.33%
35.6		10	114.6	105	133	3.347	10.59	9.24%	-52.60%
53.8		10	118.5	85	150	5.476	17.32	14.61%	-57.79%
94.2		10	140.9	122	171	5.078	16.06	11.40%	-87.62%
167		10	127.9	96	149	5.104	16.14	12.62%	-70.31%

Reproduction Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	66	77	84	79	70	72	82	69	56	96
16.6		110	119	156	103	100	115	144	116	101	101
20.9		134	125	126	124	108	111	95	95	102	113
25.6		92	110	108	93	152	71	111	176	64	167
35.6		106	105	106	126	128	133	115	112	110	105
53.8		122	150	116	136	117	125	111	117	85	106
94.2		171	125	143	137	160	122	124	143	134	150
167		149	96	136	116	116	118	133	141	131	143

CETIS Analytical Report

Report Date: 20 Jul-17 09:21 (p 1 of 2)
Test Code: SP1617-029 DA | 19-7681-6302

Daphnia magna 21-d Survival and Reproduction Test — **Nautilus Environmental Calgary**

Analysis ID:	20-6120-2709	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	20 Jul-17 9:21	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	Not Applicable
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	19-6851-8300	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	167	> 167	n/a		28.0%

Steel Many-One Rank Sum Test

Control vs	Conc-ug/L	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	16.6	155	74	0	18	Asymp	1.0000	Non-Significant Effect
	20.9	153	74	0	18	Asymp	1.0000	Non-Significant Effect
	25.6	138	74	0	18	Asymp	1.0000	Non-Significant Effect
	35.6	155	74	0	18	Asymp	1.0000	Non-Significant Effect
	53.8	154	74	0	18	Asymp	1.0000	Non-Significant Effect
	94.2	155	74	0	18	Asymp	1.0000	Non-Significant Effect
	167	154.5	74	1	18	Asymp	1.0000	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.279	3.306	0.0559	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	24469.6	3495.66	7	9.027	<1.0E-37	Significant Effect
Error	27880.6	387.231	72			
Total	52350.2		79			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	24.96	18.48	7.7E-04	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9633	0.9579	0.0216	Normal Distribution

Reproduction Summary

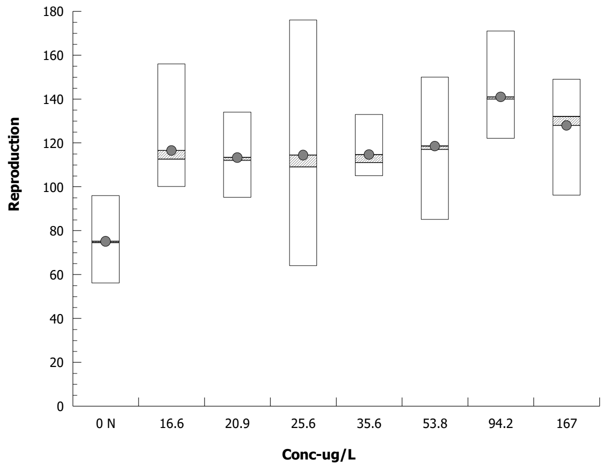
Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	10	75.1	67.18	83.02	74.5	56	96	3.501	14.74%	0.00%
16.6		10	116.5	102.8	130.2	112.5	100	156	6.058	16.44%	-55.13%
20.9		10	113.3	103.5	123.1	112	95	134	4.31	12.03%	-50.87%
25.6		10	114.4	86.77	142	109	64	176	12.22	33.77%	-52.33%
35.6		10	114.6	107	122.2	111	105	133	3.347	9.24%	-52.60%
53.8		10	118.5	106.1	130.9	117	85	150	5.476	14.61%	-57.79%
94.2		10	140.9	129.4	152.4	140	122	171	5.078	11.40%	-87.62%
167		10	127.9	116.4	139.4	132	96	149	5.104	12.62%	-70.31%

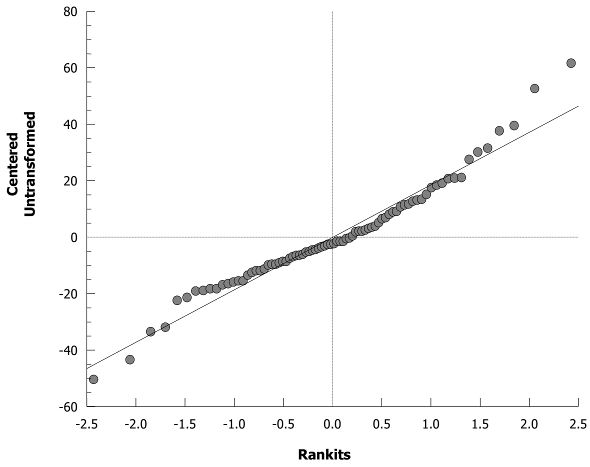
Analysis ID:	20-6120-2709	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	20 Jul-17 9:21	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Reproduction Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	66	77	84	79	70	72	82	69	56	96
16.6		110	119	156	103	100	115	144	116	101	101
20.9		134	125	126	124	108	111	95	95	102	113
25.6		92	110	108	93	152	71	111	176	64	167
35.6		106	105	106	126	128	133	115	112	110	105
53.8		122	150	116	136	117	125	111	117	85	106
94.2		171	125	143	137	160	122	124	143	134	150
167		149	96	136	116	116	118	133	141	131	143

Graphics

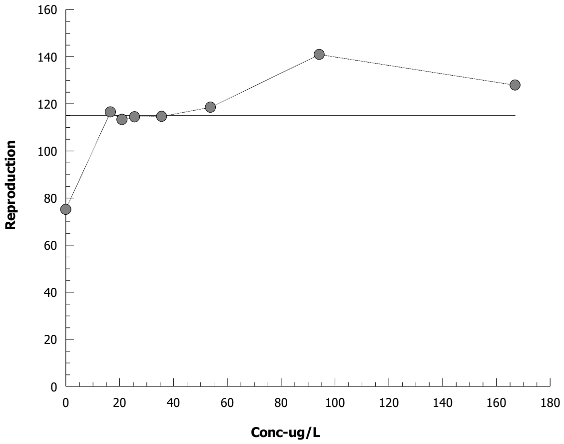




Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID: 03-5027-8011 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 20 Jul-17 9:21 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Graphics



CETIS Analytical Report

Report Date: 20 Jul-17 09:20 (p 1 of 2)
Test Code: SP1617-029 DA | 19-7681-6302

Daphnia magna 21-d Survival and Reproduction Test — **Nautilus Environmental Calgary**

Analysis ID:	17-4704-8721	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	20 Jul-17 9:20	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	Not Applicable
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	19-6851-8300	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	2054100	200	Yes	Two-Point Interpolation

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	>167	n/a	n/a
LC10	>167	n/a	n/a
LC15	>167	n/a	n/a
LC20	>167	n/a	n/a
LC25	>167	n/a	n/a
LC40	>167	n/a	n/a
LC50	>167	n/a	n/a

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	N	10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
16.6		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
20.9		10	0.9000	0.0000	1.0000	0.1000	0.3162	35.14%	10.00%	9	10
25.6		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
35.6		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
53.8		10	0.9000	0.0000	1.0000	0.1000	0.3162	35.14%	10.00%	9	10
94.2		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
167		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10

Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20.9		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000
25.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
35.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
53.8		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
94.2		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
167		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Survival Rate Binomials

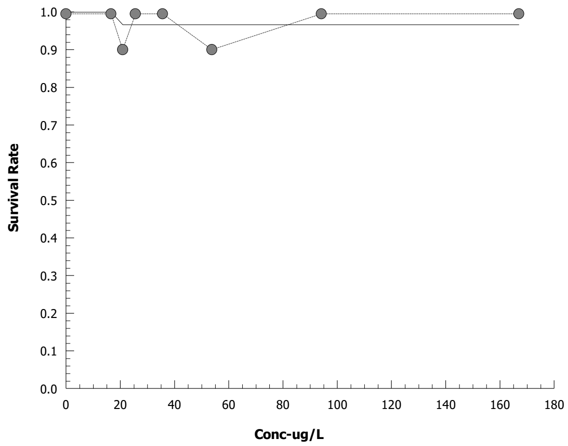
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
16.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
20.9		1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1
25.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
35.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
53.8		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1
94.2		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
167		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

Analyst:________ QA:________

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	17-4704-8721	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	20 Jul-17 9:20	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date: 20 Jul-17 09:19 (p 1 of 2)
Test Code: SP1617-029 DA | 19-7681-6302

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	03-5304-5402	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	20 Jul-17 9:19	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	Not Applicable
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	19-6851-8300	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	167	> 167	n/a		n/a

Fisher Exact/Bonferroni-Holm Test

Control vs	Group	Test Stat	P-Type	P-Value	Decision(α:5%)
Negative Control	16.6	1.0000	Exact	1.0000	Non-Significant Effect
	20.9	0.5000	Exact	1.0000	Non-Significant Effect
	25.6	1.0000	Exact	1.0000	Non-Significant Effect
	35.6	1.0000	Exact	1.0000	Non-Significant Effect
	53.8	0.5000	Exact	1.0000	Non-Significant Effect
	94.2	1.0000	Exact	1.0000	Non-Significant Effect
	167	1.0000	Exact	1.0000	Non-Significant Effect

Data Summary

Conc-ug/L	Code	NR	R	NR + R	Prop NR	Prop R	%Effect
0	N	10	0	10	1	0	0.0%
16.6		10	0	10	1	0	0.0%
20.9		9	1	10	0.9	0.1	10.0%
25.6		10	0	10	1	0	0.0%
35.6		10	0	10	1	0	0.0%
53.8		9	1	10	0.9	0.1	10.0%
94.2		10	0	10	1	0	0.0%
167		10	0	10	1	0	0.0%

Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
16.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
20.9		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000
25.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
35.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
53.8		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
94.2		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
167		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

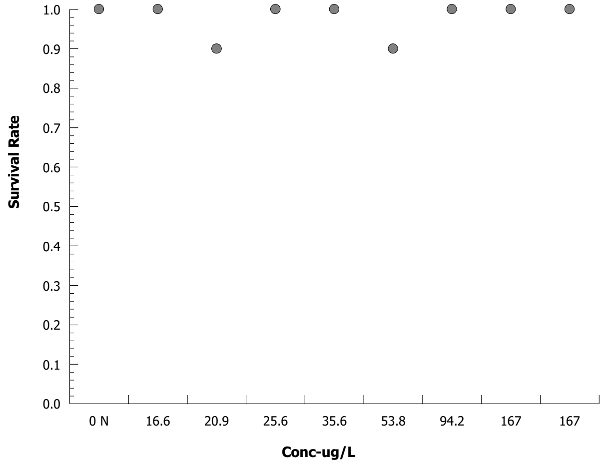
Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
16.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
20.9		1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1
25.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
35.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
53.8		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1
94.2		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
167		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

Daphnia manga 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID: 03-5304-5402 **Endpoint:** Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 20 Jul-17 9:19 **Analysis:** STP 2x2 Contingency Tables **Official Results:** Yes

Graphics



CETIS Analytical Report

Report Date: 16 Aug-17 10:19 (p 1 of 2)
Test Code: SP1617-029 DA | 21-0083-7862

Daphnia magna 21d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	10-4442-7238	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-9185-5354	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	251405	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.37	3.306	0.0383	Outlier Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	>149	n/a	n/a
IC10	>149	n/a	n/a
IC15	>149	n/a	n/a
IC20	>149	n/a	n/a
IC25	>149	n/a	n/a
IC40	>149	n/a	n/a
IC50	>149	n/a	n/a

Reproduction Summary

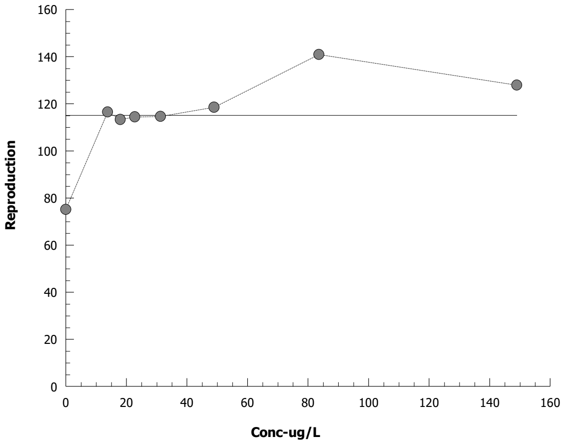
			Calculated Variate						
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
0	N	10	75.1	56	96	3.501	11.07	14.74%	0.00%
13.8		10	116.5	100	156	6.058	19.16	16.44%	-55.13%
18		10	113.3	95	134	4.31	13.63	12.03%	-50.87%
22.8		10	114.4	92	167	7.296	23.07	20.17%	-52.33%
31.3		10	114.6	105	133	3.347	10.59	9.24%	-52.60%
49		10	118.5	85	150	5.476	17.32	14.61%	-57.79%
83.6		10	140.9	122	171	5.078	16.06	11.40%	-87.62%
149		10	127.9	96	149	5.104	16.14	12.62%	-70.31%

Reproduction Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	66	77	84	79	70	72	82	69	56	96
13.8		110	119	156	103	100	115	144	116	101	101
18		134	125	126	124	108	111	95	95	102	113
22.8		92	110	108	93	119	104	111	140	100	167
31.3		106	105	106	126	128	133	115	112	110	105
49		122	150	116	136	117	125	111	117	85	106
83.6		171	125	143	137	160	122	124	143	134	150
149		149	96	136	116	116	118	133	141	131	143

Analysis ID:	10-4442-7238	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:18	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date: 16 Aug-17 10:20 (p 1 of 2)
Test Code: SP1617-029 DA | 21-0083-7862

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	13-2583-7111	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:19	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-9185-5354	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	149	> 149	n/a		23.2%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	13.8	-5.663	2.386	17.44	18	CDF	1.0000	Non-Significant Effect
	18	-5.225	2.386	17.44	18	CDF	1.0000	Non-Significant Effect
	22.8	-5.376	2.386	17.44	18	CDF	1.0000	Non-Significant Effect
	31.3	-5.403	2.386	17.44	18	CDF	1.0000	Non-Significant Effect
	49	-5.937	2.386	17.44	18	CDF	1.0000	Non-Significant Effect
	83.6	-9.001	2.386	17.44	18	CDF	1.0000	Non-Significant Effect
	149	-7.222	2.386	17.44	18	CDF	1.0000	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.37	3.306	0.0383	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	24469.6	3495.66	7	13.08	<1.0E-37	Significant Effect
Error	19240.6	267.231	72			
Total	43710.2		79			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	8.226	18.48	0.3131	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9695	0.9579	0.0531	Normal Distribution

Reproduction Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	10	75.1	67.18	83.02		56	96	3.501	14.74%	0.00%
13.8		10	116.5	102.8	130.2		100	156	6.058	16.44%	-55.13%
18		10	113.3	103.5	123.1		95	134	4.31	12.03%	-50.87%
22.8		10	114.4	97.9	130.9		92	167	7.296	20.17%	-52.33%
31.3		10	114.6	107	122.2		105	133	3.347	9.24%	-52.60%
49		10	118.5	106.1	130.9		85	150	5.476	14.61%	-57.79%
83.6		10	140.9	129.4	152.4		122	171	5.078	11.40%	-87.62%
149		10	127.9	116.4	139.4		96	149	5.104	12.62%	-70.31%

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID: 13-2583-7111 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:19 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Reproduction Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	66	77	84	79	70	72	82	69	56	96
13.8		110	119	156	103	100	115	144	116	101	101
18		134	125	126	124	108	111	95	95	102	113
22.8		92	110	108	93	119	104	111	140	100	167
31.3		106	105	106	126	128	133	115	112	110	105
49		122	150	116	136	117	125	111	117	85	106
83.6		171	125	143	137	160	122	124	143	134	150
149		149	96	136	116	116	118	133	141	131	143

CETIS Analytical Report

Report Date: 16 Aug-17 10:17 (p 1 of 2)
Test Code: SP1617-029 DA | 21-0083-7862

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	20-2240-3712	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:16	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-9185-5354	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	826116	200	Yes	Two-Point Interpolation

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	>149	n/a	n/a
LC10	>149	n/a	n/a
LC15	>149	n/a	n/a
LC20	>149	n/a	n/a
LC25	>149	n/a	n/a
LC40	>149	n/a	n/a
LC50	>149	n/a	n/a

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	N	10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
13.8		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
18		10	0.9000	0.0000	1.0000	0.1000	0.3162	35.14%	10.00%	9	10
22.8		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
31.3		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
49		10	0.9000	0.0000	1.0000	0.1000	0.3162	35.14%	10.00%	9	10
83.6		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10
149		10	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	10	10

Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13.8		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000
22.8		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
31.3		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
49		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
83.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
149		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

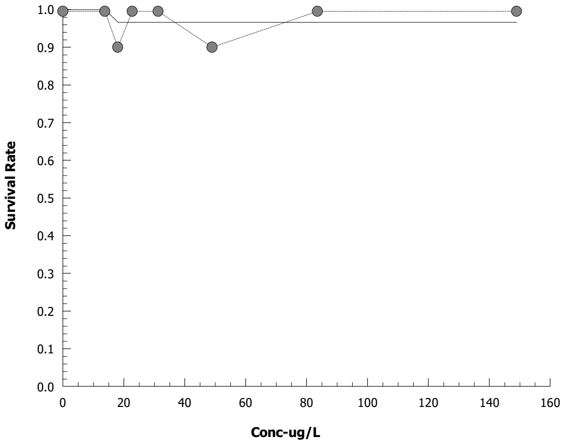
Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
13.8		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
18		1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1
22.8		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
31.3		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
49		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1
83.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
149		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

Daphnia magna 21-d Survival and Reproduction Test **Nautilus Environmental Calgary**

Analysis ID:	20-2240-3712	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:16	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Graphics



CETIS Analytical Report

Report Date: 16 Aug-17 10:17 (p 1 of 2)
Test Code: SP1617-029 DA | 21-0083-7862

Daphnia magna 21-d Survival and Reproduction Test — **Nautilus Environmental Calgary**

Analysis ID:	04-8243-0659	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:17	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

Batch ID:	06-9185-5354	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	24 May-17	**Protocol:**	ASTM E1193-97 (1997)	**Diluent:**	
Ending Date:	14 Jun-17	**Species:**	Daphnia magna	**Brine:**	
Duration:	21d 0h	**Source:**	In-House Culture	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	19d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	149	> 149	n/a		n/a

Fisher Exact/Bonferroni-Holm Test

Control vs	Group	Test Stat	P-Type	P-Value	Decision(α:5%)
Negative Control	13.8	1.0000	Exact	1.0000	Non-Significant Effect
	18	0.5000	Exact	1.0000	Non-Significant Effect
	22.8	1.0000	Exact	1.0000	Non-Significant Effect
	31.3	1.0000	Exact	1.0000	Non-Significant Effect
	49	0.5000	Exact	1.0000	Non-Significant Effect
	83.6	1.0000	Exact	1.0000	Non-Significant Effect
	149	1.0000	Exact	1.0000	Non-Significant Effect

Data Summary

Conc-ug/L	Code	NR	R	NR + R	Prop NR	Prop R	%Effect
0	N	10	0	10	1	0	0.0%
13.8		10	0	10	1	0	0.0%
18		9	1	10	0.9	0.1	10.0%
22.8		10	0	10	1	0	0.0%
31.3		10	0	10	1	0	0.0%
49		9	1	10	0.9	0.1	10.0%
83.6		10	0	10	1	0	0.0%
149		10	0	10	1	0	0.0%

Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13.8		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
18		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000
22.8		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
31.3		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
49		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000
83.6		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
149		1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
13.8		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
18		1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1	1/1
22.8		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
31.3		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
49		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	0/1	1/1
83.6		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1
149		1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

Analysis ID:	04-8243-0659	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:17	**Analysis:**	STP 2x2 Contingency Tables	**Official Results:**	Yes

APPENDIX C – *Pimephales promelas* Toxicity Test Data

pans labelled

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Organism Information

Source: AQUATOX Batch: 20170525FMELS Egg Stage: 13 somites Organisms Received in Good Condition: [✓ Yes] or No

Test Log

Date	Day	Time	Technicians	Chem Cart Used	Fed		Sample Pre-Aeration Time	Bench Sheet Review	
					AM	PM		First	Second
2017/05/25	0	1430	JW/NM/JN	2	-	-	60 mins	JW	JN
2017/05/26	1	1200	NM/EP	2	-	-	60 mins	JW	NM
2017/05/27	2	1530	LC/JW	2	-	-	60 min	LC	JW
2017/05/28	3	1400	NM	2	—	—	60 min.	NM	SS
2017/05/29	4	1340	NM	2	—	✓	60 min.	JW	SS
2017/05/30	5	1445	LC/SS	2	✓	✓	60 min	JW	EP
2017/05/31	6	1430	JW	2	✓	✓	60 min	JW	NM.
2017/06/01	7	1400	JW	2	✓	✓	60 min	JW	LC
2017/06/02	8	1415	JW/EP	2	✓	✓	60 min	CR	LC
2017/06/03	9	1415	LC	2	✓	✓	60 min	LC	EP
2017/06/04	10	1345	NM/JW	2	✓	✓	60 min	JW	NM
2017/06/05	11	1450	JW/EP	2	✓	✓	60 mins	JW	EP
2017/06/06	12	1400	JW	2	✓	✓	60 mins	JW	EP
2017/06/07	13	1500	JW/LC	2	✓	✓	60 mins	JW	SS
2017/06/08	14	1200	JW	2	✓	✓	60 mins	HS	SS
2017/06/09	15	1220	SS	2	✓	✓	60 min	LC	EP
2017/06/10	16	1400	LC/HS	2	✓	✓	60 min	HS	LC
2017/06/11	17	1330	SS/NM	2	✓	✓	60 min	NM	SS
2017/06/12	18	1330	HS	2	✓	✓	60 min	HS	SS
2017/06/13	19	1130	LC	2	✓	✓	60 min	NM	EP
2017/06/14	20	1200	HS	2	✓	✓	60 min	HS	JW
2017/06/15	21	1100	SS	2	✓	✓	60 min	JW	LC
2017/06/16	22	1530	EP	2	✓	✓	60 min	JW	LC
2017/06/17	23	1200	JW	2	✓	✓	60 min	JW	LC
2017/06/18	24	1430	NM	2	✓	✓	60 min.	NM	SS
2017/06/19	25	1200	JW/NM	2	✓	✓	60 min	JW	NM
2017/06/20	26	1230	SS/JW	2	✓	✓	60 min	SS	JW
2017/06/21	27	1230	HS/JW	2	✓	✓	60 min	HS	JW
2017/06/22	28	1400	JW/EP	2	✓	✓	60 min	JW	EP
2017/06/23	29	1400	JW/HS	2	✓	✓	60 min	HS	JW
2017/06/24	30	1330	EP	2	✓	✓	60 min	EP	LC
2017/06/25	31	1300	SS	2	✓	✓	60 min	HS	SS
2017/06/26	32	1100	JW/NM	2	—	—	—	JW	EP

* feeding adj

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Control hatching success must be >66% (≥10 per replicate). Post hatch survival must be >70%.

Number of Alive Embryos and Hatched Organisms

	CTL		SITE CTL		5 ug/L		10 ug/L		20 ug/L		40 ug/L		80 ug/L		160 ug/L	
	Day 1		Day 1		Day 1		Day 1		Day 1		Day 1		Day 1		Day 1	
replicate	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos	Alive Embryos	Dead Embryos
a	13	2	14	1	13	2	14	1	*12	3	13	2	15	0	14	1
b	15	0	15	0	14	1	13	2	14	1	14	1	13	2	15	0
c	15	0	13	2	14	1	13	2	13	2	15	0	15	0	13	2
d	15	0	13	2	12	3	14	1	12	3	13	2	12	3	13	2
e	29	1	29	1	27	3	25	5	26	4	25	5	25	5	26	4
f	28	2	27	3	28	2	26	3	27	3	27	3	30	0	29	1

Comments/Observations: * 1 hatched + alive

Number of Alive Embryos and Hatched Organisms

	CTL			SITE CTL			5 ug/L			10 ug/L		
	Day 2			Day 2			Day 2			Day 2		
replicate	Alive Embryos	Dead Embryos	Cull to 15	Alive Embryos	Dead Embryos	Cull to 15	Alive Embryos	Dead Embryos	Cull to 15	Alive Embryos	Dead Embryos	Cull to 15
a	13	0	15	14	0	15	12	1	15	14	0	15
b	15	0	15	15	0	15	14	0	15	13	0	15
c	14	1	15	13	0	15	14	0	15	12	1	15
d	15	0	15	13	0	15	12	0	15	13	1	15
e	29	0		26	3		25	2		23	2	
f	28	0		27	0		26	2		25	1	

	20 ug/L			40 ug/L			80 ug/L			160 ug/L		
	Day 2			Day 2			Day 2			Day 2		
replicate	Alive Embryos	Dead Embryos	Cull to 15	Alive Embryos	Dead Embryos	Cull to 15	Alive Embryos	Dead Embryos	Cull to 15	Alive Embryos	Dead Embryos	Cull to 15
a	11	1	15	13	0	15	15	0	15	12	2	15
b	14	0	15	13	1	15	12	1	15	14	1	15
c	13	0	15	15	0	15	15	0	15	13	0	15
d	11	1	15	12	1	15	12	0	15	13	0	15
e	23	3		25	0		25	0		26	0	
f	23	4		21	0		30	0		29	0	

Day 2 - Poor looking and dead embryos in replicates a, b, c and d are replaced with healthy embryos from replicates e and f. Replicates e and f are discarded after day 2

Comments/Observations:

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL		SITE CTL		5 ug/L		10 ug/L		20 ug/L		40 ug/L		80 ug/L		160 ug/L	
	Day 3		Day 3		Day 3		Day 3		Day 3		Day 3		Day 3		Day 3	
replicate	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched
a	8	7	2	13	2	13	4	11	0	15	6	9	4	9	4	~~10~~ DM 11
b	11	4	8	~~5~~6 DM	2	13	5	10	4	11	6	9	9	6	3	12
c	9	6	8	7	7	8	7	8	4	11	7	8	4	11	7	8
d	11	4	7	7	7	8	5	10	6	9	7	8	8	~~8~~7 DM	5	8

Comments/Observations: For days 3-6 record if the dead organims was an embryo (e), partially hatched (p) or hatched (h)

	CTL		SITE CTL		5 ug/L		10 ug/L		20 ug/L		40 ug/L		80 ug/L		160 ug/L	
	Day 4		Day 4		Day 4		Day 4		Day 4		Day 4		Day 4		Day 4	
replicate	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched	Alive Embryos	Alive Hatched
a	0	15	0	15	0	14	0	15	0	15	0	15	0	11	0	15
b	0	15	0	~~15~~14 DM	0	15	0	15	0	15	0	15	0	15	0	15
c	0	14	0	15	0	15	0	15	0	15	0	15	0	13	0	15
d	1	13	0	14	~~1~~0 DM	14	0	15	0	15	1	14	0	15	0	13

Comments/Observations: For days 3-6 record if the dead organims was an embryo (e), partially hatched (p) or hatched (h)
CTL D - dead hatched, 40D → dead embryo, 5a & d → dead embryos, 80C → dead embryo, 80a → dead embryos.

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 5	Day 5	Day 5	Day 5	Day 5	Day 5	Day 5	Day 5
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	15	14	15	15	15	11	15
b	15	13	15	15	15	14	15	15
c	14	15	15(1)	15	15	15	13	15
d	~~15~~ 14 DM	14	14	15	15	15	15	13

Comments/Observations: For days 3-6 record if the dead organims was an embryo (e), partially hatched (p) or hatched (h)

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 6	Day 6	Day 6	Day 6	Day 6	Day 6	Day 6	Day 6
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	15	14	15	15	15	11	15
b	15	13	15	15	15	14	15	15
c	14	15(1)	15(1)	15	15	15	13	15
d	14	14	14	15	15	15	15	13

Comments/Observations: For days 3-6 record if the dead organims was an embryo (e), partially hatched (p) or hatched (h)

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 7	Day 7	Day 7	Day 7	Day 7	Day 7	Day 7	Day 7
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	14*	14	15	15	15	~~13~~ 11 TW	15
b	15	13	15	15	15	14	~~13~~ 15	15
c	14	15(1)	15	15	15	15	~~15~~ 13	15
d	14	14	14	15	15	15	~~13~~ 15	13

Comments/Observations: * some microbial growth on dead FM in site CTL A

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 8	Day 8	Day 8	Day 8	Day 8	Day 8	Day 8	Day 8
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	9*	13	15	15	15	11	15
b	15	12	15	15	15	14	14	15
c	14	15(1)	15(1)	15	15(1)	15	13	15
d	14	~~14~~ 13 TW	14	15	~~14~~ 15 TW	15	14	13

Comments/Observations: * microbial growth/death

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 9	Day 9	Day 9	Day 9	Day 9	Day 9	Day 9	Day 9
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6*	13	15	~~13~~ 15	15	11	15
b	15	12	15	15	15	14	14	15
c	14	15(1)	14	15	15(1)	15	13	15
d	14	13	14	15	~~14~~ 15 TW	15	14	13

Comments/Observations:
*microbial growth/dead

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 10	Day 10	Day 10	Day 10	Day 10	Day 10	Day 10	Day 10
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	15	~~15~~ TW	15	~~15~~ 10 TW	15
b	15	12	15	15	15 ~~14~~ TW	14(1)	14	15
c	14	15	14	15	14	15	13	15
d	14	13(1)	14	15	~~14~~ 15 TW	15	14	13

Comments/Observations:

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 11	Day 11	Day 11	Day 11	Day 11	Day 11	Day 11	Day 11
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	15	15	15	10	15
b	15	12	15	15	15	14	14	15
c	14	15	14	15	14(1)	15	13	15
d	14	13(1)	14	15	15	15	14	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 12	Day 12	Day 12	Day 12	Day 12	Day 12	Day 12	Day 12
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	15	15	15	10	15
b	15	12	15	15	15	14	14	15
c	14	15	14	15	14(1)	15	13	15
d	14	13	14	15	15	15	14	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 13	Day 13	Day 13	Day 13	Day 13	Day 13	Day 13	Day 13
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	15	15	15	10	15
b	15	12	15	15	15	14	14	15
c	14	15	14	15	14	15	13	15
d	14	12	14	15	15	15	14	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 14	Day 14	Day 14	Day 14	Day 14	Day 14	Day 14	Day 14
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13(1)	15	15(2)	15(1)	10	15
b	15	11	15	15	15	13	14(1)	15
c	14	15	14	15	14	15	13	15
d	13	11	14	15	15	15	14	13

Comments/Observations: *random stressed ones indicated are all more faint - not swimming or swimming weakly.

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 15	Day 15	Day 15	Day 15	Day 15	Day 15	Day 15	Day 15
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	14	14	14	10	15
b	15	11	15	15	15	13	14(1)	15
c	13	15	14	15	14	15	13	15
d	14	11	14	15	15	15	14	13

Comments/Observations:

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 16	Day 16	Day 16	Day 16	Day 16	Day 16	Day 16	Day 16
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	14	14	14	10	15
b	15	11	15	15	15	13	14	15
c	13	15	14	15	14	15	13	15
d	14	11	14	15	14	15	14	13

Comments/Observations:

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 17	Day 17	Day 17	Day 17	Day 17	Day 17	Day 17	Day 17
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15	6	13	14	14	13	9	15
b	15	11	15	15	15	13	14	15
c	13	15	14	15	14	15	13	14
d	14	11	14	15	15	15	13	13

Comments/Observations:

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 18	Day 18	Day 18	Day 18	Day 18	Day 18	Day 18	Day 18
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	15(1)	6	13	14	14	13	9	15
b	15	11	15	15	15	13	14	15
c	13(1)	15	14	15	14	15	13	14
d	14(1)	11	14	15	15	15(1)	13	13

Comments/Observations:

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 19	Day 19	Day 19	Day 19	Day 19	Day 19	Day 19	Day 19
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14 ~~15(1)~~	6	13	14	14	13	9	15
b	15	11	15	15	15	13	14	15
c	13	15	14	15	14	15	13	14
d	14(1)	11	14	15	15(1)	15(1)	13	13

Comments/Observations:

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 20	Day 20	Day 20	Day 20	Day 20	Day 20	Day 20	Day 20
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	14	13	13	9	15
b	15	11	15	15	15	13	14	15
c	13	15	14	15	14	15	13	14
d	14	11	14	15	15	15	13	13

Comments/Observations:

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 21	Day 21	Day 21	Day 21	Day 21	Day 21	Day 21	Day 21
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	14	13	13	9	15
b	15	11	15	15	15	13	14	15
c	13	15	14	15	14	15	13	14
d	14	11	14	15	15	15	13	13

Comments/Observations:

	CTL	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
	Day 22	Day 22	Day 22	Day 22	Day 22	Day 22	Day 22	Day 22
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	14	12	13	9	15
b	~~14~~ 15	11	15	15	15	13	14	15
c	13	15	14	15	14	14	13	14
d	14	11	14	15	15	14	13	13

Comments/Observations:

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 23	Day 23	Day 23	Day 23	Day 23	Day 23	Day 23	Day 23
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	13	12	13	9	15(1)
b	15	11	13*	14*	15	13	14	15
c	13	15	14	14	14	14	13	14
d	14	11	14	14	15(1)	14	13	13

Comments/Observations: * no bodies, only 13/15 - checked decanted H₂O twice. 10B - one FM dead stuck on jar - dried out

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 24	Day 24	Day 24	Day 24	Day 24	Day 24	Day 24	Day 24
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	13	10	13	9	14
b	15	11	13	14	15	13	14	15
c	13	15	14	14	14	14	13	14
d	14	11	14	14	15(1)	14	13	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 25	Day 25	Day 25	Day 25	Day 25	Day 25	Day 25	Day 25
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	~~13~~ JW 6	13	13	10	13	8	14
b	15	11	13	14	15	13	14	15
c	13	15	14	14	14	14	13	14
d	14	10	14	14	15(1)	14	13	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 26	Day 26	Day 26	Day 26	Day 26	Day 26	Day 26	Day 26
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	13	10	13	8	14
b	15	11	13	14	14	13	14	14(1)
c	13	15	14	14	14	14	13	14
d	14	10	14	14	15	14	13	13

Comments/Observations:

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 27	Day 27	Day 27	Day 27	Day 27	Day 27	Day 27	Day 27
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	13	10	13	8	14
b	15	11	13	14	14	13	14	14
c	13	15	14	14	14	14	13	14(1)
d	14	10	14	14	15(1)	14	13	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 28	Day 28	Day 28	Day 28	Day 28	Day 28	Day 28	Day 28
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14	6	13	13	10	13	8	14
b	15	11	13	14	14	~~14~~ 13 JM	14	14
c	13	15	14	14	13	14	13	14(1)
d	14	10	14	14	15(1)	14	13	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 29	Day 29	Day 29	Day 29	Day 29	Day 29	Day 29	Day 29
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14(1)	6	13	13(1)	10	13	8	14
b	15	11(1)	13	14	14	13	14	14
c	13	15	13(1)	14	13	14	12	14(1)
d	14	10	14	14	15(1)	14	13	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 30	Day 30	Day 30	Day 30	Day 30	Day 30	Day 30	Day 30
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	14(1)	6	13	13(1)	10	13	8	14
b	15	11(1)	13	14	14	13	14	14
c	13	15	13(1)	14	13	14	12	14(1)
d	14	10	14	14	15(1)	14	13	13

Comments/Observations:

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Number of Alive Embryos and Hatched Organisms

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 31	Day 31	Day 31	Day 31	Day 31	Day 31	Day 31	Day 31
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	SS ~~14~~ 13	6	13(1)	12	10	13	8	14
b	14	11(1)	~~14~~13	14(1)	14	13	12	14
c	13	15	~~13~~12	14	13	14	12	14(1)
d	14	10	14	13	15(1)	14	13	13

Comments/Observations:

	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
	Day 32	Day 32	Day 32	Day 32	Day 32	Day 32	Day 32	Day 32
replicate	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched	Alive Hatched
a	13	6	12(1)	12	10	13	8	14
b	14	11	13	14(1)	13	13	12	14
c	13	15	12	14	13	14	12	14
d	14	10	14	13	15	13	13	12

Comments/Observations:

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample SP1617-029

New Solutions

pH (units)

Conc. (%) Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0	8.2	8.0	8.0	8.0	8.0	8.0	7.9	8.0
1	8.1	7.8	7.9	8.1	8.1	8.0	8.1	8.1
2	8.1	8.0	8.0	8.0	8.1	8.1	8.1	8.1
3	8.3 ~~8.1~~	8.3	8.1	8.1	8.1	8.1	8.1	8.1
4	8.2	8.0	7.9	7.9	8.0	8.0	7.9	7.9
5	8.2	8.2	8.0	8.0	8.0	8.1	8.1	8.1
6	8.3	8.3	7.9	8.0	8.0	8.1	8.1	8.0
7	8.3	8.2	8.1	8.0	8.1	8.2	8.0	8.1
8	8.3	8.2	8.1	8.1	8.1	8.1	8.1	8.1

Conductance (µS/cm)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0	450	219	216	212	215	214	215	214
1	449	205	212	213	215	213	216	214
2	425	219	215	214	213	214	214	214
3	451 ~~408~~	229	215	214	213	214	215	214
4	445	216	214	214	214	213	214	214
5	446	222	215	214	214	214	215	214
6	443	240	225	223	222	222	223	222
7	451	237	226	224	223	222	223	223
8	448	231	225	226	222	225	225	221

Dissolved Oxygen (mg/L) (**40-100% saturation**)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2
1	7.2	7.2	7.2	7.2	7.3	7.3	7.3	7.3
2	7.1 ~~7.1~~	7.1	7.2	7.1	7.1	7.1	7.1	7.1
3	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
4	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
5	7.2	7.1	7.2	7.2	7.1	7.2	7.2	7.1
6	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
7	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1
8	7.3	7.3	7.3	7.2	7.2	7.2	7.2	7.2

Temperature (°C)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0	23.9	23.9	24.2	24.1	24.2	24.2	24.4	24.6
1	24.7	25.0	24.9	24.5	24.0	24.2	24.5	24.1
2	26.0	25.8	24.4	26.2	26.1	25.8	26.0	26.0
3	26.1 ~~24.0~~	26.0	26.2	26.0	25.5	25.6	25.8	25.8
4	26.1	26.1	26.1	26.1	26.1	26.2	26.1	26.1
5	25.4	25.3	25.4	25.4	25.3	25.3	25.4	25.8
6	26.1	25.9	26.0	26.2	26.2	26.0	26.2	26.4
7	25.7	25.9	26.1	26.2	26.3	26.3	26.4	26.4
8	24.4	24.3	24.4	24.6	24.9	24.6	24.6	24.9

Old Solutions

pH (units)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0		7.7						
1	8.0	~~479~~	7.6	7.6	7.6	7.5	7.6	7.6
2	8.1	7.8	7.6	7.6	7.7	7.7	7.7	7.8
3	8.1	7.9	7.9	8.0	7.9	7.9	7.8	7.9
4	8.1	7.9	7.8	7.8	7.7	7.7	7.7	7.8
5	8.0	7.9	7.8	7.8	8.0	7.9	7.8	7.8
6	8.1	7.9	7.8	7.7	7.7	7.7	7.7	7.7
7	8.2	8.1	7.9	7.8	7.9	7.9	7.8	7.9
8	8.2	8.0	7.9	7.8	7.8	7.8	7.8	7.8

Conductance (µS/cm)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0								
1	479	229	223	220	220	220	218	220
2	452	235	222	224	220	220	219	220
3	408	230	221	220	223	219	222	225
4	429	238	224	219	220	222	222	225
5	385	229	221	221	224	222	221	224
6	478	254	235	231	230	229	230	229
7	497	252	233	229	231	232	229	230
8	475	251	236	227	233	231	228	232

Dissolved Oxygen (mg/L) (**40-100% saturation**)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0								
1	6.3	6.3	6.3	6.2	6.2	6.0	6.1	6.3
2	6.6	6.6	6.6	6.5	6.5	6.5	6.6	6.2
3	6.7	6.5	6.6	6.5	6.6	6.5	6.4	6.4
4	7.1	7.0	6.7	6.7	6.6	6.3	6.5	6.5
5	7.1	6.3	6.0	6.0	6.2	6.2	6.2	6.3
6	6.9	6.9	6.7	6.5	6.5	6.4	6.3	6.3
7	6.8	6.8	6.6	6.7	6.9	6.5	6.4	6.3
8	6.8	6.6	6.9	6.8	6.7	6.5	6.4	6.5

Temperature (°C)

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
0								
1	24.8	24.8	24.8	25.1	25.1	25.0	25.2	24.9
2	25.1	25.2	25.2	25.6	25.8	25.8	26.0	25.9
3	24.0	24.6	25.2	24.7	24.7	25.1	25.1	25.1
4	25.0	24.9	24.9	24.9	25.1	25.2	25.3	25.2
5	24.9	25.4	25.5	25.5	25.4	25.4	25.5	25.3
6	25.0	25.0	25.3	25.4	25.3	25.2	25.7	25.6
7	24.5	24.6	24.6	24.6	24.9	25.1	25.0	25.2
8	24.0	24.0	24.0	24.1	24.9	25.0	24.9	24.8

DO Levels (60-100% saturation) -
4.4 to 7.3 mg/L at 24°C
4.5 to 7.2 mg/L at 25°C
4.3 to 7.1 mg/L at 26°C

Comments:

NAUTILUS ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample SP1617-029

	New Solutions								Old Solutions							
Conc. (%)	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
Day																
	pH (units)								pH (units)							
9	8.1	8.1	8.1	8.0	8.1	8.1	8.1	8.1	8.1	7.8	7.8	7.8	7.8	7.8	7.7	7.8
10	8.1	7.9	7.8	7.8	7.9	7.9	7.9	7.9	7.6	7.4	7.4	7.3	7.3	7.4	7.3	7.3
11	7.8	7.7	7.6	7.6	7.6	7.7	7.6	7.6	7.4	7.2	7.1	7.1	7.1	7.1	7.1	7.2
12	8.0	7.9	7.8	7.8	7.9	7.9	7.9	7.9	7.8	7.8	7.6	7.4	7.4	7.4	7.4	7.4
13	w 7.9 *~~7.5~~	7.9	7.8	7.8	7.8	7.8	7.8	7.8	7.9	7.9	7.5	7.4	7.4	7.4	7.5	7.4
14	7.9	7.9	7.8	7.8	7.9	7.9	7.9	7.9	7.6	7.6	7.5	7.5	7.5	7.4	7.4	7.6
15	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.6	7.5	7.4	7.3	7.3	7.3	7.3	7.4
16	7.8	7.8	7.8	7.7	7.8	7.8	7.8	7.8	7.6	7.4	7.3	7.3	7.3	7.3	7.3	7.4
17	8.0	7.9	7.8	7.8	7.9	8.0	7.9	7.9	7.5	7.5	7.3	7.2	7.2	7.2	7.2	7.2
	Conductance (µS/cm)								Conductance (µS/cm)							
9	430	230	226	224	223	223	225	224	477	250	236	237	235	235	232	232
10	441	227	225	222	212	234	226	225	457	252	245	256	239	223	226	240
11	422	227	224	224	224	224	226	224	463	240	234	231	226	230	227	232
12	408	226	224	224	223	223	223	224	438	255	239	233	231	233	227	250
13	447	237	235	236	234	236	236	235	464	265	246	242	242	242	242	245
14	435	243	236	234	233	233	234	234	451	266	247	242	247	244	247	249
15	474	231	236	234	233	233	234	233	442	254	246	242	245	243	242	244
16	489	234	234	234	234	233	235	232	443	252	244	243	245	244	248	245
17	452	238	235	234	233	234	234	233	501	253	245	241	253	264	250	248
	Dissolved Oxygen (mg/L) (**40-100% saturation**)								Dissolved Oxygen (mg/L) (**40-100% saturation**)							
9	7.3	7.3	7.3	7.2	7.2	7.3	7.3	7.2	6.8	6.6	6.4	6.3	6.0	6.0	6.0	6.0
10	7.1	7.2	7.2	7.2	7.3	7.3	7.2	7.2	6.0	6.0	6.0	5.9	5.6	5.4	5.5	5.4
11	7.1	7.2	7.2	7.2	7.2	7.2	7.2	7.2	6.5	6.3	6.1	5.9	5.8	5.8	5.9	5.9
12	7.1	7.2	7.2	7.2	7.2	7.3	7.2	7.2	6.6	6.6	6.5	6.1	6.2	6.2	6.2	6.2
13	7.3	7.3	7.2	7.2	7.1	7.3	7.3	7.2	6.6	6.6	6.4	6.3	6.2	6.2	6.2	6.2
14	7.2	7.1	7.1	7.1	7.1	7.1	7.1	7.1	6.4	6.3	6.3	6.1	6.1	6.2	6.0	6.1
15	7.3	7.1	7.1	7.3	7.2	7.2	7.2	7.1	6.4	6.2	6.2	6.0	6.0	6.0	6.0	5.9
16	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2	6.4	6.0	6.0	6.0	6.0	6.0	6.0	6.0
17	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2	6.2	6.4	6.4	6.4	6.4	6.4	6.2	5.9
	Temperature (°C)								Temperature (°C)							
9	23.9	24.4	24.4	25.1	25.2	24.4	24.4	25.1	24.0	24.3	24.4	24.5	24.8	25.1	25.3	25.3
10	24.9	24.7	24.7	25.1	24.1	24.4	25.3	25.3	25.2	25.2	25.2	26.4	26.4	26.4	26.3	26.4
11	25.1	24.9	24.9	25.1	25.1	25.2	25.4	25.4	24.4	24.7	25.5	25.4	25.1	24.8	24.4	24.4
12	25.5	24.9	25.2	25.3	25.3	24.4	25.2	25.4	24.9	25.0	25.3	25.2	25.1	25.2	25.3	25.3
13	24.4	24.4	26.4	25.4	24.5	24.2	24.2	25.4	24.9	24.9	25.0	25.1	25.3	25.5	25.3	25.3
14	24.6	25.5	25.5	25.5	25.5	25.5	25.6	25.8	24.6	24.6	24.5	24.4	24.4	24.5	24.5	24.5
15	24.1	25.1	25.1	24.3	25.4	24.8	24.9	25.9	24.0	24.0	24.0	24.1	24.1	24.0	24.1	24.0
16	24.0	24.7	25.0	25.0	25.2	25.0	25.3	25.3	24.0	24.0	24.7	25.0	25.4	24.2	24.2	24.7
17	24.4	24.4	24.4	24.4	24.4	24.4	24.4	25.1	23.8	24.1	24.1	24.2	24.2	24.2	24.3	24.3

DO Levels (60-100% saturation) -
4.4 to 7.3 mg/L at 24°C
4.5 to 7.2 mg/L at 25°C
4.3 to 7.1 mg/L at 26°C

Comments:

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample SP1617-029

New Solutions

Conc. (%) / Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
pH (units)								
18	7.6	7.8	7.7	7.7	7.8	7.8	7.6	7.6
19	7.7	7.9	7.8	7.8	7.8	7.8	7.8	7.8
20	7.8	8.0	8.0	8.0	8.0	8.0	8.0	8.0
21	8.1	7.9	7.9	7.9	7.9	7.9	7.8	7.9
22	8.0	7.9	7.9	7.9	7.8	7.8	7.9	7.9
23	8.1	7.8	7.9	7.9	8.0	8.0	8.0	7.9
80 24	~~7.6~~	8.0	8.0	8.0	8.0	8.0	8.0	8.0
25	8.2	7.9	7.8	7.8	7.9	7.9	7.8	7.8
26	8.0	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Conductance (µS/cm)								
18	515	241	235	234	233	234	235	233
19	424	241	235	235	234	235	232	234
20	420	234	236	234	235	235	234	235
21	431	236	232	235	235	234	235	234
22	425	232	234	240	241	240	240	233
23	421	241	237	236	235	236	237	236
24	416	236	237	233	236	238	239	233
25	431	238	236	234	231	235	235	236
26	434	240	237	236	235	035	236	235
Dissolved Oxygen (mg/L) (**40-100% saturation**)								
18	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2
19	7.1	7.2	7.2	7.2	7.1	7.2	7.1	7.2
20	7.2	7.1	7.2	7.2	7.2	7.2	7.2	7.2
7.3, 7.3 DW 21	~~7.4~~	~~7.4~~	7.3	7.2	~~7.3~~ 7.2	7.2	~~7.5~~ 7.2	~~7.8~~ 7.2
22	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
23	7.2	7.3	7.3	7.3	7.3	7.3	7.3	7.3
24	7.1	7.3	7.3	7.3	7.3	7.5	7.3	7.3
25	7.2	7.3	7.3	7.2	7.2	7.2	7.2	7.2
26	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Temperature (°C)								
18	23.8	24.5	24.9	25.1	24.9	24.8	25.3	25.1
19	24.4	24.7	25.1	25.2	25.5	25.4	25.5	25.4
20	24.2	24.4	24.4	24.4	24.4	24.4	24.6	24.6
21	24.1	24.7	25.2	25.3	25.3	25.3	25.1	25.2
22	24.5	24.5	24.6	24.7	25.1	25.1	25.1	25.1
23	24.9	24.1	24.2	24.4	24.3	24.1	24.3	24.0
24	24.1	24.1	24.0	24.0	24.3	24.3	24.1	24.2
25	24.4	24.4	24.4	25.4	25.4	25.4	25.4	25.4
26	24.2	24.7	24.7	24.7	24.8	24.8	24.9	24.5

Old Solutions

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
pH (units)								
18	7.5	7.6	7.4	7.3	7.3	7.2	7.2	7.3
19	7.6	7.6	7.4	7.4	7.3	7.1	7.1	7.1
20	7.8	7.9	7.7	7.6	7.5	7.5	7.5	7.5
21	7.4	7.3	7.3	7.3	7.2	7.2	7.2	7.4
22	7.5	7.6	7.6	7.6	7.6	7.6	7.7	7.6
23	7.4	7.4	7.3	7.4	7.3	7.3	7.1	7.2
24	7.6	7.5	7.2	7.1	7.1	7.2	7.2	7.3
25	7.9	7.8	7.6	7.4	7.4	7.4	7.4	7.5
26	7.6	7.4	7.2	7.3	7.1	7.0	7.1	7.2
Conductance (µS/cm)								
18	459	261	249	245	249	251	255	249
19	490	263	250	246	245	247	248	249
20	480	261	252	242	247	240	246	246
21	488	252	242	244	246	244	241	239
22	480	270	253	240	249	249	246	249
23	446	242	244	242	249	241	240	247
24	444	256	246	247	241	241	247	245
25	447	259	252	246	243	244	241	245
26	444	271	245	257	235	226	243	250
Dissolved Oxygen (mg/L) (**40-100% saturation**)								
18	5.7	5.8	5.8	5.7	5.6	5.4	5.4	5.3
19	5.8	5.8	5.7	5.7	5.4	5.3	5.3	5.2
20	5.8	6.0	6.1	6.1	6.0	5.9	6.1	6.1
21	6.2	6.2	5.9	5.9	5.9	5.5	5.5	5.9
22	6.1	6.0	6.0	6.0	5.9	5.7	5.7	5.7
23	6.2	6.0	6.1	5.9	5.9	5.8	5.6	5.6
24	6.1	6.1	6.1	6.0	6.1	6.1	6.1	6.1
25	6.5	6.4	6.2	5.9	5.7	5.7	5.8	5.8
26	6.5	6.3	6.2	6.1	5.2	5.4	5.1	5.3
Temperature (°C)								
18	23.9	24.1	24.1	24.2	24.4	24.8	24.8	24.9
19	23.9	24.4	24.6	25.8	25.3	25.4	25.9	25.9
20	23.9	23.9	23.9	24.0	24.1	24.1	24.1	24.1
21	23.8	23.8	23.9	23.9	23.8	23.9	24.0	24.0
22	23.9	24.0	24.1	24.1	24.1	24.1	24.1	24.1
23	23.6	23.6	23.7	23.6	23.7	23.6	23.7	23.5
24	23.6	23.6	23.8	23.8	23.7	23.8	23.6	23.6
25	23.6	23.7	23.6	23.6	23.6	23.6	23.5	23.6
26	23.5	24.2	24.4	24.5	24.2	24.1	24.3	24.3

DO Levels (60-100% saturation) -
4.4 to 7.3 mg/L at 24°C
4.5 to 7.2 mg/L at 25°C
4.3 to 7.1 mg/L at 26°C

Comments:

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample SP1617-029

New Solutions

Conc. (%) / Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
pH (units)								
27	8.3	8.0	8.0	8.0	8.0	8.0	8.0	8.0
28	7.9	7.6	7.4	7.6	7.6	7.6	7.6	7.5
29	8.0	7.6	7.7	7.7	7.7	7.7	7.7	7.7
30	8.0	7.7	7.7	7.8	7.8	7.8	7.8	7.8
31	7.9	7.9	7.7	7.7	7.8	7.8	7.8	7.8
32								
Conductance (µS/cm)								
27	427	233	230	230	229	229	229	228
28	397	230	228	229	228	247	231	228
29	408	228	228	222	226	226	227	226
30	404	231	230	232	235	230	229	230
31	414	237	227	228	227	227	227	229
32								
Dissolved Oxygen (mg/L) (40-100% saturation)								
27	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.1
28	7.1	7.1	7.2	7.2	7.2	7.2	7.2	7.1
29	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
30	7.3	7.2	7.2	7.2	7.2	7.2	7.2	7.2
31	7.2	7.2	7.2	7.2	7.2	7.2	7.1	7.2
32								
Temperature (°C)								
27	24.5	24.9	24.9	24.9	25.1	25.3	25.3	25.5
28	25.6	25.6	25.4	25.7	25.4	25.4	25.3	26.1
29	24.8	25.8	25.1	25.3	25.3	25.3	25.4	25.3
30	24.0	24.9	24.8	24.8	24.8	24.8	24.8	24.8
31	25.4	25.3	25.1	25.2	25.6	25.8	25.7	25.4
32								

Old Solutions

Day	CTL	SITE CTL	5 ug/L	10 ug/L	20 ug/L	40 ug/L	80 ug/L	160 ug/L
pH (units)								
27	8.1	7.9	7.7	7.8	7.6	7.5	7.4	7.5
28	8.1	8.0	7.5	7.9	7.7	7.6	7.6	7.6
29	7.4	7.4	7.2	7.1	7.1	7.1	7.1	7.1
30	7.5	7.6	7.7	7.7	7.7	7.7	7.5	7.6
31	7.6	7.2	7.0	7.0	7.0	7.0	7.0	7.0
32	80	79	7.6	7.3	7.3	7.2	7.3	7.4
Conductance (µS/cm)								
27	412	251	243	244	241	237	288	238
28	423	248	238	240	239	239	239	240
29	438	258	241	241	242	242	240	243
30	432	244	241	242	242	245	246	246
31	425	246	235	232	235	238	234	233
32	460	264	231	221	236	233	281	232
Dissolved Oxygen (mg/L) (40-100% saturation)								
27	6.4	6.3	6.5	6.0	6.0	6.0	5.7	5.5
28	6.4	6.4	6.4	6.1	6.1	6.1	5.8	5.7
29	5.9	5.9	5.5	5.7	5.0	5.1	5.0	5.0
30	6.0	6.0	6.0	6.0	6.1	6.0	6.0	6.0
31	5.8	5.8	5.7	5.7	5.2	5.1	5.0	5.0
32	6.2	6.1	5.6	5.3	5.1	5.0	5.0	5.2
Temperature (°C)								
27	24.6	24.6	24.4	24.1	24.2	24.2	24.2	24.2
28	24.6	24.7	24.5	24.4	24.4	24.4	24.4	24.3
29	24.0	23.9	23.8	23.8	24.0	23.9	23.6	23.5
30	24.5	24.5	24.5	24.6	24.6	24.5	24.5	24.8
31	24.9	25.0	25.0	25.0	25.2	25.4	25.8	25.3
32	25.2	25.1	25.1	24.2	25.0	24.8	24.8	24.2

DO Levels (60-100% saturation) -
4.4 to 7.3 mg/L at 24°C
4.5 to 7.2 mg/L at 25°C
4.3 to 7.1 mg/L at 26°C

Comments:

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Test Termination

For normal/abnormal column, use the following notation:

N=Normal, A= Abnormal And note location: H=head, O=oral, E=eyes, G=gills, F=fins, S=spine

Conc.

CTL

Replicate # A			Replicate # B			Replicate # C			Replicate # D		
Fish	Length (mm)	Normal/ Abnormal	Fish	Length (mm)	Normal/ Abnormal	Fish	Length (mm)	Normal/ Abnormal	Fish	Length (mm)	Normal/ Abnormal
1	10	N	1	9	N	1	9	N	1	10	N
2	10		2	10		2	10		2	9	
3	11		3	9		3	9		3	8	
4	9		4	9		4	9		4	9	
5	10		5	9		5	9		5	9	
6	10		6	10		6	9		6	9	
7	9		7	9		7	10		7	10	
8	10		8	9		8	10		8	9	
9	11		9	9		9	9		9	11	
10	10		10	11		10	9		10	10	
11	10		11	10		11	10		11	11	
12	9		12	9		12	10		12	12	
13	10	↓	13	9		13	10	↓	13	9	
14	—		14	9	↓	14	—		14	10	↓
15	—		15	—		15	—		15	—	

Comments

SITE CTL

Replicate # A			Replicate # B			Replicate # C			Replicate # D		
Fish	Length (mm)	Normal/ Abnormal	Fish	Length (mm)	Normal/ Abnormal	Fish	Length (mm)	Normal/ Abnormal	Fish	Length (mm)	Normal/ Abnormal
1	10	N	1	8	N	1	10	N	1	10	N
2	11		2	11		2	9		2	10	
3	12		3	10		3	7		3	10	
4	11		4	10		4	8		4	10	
5	10		5	9		5	10		5	9	
6	12	↓	6	10		6	9		6	10	
7	—		7	11		7	9		7	10	
8	—		8	11		8	10		8	9	
9	—		9	9		9	8		9	8	
10	—		10	10		10	9		10	11	↓
11	—		11	9	↓	11	10		11	—	
12	—		12	—		12	9		12	—	
13	—		13	—		13	9		13	—	
14	—		14	—		14	8		14	—	
15	—		15	—		15	10	↓	15	—	

Comments

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Test Termination

For normal/abnormal column, use the following notation:

N=Normal, A= Abnormal And note location: H=head, O=oral, E=eyes, G=gills, F=fins, S=spine

Conc.

5 ug/L

Replicate # A

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	9	|
3	10	|
4	9	|
5	10	|
6	9	|
7	12	|
8	8	|
9	9	|
10	9	|
11	9	|
12	8	|
13	8	↓
14	-	
15	-	

Replicate # B

Fish	Length (mm)	Normal/ Abnormal
1	8	N
2	10	|
3	9	|
4	7	|
5	8	|
6	6	|
7	8	|
8	10	|
9	9	|
10	11	|
11	9	|
12	11	|
13	10	↓
14	-	
15	-	

Replicate # C

Fish	Length (mm)	Normal/ Abnormal
1	3	N
2	11	|
3	8	|
4	10	|
5	8	|
6	9	|
7	9	|
8	9	|
9	10	|
10	10	|
11	9	|
12	8	↓
13	-	
14	-	
15	-	

Replicate # D

Fish	Length (mm)	Normal/ Abnormal
1	8	N
2	9	|
3	11	|
4	9	|
5	9	|
6	9	|
7	9	|
8	10	|
9	9	|
10	10	|
11	10	|
12	7	|
13	9	↓
14	-	
15	-	

Comments

10 ug/L

Replicate # A

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	9	|
3	8	|
4	8	|
5	10	|
6	9	|
7	9	|
8	11	|
9	10	|
10	8	|
11	10	|
12	9	↓
13	-	
14	-	
15	-	

Replicate # B

Fish	Length (mm)	Normal/ Abnormal
1	10	N
2	9	|
3	10	|
4	8	|
5	10	|
6	9	|
7	8	|
8	9	|
9	9	|
10	10	|
11	8	|
12	9	|
13	8	|
14	9	↓
15	-	

Replicate # C

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	7	|
3	10	|
4	9	|
5	9	|
6	9	|
7	9	|
8	8	|
9	10	|
10	11	|
11	10	|
12	9	|
13	9	|
14	7	↓
15	-	

Replicate # D

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	8	|
3	10	|
4	9	|
5	10	|
6	9	|
7	9	|
8	10	|
9	9	|
10	9	|
11	9	|
12	7	|
13	10	↓
14	-	
15	-	

Comments

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Test Termination

For normal/abnormal column, use the following notation:

N=Normal, A= Abnormal And note location: H=head, O=oral, E=eyes, G=gills, F=fins, S=spine

Conc.

20 ug/L

Replicate # A

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	8	↓
3	10	↓
4	10	↓
5	10	↓
6	10	↓
7	11	↓
8	9	↓
9	9	↓
10	10	↓
11	—	
12	—	
13	—	
14	—	
15	—	

Replicate # B

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	10	↓
3	11	↓
4	8	↓
5	10	↓
6	10	↓
7	8	↓
8	10	↓
9	9	↓
10	8	↓
11	9	↓
12	8	↓
13	9	↓
14	—	
15	—	

Replicate # C

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	10	↓
3	10	↓
4	11	↓
5	8	↓
6	9	↓
7	10	↓
8	10	↓
9	12	↓
10	9	↓
11	9	↓
12	9	↓
13	9	↓
14	—	
15	—	

Replicate # D

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	8	↓
3	10	↓
4	10	↓
5	10	↓
6	9	↓
7	9	↓
8	10	↓
9	10	↓
10	9	↓
11	10	↓
12	8	↓
13	9	↓
14	9	↓
15	9	↓

Comments

40 ug/L

Replicate # A

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	7	↓
3	9	↓
4	9	↓
5	10	↓
6	9	↓
7	8	↓
8	9	↓
9	9	↓
10	10	↓
11	10	↓
12	9	↓
13	9	↓
14	—	
15	—	

Replicate # B

Fish	Length (mm)	Normal/ Abnormal
1	9	
2	9	
3	11	
4	9	
5	9	
6	9	
7	9	
8	9	
9	8	
10	9	
11	10	
12	8	
13	9	
14	—	
15	—	

Replicate # C

Fish	Length (mm)	Normal/ Abnormal
1	11	N
2	9	↓
3	9	↓
4	9	↓
5	9	↓
6	9	↓
7	9	↓
8	8	↓
9	9	↓
10	10	↓
11	8	↓
12	9	↓
13	8	↓
14	9	↓
15	—	

Replicate # D

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	10	↓
3	9	↓
4	9	↓
5	9	↓
6	9	↓
7	10	↓
8	10	↓
9	9	↓
10	8	↓
11	9	↓
12	9	↓
13	8	↓
14	—	
15	—	

Comments

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample: SP1617-029

Test Termination

For normal/abnormal column, use the following notation:

N=Normal, A= Abnormal And note location: H=head, O=oral, E=eyes, G=gills, F=fins, S=spine

Conc
80 ug/L

Replicate # A

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	11	↓
3	9	
4	9	
5	11	
6	9	
7	10	
8	10	
9	—	—
10	↓	↓
11		
12		
13		
14		
15		

Replicate # B

Fish	Length (mm)	Normal/ Abnormal
1	8	N
2	9	↓
3	8	
4	10	
5	8	
6	10	
7	8	
8	9	
9	5	
10	4	
11	10	
12	9	
13	—	—
14	↓	↓
15		

Replicate # C

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	11	↓
3	9	
4	8	
5	9	
6	8	
7	9	
8	8	
9	10	
10	10	
11	9	
12	7	
13	—	—
14	—	—
15	—	—

Replicate # D

Fish	Length (mm)	Normal/ Abnormal
1	8	N
2	9	↓
3	9	
4	9	
5	9	
6	~~9~~ 10 TW	
7	8	
8	10	
9	8	
10	9	
11	11	
12	9	
13	9	
14	—	—
15	—	—

Comments

Conc.
160 ug/L

Replicate # A

Fish	Length (mm)	Normal/ Abnormal
1	10	N
2	10	↓
3	10	
4	9	
5	8	
6	8	
7	11	
8	9	
9	8	
10	10	
11	7	
12	7	
13	8	
14	8	
15	—	—

Replicate # B

Fish	Length (mm)	Normal/ Abnormal
1	8	N
2	8	↓
3	7	
4	10	
5	10	
6	9	
7	8	
8	10	
9	9	
10	8	
11	7	
12	7	
13	10	
14	7	
15	—	—

Replicate # C

Fish	Length (mm)	Normal/ Abnormal
1	9	N
2	9	↓
3	10	
4	9	
5	10	
6	5	
7	11	
8	5	
9	9	
10	9	
11	9	
12	10	
13	9	
14	9	
15	—	—

Replicate # D

Fish	Length (mm) DM	Normal/ Abnormal
1	9 9	N
2	9 8	↓
3	10 9	
4	9	
5	8	
6	9	
7	9	
8	11	
9	9	
10	8	
11	9	
12	11	
13	—	—
14	—	—
15	—	—

Comments

SP1617-029

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Reftox Log

Date/Time/ Initials	Age of Organsims (Days from Fertilization)	Biology										
		Replicate	A	B	C	D	E	F	G	H	I	J
2017/05/25 1430 JN/NM/ JW	0	Alive Embryos	50	50	50	50	50	50	50	50	50	50
		Dead Embryos	0	0	0	0	0	0	0	0	0	0
		Alive Hatched	-	-	-	-	-	-	-	-	-	-
		Alive Dead	-	-	-	-	-	-	-	-	-	-
2017/05/26 1245 NM/ EP	1	Alive Embryos	37	44	40	41	45	44	50	45	42	46
		Dead Embryos	10	6	8	9	2	6	0	5	8	4
		Alive Hatched	0	0	2	0	3	0	0	0	0	0
		Alive Dead	0	0	0	0	0	0	0	0	0	0
2017/05/27 1445 LC	2	Alive Embryos	34	44	~~28~~ 33 nm	34	38	43	47	~~42~~ 46 nm	38	46
		Dead Embryos	0	0	2	~~8~~ 2 nm	5	1	1	0	0	0
		Alive Hatched	3	0	3	5	4	0	2	3	3	0
		Alive Dead	0	0	4	0	1	0	0	0	1	0
2017/05/28 DM 1445	3	Alive Embryos	23	19	14	33 ~~28~~ DM	36	42	36	DM ~~28~~ 29	28	8
		Dead Embryos	0	0	2	0	0	0	1	0 2 DM	1	2
		Alive Hatched	14	25	6	6	6	1	10	20	11	34
		Alive Dead	0	0	0	0	0	0	0	0	1	0
2017/05/29 JW 1345	4	Alive Embryos	0	1	~~16~~ 4 nm	9	7	4	0	1	2	0
		Dead Embryos	1	0	~~1~~ 0 nm	0	1	0	1	0	1	0
		Alive Hatched	36	43	16	30	34	39	45	48	36	42
		Alive Dead	0	0	~~0~~ 0 nm	0	0	0	0	0	0	0
	5	Alive Embryos										
		Dead Embryos										
		Alive Hatched										
		Alive Dead										

Each replicate is replenished daily with de-chlorinated tap water, dead organisms are removed daily

Comments

NAUTILUS
ENVIRONMENTAL

Fathead Minnow Bench Sheet

Method FMD 32 Day ELS Client MIN100 Sample SP1617-029

Date of change 2017/05/29. **Day of change** —

Volume (mL) of *Artemia* Fed to Each Test Replicate of Each Sample / Concentration								
Replicate	**CTL**	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
A	1mL	→	→	→	→	→	→	→
B	↓							
C	↓							
D	↓							→

Date of change 2017/06/07 **Day of change**

Volume (mL) of *Artemia* Fed to Each Test Replicate of Each Sample / Concentration								
Replicate	**CTL**	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
A	1.5mL	1mL	1.5mL	1.5mL	1.5mL	1.5mL	1.5mL	1.5mL
B	↓	1.5mL	↓	↓	↓	↓	↓	↓
C	↓	↓	↓	↓	↓	↓	↓	↓
D	↓	↓	↓	↓	↓	↓	↓	↓

Date of change ________ **Day of change** ________

Volume (mL) of *Artemia* Fed to Each Test Replicate of Each Sample / Concentration								
Replicate	**CTL**	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
A								
B								
C								
D								

Date of change ________ **Day of change** ________

Volume (mL) of *Artemia* Fed to Each Test Replicate of Each Sample / Concentration								
Replicate	**CTL**	**SITE CTL**	**5 ug/L**	**10 ug/L**	**20 ug/L**	**40 ug/L**	**80 ug/L**	**160 ug/L**
A								
B								
C								
D								

***Feeding volume is maintained following a feeding change until a new feeding regime is recorded**

NAUTILUS ENVIRONMENTAL

Organism Weights Bench Sheet

Client MINING Sample SP1617-029 Organism FM (30day)

Initial Weight (mg) (dried pan)

Date: 2017/06/25 Initials: SS Balance*: Mettler #1

Conc.	CTL	SITE CTL	5	10	20	40	80	160
Replicate							40	
a	1004.67	1009.57	1004.24	998.26	1008.37	1004.88	1005.96 SS	1006.44
b	1004.58	1006.40	1005.94	1002.66	1012.07	1005.94	1001.94	1007.23
c	999.35	998.45	1008.48	1007.31	1015.75	1011.18	992.53	1001.79
d	1011.77	1004.71	1007.79	1006.5~~8~~ SS 5	1009.48	1013.00	1006.01	1000.46
e								

Final Weight (mg) (dried pan+organisms)

Date: 2017/07/05 Initials: SS Balance*: Mettler #1

Conc.	CTL	SITE CTL	5	10	20	40	80	160
Replicate	1022.13		1022.37			*1022.17 10		
a	~~1019.93~~	1024.19	~~1019.42~~ SS	1011.26	1022.23	1018.00	1018.63	1018.64
b 1019.93	~~1029.78~~	1021.96	1019.52	1017.36	1026.58 SS	~~1022.05~~*	1013.56	1018.44
c	1014.74	1014.09	1022.03	1022.13	1033.01	1024.52	1006.08	1017.30
d	1029.78	1019.46	~~1022.37~~ S	1019.61	1027.34	1028.47	1027.67	1016.812 SS
e			1019.42					

Test Validity Met: Yes/No/NA

Results are Logical: Yes/No**

**no negative numbers, consistent values across replicates

*Same balance must be used for initial and final weights

*For FM/HA/CT must use scale with 0.01 mg accuracy

Balance Calibration Check:

	Initial		Final
first pan weighed:	CTL D	first pan+org weighed:	CTL B
weight of first pan:	1011.77	weight of first pan + org:	1019.93
re-weigh of first pan after all weights measured :	1011.73	re-weigh of first pan + org after all weights measured:	1019.87

% difference <5%: [✓ Yes]/No **% difference <5%:** [✓ Yes]/No

Calculation: % difference = [initial weight-reweight/((initial weight+reweight)/2)]x100

If "no" is circled for any parameter, notify Lab Supervisor/QA Group to determine appropriate action

CETIS Analytical Report

Report Date: 25 Jul-17 14:41 (p 1 of 2)
Test Code: SP1617-029 FMD | 10-7819-7001

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	12-4253-2770	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 14:40	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:		**Species:**	Pimephales promelas	**Brine:**	
Duration:	n/a	**Source:**	Aquatox, AR	**Age:**	<24

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:		**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
19	62.12	-117.4	-113.9	0.0234	Yes	0.4532	2.621	0.8068	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	0.07638	n/a	48610
IC10	15.28	1.235E-05	2406
IC15	406.1	n/a	729300
IC20	4800	n/a	2.436E+10
IC25	36910	n/a	n/a
IC40	5032000	n/a	n/a
IC50	89200000	n/a	n/a

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1.103	0.07418	0.9513	1.255	14.87	<1.0E-37	Significant Parameter
γ	0.141	0.3305	-0.535	0.8171	0.4266	0.6728	Non-Significant Parameter
δ	89200000	2.953E+09	-5.95E+09	6.129E+09	0.0302	0.9761	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	31.56	10.52	3	477.8	<1.0E-37	Significant
Lack of Fit	0.05508	0.01102	5	0.4532	0.8068	Non-Significant
Pure Error	0.5833	0.02431	24			
Residual	0.6384	0.02201	29			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.34	2.938	0.0068	Outlier Detected
Variances	Mod Levene Equality of Variance	0.7355	2.423	0.6442	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9191	0.9338	0.0196	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	0.6929	2.492	0.0704	Normal Distribution

Analysis ID:	12-4253-2770	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 14:40	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Mean Dry Biomass-mg Summary

			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	4	1.103	1.023	1.201	0.04613	0.09226	8.36%	0.00%
18.1		4	1.01	0.9747	1.043	0.01773	0.03546	3.51%	8.52%
23		4	0.9482	0.7753	1.209	0.092	0.184	19.41%	14.08%
27		4	0.9263	0.8667	0.988	0.03334	0.06669	7.20%	16.05%
37.5		4	1.058	0.924	1.191	0.06629	0.1326	12.53%	4.15%
54.7		4	0.9693	0.8747	1.082	0.05156	0.1031	10.64%	12.16%
93.1		4	1.001	0.7747	1.444	0.1503	0.3007	30.04%	9.29%
169.6		4	0.9213	0.7473	1.091	0.08332	0.1666	18.09%	16.51%

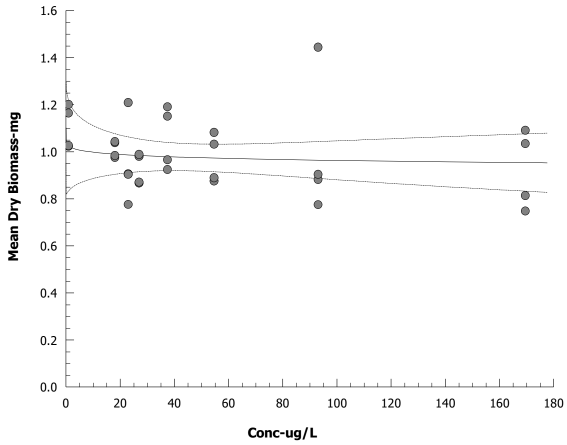
Mean Dry Biomass-mg Detail

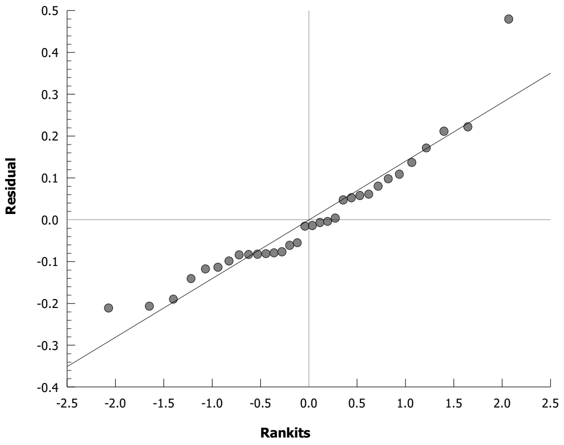
Conc-ug/L	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**
0	N	1.164	1.023	1.026	1.201
18.1		0.9747	1.037	1.043	0.9833
23		1.209	0.9053	0.9033	0.7753
27		0.8667	0.98	0.988	0.8707
37.5		0.924	0.9653	1.151	1.191
54.7		0.8747	1.082	0.8893	1.031
93.1		0.882	0.7747	0.9033	1.444
169.6		0.8133	0.7473	1.034	1.091

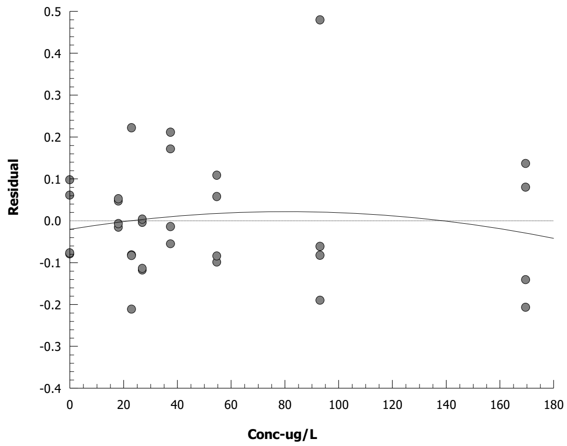
Graphics

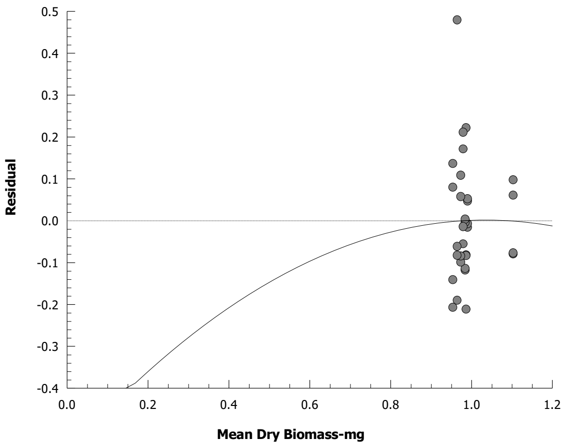
Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ]

Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 25 Jul-17 14:36 (p 1 of 2)
Test Code: SP1617-029 FMD | 10-7819-7001

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	20-8847-4197	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 14:35	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:		**Species:**	Pimephales promelas	**Brine:**	
Duration:	n/a	**Source:**	Aquatox, AR	**Age:**	<24

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:		**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	169.6	> 169.6	n/a		24.8%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	18.1	0.8527	2.482	0.274	6	CDF	0.5498	Non-Significant Effect
	23	1.409	2.482	0.274	6	CDF	0.3025	Non-Significant Effect
	27	1.607	2.482	0.274	6	CDF	0.2304	Non-Significant Effect
	37.5	0.4158	2.482	0.274	6	CDF	0.7413	Non-Significant Effect
	54.7	1.217	2.482	0.274	6	CDF	0.3824	Non-Significant Effect
	93.1	0.9298	2.482	0.274	6	CDF	0.5137	Non-Significant Effect
	169.6	1.652	2.482	0.274	6	CDF	0.2156	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.229	2.938	0.0124	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.11549	0.0164986	7	0.6788	0.6883	Non-Significant Effect
Error	0.583338	0.0243058	24			
Total	0.698829		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	13.55	18.48	0.0597	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9278	0.9081	0.0339	Normal Distribution

Mean Dry Biomass-mg Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.103	0.9567	1.25		1.023	1.201	0.04613	8.36%	0.00%
18.1		4	1.01	0.9531	1.066		0.9747	1.043	0.01773	3.51%	8.52%
23		4	0.9482	0.6554	1.241		0.7753	1.209	0.092	19.41%	14.08%
27		4	0.9263	0.8202	1.032		0.8667	0.988	0.03334	7.20%	16.05%
37.5		4	1.058	0.8467	1.269		0.924	1.191	0.06629	12.53%	4.15%
54.7		4	0.9693	0.8053	1.133		0.8747	1.082	0.05156	10.64%	12.16%
93.1		4	1.001	0.5226	1.479		0.7747	1.444	0.1503	30.04%	9.29%
169.6		4	0.9213	0.6562	1.186		0.7473	1.091	0.08332	18.09%	16.51%

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 20-8847-4197 **Endpoint:** Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 25 Jul-17 14:35 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.164	1.023	1.026	1.201
18.1		0.9747	1.037	1.043	0.9833
23		1.209	0.9053	0.9033	0.7753
27		0.8667	0.98	0.988	0.8707
37.5		0.924	0.9653	1.151	1.191
54.7		0.8747	1.082	0.8893	1.031
93.1		0.882	0.7747	0.9033	1.444
169.6		0.8133	0.7473	1.034	1.091

CETIS Analytical Report

Report Date:	16 Aug-17 09:55 (p 1 of 2)
Test Code:	SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	13-7595-1313	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:55	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	277030	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.735	2.938	0.1164	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	>168	n/a	n/a
LC10	>168	n/a	n/a
LC15	>168	n/a	n/a
LC20	>168	n/a	n/a
LC25	>168	n/a	n/a
LC40	>168	n/a	n/a
LC50	>168	n/a	n/a

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	N	4	0.9667	0.9333	1.0000	0.0192	0.0385	3.98%	0.00%	58	60
14		4	0.9500	0.8667	1.0000	0.0319	0.0638	6.72%	1.72%	57	60
19.9		4	0.9667	0.9333	1.0000	0.0192	0.0385	3.98%	0.00%	58	60
24.2		4	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	-3.45%	60	60
32.9		4	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	-3.45%	60	60
51.4		4	0.9833	0.9333	1.0000	0.0167	0.0333	3.39%	-1.72%	59	60
95.1		4	0.9000	0.7333	1.0000	0.0638	0.1277	14.18%	6.90%	54	60
168		4	0.9667	0.8667	1.0000	0.0333	0.0667	6.90%	0.00%	58	60

Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.0000	1.0000	0.9333	0.9333
14		1.0000	0.8667	1.0000	0.9333
19.9		0.9333	1.0000	1.0000	0.9333
24.2		1.0000	1.0000	1.0000	1.0000
32.9		1.0000	1.0000	1.0000	1.0000
51.4		1.0000	0.9333	1.0000	1.0000
95.1		0.7333	1.0000	0.8667	1.0000
168		1.0000	1.0000	1.0000	0.8667

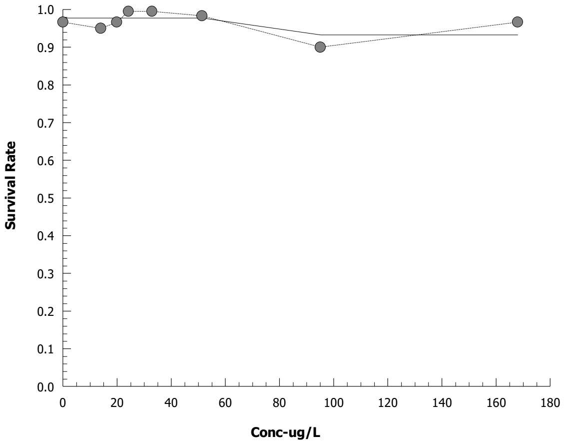
Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 13-7595-1313 **Endpoint:** Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:55 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	15/15	15/15	14/15	14/15
14		15/15	13/15	15/15	14/15
19.9		14/15	15/15	15/15	14/15
24.2		15/15	15/15	15/15	15/15
32.9		15/15	15/15	15/15	15/15
51.4		15/15	14/15	15/15	15/15
95.1		11/15	15/15	13/15	15/15
168		15/15	15/15	15/15	13/15

Graphics



CETIS Analytical Report

Report Date: 16 Aug-17 09:56 (p 1 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	00-0174-0126	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:55	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	168	> 168	n/a		10.6%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	14	0.3852	2.482	0.181	6	CDF	0.7531	Non-Significant Effect
	19.9	0	2.482	0.181	6	CDF	0.8750	Non-Significant Effect
	24.2	-0.9008	2.482	0.181	6	CDF	0.9868	Non-Significant Effect
	32.9	-0.9008	2.482	0.181	6	CDF	0.9868	Non-Significant Effect
	51.4	-0.4504	2.482	0.181	6	CDF	0.9547	Non-Significant Effect
	95.1	1.348	2.482	0.181	6	CDF	0.3270	Non-Significant Effect
	168	-0.06519	2.482	0.181	6	CDF	0.8905	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.735	2.938	0.1164	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.0802069	0.0114581	7	1.072	0.4108	Non-Significant Effect
Error	0.256496	0.0106873	24			
Total	0.336703		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Levene Equality of Variance Test	7.869	3.496	5.7E-05	Unequal Variances
Variances	Mod Levene Equality of Variance Test	3.101	3.496	0.0178	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9469	0.9081	0.1173	Normal Distribution

Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.9667	0.9054	1.0000		0.9333	1.0000	0.0192	3.98%	0.00%
14		4	0.9500	0.8484	1.0000		0.8667	1.0000	0.0319	6.72%	1.72%
19.9		4	0.9667	0.9054	1.0000		0.9333	1.0000	0.0192	3.98%	0.00%
24.2		4	1.0000	1.0000	1.0000		1.0000	1.0000	0.0000	0.00%	-3.45%
32.9		4	1.0000	1.0000	1.0000		1.0000	1.0000	0.0000	0.00%	-3.45%
51.4		4	0.9833	0.9303	1.0000		0.9333	1.0000	0.0167	3.39%	-1.72%
95.1		4	0.9000	0.6969	1.0000		0.7333	1.0000	0.0638	14.18%	6.90%
168		4	0.9667	0.8606	1.0000		0.8667	1.0000	0.0333	6.90%	0.00%

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 00-0174-0126 **Endpoint:** Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:55 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.375	1.254	1.496		1.31	1.441	0.03802	5.53%	0.00%
14		4	1.347	1.16	1.535		1.197	1.441	0.05894	8.75%	2.05%
19.9		4	1.375	1.254	1.496		1.31	1.441	0.03802	5.53%	0.00%
24.2		4	1.441	1.441	1.442		1.441	1.441	0	0.00%	-4.79%
32.9		4	1.441	1.441	1.442		1.441	1.441	0	0.00%	-4.79%
51.4		4	1.408	1.304	1.513		1.31	1.441	0.03292	4.68%	-2.39%
95.1		4	1.277	0.9556	1.598		1.028	1.441	0.101	15.81%	7.16%
168		4	1.38	1.186	1.575		1.197	1.441	0.06108	8.85%	-0.35%

Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.0000	1.0000	0.9333	0.9333
14		1.0000	0.8667	1.0000	0.9333
19.9		0.9333	1.0000	1.0000	0.9333
24.2		1.0000	1.0000	1.0000	1.0000
32.9		1.0000	1.0000	1.0000	1.0000
51.4		1.0000	0.9333	1.0000	1.0000
95.1		0.7333	1.0000	0.8667	1.0000
168		1.0000	1.0000	1.0000	0.8667

Angular (Corrected) Transformed Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N				
14					
19.9					
24.2					
32.9					
51.4					
95.1					
168					

CETIS Analytical Report

Report Date:	09 Aug-17 14:08 (p 1 of 2)
Test Code:	SP1617-029 FM | 03-6991-1553

Larval Fish 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	02-2652-3806	**Endpoint:**	Mean Length-mm	**CETIS Version:**	CETISv1.9.0
Analyzed:	09 Aug-17 14:07	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	42d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	03-3414-4083	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
7	27.2	-47.55	-44.01	0.2676	Yes	1.849	2.621	0.1412	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	50.54	23.57	87.18
IC10	161.9	68.66	305.7
IC15	355.2	69.25	1013
IC20	663.2	51.59	2847
IC25	1133	31.09	7356
IC40	4370	n/a	152300
IC50	9844	n/a	n/a

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	9.658	0.2162	9.216	10.1	44.66	<1.0E-37	Significant Parameter
γ	3.205	1.524	0.08914	6.321	2.104	0.0442	Significant Parameter
δ	9844	19230	-29480	49170	0.512	0.6125	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	2728	909.2	3	4657	<1.0E-37	Significant
Lack of Fit	1.575	0.3149	5	1.849	0.1412	Non-Significant
Pure Error	4.088	0.1703	24			
Residual	5.662	0.1952	29			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.698	2.938	7.3E-04	Outlier Detected
Variances	Mod Levene Equality of Variance	1.794	2.423	0.1350	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.8628	0.9338	7.9E-04	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	1.334	2.492	0.0013	Non-Normal Distribution

CETIS Analytical Report

Report Date: 09 Aug-17 14:08 (p 2 of 2)
Test Code: SP1617-029 FM | 03-6991-1553

Larval Fish 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 02-2652-3806 **Endpoint:** Mean Length-mm **CETIS Version:** CETISv1.9.0
Analyzed: 09 Aug-17 14:07 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

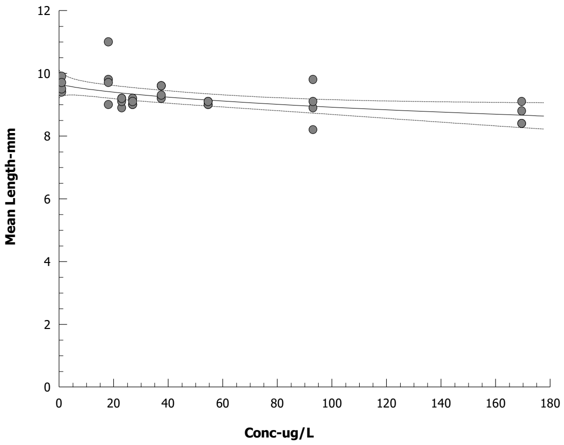
Mean Length-mm Summary

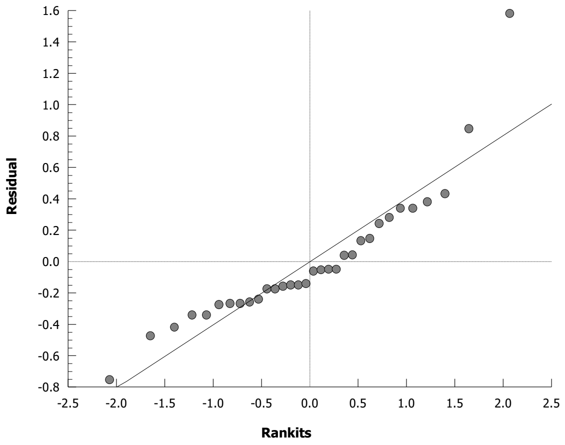
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	4	9.625	9.4	9.9	0.1109	0.2217	2.30%	0.00%
18.1		4	9.875	9	11	0.4151	0.8302	8.41%	-2.60%
23		4	9.1	8.9	9.2	0.07071	0.1414	1.55%	5.45%
27		4	9.075	9	9.2	0.04787	0.09574	1.06%	5.71%
37.5		4	9.425	9.2	9.6	0.1031	0.2062	2.19%	2.08%
54.7		4	9.05	9	9.1	0.02886	0.05773	0.64%	5.97%
93.1		4	9	8.2	9.8	0.3291	0.6583	7.31%	6.49%
169.6		4	8.675	8.4	9.1	0.1702	0.3403	3.92%	9.87%

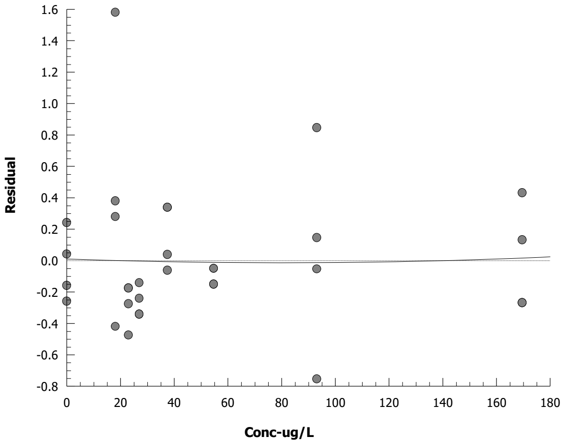
Mean Length-mm Detail

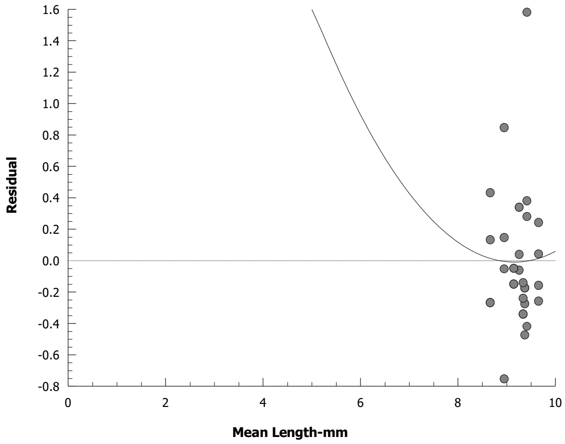
Conc-ug/L	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**
0	N	9.9	9.4	9.5	9.7
18.1		11	9.8	9	9.7
23		9.2	8.9	9.1	9.2
27		9.2	9	9	9.1
37.5		9.6	9.2	9.6	9.3
54.7		9	9.1	9	9.1
93.1		9.8	8.2	8.9	9.1
169.6		8.8	8.4	8.4	9.1

Graphics Model: 3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date:	09 Aug-17 14:15 (p 1 of 2)
Test Code:	SP1617-029 FM | 03-6991-1553

Larval Fish 32-d Survival and Growth Test — **Nautilus Environmental Calgary**

Analysis ID:	14-4361-3524	**Endpoint:**	Mean Length-mm	**CETIS Version:**	CETISv1.9.0
Analyzed:	09 Aug-17 14:14	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	42d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	03-3414-4083	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	93.1	169.6	125.7		7.52%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	18.1	-0.8567	2.482	0.724	6	CDF	0.9850	Non-Significant Effect
	23	1.799	2.482	0.724	6	CDF	0.1721	Non-Significant Effect
	27	1.885	2.482	0.724	6	CDF	0.1498	Non-Significant Effect
	37.5	0.6854	2.482	0.724	6	CDF	0.6270	Non-Significant Effect
	54.7	1.97	2.482	0.724	6	CDF	0.1297	Non-Significant Effect
	93.1	2.142	2.482	0.724	6	CDF	0.0959	Non-Significant Effect
	169.6*	3.255	2.482	0.724	6	CDF	0.0093	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.098	2.938	0.0239	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	4.17719	0.596741	7	3.504	0.0099	Significant Effect
Error	4.0875	0.170313	24			
Total	8.26469		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	25.82	18.48	5.4E-04	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.8789	0.9081	0.0019	Non-Normal Distribution

Mean Length-mm Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	9.625	9.272	9.978		9.4	9.9	0.1109	2.30%	0.00%
18.1		4	9.875	8.554	11.2		9	11	0.4151	8.41%	-2.60%
23		4	9.1	8.875	9.325		8.9	9.2	0.07071	1.55%	5.45%
27		4	9.075	8.923	9.227		9	9.2	0.04787	1.06%	5.71%
37.5		4	9.425	9.097	9.753		9.2	9.6	0.1031	2.19%	2.08%
54.7		4	9.05	8.958	9.142		9	9.1	0.02886	0.64%	5.97%
93.1		4	9	7.953	10.05		8.2	9.8	0.3291	7.31%	6.49%
169.6		4	8.675	8.133	9.217		8.4	9.1	0.1702	3.92%	9.87%

Larval Fish 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 14-4361-3524 **Endpoint:** Mean Length-mm **CETIS Version:** CETISv1.9.0
Analyzed: 09 Aug-17 14:14 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Mean Length-mm Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	9.9	9.4	9.5	9.7
18.1		11	9.8	9	9.7
23		9.2	8.9	9.1	9.2
27		9.2	9	9	9.1
37.5		9.6	9.2	9.6	9.3
54.7		9	9.1	9	9.1
93.1		9.8	8.2	8.9	9.1
169.6		8.8	8.4	8.4	9.1

CETIS Analytical Report

Report Date: 25 Jul-17 13:50 (p 1 of 2)
Test Code: SP1617-029 FMD | 10-7819-7001

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	14-5361-7061	**Endpoint:**	Overall Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 13:50	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:		**Species:**	Pimephales promelas	**Brine:**	
Duration:	n/a	**Source:**	Aquatox, AR	**Age:**	<24

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:		**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1453355	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.986	2.938	0.0404	Outlier Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	7.132	n/a	n/a
LC10	>169.6	n/a	n/a
LC15	>169.6	n/a	n/a
LC20	>169.6	n/a	n/a
LC25	>169.6	n/a	n/a
LC40	>169.6	n/a	n/a
LC50	>169.6	n/a	n/a

Overall Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	N	4	0.9000	0.8667	0.9333	0.0193	0.0385	4.28%	0.00%	54	60
18.1		4	0.7000	0.4000	1.0000	0.1232	0.2465	35.21%	22.22%	42	60
23		4	0.8667	0.8000	0.9333	0.0272	0.0544	6.28%	3.70%	52	60
27		4	0.8833	0.8000	0.9333	0.0319	0.0638	7.23%	1.85%	53	60
37.5		4	0.8500	0.6667	1.0000	0.0687	0.1374	16.17%	5.56%	51	60
54.7		4	0.8833	0.8667	0.9333	0.0167	0.0333	3.77%	1.85%	53	60
93.1		4	0.7500	0.5333	0.8667	0.0739	0.1478	19.71%	16.67%	45	60
169.6		4	0.9000	0.8000	0.9333	0.0333	0.0667	7.41%	0.00%	54	60

Overall Survival Rate

Detail Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.8667	0.9333
18.1		0.4000	0.7333	1.0000	0.6667
23		0.8667	0.8667	0.8000	0.9333
27		0.8000	0.9333	0.9333	0.8667
37.5		0.6667	0.8667	0.8667	1.0000
54.7		0.8667	0.8667	0.9333	0.8667
93.1		0.5333	0.8000	0.8000	0.8667
169.6		0.9333	0.9333	0.9333	0.8000

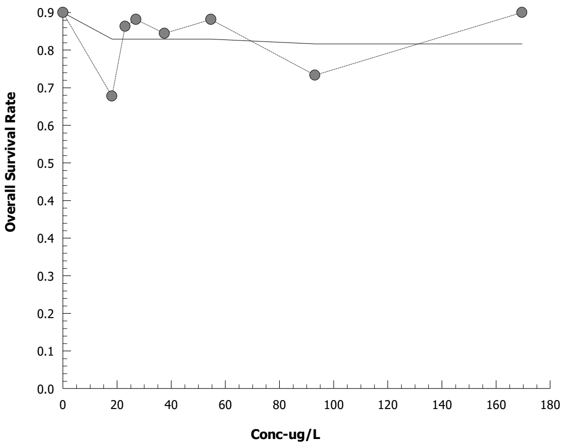
Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 14-5361-7061 **Endpoint:** Overall Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 25 Jul-17 13:50 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Overall Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	13/15	14/15	13/15	14/15
18.1		6/15	11/15	15/15	10/15
23		13/15	13/15	12/15	14/15
27		12/15	14/15	14/15	13/15
37.5		10/15	13/15	13/15	15/15
54.7		13/15	13/15	14/15	13/15
93.1		8/15	12/15	12/15	13/15
169.6		14/15	14/15	14/15	12/15

Graphics



CETIS Analytical Report

Report Date:	25 Jul-17 13:49 (p 1 of 2)
Test Code:	SP1617-029 FMD | 10-7819-7001

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	06-6798-4520	**Endpoint:**	Overall Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 13:48	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:		**Species:**	Pimephales promelas	**Brine:**	
Duration:	n/a	**Source:**	Aquatox, AR	**Age:**	<24

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	169.6	> 169.6	n/a		23.7%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	18.1	2.028	2.482	0.277	6	CDF	0.1175	Non-Significant Effect
	23	0.4543	2.482	0.277	6	CDF	0.7261	Non-Significant Effect
	27	0.2016	2.482	0.277	6	CDF	0.8176	Non-Significant Effect
	37.5	0.4995	2.482	0.277	6	CDF	0.7076	Non-Significant Effect
	54.7	0.2527	2.482	0.277	6	CDF	0.8008	Non-Significant Effect
	93.1	1.757	2.482	0.277	6	CDF	0.1838	Non-Significant Effect
	169.6	-0.05111	2.482	0.277	6	CDF	0.8873	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.986	2.938	0.0404	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.221379	0.0316256	7	1.274	0.3045	Non-Significant Effect
Error	0.595915	0.0248298	24			
Total	0.817295		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	13.39	18.48	0.0631	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9322	0.9081	0.0452	Normal Distribution

Overall Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.9000	0.8388	0.9612		0.8667	0.9333	0.0193	4.28%	0.00%
18.1		4	0.7000	0.3078	1.0000		0.4000	1.0000	0.1232	35.21%	22.22%
23		4	0.8667	0.7801	0.9533		0.8000	0.9333	0.0272	6.28%	3.70%
27		4	0.8833	0.7818	0.9849		0.8000	0.9333	0.0319	7.23%	1.85%
37.5		4	0.8500	0.6313	1.0000		0.6667	1.0000	0.0687	16.17%	5.56%
54.7		4	0.8833	0.8303	0.9364		0.8667	0.9333	0.0167	3.77%	1.85%
93.1		4	0.7500	0.5148	0.9852		0.5333	0.8667	0.0739	19.71%	16.67%
169.6		4	0.9000	0.7939	1.0000		0.8000	0.9333	0.0333	7.41%	0.00%

Analysis ID:	06-6798-4520	**Endpoint:**	Overall Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 13:48	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.253	1.15	1.357		1.197	1.31	0.03251	5.19%	0.00%
18.1		4	1.027	0.5293	1.525		0.6847	1.441	0.1565	30.47%	18.03%
23		4	1.203	1.071	1.335		1.107	1.31	0.04146	6.90%	4.04%
27		4	1.231	1.075	1.387		1.107	1.31	0.04904	7.97%	1.79%
37.5		4	1.198	0.8819	1.513		0.9553	1.441	0.09921	16.57%	4.44%
54.7		4	1.225	1.136	1.315		1.197	1.31	0.02816	4.60%	2.25%
93.1		4	1.058	0.7954	1.32		0.8188	1.197	0.08236	15.58%	15.62%
169.6		4	1.259	1.098	1.42		1.107	1.31	0.05062	8.04%	-0.45%

Overall Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.8667	0.9333
18.1		0.4000	0.7333	1.0000	0.6667
23		0.8667	0.8667	0.8000	0.9333
27		0.8000	0.9333	0.9333	0.8667
37.5		0.6667	0.8667	0.8667	1.0000
54.7		0.8667	0.8667	0.9333	0.8667
93.1		0.5333	0.8000	0.8000	0.8667
169.6		0.9333	0.9333	0.9333	0.8000

CETIS Analytical Report

Report Date: 25 Jul-17 14:05 (p 1 of 2)
Test Code: SP1617-029 FMD | 10-7819-7001

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	15-3309-8262	**Endpoint:**	Post Hatch Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 14:05	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:		**Species:**	Pimephales promelas	**Brine:**	
Duration:	n/a	**Source:**	Aquatox, AR	**Age:**	<24

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:		**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	370153	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.835	2.938	0.0777	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	6.173	n/a	n/a
LC10	>169.6	n/a	n/a
LC15	>169.6	n/a	n/a
LC20	>169.6	n/a	n/a
LC25	>169.6	n/a	n/a
LC40	>169.6	n/a	n/a
LC50	>169.6	n/a	n/a

Post Hatch Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	N	4	0.9321	0.8667	1.0000	0.0272	0.0545	5.85%	0.00%	54	58
18.1		4	0.7401	0.4000	1.0000	0.1275	0.2550	34.46%	20.60%	42	57
23		4	0.8988	0.8000	1.0000	0.0427	0.0855	9.51%	3.58%	52	58
27		4	0.8833	0.8000	0.9333	0.0319	0.0638	7.23%	5.24%	53	60
37.5		4	0.8500	0.6667	1.0000	0.0687	0.1374	16.17%	8.81%	51	60
54.7		4	0.8988	0.8667	0.9333	0.0186	0.0372	4.14%	3.58%	53	59
93.1		4	0.8293	0.7273	0.9231	0.0423	0.0846	10.20%	11.04%	45	54
169.6		4	0.9308	0.9231	0.9333	0.0026	0.0051	0.55%	0.15%	54	58

Post Hatch Survival Rate

Detail Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.9286	1.0000
18.1		0.4000	0.8462	1.0000	0.7143
23		0.9286	0.8667	0.8000	1.0000
27		0.8000	0.9333	0.9333	0.8667
37.5		0.6667	0.8667	0.8667	1.0000
54.7		0.8667	0.9286	0.9333	0.8667
93.1		0.7273	0.8000	0.9231	0.8667
169.6		0.9333	0.9333	0.9333	0.9231

Analyst:________ QA:________

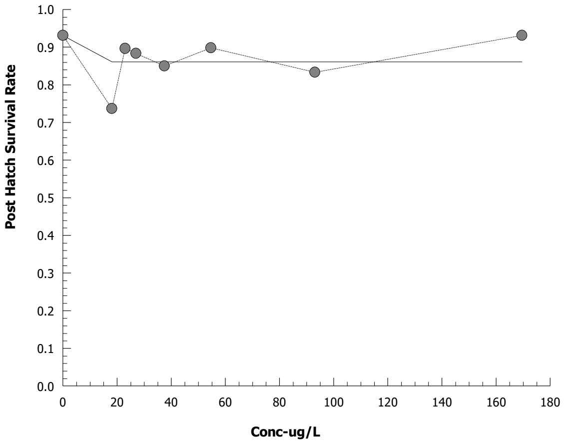
Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 15-3309-8262 **Endpoint:** Post Hatch Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 25 Jul-17 14:05 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Post Hatch Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	13/15	14/15	13/14	14/14
18.1		6/15	11/13	15/15	10/14
23		13/14	13/15	12/15	14/14
27		12/15	14/15	14/15	13/15
37.5		10/15	13/15	13/15	15/15
54.7		13/15	13/14	14/15	13/15
93.1		8/11	12/15	12/13	13/15
169.6		14/15	14/15	14/15	12/13

Graphics



CETIS Analytical Report

Report Date:	25 Jul-17 14:07 (p 1 of 2)
Test Code:	SP1617-029 FMD | 10-7819-7001

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	12-3771-5242	**Endpoint:**	Post Hatch Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	25 Jul-17 14:07	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	Not Applicable
Ending Date:		**Species:**	Pimephales promelas	**Brine:**	
Duration:	n/a	**Source:**	Aquatox, AR	**Age:**	<24

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:		**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	169.6	> 169.6	n/a		14.2%

Williams Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	18.1	2.13	1.711	0.189	6	CDF	>0.05	Non-Significant Effect
	23	1.294	1.791	0.198	6	CDF	>0.05	Non-Significant Effect
	27	1.104	1.818	0.201	6	CDF	>0.05	Non-Significant Effect
	37.5	1.084	1.83	0.203	6	CDF	>0.05	Non-Significant Effect
	54.7	0.9752	1.838	0.203	6	CDF	>0.05	Non-Significant Effect
	93.1	1.42	1.843	0.204	6	CDF	>0.05	Non-Significant Effect
	169.6	0.9074	1.846	0.204	6	CDF	>0.05	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.835	2.938	0.0777	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.175675	0.0250964	7	1.024	0.4398	Non-Significant Effect
Error	0.587932	0.0244972	24			
Total	0.763607		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	21.72	18.48	0.0028	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9564	0.9081	0.2179	Normal Distribution

Post Hatch Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.9321	0.8454	1.0000		0.8667	1.0000	0.0272	5.85%	0.00%
18.1		4	0.7401	0.3343	1.0000		0.4000	1.0000	0.1275	34.46%	20.60%
23		4	0.8988	0.7628	1.0000		0.8000	1.0000	0.0427	9.51%	3.58%
27		4	0.8833	0.7818	0.9849		0.8000	0.9333	0.0319	7.23%	5.24%
37.5		4	0.8500	0.6313	1.0000		0.6667	1.0000	0.0687	16.17%	8.81%
54.7		4	0.8988	0.8397	0.9579		0.8667	0.9333	0.0186	4.14%	3.58%
93.1		4	0.8293	0.6947	0.9638		0.7273	0.9231	0.0423	10.20%	11.04%
169.6		4	0.9308	0.9226	0.9389		0.9231	0.9333	0.0026	0.55%	0.15%

Fathead Minnow 32-d Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 12-3771-5242 **Endpoint:** Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 25 Jul-17 14:07 **Analysis:** Parametric-Control vs Ord.Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.311	1.155	1.467		1.197	1.437	0.0491	7.49%	0.00%
18.1		4	1.075	0.5722	1.578		0.6847	1.441	0.1581	29.40%	17.98%
23		4	1.26	1.035	1.486		1.107	1.437	0.07083	11.24%	3.86%
27		4	1.231	1.075	1.387		1.107	1.31	0.04904	7.97%	6.11%
37.5		4	1.198	0.8819	1.513		0.9553	1.441	0.09921	16.57%	8.64%
54.7		4	1.251	1.152	1.35		1.197	1.31	0.03122	4.99%	4.57%
93.1		4	1.154	0.9699	1.338		1.021	1.29	0.05779	10.02%	11.98%
169.6		4	1.305	1.289	1.32		1.29	1.31	0.00497	0.76%	0.48%

Post Hatch Survival Rate

Detail Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.9286	1.0000
18.1		0.4000	0.8462	1.0000	0.7143
23		0.9286	0.8667	0.8000	1.0000
27		0.8000	0.9333	0.9333	0.8667
37.5		0.6667	0.8667	0.8667	1.0000
54.7		0.8667	0.9286	0.9333	0.8667
93.1		0.7273	0.8000	0.9231	0.8667
169.6		0.9333	0.9333	0.9333	0.9231

CETIS Analytical Report

Report Date:	16 Aug-17 10:11 (p 1 of 2)
Test Code:	SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	04-1109-2037	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:10	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
19	62.13	-117.4	-113.9	0.0237	Yes	0.4519	2.621	0.8077	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	0.06048	n/a	45080
IC10	13.47	1.156E-05	2271
IC15	382.8	n/a	729200
IC20	4758	n/a	2.548E+10
IC25	38140	n/a	n/a
IC40	5745000	n/a	n/a
IC50	108000000	n/a	n/a

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1.103	0.07417	0.9514	1.255	14.87	<1.0E-37	Significant Parameter
γ	0.1382	0.3192	-0.5146	0.7911	0.433	0.6682	Non-Significant Parameter
δ	108000000	3.591E+09	-7.24E+09	7.452E+09	0.03007	0.9762	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	31.56	10.52	3	477.9	<1.0E-37	Significant
Lack of Fit	0.05492	0.01098	5	0.4519	0.8077	Non-Significant
Pure Error	0.5833	0.02431	24			
Residual	0.6383	0.02201	29			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.342	2.938	0.0067	Outlier Detected
Variances	Mod Levene Equality of Variance	0.7355	2.423	0.6442	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9189	0.9338	0.0194	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	0.6946	2.492	0.0697	Normal Distribution

Analysis ID: 04-1109-2037 **Endpoint:** Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:10 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

Mean Dry Biomass-mg Summary

			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	4	1.103	1.023	1.201	0.04613	0.09226	8.36%	0.00%
15.3		4	1.01	0.9747	1.043	0.01773	0.03546	3.51%	8.52%
20.1		4	0.9482	0.7753	1.209	0.092	0.184	19.41%	14.08%
24.5		4	0.9263	0.8667	0.988	0.03334	0.06669	7.20%	16.05%
33.4		4	1.058	0.924	1.191	0.06629	0.1326	12.53%	4.15%
50.9		4	0.9693	0.8747	1.082	0.05156	0.1031	10.64%	12.16%
86.9		4	1.001	0.7747	1.444	0.1503	0.3007	30.04%	9.29%
158		4	0.9213	0.7473	1.091	0.08332	0.1666	18.09%	16.51%

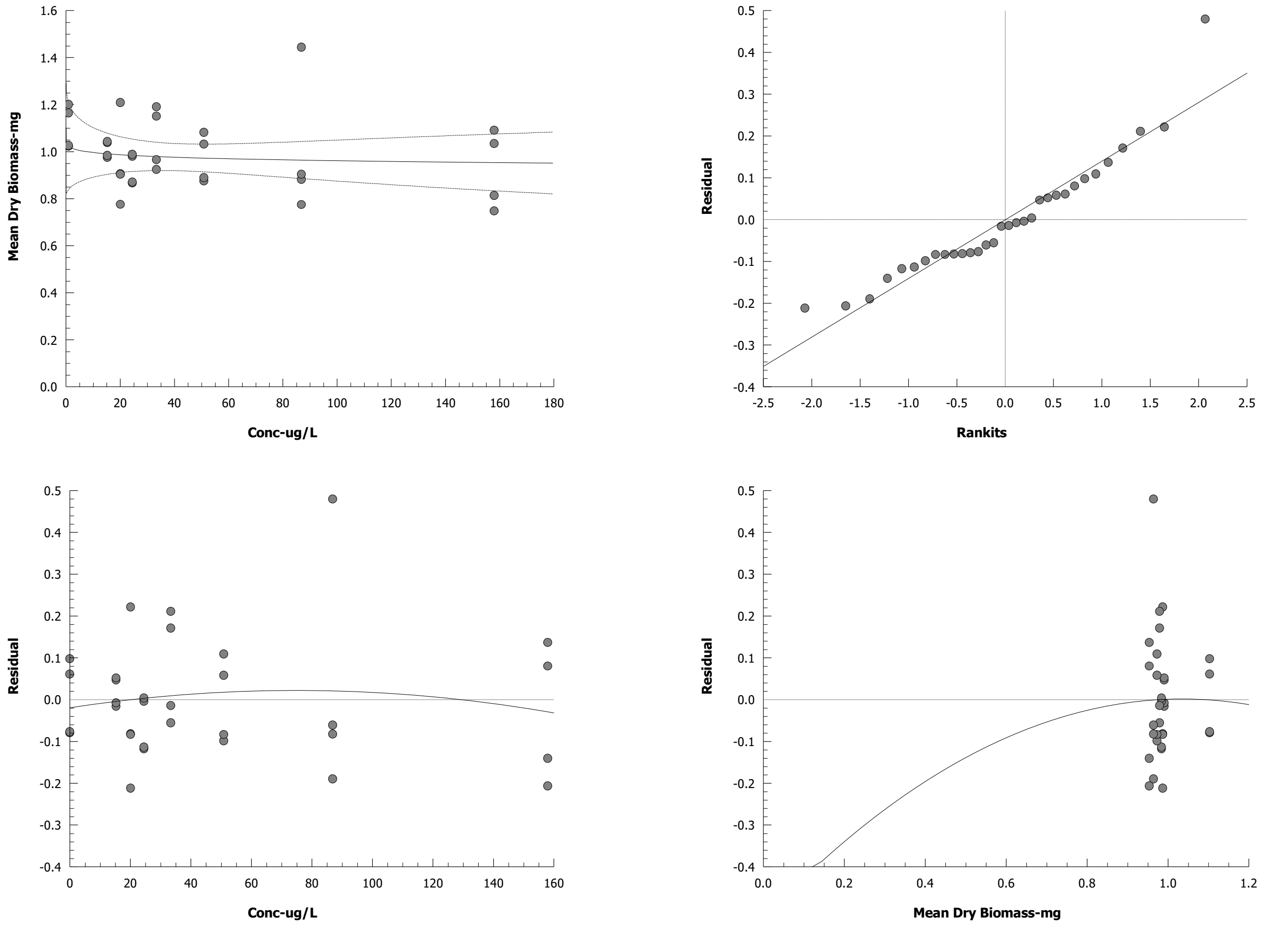
Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.164	1.023	1.026	1.201
15.3		0.9747	1.037	1.043	0.9833
20.1		1.209	0.9053	0.9033	0.7753
24.5		0.8667	0.98	0.988	0.8707
33.4		0.924	0.9653	1.151	1.191
50.9		0.8747	1.082	0.8893	1.031
86.9		0.882	0.7747	0.9033	1.444
158		0.8133	0.7473	1.034	1.091

Graphics

Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ]

Distribution: Normal [ω=1]



CETIS Analytical Report

Report Date: 16 Aug-17 10:11 (p 1 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	17-1903-2022	**Endpoint:**	Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:11	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	158	> 158	n/a		24.8%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	15.3	0.8527	2.482	0.274	6	CDF	0.5498	Non-Significant Effect
	20.1	1.409	2.482	0.274	6	CDF	0.3025	Non-Significant Effect
	24.5	1.607	2.482	0.274	6	CDF	0.2304	Non-Significant Effect
	33.4	0.4158	2.482	0.274	6	CDF	0.7413	Non-Significant Effect
	50.9	1.217	2.482	0.274	6	CDF	0.3824	Non-Significant Effect
	86.9	0.9298	2.482	0.274	6	CDF	0.5137	Non-Significant Effect
	158	1.652	2.482	0.274	6	CDF	0.2156	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.229	2.938	0.0124	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.11549	0.0164986	7	0.6788	0.6883	Non-Significant Effect
Error	0.583338	0.0243058	24			
Total	0.698829		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	13.55	18.48	0.0597	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9278	0.9081	0.0339	Normal Distribution

Mean Dry Biomass-mg Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.103	0.9567	1.25		1.023	1.201	0.04613	8.36%	0.00%
15.3		4	1.01	0.9531	1.066		0.9747	1.043	0.01773	3.51%	8.52%
20.1		4	0.9482	0.6554	1.241		0.7753	1.209	0.092	19.41%	14.08%
24.5		4	0.9263	0.8202	1.032		0.8667	0.988	0.03334	7.20%	16.05%
33.4		4	1.058	0.8467	1.269		0.924	1.191	0.06629	12.53%	4.15%
50.9		4	0.9693	0.8053	1.133		0.8747	1.082	0.05156	10.64%	12.16%
86.9		4	1.001	0.5226	1.479		0.7747	1.444	0.1503	30.04%	9.29%
158		4	0.9213	0.6562	1.186		0.7473	1.091	0.08332	18.09%	16.51%

Analysis ID: 17-1903-2022 **Endpoint:** Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:11 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.164	1.023	1.026	1.201
15.3		0.9747	1.037	1.043	0.9833
20.1		1.209	0.9053	0.9033	0.7753
24.5		0.8667	0.98	0.988	0.8707
33.4		0.924	0.9653	1.151	1.191
50.9		0.8747	1.082	0.8893	1.031
86.9		0.882	0.7747	0.9033	1.444
158		0.8133	0.7473	1.034	1.091

CETIS Analytical Report

Report Date: 16 Aug-17 09:59 (p 1 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 17-0659-5951 **Endpoint:** Hatch **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:59 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Batch ID: 20-1684-1453 **Test Type:** Survival-Growth **Analyst:** Leila Oosterbroek
Start Date: 25 May-17 **Protocol:** Not Applicable **Diluent:**
Ending Date: 26 Jun-17 **Species:** Pimephales promelas **Brine:**
Duration: 32d 0h **Source:** Aquatox, AR **Age:**

Sample ID: 02-7886-7783 **Code:** SP1617-029 **Client:** Minnow Environmental
Sample Date: 05 May-17 **Material:** Dissolved Copper **Project:**
Receipt Date: 12 May-17 **Source:** Minnow Environmental
Sample Age: 20d 0h (6 °C) **Station:** Minto

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	390279	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.735	2.938	0.1164	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	>144	n/a	n/a
LC10	>144	n/a	n/a
LC15	>144	n/a	n/a
LC20	>144	n/a	n/a
LC25	>144	n/a	n/a
LC40	>144	n/a	n/a
LC50	>144	n/a	n/a

Hatch Summary

			Calculated Variate(A/B)								
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	N	4	0.9667	0.9333	1.0000	0.0192	0.0385	3.98%	0.00%	58	60
12.1		4	0.9500	0.8667	1.0000	0.0319	0.0638	6.72%	1.72%	57	60
16.5		4	0.9667	0.9333	1.0000	0.0192	0.0385	3.98%	0.00%	58	60
22.3		4	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	-3.45%	60	60
29.7		4	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	-3.45%	60	60
46.6		4	0.9833	0.9333	1.0000	0.0167	0.0333	3.39%	-1.72%	59	60
85		4	0.9000	0.7333	1.0000	0.0638	0.1277	14.18%	6.90%	54	60
144		4	0.9667	0.8667	1.0000	0.0333	0.0667	6.90%	0.00%	58	60

Hatch Detail

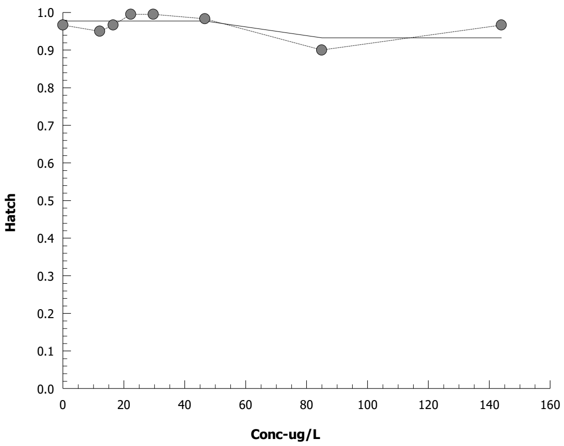
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.0000	1.0000	0.9333	0.9333
12.1		1.0000	0.8667	1.0000	0.9333
16.5		0.9333	1.0000	1.0000	0.9333
22.3		1.0000	1.0000	1.0000	1.0000
29.7		1.0000	1.0000	1.0000	1.0000
46.6		1.0000	0.9333	1.0000	1.0000
85		0.7333	1.0000	0.8667	1.0000
144		1.0000	1.0000	1.0000	0.8667

Analysis ID: 17-0659-5951 **Endpoint:** Hatch **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:59 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Hatch Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	15/15	15/15	14/15	14/15
12.1		15/15	13/15	15/15	14/15
16.5		14/15	15/15	15/15	14/15
22.3		15/15	15/15	15/15	15/15
29.7		15/15	15/15	15/15	15/15
46.6		15/15	14/15	15/15	15/15
85		11/15	15/15	13/15	15/15
144		15/15	15/15	15/15	13/15

Graphics



CETIS Analytical Report

Report Date:	16 Aug-17 10:00 (p 1 of 2)
Test Code:	SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	02-4821-4436	**Endpoint:**	Hatch	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:59	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	144	> 144	n/a		10.6%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	12.1	0.3852	2.482	0.181	6	CDF	0.7531	Non-Significant Effect
	16.5	0	2.482	0.181	6	CDF	0.8750	Non-Significant Effect
	22.3	-0.9008	2.482	0.181	6	CDF	0.9868	Non-Significant Effect
	29.7	-0.9008	2.482	0.181	6	CDF	0.9868	Non-Significant Effect
	46.6	-0.4504	2.482	0.181	6	CDF	0.9547	Non-Significant Effect
	85	1.348	2.482	0.181	6	CDF	0.3270	Non-Significant Effect
	144	-0.06519	2.482	0.181	6	CDF	0.8905	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.735	2.938	0.1164	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.0802069	0.0114581	7	1.072	0.4108	Non-Significant Effect
Error	0.256496	0.0106873	24			
Total	0.336703		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Levene Equality of Variance Test	7.869	3.496	5.7E-05	Unequal Variances
Variances	Mod Levene Equality of Variance Test	3.101	3.496	0.0178	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9469	0.9081	0.1173	Normal Distribution

Hatch Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.9667	0.9054	1.0000		0.9333	1.0000	0.0192	3.98%	0.00%
12.1		4	0.9500	0.8484	1.0000		0.8667	1.0000	0.0319	6.72%	1.72%
16.5		4	0.9667	0.9054	1.0000		0.9333	1.0000	0.0192	3.98%	0.00%
22.3		4	1.0000	1.0000	1.0000		1.0000	1.0000	0.0000	0.00%	-3.45%
29.7		4	1.0000	1.0000	1.0000		1.0000	1.0000	0.0000	0.00%	-3.45%
46.6		4	0.9833	0.9303	1.0000		0.9333	1.0000	0.0167	3.39%	-1.72%
85		4	0.9000	0.6969	1.0000		0.7333	1.0000	0.0638	14.18%	6.90%
144		4	0.9667	0.8606	1.0000		0.8667	1.0000	0.0333	6.90%	0.00%

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 02-4821-4436 **Endpoint:** Hatch **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:59 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.375	1.254	1.496		1.31	1.441	0.03802	5.53%	0.00%
12.1		4	1.347	1.16	1.535		1.197	1.441	0.05894	8.75%	2.05%
16.5		4	1.375	1.254	1.496		1.31	1.441	0.03802	5.53%	0.00%
22.3		4	1.441	1.441	1.442		1.441	1.441	0	0.00%	-4.79%
29.7		4	1.441	1.441	1.442		1.441	1.441	0	0.00%	-4.79%
46.6		4	1.408	1.304	1.513		1.31	1.441	0.03292	4.68%	-2.39%
85		4	1.277	0.9556	1.598		1.028	1.441	0.101	15.81%	7.16%
144		4	1.38	1.186	1.575		1.197	1.441	0.06108	8.85%	-0.35%

Hatch Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	1.0000	1.0000	0.9333	0.9333
12.1		1.0000	0.8667	1.0000	0.9333
16.5		0.9333	1.0000	1.0000	0.9333
22.3		1.0000	1.0000	1.0000	1.0000
29.7		1.0000	1.0000	1.0000	1.0000
46.6		1.0000	0.9333	1.0000	1.0000
85		0.7333	1.0000	0.8667	1.0000
144		1.0000	1.0000	1.0000	0.8667

Angular (Corrected) Transformed Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N				
12.1					
16.5					
22.3					
29.7					
46.6					
85					
144					

CETIS Analytical Report

Report Date: 16 Aug-17 10:08 (p 1 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	11-7618-8288	**Endpoint:**	Mean Length-mm	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:07	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Cumulative Log-Normal: $\mu=\alpha\cdot[1-\Phi[\log[x/\delta]/\gamma]]$	Normal: $\omega=1$	Off: $\mu^*=\mu$	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
7	27.3	-47.74	-44.2	0.2721	Yes	1.809	2.621	0.1492	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	45.32	20.67	79.44
IC10	150.4	62.96	287.2
IC15	337.7	63.9	986.5
IC20	642.5	47.6	2858
IC25	1116	28.71	7592
IC40	4480	n/a	170500
IC50	10340	n/a	n/a

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	9.661	0.2154	9.22	10.1	44.85	<1.0E-37	Significant Parameter
γ	3.301	1.566	0.09885	6.504	2.108	0.0438	Significant Parameter
δ	10340	20730	-32060	52740	0.4988	0.6217	Non-Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	2728	909.2	3	4685	<1.0E-37	Significant
Lack of Fit	1.54	0.3081	5	1.809	0.1492	Non-Significant
Pure Error	4.088	0.1703	24			
Residual	5.628	0.1941	29			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.691	2.938	7.6E-04	Outlier Detected
Variances	Mod Levene Equality of Variance	1.794	2.423	0.1350	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.8643	0.9338	8.6E-04	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	1.304	2.492	0.0018	Non-Normal Distribution

Fathead Minnow 32-d Larval Survival and Growth Test | **Nautilus Environmental Calgary**

Analysis ID: 11-7618-8288 **Endpoint:** Mean Length-mm **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:07 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

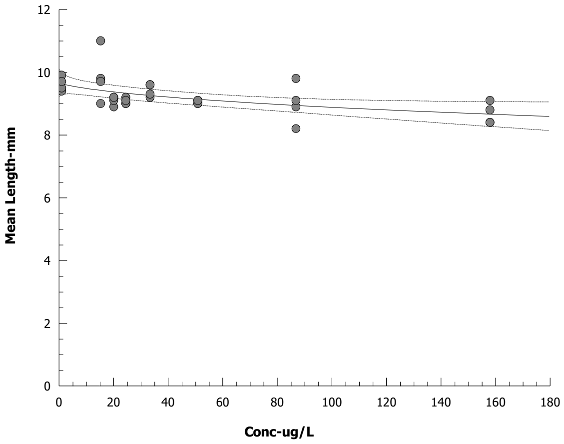
Mean Length-mm Summary

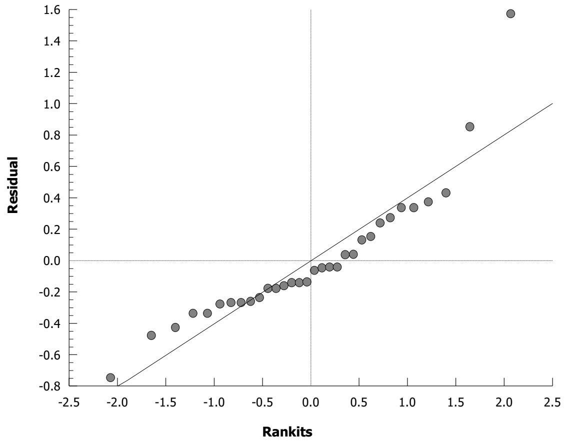
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	4	9.625	9.4	9.9	0.1109	0.2217	2.30%	0.00%
15.3		4	9.875	9	11	0.4151	0.8302	8.41%	-2.60%
20.1		4	9.1	8.9	9.2	0.07071	0.1414	1.55%	5.45%
24.5		4	9.075	9	9.2	0.04787	0.09574	1.06%	5.71%
33.4		4	9.425	9.2	9.6	0.1031	0.2062	2.19%	2.08%
50.9		4	9.05	9	9.1	0.02886	0.05773	0.64%	5.97%
86.9		4	9	8.2	9.8	0.3291	0.6583	7.31%	6.49%
158		4	8.675	8.4	9.1	0.1702	0.3403	3.92%	9.87%

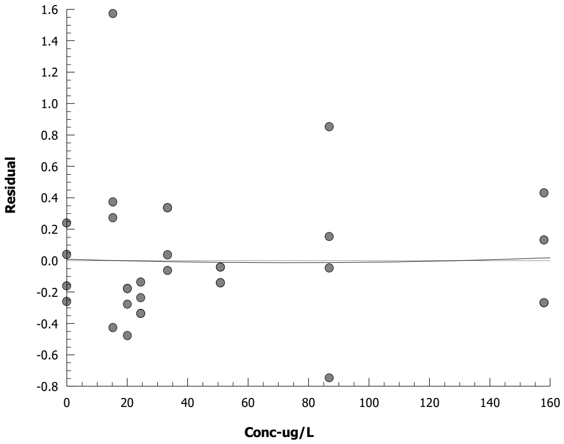
Mean Length-mm Detail

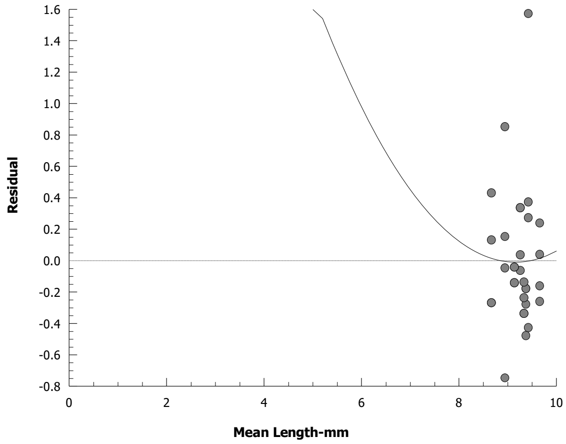
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	9.9	9.4	9.5	9.7
15.3		11	9.8	9	9.7
20.1		9.2	8.9	9.1	9.2
24.5		9.2	9	9	9.1
33.4		9.6	9.2	9.6	9.3
50.9		9	9.1	9	9.1
86.9		9.8	8.2	8.9	9.1
158		8.8	8.4	8.4	9.1

Graphics Model: 3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 16 Aug-17 10:09 (p 1 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	06-1813-2912	**Endpoint:**	Mean Length-mm	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:08	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	86.9	158	117.2		7.52%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	15.3	-0.8567	2.482	0.724	6	CDF	0.9850	Non-Significant Effect
	20.1	1.799	2.482	0.724	6	CDF	0.1721	Non-Significant Effect
	24.5	1.885	2.482	0.724	6	CDF	0.1498	Non-Significant Effect
	33.4	0.6854	2.482	0.724	6	CDF	0.6270	Non-Significant Effect
	50.9	1.97	2.482	0.724	6	CDF	0.1297	Non-Significant Effect
	86.9	2.142	2.482	0.724	6	CDF	0.0959	Non-Significant Effect
	158*	3.255	2.482	0.724	6	CDF	0.0093	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.098	2.938	0.0239	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	4.17719	0.596741	7	3.504	0.0099	Significant Effect
Error	4.0875	0.170313	24			
Total	8.26469		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	25.82	18.48	5.4E-04	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.8789	0.9081	0.0019	Non-Normal Distribution

Mean Length-mm Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	9.625	9.272	9.978		9.4	9.9	0.1109	2.30%	0.00%
15.3		4	9.875	8.554	11.2		9	11	0.4151	8.41%	-2.60%
20.1		4	9.1	8.875	9.325		8.9	9.2	0.07071	1.55%	5.45%
24.5		4	9.075	8.923	9.227		9	9.2	0.04787	1.06%	5.71%
33.4		4	9.425	9.097	9.753		9.2	9.6	0.1031	2.19%	2.08%
50.9		4	9.05	8.958	9.142		9	9.1	0.02886	0.64%	5.97%
86.9		4	9	7.953	10.05		8.2	9.8	0.3291	7.31%	6.49%
158		4	8.675	8.133	9.217		8.4	9.1	0.1702	3.92%	9.87%

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 06-1813-2912 **Endpoint:** Mean Length-mm **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:08 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Mean Length-mm Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	9.9	9.4	9.5	9.7
15.3		11	9.8	9	9.7
20.1		9.2	8.9	9.1	9.2
24.5		9.2	9	9	9.1
33.4		9.6	9.2	9.6	9.3
50.9		9	9.1	9	9.1
86.9		9.8	8.2	8.9	9.1
158		8.8	8.4	8.4	9.1

CETIS Analytical Report

Report Date: 16 Aug-17 10:05 (p 1 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	16-7017-8720	**Endpoint:**	Overall Survival	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:04	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	967869	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.986	2.938	0.0404	Outlier Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	6.266	n/a	n/a
LC10	>158	n/a	n/a
LC15	>158	n/a	n/a
LC20	>158	n/a	n/a
LC25	>158	n/a	n/a
LC40	>158	n/a	n/a
LC50	>158	n/a	n/a

Overall Survival Summary

			Calculated Variate(A/B)								
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	N	4	0.9000	0.8667	0.9333	0.0193	0.0385	4.28%	0.00%	54	60
15.3		4	0.7000	0.4000	1.0000	0.1232	0.2465	35.21%	22.22%	42	60
20.1		4	0.8667	0.8000	0.9333	0.0272	0.0544	6.28%	3.70%	52	60
24.5		4	0.8833	0.8000	0.9333	0.0319	0.0638	7.23%	1.85%	53	60
33.4		4	0.8500	0.6667	1.0000	0.0687	0.1374	16.17%	5.56%	51	60
50.9		4	0.8833	0.8667	0.9333	0.0167	0.0333	3.77%	1.85%	53	60
86.9		4	0.7500	0.5333	0.8667	0.0739	0.1478	19.71%	16.67%	45	60
158		4	0.9000	0.8000	0.9333	0.0333	0.0667	7.41%	0.00%	54	60

Overall Survival

Detail Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.8667	0.9333
15.3		0.4000	0.7333	1.0000	0.6667
20.1		0.8667	0.8667	0.8000	0.9333
24.5		0.8000	0.9333	0.9333	0.8667
33.4		0.6667	0.8667	0.8667	1.0000
50.9		0.8667	0.8667	0.9333	0.8667
86.9		0.5333	0.8000	0.8000	0.8667
158		0.9333	0.9333	0.9333	0.8000

CETIS Analytical Report

Report Date: 16 Aug-17 10:05 (p 2 of 2)
Test Code: SP1617-029 FM2 | 18-3772-6964

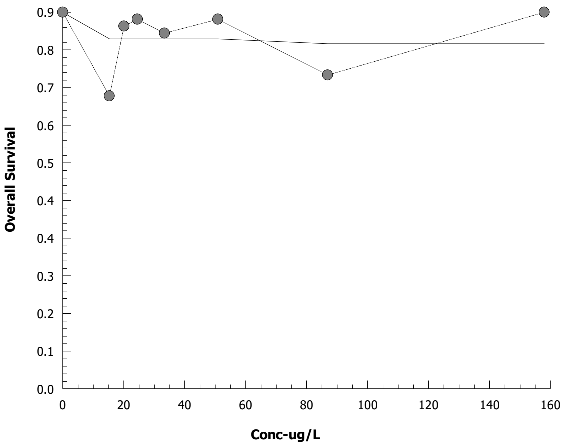
Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 16-7017-8720 **Endpoint:** Overall Survival **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:04 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Overall Survial Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	13/15	14/15	13/15	14/15
15.3		6/15	11/15	15/15	10/15
20.1		13/15	13/15	12/15	14/15
24.5		12/15	14/15	14/15	13/15
33.4		10/15	13/15	13/15	15/15
50.9		13/15	13/15	14/15	13/15
86.9		8/15	12/15	12/15	13/15
158		14/15	14/15	14/15	12/15

Graphics



CETIS Analytical Report

Report Date:	04 Oct-17 11:11 (p 1 of 2)
Test Code:	SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	15-3113-0393	**Endpoint:**	Overall Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	04 Oct-17 11:10	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	158	> 158	n/a		23.7%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	15.3	2.028	2.482	0.277	6	CDF	0.1175	Non-Significant Effect
	20.1	0.4543	2.482	0.277	6	CDF	0.7261	Non-Significant Effect
	24.5	0.2016	2.482	0.277	6	CDF	0.8176	Non-Significant Effect
	33.4	0.4995	2.482	0.277	6	CDF	0.7076	Non-Significant Effect
	50.9	0.2527	2.482	0.277	6	CDF	0.8008	Non-Significant Effect
	86.9	1.757	2.482	0.277	6	CDF	0.1838	Non-Significant Effect
	158	-0.05111	2.482	0.277	6	CDF	0.8873	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.986	2.938	0.0404	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.221379	0.0316256	7	1.274	0.3045	Non-Significant Effect
Error	0.595915	0.0248298	24			
Total	0.817295		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	13.39	18.48	0.0631	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9322	0.9081	0.0452	Normal Distribution

Overall Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.9000	0.8388	0.9612		0.8667	0.9333	0.0193	4.28%	0.00%
15.3		4	0.7000	0.3078	1.0000		0.4000	1.0000	0.1232	35.21%	22.22%
20.1		4	0.8667	0.7801	0.9533		0.8000	0.9333	0.0272	6.28%	3.70%
24.5		4	0.8833	0.7818	0.9849		0.8000	0.9333	0.0319	7.23%	1.85%
33.4		4	0.8500	0.6313	1.0000		0.6667	1.0000	0.0687	16.17%	5.56%
50.9		4	0.8833	0.8303	0.9364		0.8667	0.9333	0.0167	3.77%	1.85%
86.9		4	0.7500	0.5148	0.9852		0.5333	0.8667	0.0739	19.71%	16.67%
158		4	0.9000	0.7939	1.0000		0.8000	0.9333	0.0333	7.41%	0.00%

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 15-3113-0393 **Endpoint:** Overall Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 04 Oct-17 11:10 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.253	1.15	1.357		1.197	1.31	0.03251	5.19%	0.00%
15.3		4	1.027	0.5293	1.525		0.6847	1.441	0.1565	30.47%	18.03%
20.1		4	1.203	1.071	1.335		1.107	1.31	0.04146	6.90%	4.04%
24.5		4	1.231	1.075	1.387		1.107	1.31	0.04904	7.97%	1.79%
33.4		4	1.198	0.8819	1.513		0.9553	1.441	0.09921	16.57%	4.44%
50.9		4	1.225	1.136	1.315		1.197	1.31	0.02816	4.60%	2.25%
86.9		4	1.058	0.7954	1.32		0.8188	1.197	0.08236	15.58%	15.62%
158		4	1.259	1.098	1.42		1.107	1.31	0.05062	8.04%	-0.45%

Overall Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.8667	0.9333
15.3		0.4000	0.7333	1.0000	0.6667
20.1		0.8667	0.8667	0.8000	0.9333
24.5		0.8000	0.9333	0.9333	0.8667
33.4		0.6667	0.8667	0.8667	1.0000
50.9		0.8667	0.8667	0.9333	0.8667
86.9		0.5333	0.8000	0.8000	0.8667
158		0.9333	0.9333	0.9333	0.8000

Angular (Corrected) Transformed Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N				
15.3					
20.1					
24.5					
33.4					
50.9					
86.9					
158					

CETIS Analytical Report

Report Date:	16 Aug-17 10:02 (p 1 of 2)
Test Code:	SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	03-1952-4791	**Endpoint:**	Post Hatch Survival	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:01	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1995805	200	Yes	Two-Point Interpolation

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.835	2.938	0.0777	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	5.452	n/a	n/a
LC10	>158	n/a	n/a
LC15	>158	n/a	n/a
LC20	>158	n/a	n/a
LC25	>158	n/a	n/a
LC40	>158	n/a	n/a
LC50	>158	n/a	n/a

Post Hatch Survival Summary

			Calculated Variate(A/B)								
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	N	4	0.9321	0.8667	1.0000	0.0272	0.0545	5.85%	0.00%	54	58
15.3		4	0.7401	0.4000	1.0000	0.1275	0.2550	34.46%	20.60%	42	57
20.1		4	0.8988	0.8000	1.0000	0.0427	0.0855	9.51%	3.58%	52	58
24.5		4	0.8833	0.8000	0.9333	0.0319	0.0638	7.23%	5.24%	53	60
33.4		4	0.8500	0.6667	1.0000	0.0687	0.1374	16.17%	8.81%	51	60
50.9		4	0.8988	0.8667	0.9333	0.0186	0.0372	4.14%	3.58%	53	59
86.9		4	0.8293	0.7273	0.9231	0.0423	0.0846	10.20%	11.04%	45	54
158		4	0.9308	0.9231	0.9333	0.0026	0.0051	0.55%	0.15%	54	58

Post Hatch Survival

Detail Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.9286	1.0000
15.3		0.4000	0.8462	1.0000	0.7143
20.1		0.9286	0.8667	0.8000	1.0000
24.5		0.8000	0.9333	0.9333	0.8667
33.4		0.6667	0.8667	0.8667	1.0000
50.9		0.8667	0.9286	0.9333	0.8667
86.9		0.7273	0.8000	0.9231	0.8667
158		0.9333	0.9333	0.9333	0.9231

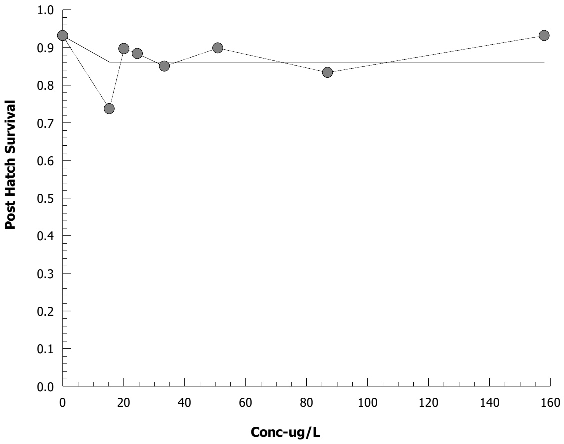
Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID: 03-1952-4791 **Endpoint:** Post Hatch Survival **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 10:01 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

Post Hatch Survival Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	13/15	14/15	13/14	14/14
15.3		6/15	11/13	15/15	10/14
20.1		13/14	13/15	12/15	14/14
24.5		12/15	14/15	14/15	13/15
33.4		10/15	13/15	13/15	15/15
50.9		13/15	13/14	14/15	13/15
86.9		8/11	12/15	12/13	13/15
158		14/15	14/15	14/15	12/13

Graphics



CETIS Analytical Report

Report Date:	16 Aug-17 10:02 (p 1 of 2)
Test Code:	SP1617-029 FM2 | 18-3772-6964

Fathead Minnow 32-d Larval Survival and Growth Test **Nautilus Environmental Calgary**

Analysis ID:	06-3044-8082	**Endpoint:**	Post Hatch Survival	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:02	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Batch ID:	20-1684-1453	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	Not Applicable	**Diluent:**	
Ending Date:	26 Jun-17	**Species:**	Pimephales promelas	**Brine:**	
Duration:	32d 0h	**Source:**	Aquatox, AR	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	158	> 158	n/a		14.2%

Williams Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	15.3	2.13	1.711	0.189	6	CDF	>0.05	Non-Significant Effect
	20.1	1.294	1.791	0.198	6	CDF	>0.05	Non-Significant Effect
	24.5	1.104	1.818	0.201	6	CDF	>0.05	Non-Significant Effect
	33.4	1.084	1.83	0.203	6	CDF	>0.05	Non-Significant Effect
	50.9	0.9752	1.838	0.203	6	CDF	>0.05	Non-Significant Effect
	86.9	1.42	1.843	0.204	6	CDF	>0.05	Non-Significant Effect
	158	0.9074	1.846	0.204	6	CDF	>0.05	Non-Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.835	2.938	0.0777	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.175675	0.0250964	7	1.024	0.4398	Non-Significant Effect
Error	0.587932	0.0244972	24			
Total	0.763607		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	21.72	18.48	0.0028	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9564	0.9081	0.2179	Normal Distribution

Post Hatch Survival Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.9321	0.8454	1.0000		0.8667	1.0000	0.0272	5.85%	0.00%
15.3		4	0.7401	0.3343	1.0000		0.4000	1.0000	0.1275	34.46%	20.60%
20.1		4	0.8988	0.7628	1.0000		0.8000	1.0000	0.0427	9.51%	3.58%
24.5		4	0.8833	0.7818	0.9849		0.8000	0.9333	0.0319	7.23%	5.24%
33.4		4	0.8500	0.6313	1.0000		0.6667	1.0000	0.0687	16.17%	8.81%
50.9		4	0.8988	0.8397	0.9579		0.8667	0.9333	0.0186	4.14%	3.58%
86.9		4	0.8293	0.6947	0.9638		0.7273	0.9231	0.0423	10.20%	11.04%
158		4	0.9308	0.9226	0.9389		0.9231	0.9333	0.0026	0.55%	0.15%

Analysis ID:	06-3044-8082	**Endpoint:**	Post Hatch Survival	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 10:02	**Analysis:**	Parametric-Control vs Ord.Treatments	**Official Results:**	Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	1.311	1.155	1.467		1.197	1.437	0.0491	7.49%	0.00%
15.3		4	1.075	0.5722	1.578		0.6847	1.441	0.1581	29.40%	17.98%
20.1		4	1.26	1.035	1.486		1.107	1.437	0.07083	11.24%	3.86%
24.5		4	1.231	1.075	1.387		1.107	1.31	0.04904	7.97%	6.11%
33.4		4	1.198	0.8819	1.513		0.9553	1.441	0.09921	16.57%	8.64%
50.9		4	1.251	1.152	1.35		1.197	1.31	0.03122	4.99%	4.57%
86.9		4	1.154	0.9699	1.338		1.021	1.29	0.05779	10.02%	11.98%
158		4	1.305	1.289	1.32		1.29	1.31	0.00497	0.76%	0.48%

Post Hatch Survival Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.8667	0.9333	0.9286	1.0000
15.3		0.4000	0.8462	1.0000	0.7143
20.1		0.9286	0.8667	0.8000	1.0000
24.5		0.8000	0.9333	0.9333	0.8667
33.4		0.6667	0.8667	0.8667	1.0000
50.9		0.8667	0.9286	0.9333	0.8667
86.9		0.7273	0.8000	0.9231	0.8667
158		0.9333	0.9333	0.9333	0.9231

Angular (Corrected) Transformed Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N				
15.3					
20.1					
24.5					
33.4					
50.9					
86.9					
158					

APPENDIX D – *Hyalella azteca* Toxicity Test Data

Hyalella Bench Sheet

Method 42-d HA | Client MIN100 | Sample SP1617-029

Test Log

Date	Day	Time	Technicians	Temp (°C)*	Chem Cart Used	Fed	Feeding Rate (per replicate)		C YAT Expiry Date	Bench Sheet Review	
							YAT	Tetramin	06/25	First	Second
2017/05/25	0	1000	NM/JN	22	3	✓	1 mL	0.25 mg	06/11	JN	JW
2017/05/26	1	1000	NM	23	3	✓	1 mL	0.25 mg	06/~~11~~25	JN	JW
2017/05/27	2	1300	JW	23	-	✓	1 mL	0.25 mg	06/25	JW	LC
2017/05/28	3	1210	NM	23	-	✓	1 mL	0.25 mg	06/25.	NM	SS
2017/05/29	4	1130	NM	23	3	✓	1 mL	0.25 mg	06/25	JW	SS
2017/05/30	5	0830	NM	23	-	✓	1 mL	0.25 mg	06/25	SS	EP
2017/05/31	6	1550	NM/EP	23	3	✓	1 mL	0.25 mg	06/25	Ca	JW
2017/06/01	7	1200	EP	23	-	✓	1 mL	0.5 mg	06/25	JW	LC
2017/06/02	8	1345	EP	23	3	✓	1 mL	0.5 mg	06/31	Ca	EP
2017/06/03	9	0930	EP	23	-	✓	1 mL	0.5 mg	06/31	LC	EP
2017/06/04	10	1400	NM	23	-	✓	1 mL	0.5 mg	06/31	JW	NM
2017/06/05	11	1200	NM	23	3	✓	1 mL	0.5 mg	06/31	JW	EP
2017/06/06	12	1200	EP	23	-	✓	1 mL	0.5 mg	06/31	JW	EP
2017/06/07	13	1100	SS	23	3	✓	1 mL	0.5 mg	06/31	LC	JW
2017/06/08	14	1400	NM/HS	24	-	✓	1 mL	1.0 mg	06/31	HS	SS
2017/06/09	15	1230	EP	24	3	✓	1 mL	1.0 mg	06/31	LC	SS
2017/06/10	16	1400	HS	24	-	✓	1 mL	1.0 mg	06/31	LC	HS
2017/06/11	17	1500	NM	23	-	✓	1 mL	1.0 mg	06/31	SS	
2017/06/12	18	1130	HS	23	3	✓	1 mL	1.0 mg	06/31	HS	SS
2017/06/13	19	1430	NM	23	-	✓	1 mL	1.0 mg	06/31	NM	HS
2017/06/14	20	1400	NM	22	3	✓	1 mL	1.0 mg	06/31	JW	HS
2017/06/15	21	1100	JW	23	-	✓	1 mL	1.5 mg	06/31	JW	Ca
2017/06/16	22	1345	EP	23	3	✓	1 mL	1.5 mg	06/31	JW	EP
2017/06/17	23	1300	JW	23	-	✓	1 mL	1.5 mg	06/31	JW	LC
2017/06/18	24	1600	NM	25	-	✓	1 mL	1.5 mg	06/31	DM	SS
2017/06/19	25	1530	NM	23	3	✓	1 mL	1.5 mg	06/31	JW	NM
2017/06/20	26	1345	SS	23	-	✓	1 mL	1.5 mg	06/31	JW	ED
2017/06/21	27	1310	SS	23	3	✓	1 mL	1.5 mg	06/31	JW	HS
2017/06/22	28	1115	NM	23	-	✓	1 mL	2.0 mg	06/31	HS	EP
2017/06/23	29	1510	EP	23	3		1 mL	2.0 mg	06/31	HS	EP
2017/06/24	30	1045	EP	23	-	✓	1 mL	2.0 mg	06/31	LC	EP
2017/06/25	31	1330	HS	23	-	✓	1 mL	2.0 mg	06/31	HS	SS
2017/06/26	32	1120	EP	23	3	✓	1 mL	2.0 mg	06/31	JW	LC
2017/06/27	33	0930	JW	23	-	✓	1 mL	2.0 mg	07/14	JW	LC
2017/06/28	34	1030	SS	23	3	✓	1 mL	2.0 mg	07/14	HS	EP
2017/06/29	35	0900	HS/EP	23	-	✓	1 mL	2.5 mg	07/14	HS	LC
2017/06/30	36	1230	EP	23	3	✓	1 mL	2.5 mg	07/14	LC	EP
2017/07/01	37	1200	HS	23	-	✓	1 mL	2.5 mg	07/14	HS	SS
2017/07/02	38	1300	NM	23	-	✓	1 mL	2.5 mg	07/14	JW	NM
2017/07/03	39	1200	JW	23	3	✓	1 mL	2.5 mg	07/14	JW	LC
2017/07/04	40	1200	E	23	-	✓	1 mL	2.5 mg	07/14		
2017/07/05	41	0930	NM	24	3	✓	1 mL	2.5 mg	07/14	HS	EP
2017/07/06	42	0800	HS/LC	24	3	–	1 mL	2.5 mg	–	HS	LC

*23 ± 1°C (23 ± 3°C instantaneous)

Bolded days are to be scored for survival and/or reproduction

Comments:

- Feed ~~1.95 mL~~ 0.97mL per Jar from ~~06/11~~ 06/25 YCT. (Take from undiluted bottle) NM -
- Feeding calculated as the same for 06/31 batch 2017/06/01 EP

NAUTILUS
ENVIRONMENTAL

#3, 6125 12th Street SE Calgary, Albert[illegible]na[illegible] T2H 2K[illegible]
Tel (403) 253-7121 Fax (403) 252-9363 www.nautilusenvironmental.ca

Hyalella Bench Sheet

Method 42-d HA
Client MINTEC
Sample SP1617-029

Chemistry (Monday, Wednesday, Friday)

New Solutions

pH (units)

dose (ug/L) day	Lab CTL	Site CTL	5	10	20	40	80	160
0	7.4	7.6	7.6	7.6	7.6	7.6	7.6	7.6
1	7.4	7.2	7.2	7.2	7.2	7.1	7.2	7.2
4	7.5	7.3	7.2	7.2	7.2	7.2	7.2	7.2
6	7.4	7.5	7.3	7.3	7.3	7.2	7.3	7.3
8	7.4	7.5	7.3	7.3	7.3	7.3	7.3	7.3
11	7.9	7.5	7.5	7.4	7.5	7.5	7.4	7.4
13	7.8	7.4	7.4	7.4	7.4	7.5	7.5	7.4
15	7.7	7.5	7.5	7.5	7.5	7.5	7.5	7.4
18	7.8	7.5	7.5	7.5	7.5	7.5	7.5	7.5
20	7.9	7.6	7.4	7.4	7.4	7.4	7.4	7.4
22	7.8	7.2	7.5	7.2	7.3	7.3	7.3	7.4
25 4°	7.8	7.4	7.4	7.4	7.3	7.3	7.3	7.4
27 7.9	7.5	7.6	7.6	7.5	7.5	7.5	7.5	7.6
29	7.7	7.8	7.8	7.8	7.7	7.7	7.7	7.7
32	7.6	7.4	7.8	7.8	7.8	7.8	7.8	7.8
34	8.0	7.7	7.7	7.6	7.6	7.6	7.6	7.7
36	8.1	7.8	7.8	7.8	7.8	7.8	7.8	7.8
39	7.9	7.5	7.5	7.4	7.4	7.5	7.6	7.6
41	7.8	7.5	7.5	7.4	7.5	7.5	7.4	7.5
42								

Lab CTL	Site CTL	5	10	20	40	80	160
7.2	7.3	7.3	7.3	7.3	7.3	7.3	7.3
7.0	7.2	7.2	7.1	7.1	7.2	7.2	7.3
7.0	7.3	7.2	7.2	7.1	7.3	7.4	7.4
6.9	7.3	7.0	7.2	7.2	7.2	7.4	7.4
7.3	7.6	7.5	7.5	7.4	7.4	7.5	7.6
7.3	7.4	7.3	7.3	7.3	7.4	7.4	7.4
7.2	7.4	7.4	7.4	7.4	7.4	7.4	7.4
7.5	7.4	7.5	7.6	7.4	7.4	7.5	7.4
7.4	7.4	7.5	7.5	7.4	7.4	7.4	7.4
7.3	7.3	7.4	7.4	7.4	7.4	7.4	7.3
7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.4
7.5	7.7	7.6	7.6	7.6	7.6	7.6	7.5
7.5	7.7	7.7	7.7	7.7	7.7	7.7	7.7
7.6	7.6	7.6	7.6	7.6	7.6	7.7	7.7
7.2	7.4	7.3	7.4	7.3	7.4	7.4	7.4
7.2	7.4	7.5	7.5	7.5	7.5	7.5	7.5
7.0	7.0	7.1	7.1	7.1	7.1	7.1	7.0
7.1	7.3	7.3	7.3	7.2	7.3	7.3	7.3
7.3	7.4	7.4	7.4	7.4	7.4	7.3	7.3

244 conductance (uS/cm)

0	443	328	247	~~483~~	244	237	247	245
1	459	320	326	325	326	301	325	323
4	455	321	325	322	324	331	329	327
6 [illegible]	465	338	337	337	337	344	340	335
8 457	~~461~~	327	327	326	323	326	328	327
11	395	337	330	320	326	321	323	327
13	445	331	320	324	319	322	324	325
15	460	340	341	340	330	332	335	341
18	446	331	326	324	322	326	326	323
20	463	349	337	337	338	336	337	326
22	458	350	341	333	340	333	331	334
25 58	437	327	349	340	342	347	339	339
27 452	~~476~~	334	332	333	334	329	330	329
29	458	350	341	326	329	336	340	335
32	444	348	343	343	340	340	336	327
34	439	307	308	306	308	309	311	313
36	440	310	311	310	312	314	312	314
39	404	318	313	313	310	320	301	304
41	432	337	313	313	330	334	336	335
42								

conductance (uS/cm)

450	340	302	302	277	278	282	283
466	356	344	335	332	337	337	341
490	366	355	352	355	357	356	363
491	361	357	344	356	357	344	355
425	345	340	342	300	289	292	299
449	350	335	331	335	331	336	331
460	362	365	365	360	357	352	350
432	358	341	338	337	339	339	334
428	353	351	353	354	353	350	355
445	355	348	350	347	348	350	343
438	350	340	324	345	343	347	348
476	345	338	336	342	338	341	340
461	352	357	344	345	345	342	341
450	347	344	345	347	348	345	345
447	326	313	314	313	318	319	321
440	330	325	326	321	321	322	320
436	341	328	324	325	330	324	325
436	353	342	343	342	342	343	345
452	359	352	351	351	351	344	332

dissolved oxygen (mg/L)

0	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.5
1	7.6	8.8	8.8	8.6	8.8	9.1	9.1	9.1
4	7.4	8.8	8.8	8.8	8.8	8.8	8.7	8.7
6	7.3	8.7	8.7	8.5	8.5	8.5	8.5	8.6
8	7.4	8.5	8.4	8.5	8.5	8.6	8.7	8.6
11	7.9	8.7	8.7	8.7	8.7	8.7	8.7	8.7
13	7.5	8.6	8.5	8.7	8.7	8.7	8.8	8.7
15	7.5	8.5	8.5	8.5	8.6	8.6	8.5	8.4
18	7.3	8.5	8.3	8.4	8.6	8.7	8.8	8.7
20	7.4	7.4	8.7	8.6	8.7	8.7	8.8	8.8
22	7.5	8.3	8.4	8.5	8.4	8.5	8.5	8.6
25	7.3	8.2	8.4	8.4	8.2	8.3	8.5	8.4
27	7.9	8.2	8.5	8.5	8.5	8.7	8.7	8.8
29	7.8	7.8	8.0	8.1	8.1	8.1	8.1	8.2
32	7.8	7.8	7.8	7.9	7.9	7.9	7.9	7.9
34	7.4	7.5	7.5	7.5	7.6	7.6	7.6	7.8
36	7.5	7.5	7.6	7.7	7.8	7.8	7.8	7.8
39	7.2	7.9	7.6	7.6	7.5	7.6	7.8	8.0
41	7.3	7.8	7.7	7.7	7.7	7.9	8.2	8.4
42								

dissolved oxygen (mg/L)

7.1	7.1	7.1	7.2	7.2	7.2	7.2	7.2
6.3	6.4	6.2	6.1	6.0	5.9	6.1	6.1
6.2	5.8	5.8	5.8	5.8	5.8	5.8	6.0
6.5	6.3	5.8	5.5	5.5	5.4	5.4	5.1
5.5	5.5	5.5	5.6	5.6	5.6	5.6	5.6
6.1	5.8	5.6	5.5	5.5	5.5	5.6	5.7
6.0	5.5	5.5	5.4	5.4	5.4	5.4	5.4
5.6	5.6	5.7	5.7	5.7	5.6	5.7	5.6
5.7	6.6	5.8	5.8	5.8	5.7	5.6	5.7
5.4	5.4	5.4	5.5	5.5	5.5	5.5	5.5
5.7	5.8	5.6	5.5	5.4	5.1	4.8	5.5
5.5	5.5	5.5	5.4	5.4	5.4	5.4	5.3
5.6	5.6	5.6	5.7	5.6	5.6	5.6	5.6
5.4	5.4	5.4	5.5	5.5	5.5	5.5	5.5
5.3	5.4	4.4	4.6	4.5	4.5	4.4	4.4
5.5	5.5	5.6	5.3	5.2	5.2	5.2	5.1
4.4	3.9	3.8	4.0	3.7	4.0	3.9	3.8
4.4	4.5	4.4	3.9	3.8	4.0	4.0	4.2
6.3	6.4	5.6	5.6	5.5	5.4	5.3	5.0

NAUTILUS
ENVIRONMENTAL
#3, 6125 12th Street SE Calgary, Alberta Canada T2H 2K1
Tel (403) 253-7121 Fax (403) 252-9363 www.nautilusenvironmental.ca

Hyalella Bench Sheet

Method 42-d HA
Client MIN100
Sample SP1617-029

Biology (# of surviving organisms, young produced - day 35)

dose (ug/L)	Lab CTL	Site CTL	5	10	20	40	80	160
replicate	***day 35 - adult survival***							
a	9	9	9	9	9	9	9	8
b	8	10	10	10	10	10	10	6
c	9	10	8	HS ~~8~~ 9	7	10	8	9
d	10	10	9	10	7	9	10	~~8~~ 9
e	9	10	HS ~~8~~ 9	10	8	10	10	8
f	9	10	8	9	9	9	10	8
g	10	8	HS ~~8~~ 9	9	8	10	10	HS ~~8~~ 9
h	10	9	10	8	8	10	10	10

dose (ug/L)	Lab CTL	Site CTL	5	10	20	40	80	160
replicate	***day 35 - young produced***							
a	13	10	HS 26	3	7	9	0	3
b	7	7	8	5	7	10	5	0
c	6	5	7	4	8	10	4	0
d	6	12	11	3	9	9	0	0
e	4	4	17	7	2	10	3	0
f	3	0	8	0	7	9	3	0
g	4	4	4	5	3	10	2	HS ~~8~~ 0
h	5	2	0	3	7	10	0	0

4
3
0
3
0
0
6
5

Day 35 - Remove young from the replicates and place the adults back into their appropriate replicate

Biology (# of surviving organisms, young produced - day 42)

replicate	***day 42 - adult survival***							
a	8	9	7	8	9	9	9	8
b	7	8	10	10	10	9	10	6
c	9	7	7	9	7	8	8	8
d	9	10	9	10	7	9	8	6
e	HS ~~8~~ 9	10	9	7	8	10	9	7
f	9	HS ~~10~~ 8	8	7	7	9	HS ~~8~~ 9	7
g	10	8	9	9	8	10	10	9
h	10	9	9	6	8	10	10	10

replicate	**day 42 - number of males**							
a	4	3	3	4	3	5	3	2
b	6	5	3	6	3	4	3	2
c	4	4	2	3	2	4	7	1
d	6	3	4	4	2	2	3	6
e	4	4	4	2	3	2	3	3
f	5	4	4	3	4	5	4	1
g	4	4	4	4	5	3	2	3
h	4	2	7	3	5	4	4	3

replicate	***day 42 - young produced***							
a	105	21	67	16	~~55~~ HS 61	7	~~8~~ 25	3
b	36	14	68	7	33	17	51	0
c	47	17	27	22	18	HS ~~43~~ 35 HS	0	0
d	41	18	48	24	22	20	11	0
e	33	21	36	15	25	35	0	0
f	42	24	24	0	21	18	0	8
g	62	26	46	18	20	19	12	0
h	43	22	11	10	23	13	6	0

Day 42 - Place all adult HA into pre-weighed weigh boats to determine growth

Comments:

NAUTILUS
ENVIRONMENTAL

#3, 6125 12th Street SE Calgary, Alberta Canada T2H 2K1
Tel (403) 253-7121 Fax (403) 252-9363 www.nautilusenvironmental.ca

Hyalella Bench Sheet

Method 42-d HA

Client MIN100		Sample SP 1617-029

Culture Information:

Organism Batch: 20170523HA
Source: Chesapeake Cultures.
Age: 4-5 Day old.

Culture Acclimation Mortality (%): ~~<1%~~ NM. 0%.

Lab Control Water Preparation Date(s):
2017/05/23 HS.
2017/05/30 NM

Comments:

Hyalella Bench Sheet

Method 42-d HA | Client MINICO | Sample SP1617-029

Biology (# of surviving organisms)

day 0

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
a	10	10	10	10	10	10	10	10
b								
c								
d								
e								
f								
g								
h								
i								
j								
k								
l	↓	↓	↓	↓	↓	↓	↓	↓

day 7

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
a	10	10	10	10	10	10	10	10
b					10 10			10
c					~~8~~ 10			10
d					10 ~~8~~ 10			10 ~~9~~ 10
e		10			10			10
f		~~9~~ 10		ML	10			
g		10		9 ~~8~~	10 10			
h	↓			10	~~10~~ 9 9			
i	9				9			
j	10				10 ~~9~~ 10			
k					~~10~~			
l	↓	↓	↓	↓	10	↓	↓	↓

day 14

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
a	10	10	10	10	10	10	10	10
b	10	10	10	10	10	10	10	10
c	10	10	10	10	10	10	10	10
d	10	10	10	10	10	10	10	10
e	10	10	10	10	10	10	10	10
f	10	10	10	10	10	10	10	10
g	10	10	10	9	10	10	10	10
h	10	10	10	10	9	10	10	10
i	9	10	10	10	9	10	10	10
j	10	10	10	10	10	10	10	10
k	10	10	10	10	10	10	10	10
l	10	10	10	10	10	10	10	10

day 21

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
a	10	9	9	10	9	9	10	9
b	9	10	10	10	10	10	10	10
c	9	10	10	9	7	10	9	9
d	10MW ~~9~~*	10	10	10	7	9	10	9
e	10	10	9	10	9	10	10	8
f	9	10	8	9	10	10	10	8
g	10	10	9	9	10	10	10	9
h	10	9	10	8	9	10	10	10
i	8	10	10	10	9	10	10	9
j	10	10	10	9	10	10	10	9
k	10	10	9	9	10	9	10	10
l	9	10	10	9	9	10	9	8

day 28

dose (ug/L) / replicate	Lab CTL	Site CTL	5	10	20	40	80	160
a	9	9	9	9	9	9	10	8
b	9	10	10	10	10	10	10	9
c	9	10	10	9	7	10	9	9
d	10	10	10	10	7	9	10	9
e	10	10	9	10	9	10	10	8
f	9	10	8	9	10	10	10	8
g	10	8	9	9	8	10	10	9
h	10	9	10	8	8	10	10	10
i	8	10	10	10	~~10~~ 9	10	10	8
j	10	10	8	9	10MW	10	9	8
k	10MW ~~9~~ 10	9	9	9	10	9	10	10
l	9	8	10	8	9	9	9	7

Day 28 - Place HA from replicates I, j, k, I into pre-weighed weigh dishes to determine growth

Comments:

NAUTILUS ENVIRONMENTAL

Organism Weights
Bench Sheet

Client MINIDO Sample SP16 17-029 Organism HA - 28d

Initial Weight (mg) (dried pan)

Date: 2017/06/20 Initials: DM Balance*: Mettler #1

Conc.	CTL	~~5~~ DM Site CTL	5	10	20	40	80	160

Replicate								
I ~~a~~ DM	416.70	411.61	421.12	414.41	415.07	421.57	418.30	408.33
J ~~b~~ DM	412.43	409.81	406.00	411.96	410.69	420.25	425.75	415.23
K ~~c~~ DM	411.64	410.25	409.92	412.81	413.68	417.35	416.78	416.20
L ~~d~~ DM	423.83	411.47	~~409.9~~ DM	421.17	413.59	412.76	416.02	423.72
e			418.18					

Final Weight (mg) (dried pan+organisms)

Date: 2017/07/19 Initials: FP Balance*: #1

Conc.	CTL	Site CTL	5	10	20	40	80	160

Replicate	422.45 FP							
a	~~419.36~~	419.36	428.71	423.18	422.28	428.11	424.21	411.89
b 419.00	~~416.42~~	417.42	413.05	419.95	417.84	425.77	431.55	417.89
419.64 FP	~~416.66~~	416.88	415.91	420.52	421.59	4249.1	422.98	419.69
d	431.20	416.98	424.71	427.99	422.29	420.01	423.20	426.80
e								

Test Validity Met: Yes/No/NA

Results are Logical: Yes/No**
**no negative numbers, consistent values across replicates

*Same balance must be used for initial and final weights
*For FM/HA/CT must use scale with 0.01 mg accuracy

Balance Calibration Check:

	Initial		Final
first pan weighed:	CTL I	first pan+org weighed:	Site CTL I
weight of first pan:	416.70	weight of first pan + org:	419.36
re-weigh of first pan after all weights measured :	416.72	re-weigh of first pan + org after all weights measured:	419.39
% difference <5%:	**[✓ Yes]/No**	**% difference <5%:**	**[✓ Yes]/No**

Calculation: % difference = [initial weight-reweight/((initial weight+reweight)/2)]x100

If "no" is circled for any parameter, notify Lab Supervisor/QA Group to determine appropriate action

Organism Weights
Bench Sheet

Client MIN100 Sample SP1617-029 Organism 4G

Initial Weight (mg) (dried pan)

Date: 2017/07/05 Initials: HS Balance*: Mettler #1

Conc.	LAB CTL	SITE CTL	5	10	20	40	80	160	ug
Replicate									
a	409.00	411.30	414.27	413.89	422.19	414.39	415.83	408.57	
b	420.04	418.98	418.33	414.62	419.13	411.91	407.37	414.09	
c	415.77	412.08	410.34	417.81	419.26	412.71	410.46	414.55	
d	410.87	416.51	414.02	415.19	414.09	414.37	419.84	414.20	
e	414.42	417.98	414.13	418.34	408.91	418.48	403.05	414.84	

Final Weight (mg) (dried pan+organisms)

Date: 2017/07/27 Initials: BS Balance*: Mettler #1

Conc.	Lab CTL	Site CTL	5	10	20	40	80	160	mg/L
Replicate									
a	417.94	422.09	422.58	422.45	432.04	423.77	423.14	415.33	
b	427.11	427.27	428.91	424.42	429.87	420.~~60~~85	416.40	416.88	
c	424.05	419.36	417.24	427.02	428.37	420.85	419.47	419.53	
d	420.13	426.70	423.~~49~~51	426.31	422.74	423.52	426.13	419.26	
e	423.41	428.93	424.55	427.32	417.05	429.22	407.12	418.49	

Test Validity Met: Yes/No/NA

Results are Logical:** [✓ **Yes**]/**No**

**no negative numbers, consistent values across replicates

*Same balance must be used for initial and final weights

*For FM/HA/CT must use scale with 0.01 mg accuracy

Balance Calibration Check:

	Initial		Final
first pan weighed:	160 A	first pan+org weighed:	20E
weight of first pan:	408.57	weight of first pan + org:	417.05
re-weigh of first pan after all weights measured :	408.60	re-weigh of first pan + org after all weights measured:	417.03
% difference <5%:	[✓ **Yes**]/**No**	**% difference <5%:**	[✓ **Yes**]/**No**

Calculation: % difference = [initial weight-reweight/((initial weight+reweight)/2)]x100

If "no" is circled for any parameter, notify Lab Supervisor/QA Group to determine appropriate action

NAUTILUS
ENVIRONMENTAL

Organism Weights
Bench Sheet

Client MINTOO Sample SP1617-029 Organism HA

Initial Weight (mg) (dried pan)

Date: Initials: Balance*:

Conc.	LAB CTL	SITE CTL	5	10	20	40	80	160	ug/L

Replicate								
~~a~~ f	408.64	424.04	413.33	415.70	408.47	417.19	409.13	410.86
~~b~~ g	411.58	415.83	407.35	421.79	406.51	413.07	413.53	415.38
~~c~~ h	413.98	414.91	405.66	417.71	413.55	412.51	409.04	410.42
~~d~~								
~~e~~								

HS

Final Weight (mg) (dried pan+organisms)

Date: 2017/02/27 Initials: BS Balance*: Mettler #1

Conc.	Lab CTL	Site CTL	5	10	20	40	80	160	ug/L

Replicate								
~~a~~ f	417.47	430.84	422.33	423.76	416.16	426.07	417.17	414.35
~~b~~ g	421.29	424.50	418.10	431.78	415.07	423.99	421.00	420.99
~~c~~ h	423.03	425.29	~~416.56~~ BS	425.33	421.96	422.68	417.00	417.06
~~d~~			415.71					
~~e~~								

HS

Test Validity Met: Yes/No/NA

Results are Logical: [✓ Yes]/No**
**no negative numbers, consistent values across replicates

*Same balance must be used for initial and final weights
*For FM/HA/CT must use scale with 0.01 mg accuracy

Balance Calibration Check:

Initial
first pan weighed:
weight of first pan:
re-weigh of first pan after all weights measured :

% difference <5%: Yes/No

Final
first pan+org weighed:
weight of first pan + org:
re-weigh of first pan + org after all weights measured:

% difference <5%: Yes/No

Calculation: % difference = [initial weight-reweight/((initial weight+reweight)/2)]x100

If "no" is circled for any parameter, notify Lab Supervisor/QA Group to determine appropriate action

CETIS Analytical Report

Report Date: 02 Aug-17 11:16 (p 1 of 2)
Test Code: SP1617-029 HA | 16-7437-8210

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	11-3267-1705	**Endpoint:**	28-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	02 Aug-17 11:15	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes
Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	
Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
5	81.72	-156.6	-153	0.7268	Yes	1.538	2.621	0.2156	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	68.23	n/a	88.7
IC10	84.24	31.84	105.2
IC15	95.98	62.74	117
IC20	105.9	78.97	126.4
IC25	114.8	91.85	134.5
IC40	139.6	122.4	157.5
IC50	156.6	138.6	176.9

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.7207	0.01795	0.684	0.7574	40.16	<1.0E-37	Significant Parameter
γ	3.545	0.9311	1.641	5.449	3.807	6.7E-04	Significant Parameter
δ	156.6	9.558	137	176.1	16.38	<1.0E-37	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	14.31	4.77	3	737.5	<1.0E-37	Significant
Lack of Fit	0.04551	0.009102	5	1.538	0.2156	Non-Significant
Pure Error	0.142	0.005919	24			
Residual	0.1876	0.006467	29			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.178	2.938	0.7768	No Outliers Detected
Variances	Bartlett Equality of Variance Test	2.425	14.07	0.9326	Equal Variances
	Mod Levene Equality of Variance	0.5283	2.423	0.8044	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9839	0.9338	0.9020	Normal Distribution
	Anderson-Darling A2 Normality Te	0.1958	2.492	0.9385	Normal Distribution

Analysis ID:	11-3267-1705	**Endpoint:**	28-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	02 Aug-17 11:15	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

28-d Mean Dry Biomass-mg Summary

			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	4	0.7048	0.625	0.8	0.03953	0.07906	11.22%	0.00%
17.6		4	0.6875	0.551	0.775	0.05187	0.1037	15.09%	2.45%
22.1		4	0.679	0.599	0.759	0.03434	0.06868	10.12%	3.65%
25.9		4	0.7823	0.682	0.877	0.04024	0.08049	10.29%	-11.00%
35.6		4	0.7743	0.715	0.87	0.03628	0.07256	9.37%	-9.86%
53.3		4	0.6717	0.552	0.756	0.04527	0.09053	13.48%	4.68%
92.7		4	0.6273	0.58	0.718	0.0314	0.06281	10.01%	11.00%
166.8		4	0.3198	0.266	0.356	0.02081	0.04162	13.02%	54.63%

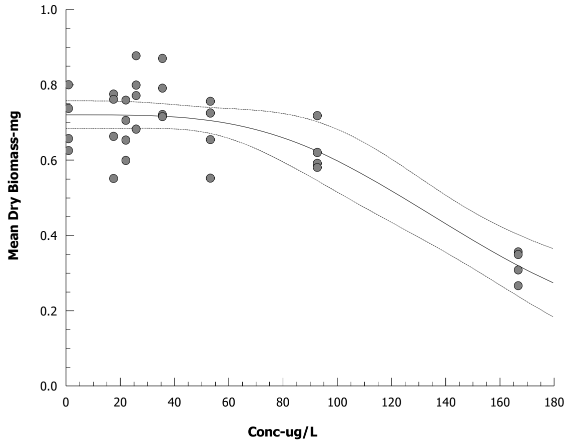
28-d Mean Dry Biomass-mg Detail

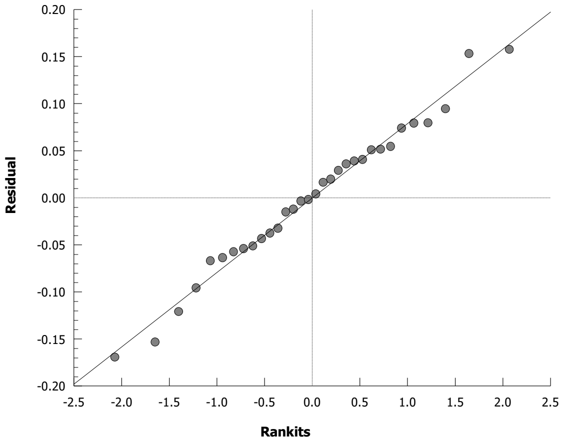
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.625	0.657	0.8	0.737
17.6		0.775	0.761	0.663	0.551
22.1		0.759	0.705	0.599	0.653
25.9		0.877	0.799	0.771	0.682
35.6		0.721	0.715	0.791	0.87
53.3		0.654	0.552	0.756	0.725
92.7		0.591	0.58	0.62	0.718
166.8		0.356	0.266	0.349	0.308

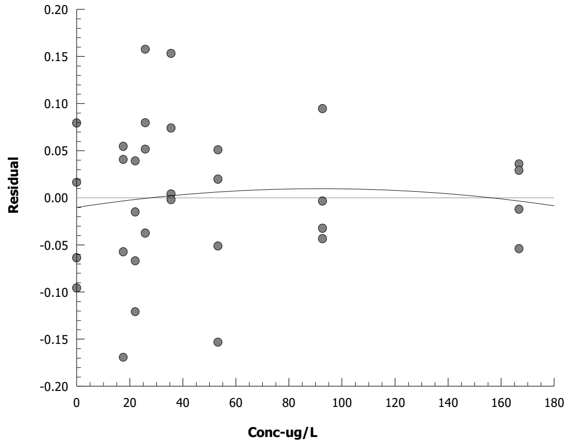
Graphics

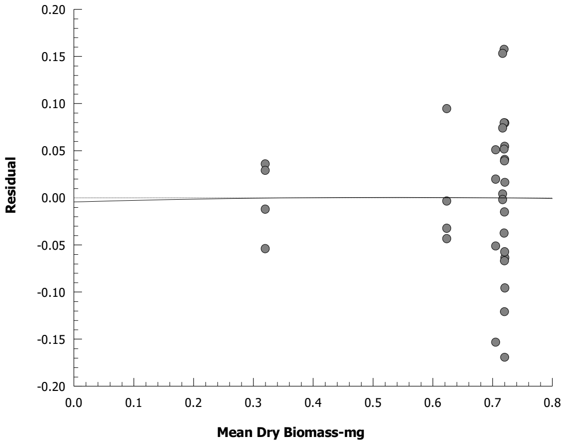
Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ]

Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 02 Aug-17 11:12 (p 1 of 2)
Test Code: SP1617-029 HA | 16-7437-8210

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test — **Nautilus Environmental Calgary**

Analysis ID:	05-6466-1748	**Endpoint:**	28-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	02 Aug-17 11:11	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	92.7	166.8	124.3		19.2%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	17.6	0.3171	2.482	0.135	6	CDF	0.7783	Non-Significant Effect
	22.1	0.4734	2.482	0.135	6	CDF	0.7184	Non-Significant Effect
	25.9	-1.425	2.482	0.135	6	CDF	0.9975	Non-Significant Effect
	35.6	-1.278	2.482	0.135	6	CDF	0.9959	Non-Significant Effect
	53.3	0.6066	2.482	0.135	6	CDF	0.6620	Non-Significant Effect
	92.7	1.425	2.482	0.135	6	CDF	0.2964	Non-Significant Effect
	166.8*	7.077	2.482	0.135	6	CDF	1.6E-06	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.017	2.938	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.591833	0.0845476	7	14.29	3.6E-07	Significant Effect
Error	0.142045	0.0059186	24			
Total	0.733879		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	2.425	18.48	0.9326	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9514	0.9081	0.1582	Normal Distribution

28-d Mean Dry Biomass-mg Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.7048	0.5789	0.8306		0.625	0.8	0.03953	11.22%	0.00%
17.6		4	0.6875	0.5224	0.8526		0.551	0.775	0.05187	15.09%	2.45%
22.1		4	0.679	0.5697	0.7883		0.599	0.759	0.03434	10.12%	3.65%
25.9		4	0.7823	0.6542	0.9103		0.682	0.877	0.04024	10.29%	-11.00%
35.6		4	0.7743	0.6588	0.8897		0.715	0.87	0.03628	9.37%	-9.86%
53.3		4	0.6717	0.5277	0.8158		0.552	0.756	0.04527	13.48%	4.68%
92.7		4	0.6273	0.5273	0.7272		0.58	0.718	0.0314	10.01%	11.00%
166.8		4	0.3198	0.2535	0.386		0.266	0.356	0.02081	13.02%	54.63%

Analysis ID: 05-6466-1748 **Endpoint:** 28-d Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 02 Aug-17 11:11 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

28-d Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.625	0.657	0.8	0.737
17.6		0.775	0.761	0.663	0.551
22.1		0.759	0.705	0.599	0.653
25.9		0.877	0.799	0.771	0.682
35.6		0.721	0.715	0.791	0.87
53.3		0.654	0.552	0.756	0.725
92.7		0.591	0.58	0.62	0.718
166.8		0.356	0.266	0.349	0.308

CETIS Analytical Report

Report Date: 26 Jul-17 12:20 (p 1 of 2)
Test Code: SP1617-029 HA28 | 00-0208-7308

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test — **Nautilus Environmental Calgary**

Analysis ID:	11-9553-0133	**Endpoint:**	28-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	26 Jul-17 12:20	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	113382	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

		TAC Limits			
Attribute	Test Stat	Lower	Upper	Overlap	Decision
Control Resp	0.9417	0.8	>>	Yes	Passes Acceptibility Criteria

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.205	3.37	1.0000	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	122.6	92.97	n/a
LC10	>166.8	n/a	n/a
LC15	>166.8	n/a	n/a
LC20	>166.8	n/a	n/a
LC25	>166.8	n/a	n/a
LC40	>166.8	n/a	n/a
LC50	>166.8	n/a	n/a

28-d Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	N	12	0.9417	0.8000	1.0000	0.0193	0.0669	7.10%	0.00%	113	120
17.6		12	0.9417	0.8000	1.0000	0.0229	0.0793	8.42%	0.00%	113	120
22.1		12	0.9333	0.8000	1.0000	0.0225	0.0779	8.34%	0.88%	112	120
25.9		12	0.9167	0.8000	1.0000	0.0207	0.0718	7.83%	2.65%	110	120
35.6		12	0.8833	0.7000	1.0000	0.0322	0.1115	12.62%	6.19%	106	120
53.3		12	0.9667	0.9000	1.0000	0.0142	0.0492	5.09%	-2.65%	116	120
92.7		12	0.9750	0.9000	1.0000	0.0131	0.0452	4.64%	-3.54%	117	120
166.8		12	0.8500	0.7000	1.0000	0.0261	0.0905	10.64%	9.73%	102	120

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 11-9553-0133 **Endpoint:** 28-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 26 Jul-17 12:20 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

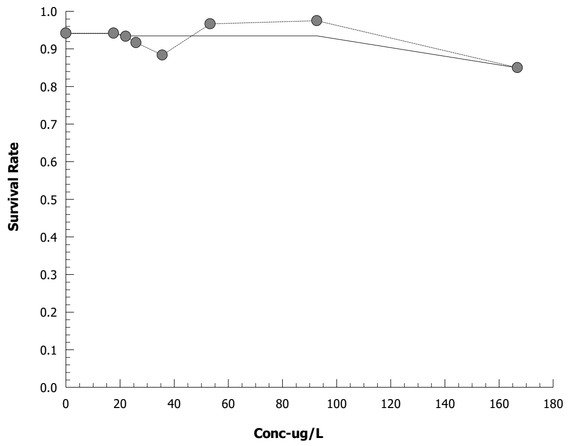
28-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000
		1.0000	0.9000								
17.6		0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
		0.9000	0.8000								
22.1		0.9000	1.0000	1.0000	1.0000	0.9000	0.8000	0.9000	1.0000	1.0000	0.8000
		0.9000	1.0000								
25.9		0.9000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	0.8000	1.0000	0.9000
		0.9000	0.8000								
35.6		0.9000	1.0000	0.7000	0.7000	0.9000	1.0000	0.8000	0.8000	0.9000	1.0000
		1.0000	0.9000								
53.3		0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		0.9000	0.9000								
92.7		1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000
		1.0000	0.9000								
166.8		0.8000	0.9000	0.9000	0.9000	0.8000	0.8000	0.8000	1.0000	0.8000	0.8000
		1.0000	0.7000								

28-d Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	9/10	9/10	9/10	10/10	10/10	9/10	10/10	10/10	8/10	10/10
		10/10	9/10								
17.6		9/10	10/10	10/10	10/10	10/10	10/10	8/10	9/10	10/10	10/10
		9/10	8/10								
22.1		9/10	10/10	10/10	10/10	9/10	8/10	9/10	10/10	10/10	8/10
		9/10	10/10								
25.9		9/10	10/10	9/10	10/10	10/10	9/10	9/10	8/10	10/10	9/10
		9/10	8/10								
35.6		9/10	10/10	7/10	7/10	9/10	10/10	8/10	8/10	9/10	10/10
		10/10	9/10								
53.3		9/10	10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10
		9/10	9/10								
92.7		10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10	9/10
		10/10	9/10								
166.8		8/10	9/10	9/10	9/10	8/10	8/10	8/10	10/10	8/10	8/10
		10/10	7/10								

Graphics



CETIS Analytical Report

Report Date: 26 Jul-17 12:19 (p 1 of 2)
Test Code: SP1617-029 HA28 | 00-0208-7308

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	01-2178-3731	**Endpoint:**	28-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	26 Jul-17 12:19	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	166.8	> 166.8	n/a		7.3%

Steel Many-One Rank Sum Test

Control vs	Conc-ug/L	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	17.6	152.5	109	3	22	Asymp	0.9077	Non-Significant Effect
	22.1	147	109	3	22	Asymp	0.8261	Non-Significant Effect
	25.9	136	109	3	22	Asymp	0.5671	Non-Significant Effect
	35.6	129	109	3	22	Asymp	0.3761	Non-Significant Effect
	53.3	164	109	2	22	Asymp	0.9840	Non-Significant Effect
	92.7	169.5	109	2	22	Asymp	0.9944	Non-Significant Effect
	166.8	109.5	109	3	22	Asymp	0.0503	Non-Significant Effect

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits Lower	TAC Limits Upper	Overlap	Decision
Control Resp	0.9417	0.8	>>	Yes	Passes Acceptibility Criteria

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.205	3.37	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.324851	0.0464073	7	3.465	0.0025	Significant Effect
Error	1.17853	0.0133924	88			
Total	1.50338		95			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	8.91	18.48	0.2592	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9635	0.9642	0.0089	Non-Normal Distribution

28-d Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	12	0.9417	0.8992	0.9841		0.8000	1.0000	0.0193	7.10%	0.00%
17.6		12	0.9417	0.8913	0.9920		0.8000	1.0000	0.0229	8.42%	0.00%
22.1		12	0.9333	0.8839	0.9828		0.8000	1.0000	0.0225	8.34%	0.88%
25.9		12	0.9167	0.8711	0.9623		0.8000	1.0000	0.0207	7.83%	2.65%
35.6		12	0.8833	0.8125	0.9542		0.7000	1.0000	0.0322	12.62%	6.19%
53.3		12	0.9667	0.9354	0.9980		0.9000	1.0000	0.0142	5.09%	-2.65%
92.7		12	0.9750	0.9463	1.0000		0.9000	1.0000	0.0131	4.64%	-3.54%
166.8		12	0.8500	0.7925	0.9075		0.7000	1.0000	0.0261	10.64%	9.73%

Analysis ID: 01-2178-3731 **Endpoint:** 28-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 26 Jul-17 12:19 **Analysis:** Nonparametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	12	1.319	1.252	1.385		1.107	1.412	0.03031	7.96%	0.00%
17.6		12	1.32	1.243	1.398		1.107	1.412	0.03535	9.27%	-0.13%
22.1		12	1.307	1.23	1.383		1.107	1.412	0.03476	9.21%	0.90%
25.9		12	1.28	1.209	1.35		1.107	1.412	0.03201	8.66%	2.96%
35.6		12	1.237	1.136	1.338		0.9912	1.412	0.04587	12.85%	6.22%
53.3		12	1.358	1.307	1.409		1.249	1.412	0.02316	5.91%	-2.96%
92.7		12	1.371	1.324	1.418		1.249	1.412	0.02128	5.38%	-3.99%
166.8		12	1.184	1.1	1.267		0.9912	1.412	0.03787	11.08%	10.23%

28-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000
		1.0000	0.9000								
17.6		0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
		0.9000	0.8000								
22.1		0.9000	1.0000	1.0000	1.0000	0.9000	0.8000	0.9000	1.0000	1.0000	0.8000
		0.9000	1.0000								
25.9		0.9000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	0.8000	1.0000	0.9000
		0.9000	0.8000								
35.6		0.9000	1.0000	0.7000	0.7000	0.9000	1.0000	0.8000	0.8000	0.9000	1.0000
		1.0000	0.9000								
53.3		0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		0.9000	0.9000								
92.7		1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000
		1.0000	0.9000								
166.8		0.8000	0.9000	0.9000	0.9000	0.8000	0.8000	0.8000	1.0000	0.8000	0.8000
		1.0000	0.7000								

CETIS Analytical Report

Report Date: 09 Aug-17 14:27 (p 1 of 2)
Test Code: SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test — **Nautilus Environmental Calgary**

Analysis ID:	00-3806-6440	**Endpoint:**	42-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	09 Aug-17 14:26	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	09-4919-8630	**Code:**	SP1617-029	**Client:**	
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
13	133.4	-260.4	-254.4	0.5622	Yes	0.8177	2.38	0.5422	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	61.57	n/a	80.5
IC10	77.51	47.99	97.58
IC15	90.54	66.73	110.6
IC20	102.4	81.61	121.8
IC25	113.9	95.03	132.5
IC40	148.7	129.5	169.5
IC50	174.6	148.3	205.6

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.9185	0.0207	0.8771	0.9599	44.38	<1.0E-37	Significant Parameter
γ	0.6337	0.1494	0.335	0.9325	4.242	7.7E-05	Significant Parameter
δ	174.6	14.13	146.4	202.9	12.36	<1.0E-37	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	46.54	15.51	3	971.7	<1.0E-37	Significant
Lack of Fit	0.06627	0.01325	5	0.8177	0.5422	Non-Significant
Pure Error	0.9077	0.01621	56			
Residual	0.974	0.01597	61			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.924	3.224	0.1614	No Outliers Detected
Variances	Bartlett Equality of Variance Test	6.045	14.07	0.5345	Equal Variances
	Mod Levene Equality of Variance	1.128	2.178	0.3591	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9755	0.9626	0.2332	Normal Distribution
	Anderson-Darling A2 Normality Te	0.2967	2.492	0.6220	Normal Distribution

CETIS Analytical Report

Report Date: 09 Aug-17 14:27 (p 2 of 2)
Test Code: SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 00-3806-6440 **Endpoint:** Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 09 Aug-17 14:26 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

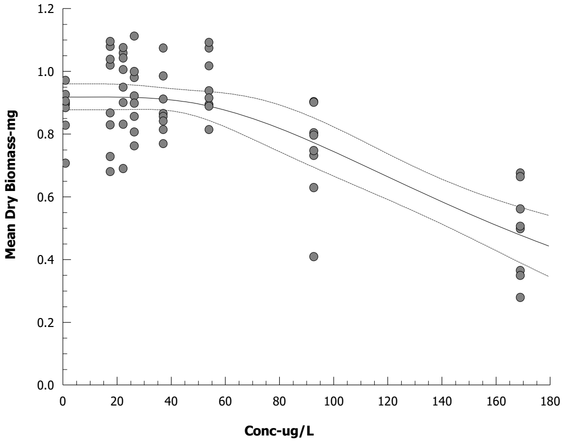
42-d Mean Dry Biomass-mg Summary

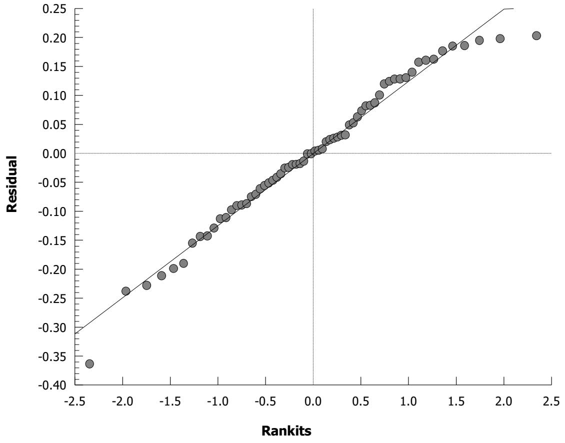
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	8	0.8766	0.707	0.971	0.02807	0.0794	9.06%	0.00%
17.5		8	0.9169	0.68	1.095	0.05749	0.1626	17.74%	-4.59%
22.3		8	0.9438	0.69	1.075	0.04681	0.1324	14.03%	-7.66%
26.4		8	0.9167	0.762	1.112	0.0399	0.1129	12.31%	-4.58%
37.1		8	0.8894	0.769	1.074	0.03483	0.0985	11.08%	-1.45%
54		8	0.954	0.814	1.092	0.03452	0.09765	10.24%	-8.83%
92.7		8	0.74	0.409	0.903	0.05697	0.1611	21.77%	15.59%
169		8	0.4872	0.279	0.676	0.05179	0.1465	30.06%	44.42%

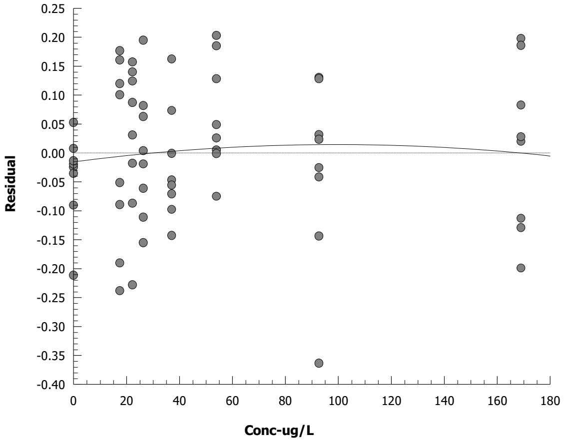
42-d Mean Dry Biomass-mg Detail

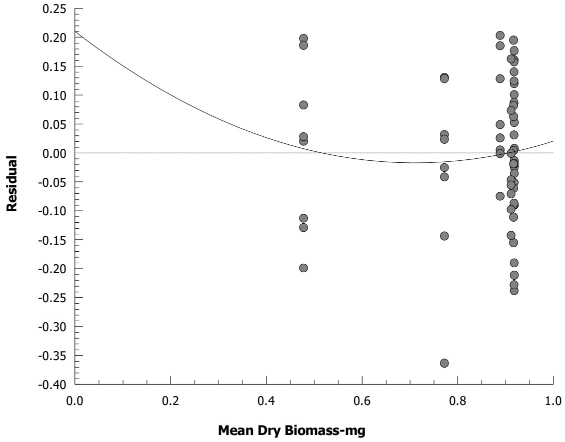
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.894	0.707	0.828	0.926	0.899	0.883	0.971	0.905
17.5		1.079	0.829	0.728	1.019	1.095	0.68	0.867	1.038
22.3		0.831	1.058	0.69	0.949	1.042	0.9	1.075	1.005
26.4		0.856	0.98	0.921	1.112	0.898	0.806	0.999	0.762
37.1		0.985	1.074	0.911	0.865	0.814	0.769	0.856	0.841
54		0.938	0.894	0.814	0.915	1.074	0.888	1.092	1.017
92.7		0.731	0.903	0.901	0.629	0.409	0.804	0.747	0.796
169		0.676	0.279	0.498	0.506	0.365	0.349	0.561	0.664

Graphics Model: 3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 09 Aug-17 14:21 (p 1 of 2)
Test Code: SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	20-7907-5112	**Endpoint:**	42-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	09 Aug-17 14:19	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	09-4919-8630	**Code:**	SP1617-029	**Client:**	
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	92.7	169	125.2		17.4%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	17.5	-0.6323	2.399	0.153	14	CDF	0.9725	Non-Significant Effect
	22.3	-1.054	2.399	0.153	14	CDF	0.9924	Non-Significant Effect
	26.4	-0.6303	2.399	0.153	14	CDF	0.9723	Non-Significant Effect
	37.1	-0.2003	2.399	0.153	14	CDF	0.9184	Non-Significant Effect
	54	-1.215	2.399	0.153	14	CDF	0.9956	Non-Significant Effect
	92.7	2.146	2.399	0.153	14	CDF	0.0854	Non-Significant Effect
	169*	6.117	2.399	0.153	14	CDF	9.5E-07	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.758	3.224	0.2919	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.39016	0.198594	7	12.25	<1.0E-37	Significant Effect
Error	0.907723	0.0162093	56			
Total	2.29788		63			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	6.045	18.48	0.5345	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9761	0.9488	0.2486	Normal Distribution

42-d Mean Dry Biomass-mg Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	0.8766	0.8102	0.943		0.707	0.971	0.02807	9.06%	0.00%
17.5		8	0.9169	0.7809	1.053		0.68	1.095	0.05749	17.74%	-4.59%
22.3		8	0.9438	0.8331	1.054		0.69	1.075	0.04681	14.03%	-7.66%
26.4		8	0.9167	0.8224	1.011		0.762	1.112	0.0399	12.31%	-4.58%
37.1		8	0.8894	0.807	0.9717		0.769	1.074	0.03483	11.08%	-1.45%
54		8	0.954	0.8724	1.036		0.814	1.092	0.03452	10.24%	-8.83%
92.7		8	0.74	0.6053	0.8747		0.409	0.903	0.05697	21.77%	15.59%
169		8	0.4872	0.3648	0.6097		0.279	0.676	0.05179	30.06%	44.42%

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 20-7907-5112 **Endpoint:** 42-d Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 09 Aug-17 14:19 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

42-d Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.894	0.707	0.828	0.926	0.899	0.883	0.971	0.905
17.5		1.079	0.829	0.728	1.019	1.095	0.68	0.867	1.038
22.3		0.831	1.058	0.69	0.949	1.042	0.9	1.075	1.005
26.4		0.856	0.98	0.921	1.112	0.898	0.806	0.999	0.762
37.1		0.985	1.074	0.911	0.865	0.814	0.769	0.856	0.841
54		0.938	0.894	0.814	0.915	1.074	0.888	1.092	1.017
92.7		0.731	0.903	0.901	0.629	0.409	0.804	0.747	0.796
169		0.676	0.279	0.498	0.506	0.365	0.349	0.561	0.664

CETIS Analytical Report

Report Date: 26 Jul-17 12:26 (p 1 of 2)
Test Code: SP1617-029 HA42 | 19-7989-2732

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	07-7483-6365	**Endpoint:**	42-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	26 Jul-17 12:25	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1552901	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits Lower	TAC Limits Upper	Overlap	Decision
Control Resp	0.8625	0.8	>>	Yes	Passes Acceptibility Criteria

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.357	3.224	1.0000	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	119.2	12.82	n/a
LC10	153.2	108	n/a
LC15	>169	n/a	n/a
LC20	>169	n/a	n/a
LC25	>169	n/a	n/a
LC40	>169	n/a	n/a
LC50	>169	n/a	n/a

42-d Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	N	8	0.8625	0.7000	1.0000	0.0324	0.0916	10.62%	0.00%	69	80
17.5		8	0.8625	0.7000	1.0000	0.0375	0.1061	12.30%	0.00%	69	80
22.3		8	0.8500	0.7000	1.0000	0.0378	0.1069	12.58%	1.45%	68	80
26.4		8	0.8500	0.6000	1.0000	0.0500	0.1414	16.64%	1.45%	68	80
37.1		8	0.8000	0.7000	1.0000	0.0378	0.1069	13.36%	7.25%	64	80
54		8	0.9250	0.8000	1.0000	0.0250	0.0707	7.64%	-7.25%	74	80
92.7		8	0.9125	0.8000	1.0000	0.0295	0.0835	9.15%	-5.80%	73	80
169		8	0.7625	0.6000	1.0000	0.0498	0.1408	18.46%	11.59%	61	80

42-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.8000	0.7000	0.9000	0.9000	0.9000	0.9000	1.0000	0.8000
17.5		0.9000	0.8000	0.7000	1.0000	1.0000	0.8000	0.8000	0.9000
22.3		0.7000	1.0000	0.7000	0.9000	0.9000	0.8000	0.9000	0.9000
26.4		0.8000	1.0000	0.9000	1.0000	0.9000	0.7000	0.9000	0.6000
37.1		0.9000	1.0000	0.7000	0.7000	0.8000	0.7000	0.8000	0.8000
54		0.9000	0.9000	0.8000	0.9000	1.0000	0.9000	1.0000	1.0000
92.7		0.9000	1.0000	0.8000	0.8000	0.9000	0.9000	1.0000	1.0000
169		0.8000	0.6000	0.8000	0.6000	0.7000	0.7000	0.9000	1.0000

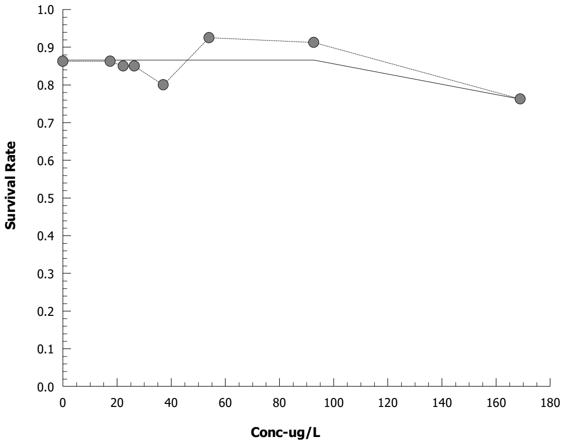
Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 07-7483-6365 **Endpoint:** 42-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 26 Jul-17 12:25 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

42-d Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	8/10	7/10	9/10	9/10	9/10	9/10	10/10	8/10
17.5		9/10	8/10	7/10	10/10	10/10	8/10	8/10	9/10
22.3		7/10	10/10	7/10	9/10	9/10	8/10	9/10	9/10
26.4		8/10	10/10	9/10	10/10	9/10	7/10	9/10	6/10
37.1		9/10	10/10	7/10	7/10	8/10	7/10	8/10	8/10
54		9/10	9/10	8/10	9/10	10/10	9/10	10/10	10/10
92.7		9/10	10/10	8/10	8/10	9/10	9/10	10/10	10/10
169		8/10	6/10	8/10	6/10	7/10	7/10	9/10	10/10

Graphics



CETIS Analytical Report

Report Date:	26 Jul-17 12:25 (p 1 of 2)
Test Code:	SP1617-029 HA42 | 19-7989-2732

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	07-3382-3748	**Endpoint:**	42-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	26 Jul-17 12:25	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	169	> 169	n/a		15.6%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	17.5	-0.03513	2.399	0.18	14	CDF	0.8836	Non-Significant Effect
	22.3	0.1934	2.399	0.18	14	CDF	0.8199	Non-Significant Effect
	26.4	0.09687	2.399	0.18	14	CDF	0.8491	Non-Significant Effect
	37.1	1.096	2.399	0.18	14	CDF	0.4326	Non-Significant Effect
	54	-1.21	2.399	0.18	14	CDF	0.9955	Non-Significant Effect
	92.7	-0.9734	2.399	0.18	14	CDF	0.9901	Non-Significant Effect
	169	1.64	2.399	0.18	14	CDF	0.2113	Non-Significant Effect

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits Lower	TAC Limits Upper	Overlap	Decision
Control Resp	0.8625	0.8	>>	Yes	Passes Acceptibility Criteria

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.357	3.224	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.281983	0.0402833	7	1.792	0.1071	Non-Significant Effect
Error	1.25916	0.022485	56			
Total	1.54115		63			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	3.015	18.48	0.8836	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.98	0.9488	0.3839	Normal Distribution

42-d Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	0.8625	0.7859	0.9391		0.7000	1.0000	0.0324	10.62%	0.00%
17.5		8	0.8625	0.7738	0.9512		0.7000	1.0000	0.0375	12.30%	0.00%
22.3		8	0.8500	0.7606	0.9394		0.7000	1.0000	0.0378	12.58%	1.45%
26.4		8	0.8500	0.7318	0.9682		0.6000	1.0000	0.0500	16.64%	1.45%
37.1		8	0.8000	0.7106	0.8894		0.7000	1.0000	0.0378	13.36%	7.25%
54		8	0.9250	0.8659	0.9841		0.8000	1.0000	0.0250	7.64%	-7.25%
92.7		8	0.9125	0.8427	0.9823		0.8000	1.0000	0.0295	9.15%	-5.80%
169		8	0.7625	0.6448	0.8802		0.6000	1.0000	0.0498	18.46%	11.59%

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 07-3382-3748 **Endpoint:** 42-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 26 Jul-17 12:25 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	1.202	1.094	1.309		0.9912	1.412	0.0454	10.68%	0.00%
17.5		8	1.204	1.076	1.332		0.9912	1.412	0.05412	12.71%	-0.22%
22.3		8	1.187	1.065	1.309		0.9912	1.412	0.0516	12.29%	1.21%
26.4		8	1.194	1.037	1.352		0.8861	1.412	0.0665	15.75%	0.60%
37.1		8	1.119	0.9962	1.243		0.9912	1.412	0.05214	13.17%	6.84%
54		8	1.292	1.2	1.384		1.107	1.412	0.0389	8.51%	-7.55%
92.7		8	1.275	1.168	1.382		1.107	1.412	0.04525	10.04%	-6.07%
169		8	1.079	0.9268	1.231		0.8861	1.412	0.06426	16.85%	10.23%

42-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.8000	0.7000	0.9000	0.9000	0.9000	0.9000	1.0000	0.8000
17.5		0.9000	0.8000	0.7000	1.0000	1.0000	0.8000	0.8000	0.9000
22.3		0.7000	1.0000	0.7000	0.9000	0.9000	0.8000	0.9000	0.9000
26.4		0.8000	1.0000	0.9000	1.0000	0.9000	0.7000	0.9000	0.6000
37.1		0.9000	1.0000	0.7000	0.7000	0.8000	0.7000	0.8000	0.8000
54		0.9000	0.9000	0.8000	0.9000	1.0000	0.9000	1.0000	1.0000
92.7		0.9000	1.0000	0.8000	0.8000	0.9000	0.9000	1.0000	1.0000
169		0.8000	0.6000	0.8000	0.6000	0.7000	0.7000	0.9000	1.0000

CETIS Analytical Report

Report Date:	26 Jul-17 12:33 (p 1 of 2)
Test Code:	SP1617-029 HA42 | 08-6375-1836

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	04-1428-7151	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	26 Jul-17 12:32	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
9	-102.2	210.8	216.8	0.4490	Yes	1.883	2.383	0.1121	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	0.6054	n/a	4.927
IC10	1.374	n/a	7.475
IC15	2.281	n/a	10.45
IC20	3.342	n/a	13.63
IC25	4.582	n/a	16.86
IC40	9.797	2.952	25.84
IC50	15.28	7.479	31.22

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	17.69	1.818	14.05	21.33	9.728	<1.0E-37	Significant Parameter
γ	0.912	0.3606	0.1906	1.633	2.529	0.0141	Significant Parameter
δ	15.28	6.17	2.939	27.62	2.477	0.0161	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	4312	1437	3	54.28	<1.0E-37	Significant
Lack of Fit	232.3	46.45	5	1.883	0.1121	Non-Significant
Pure Error	1357	24.66	55			
Residual	1589	26.48	60			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	5	3.218	2.1E-07	Outlier Detected
Variances	Mod Levene Equality of Variance	2.036	2.185	0.0671	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.8139	0.9621	1.8E-07	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	3.117	2.492	<1.0E-37	Non-Normal Distribution

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 04-1428-7151 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 26 Jul-17 12:32 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

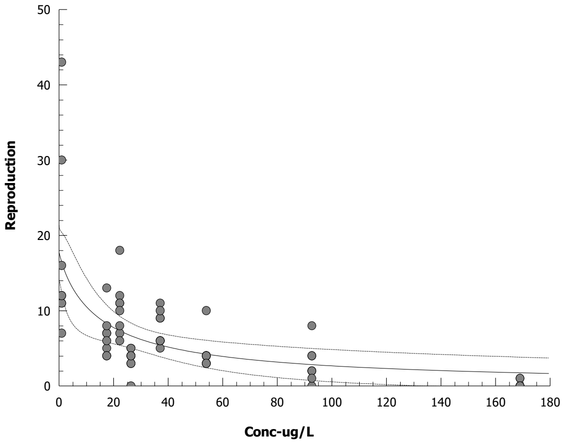
Reproduction Summary

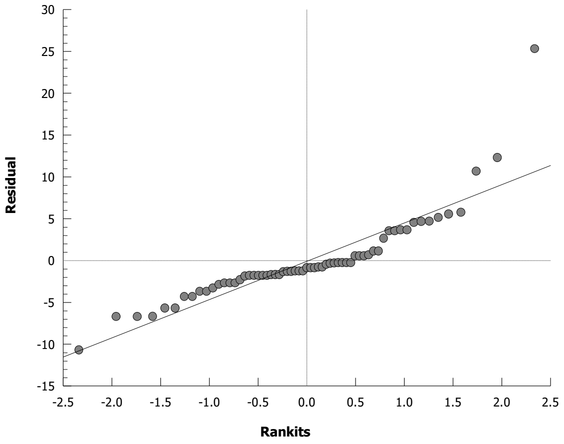
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	8	17.75	7	43	4.358	12.33	69.44%	0.00%
17.5		8	6.75	4	13	1.031	2.915	43.19%	61.97%
22.3		8	10.38	6	18	1.322	3.739	36.04%	41.55%
26.4		8	3.5	0	5	0.5669	1.604	45.82%	80.28%
37.1		8	7.75	5	11	0.7962	2.252	29.06%	56.34%
54		8	4.375	3	10	0.8224	2.326	53.17%	75.35%
92.7		8	2.875	0	8	0.875	2.475	86.08%	83.80%
169		7	0.2857	0	1	0.1844	0.488	170.78%	98.39%

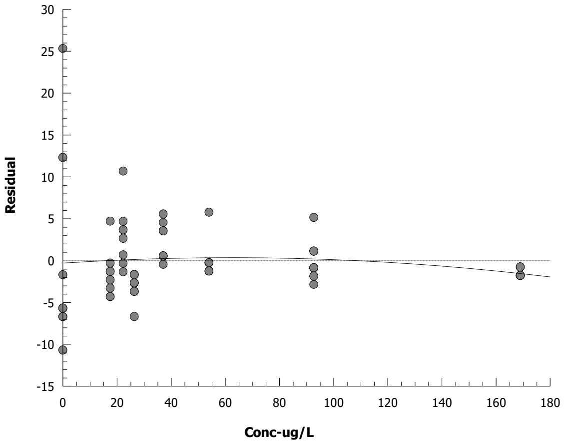
Reproduction Detail

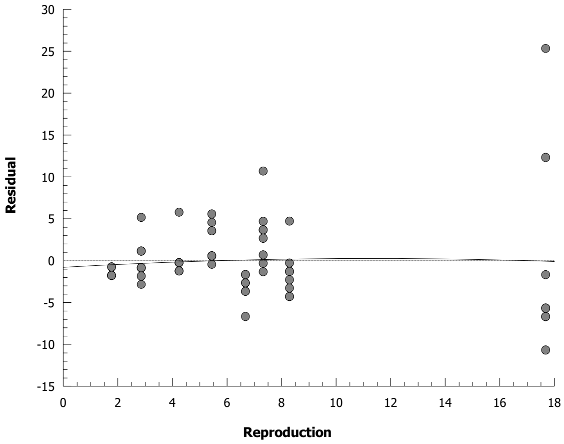
Conc-ug/L	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**
0	N	30	43	11	16	7	12	11	12
17.5		5	7	7	13	4	6	8	4
22.3		18	11	7	12	11	8	10	6
26.4		5	3	4	4	3	0	5	4
37.1		11	6	5	6	6	9	9	10
54		3	4	10	3	4	4	4	3
92.7		4	8	4	2	0	2	2	1
169		1	0	0	0	1	0	0	

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 26 Jul-17 12:36 (p 1 of 2)
Test Code: SP1617-029 HA42 | 08-6375-1836

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	10-4003-9940	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	26 Jul-17 12:35	**Analysis:**	Nonparametric-Multiple Comparison	**Official Results:**	Yes

Batch ID:	06-3155-2206	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	22.3	26.4	24.26		36.6%

Wilcoxon/Bonferroni Adj Test

Control vs	Control II	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	17.5*	43	NA	1	14	Exact	0.0250	Significant Effect
	22.3	52.5	NA	3	14	Exact	0.3742	Non-Significant Effect
	26.4*	36	NA	0	14	Exact	5.4E-04	Significant Effect
	37.1*	41	NA	1	14	Exact	0.0082	Significant Effect
	54*	37	NA	0	14	Exact	0.0011	Significant Effect
	92.7*	37	NA	0	14	Exact	0.0011	Significant Effect
	169*	28	NA	0	13	Exact	0.0011	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	5.398	3.218	2.3E-07	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1623.16	231.88	7	9.401	1.3E-07	Significant Effect
Error	1356.55	24.6646	55			
Total	2979.71		62			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	69.99	18.48	<1.0E-37	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.7527	0.9481	5.9E-09	Non-Normal Distribution

Reproduction Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	17.75	7.445	28.05		7	43	4.358	69.44%	0.00%
17.5		8	6.75	4.313	9.187		4	13	1.031	43.19%	61.97%
22.3		8	10.38	7.249	13.5		6	18	1.322	36.04%	41.55%
26.4		8	3.5	2.159	4.841		0	5	0.5669	45.82%	80.28%
37.1		8	7.75	5.867	9.633		5	11	0.7962	29.06%	56.34%
54		8	4.375	2.43	6.32		3	10	0.8224	53.17%	75.35%
92.7		8	2.875	0.806	4.944		0	8	0.875	86.08%	83.80%
169		7	0.2857	-0.1656	0.737		0	1	0.1844	170.78%	98.39%

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 10-4003-9940 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 26 Jul-17 12:35 **Analysis:** Nonparametric-Multiple Comparison **Official Results:** Yes

Reproduction Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	30	43	11	16	7	12	11	12
17.5		5	7	7	13	4	6	8	4
22.3		18	11	7	12	11	8	10	6
26.4		5	3	4	4	3	0	5	4
37.1		11	6	5	6	6	9	9	10
54		3	4	10	3	4	4	4	3
92.7		4	8	4	2	0	2	2	1
169		1	0	0	0	1	0	0	

CETIS Analytical Report

Report Date: 08 Aug-17 14:30 (p 1 of 2)
Test Code: SP1617-029 HA r | 09-4407-0965

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	18-4602-2782	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	08 Aug-17 14:29	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Gompertz: μ=α·exp[log[0.5]·[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
6	-60.96	128.4	133.9	0.3720	Yes	8.29	2.565	0.0000	Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	13	n/a	45.24
IC10	20.55	n/a	40.1
IC15	27.07	7.517	42.18
IC20	33.11	14.95	48.95
IC25	38.92	19.37	57.06
IC40	56.08	34.08	80.17
IC50	68.09	45.46	95.49

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	8.131	1.85	4.419	11.84	4.395	5.5E-05	Significant Parameter
γ	1.572	0.9903	-0.415	3.559	1.588	0.1184	Non-Significant Parameter
δ	68.09	22.77	22.39	113.8	2.99	0.0043	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	1821	607.2	3	63.72	<1.0E-37	Significant
Lack of Fit	202.5	50.61	4	8.29	3.6E-05	Significant
Pure Error	293.1	6.105	48			
Residual	495.5	9.529	52			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.561	3.166	0.0083	Outlier Detected
Variances	Mod Levene Equality of Variance	1.364	2.299	0.2487	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9235	0.9575	0.0018	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	1.674	2.492	1.8E-07	Non-Normal Distribution

Reproduction Summary

			Calculated Variate						
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect
17.5	N	8	6.75	4	13	1.031	2.915	43.19%	0.00%
22.3		8	10.38	6	18	1.322	3.739	36.04%	-53.70%
26.4		8	3.5	0	5	0.5669	1.604	45.82%	48.15%
37.1		8	7.75	5	11	0.7962	2.252	29.06%	-14.81%
54		8	4.375	3	10	0.8224	2.326	53.17%	35.19%
92.7		8	2.875	0	8	0.875	2.475	86.08%	57.41%
169		7	0.2857	0	1	0.1844	0.488	170.78%	95.77%

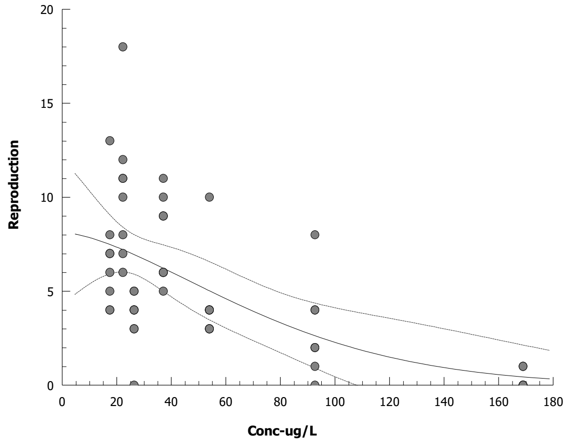
Hyalella 42-d Survival, Growth, and Reproduction Sediment Test | **Nautilus Environmental Calgary**

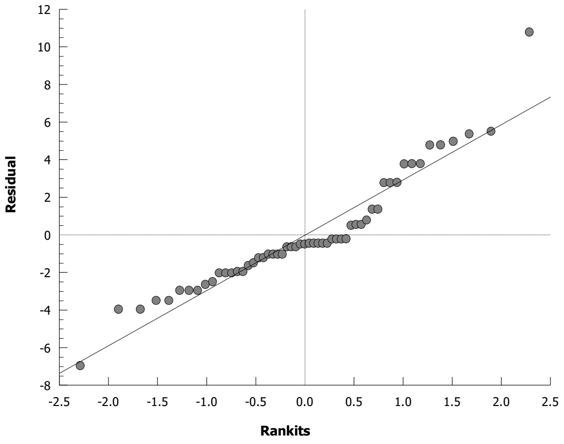
Analysis ID: 18-4602-2782 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 08 Aug-17 14:29 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

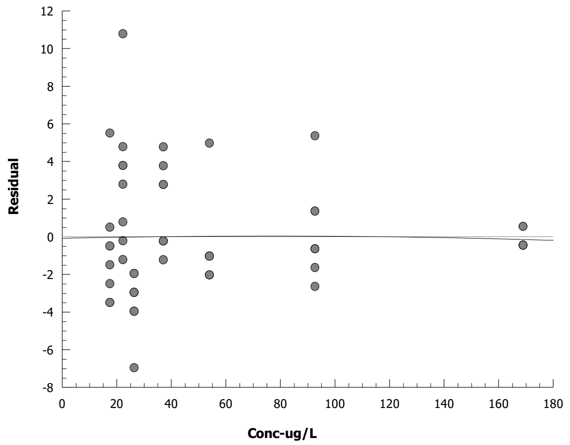
Reproduction Detail

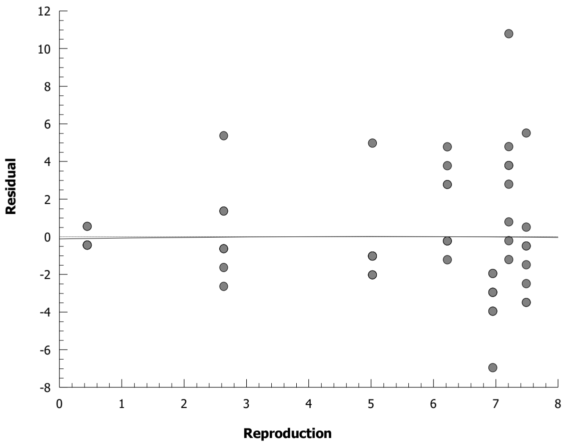
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
17.5	N	5	7	7	13	4	6	8	4
22.3		18	11	7	12	11	8	10	6
26.4		5	3	4	4	3	0	5	4
37.1		11	6	5	6	6	9	9	10
54		3	4	10	3	4	4	4	3
92.7		4	8	4	2	0	2	2	1
169		1	0	0	0	1	0	0	

Graphics Model: 3P Log-Gompertz: μ=α·exp[log[0.5]·[x/δ]^γ] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date:	08 Aug-17 14:25 (p 1 of 2)
Test Code:	SP1617-029 HA r | 09-4407-0965

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	04-6301-4282	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	08 Aug-17 14:24	**Analysis:**	Nonparametric-Multiple Comparison	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Total Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	54	92.7	70.75		47.0%

Wilcoxon/Bonferroni Adj Test

Control vs	Conc-ug/L	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	22.3	87	NA	3	14	Exact	1.0000	Non-Significant Effect
	26.4*	44	NA	2	14	Exact	0.0312	Significant Effect
	37.1	77	NA	2	14	Exact	1.0000	Non-Significant Effect
	54	47	NA	1	14	Exact	0.0639	Non-Significant Effect
	92.7*	44.5	NA	2	14	Exact	0.0340	Significant Effect
	169*	28	NA	0	13	Exact	9.3E-04	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.273	3.166	0.0317	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	526.328	87.7214	6	14.37	<1.0E-37	Significant Effect
Error	293.054	6.10528	48			
Total	819.382		54			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	18.49	16.81	0.0051	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9119	0.9417	6.6E-04	Non-Normal Distribution

Reproduction Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
17.5	N	8	6.75	4.313	9.187	6.5	4	13	1.031	43.19%	0.00%
22.3		8	10.38	7.249	13.5	10.5	6	18	1.322	36.04%	-53.70%
26.4		8	3.5	2.159	4.841	4	0	5	0.5669	45.82%	48.15%
37.1		8	7.75	5.867	9.633	7.5	5	11	0.7962	29.06%	-14.81%
54		8	4.375	2.43	6.32	4	3	10	0.8224	53.17%	35.19%
92.7		8	2.875	0.806	4.944	2	0	8	0.875	86.08%	57.41%
169		7	0.2857	-0.1656	0.737	0	0	1	0.1844	170.78%	95.77%

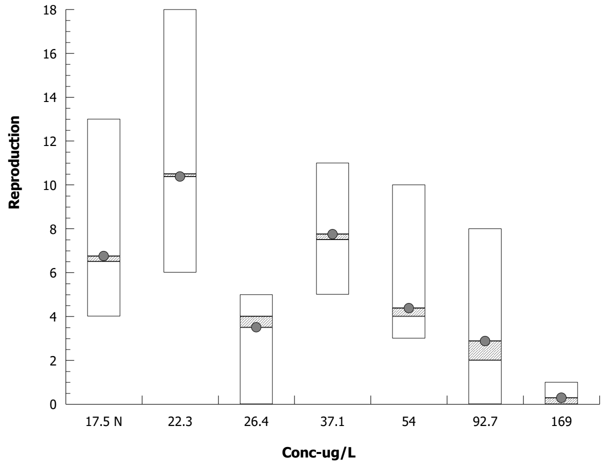
Reproduction Detail

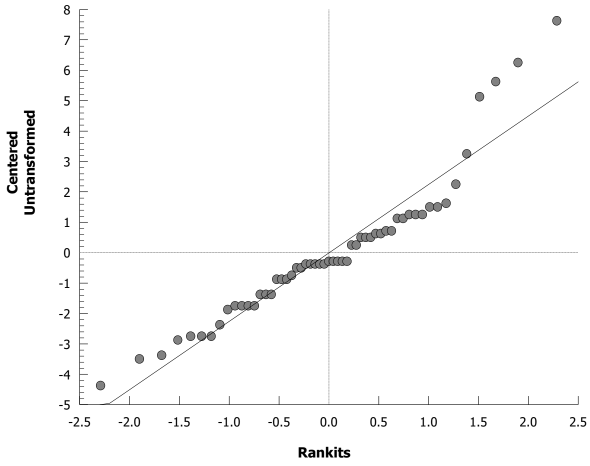
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
17.5	N	5	7	7	13	4	6	8	4
22.3		18	11	7	12	11	8	10	6
26.4		5	3	4	4	3	0	5	4
37.1		11	6	5	6	6	9	9	10
54		3	4	10	3	4	4	4	3
92.7		4	8	4	2	0	2	2	1
169		1	0	0	0	1	0	0	

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 04-6301-4282 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 08 Aug-17 14:24 **Analysis:** Nonparametric-Multiple Comparison **Official Results:** Yes

Graphics





CETIS Analytical Report

Report Date:	16 Aug-17 12:26 (p 1 of 2)
Test Code:	SP1617-029 HA 2 | 03-1094-5659

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	06-5099-7677	**Endpoint:**	28-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 12:26	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	03-1012-0093	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissovled Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	973576	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

		TAC Limits			
Attribute	Test Stat	Lower	Upper	Overlap	Decision
Control Resp	0.9417	0.8	>>	Yes	Passes Acceptibility Criteria

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.205	3.37	1.0000	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	112.6	85.14	143.8
LC10	>154	n/a	n/a
LC15	>154	n/a	n/a
LC20	>154	n/a	n/a
LC25	>154	n/a	n/a
LC40	>154	n/a	n/a
LC50	>154	n/a	n/a

28-d Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	Code	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	N	12	0.9417	0.8000	1.0000	0.0193	0.0669	7.10%	0.00%	113	120
14.7		12	0.9417	0.8000	1.0000	0.0229	0.0793	8.42%	0.00%	113	120
19.1		12	0.9333	0.8000	1.0000	0.0225	0.0779	8.34%	0.88%	112	120
23.7		12	0.9167	0.8000	1.0000	0.0207	0.0718	7.83%	2.65%	110	120
32.4		12	0.8833	0.7000	1.0000	0.0322	0.1115	12.62%	6.19%	106	120
49.7		12	0.9667	0.9000	1.0000	0.0142	0.0492	5.09%	-2.65%	116	120
84.7		12	0.9750	0.9000	1.0000	0.0131	0.0452	4.64%	-3.54%	117	120
154		12	0.8500	0.7000	1.0000	0.0261	0.0905	10.64%	9.73%	102	120

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 06-5099-7677 **Endpoint:** 28-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 12:26 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

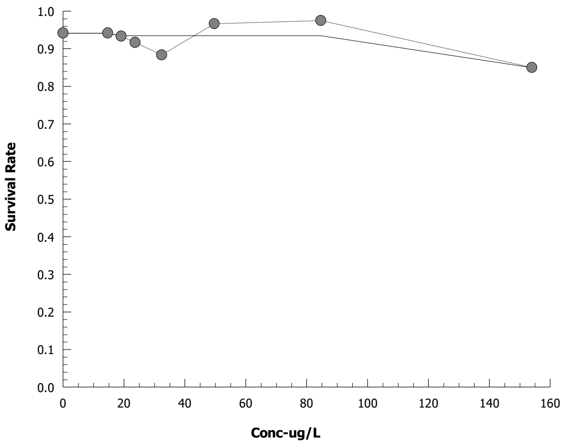
28-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000
		1.0000	0.9000								
14.7		0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
		0.9000	0.8000								
19.1		0.9000	1.0000	1.0000	1.0000	0.9000	0.8000	0.9000	1.0000	1.0000	0.8000
		0.9000	1.0000								
23.7		0.9000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	0.8000	1.0000	0.9000
		0.9000	0.8000								
32.4		0.9000	1.0000	0.7000	0.7000	0.9000	1.0000	0.8000	0.8000	0.9000	1.0000
		1.0000	0.9000								
49.7		0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		0.9000	0.9000								
84.7		1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000
		1.0000	0.9000								
154		0.8000	0.9000	0.9000	0.9000	0.8000	0.8000	0.8000	1.0000	0.8000	0.8000
		1.0000	0.7000								

28-d Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	9/10	9/10	9/10	10/10	10/10	9/10	10/10	10/10	8/10	10/10
		10/10	9/10								
14.7		9/10	10/10	10/10	10/10	10/10	10/10	8/10	9/10	10/10	10/10
		9/10	8/10								
19.1		9/10	10/10	10/10	10/10	9/10	8/10	9/10	10/10	10/10	8/10
		9/10	10/10								
23.7		9/10	10/10	9/10	10/10	10/10	9/10	9/10	8/10	10/10	9/10
		9/10	8/10								
32.4		9/10	10/10	7/10	7/10	9/10	10/10	8/10	8/10	9/10	10/10
		10/10	9/10								
49.7		9/10	10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10
		9/10	9/10								
84.7		10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10	9/10
		10/10	9/10								
154		8/10	9/10	9/10	9/10	8/10	8/10	8/10	10/10	8/10	8/10
		10/10	7/10								

Graphics



CETIS Analytical Report

Report Date: 16 Aug-17 12:29 (p 1 of 3)
Test Code: SP1617-029 HA 2 | 03-1094-5659

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	03-3130-6276	**Endpoint:**	28- d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 12:28	**Analysis:**	Nonparametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	03-1012-0093	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	154	> 154	n/a		7.3%

Steel Many-One Rank Sum Test

Control vs	Conc-ug/L	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	14.7	152.5	109	3	22	Asymp	0.9077	Non-Significant Effect
	19.1	147	109	3	22	Asymp	0.8261	Non-Significant Effect
	23.7	136	109	3	22	Asymp	0.5671	Non-Significant Effect
	32.4	129	109	3	22	Asymp	0.3761	Non-Significant Effect
	49.7	164	109	2	22	Asymp	0.9840	Non-Significant Effect
	84.7	169.5	109	2	22	Asymp	0.9944	Non-Significant Effect
	154	109.5	109	3	22	Asymp	0.0503	Non-Significant Effect

Test Acceptability Criteria

Attribute	Test Stat	TAC Limits Lower	TAC Limits Upper	Overlap	Decision
Control Resp	0.9417	0.8	>>	Yes	Passes Acceptibility Criteria

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.205	3.37	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.324851	0.0464073	7	3.465	0.0025	Significant Effect
Error	1.17853	0.0133924	88			
Total	1.50338		95			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	8.91	18.48	0.2592	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9635	0.9642	0.0089	Non-Normal Distribution

Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	12	0.9417	0.8992	0.9841	0.9500	0.8000	1.0000	0.0193	7.10%	0.00%
14.7		12	0.9417	0.8913	0.9920	1.0000	0.8000	1.0000	0.0229	8.42%	0.00%
19.1		12	0.9333	0.8839	0.9828	0.9500	0.8000	1.0000	0.0225	8.34%	0.88%
23.7		12	0.9167	0.8711	0.9623	0.9000	0.8000	1.0000	0.0207	7.83%	2.65%
32.4		12	0.8833	0.8125	0.9542	0.9000	0.7000	1.0000	0.0322	12.62%	6.19%
49.7		12	0.9667	0.9354	0.9980	1.0000	0.9000	1.0000	0.0142	5.09%	-2.65%
84.7		12	0.9750	0.9463	1.0000	1.0000	0.9000	1.0000	0.0131	4.64%	-3.54%
154		12	0.8500	0.7925	0.9075	0.8000	0.7000	1.0000	0.0261	10.64%	9.73%

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 03-3130-6276 **Endpoint:** 28-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 12:28 **Analysis:** Nonparametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	12	1.319	1.252	1.385	1.331	1.107	1.412	0.03031	7.96%	0.00%
14.7		12	1.32	1.243	1.398	1.412	1.107	1.412	0.03535	9.27%	-0.13%
19.1		12	1.307	1.23	1.383	1.331	1.107	1.412	0.03476	9.21%	0.90%
23.7		12	1.28	1.209	1.35	1.249	1.107	1.412	0.03201	8.66%	2.96%
32.4		12	1.237	1.136	1.338	1.249	0.9912	1.412	0.04587	12.85%	6.22%
49.7		12	1.358	1.307	1.409	1.412	1.249	1.412	0.02316	5.91%	-2.96%
84.7		12	1.371	1.324	1.418	1.412	1.249	1.412	0.02128	5.38%	-3.99%
154		12	1.184	1.1	1.267	1.107	0.9912	1.412	0.03787	11.08%	10.23%

28-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	0.9000	0.9000	0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	0.8000	1.0000
		1.0000	0.9000								
14.7		0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	0.8000	0.9000	1.0000	1.0000
		0.9000	0.8000								
19.1		0.9000	1.0000	1.0000	1.0000	0.9000	0.8000	0.9000	1.0000	1.0000	0.8000
		0.9000	1.0000								
23.7		0.9000	1.0000	0.9000	1.0000	1.0000	0.9000	0.9000	0.8000	1.0000	0.9000
		0.9000	0.8000								
32.4		0.9000	1.0000	0.7000	0.7000	0.9000	1.0000	0.8000	0.8000	0.9000	1.0000
		1.0000	0.9000								
49.7		0.9000	1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
		0.9000	0.9000								
84.7		1.0000	1.0000	0.9000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.9000
		1.0000	0.9000								
154		0.8000	0.9000	0.9000	0.9000	0.8000	0.8000	0.8000	1.0000	0.8000	0.8000
		1.0000	0.7000								

Angular (Corrected) Transformed Detail

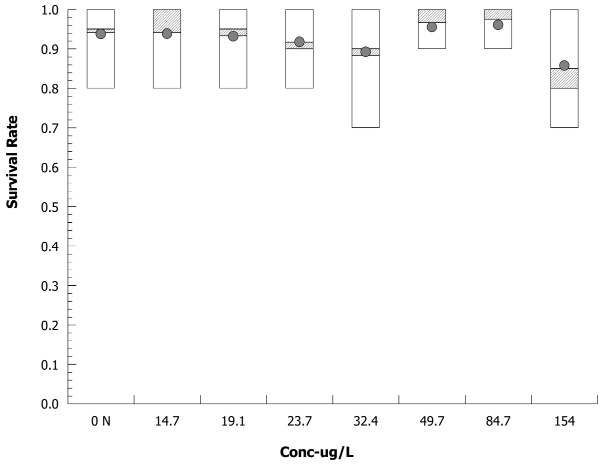
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	1.249	1.249	1.249	1.412	1.412	1.249	1.412	1.412	1.107	1.412
14.7		1.249	1.412	1.412	1.412	1.412	1.412	1.107	1.249	1.412	1.412
19.1		1.249	1.412	1.412	1.412	1.249	1.107	1.249	1.412	1.412	1.107
23.7		1.249	1.412	1.249	1.412	1.412	1.249	1.249	1.107	1.412	1.249
32.4		1.249	1.412	0.9912	0.9912	1.249	1.412	1.107	1.107	1.249	1.412
49.7		1.249	1.412	1.412	1.249	1.412	1.412	1.412	1.412	1.412	1.412
84.7		1.412	1.412	1.249	1.412	1.412	1.412	1.412	1.412	1.412	1.249
154		1.107	1.249	1.249	1.249	1.107	1.107	1.107	1.412	1.107	1.107

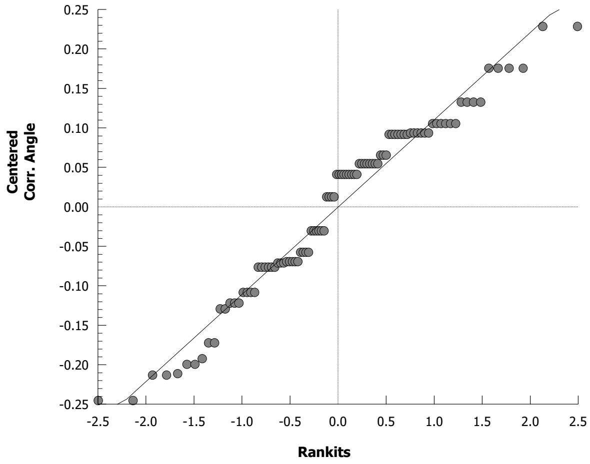
Analysis ID: 03-3130-6276 **Endpoint:** 28-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 12:28 **Analysis:** Nonparametric-Control vs Treatments **Official Results:** Yes

28-d Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	N	9/10	9/10	9/10	10/10	10/10	9/10	10/10	10/10	8/10	10/10
		10/10	9/10								
14.7		9/10	10/10	10/10	10/10	10/10	10/10	8/10	9/10	10/10	10/10
		9/10	8/10								
19.1		9/10	10/10	10/10	10/10	9/10	8/10	9/10	10/10	10/10	8/10
		9/10	10/10								
23.7		9/10	10/10	9/10	10/10	10/10	9/10	9/10	8/10	10/10	9/10
		9/10	8/10								
32.4		9/10	10/10	7/10	7/10	9/10	10/10	8/10	8/10	9/10	10/10
		10/10	9/10								
49.7		9/10	10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10
		9/10	9/10								
84.7		10/10	10/10	9/10	10/10	10/10	10/10	10/10	10/10	10/10	9/10
		10/10	9/10								
154		8/10	9/10	9/10	9/10	8/10	8/10	8/10	10/10	8/10	8/10
		10/10	7/10								

Graphics





CETIS Analytical Report

Report Date: 16 Aug-17 09:46 (p 1 of 2)
Test Code: SP1617-029 HA 2 | 03-1094-5659

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test | **Nautilus Environmental Calgary**

Analysis ID:	21-3430-3370	**Endpoint:**	28-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:46	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	03-1012-0093	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
5	81.75	-156.6	-153.1	0.7272	Yes	1.529	2.621	0.2183	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	62.01	n/a	80.83
IC10	76.84	30.6	96.19
IC15	87.74	57.38	107.1
IC20	96.97	72.21	115.9
IC25	105.3	84.08	123.6
IC40	128.5	112.4	145.2
IC50	144.3	127.5	163.4

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.721	0.01801	0.6842	0.7579	40.03	<1.0E-37	Significant Parameter
γ	3.485	0.9086	1.627	5.344	3.836	6.2E-04	Significant Parameter
δ	144.3	8.955	126	162.6	16.12	<1.0E-37	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	14.31	4.77	3	738.6	<1.0E-37	Significant
Lack of Fit	0.04524	0.009049	5	1.529	0.2183	Non-Significant
Pure Error	0.142	0.005919	24			
Residual	0.1873	0.006458	29			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.184	2.938	0.7633	No Outliers Detected
Variances	Bartlett Equality of Variance Test	2.425	14.07	0.9326	Equal Variances
	Mod Levene Equality of Variance	0.5283	2.423	0.8044	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9842	0.9338	0.9084	Normal Distribution
	Anderson-Darling A2 Normality Te	0.1942	2.492	0.9424	Normal Distribution

Analysis ID: 21-3430-3370 **Endpoint:** 28-d Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:46 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

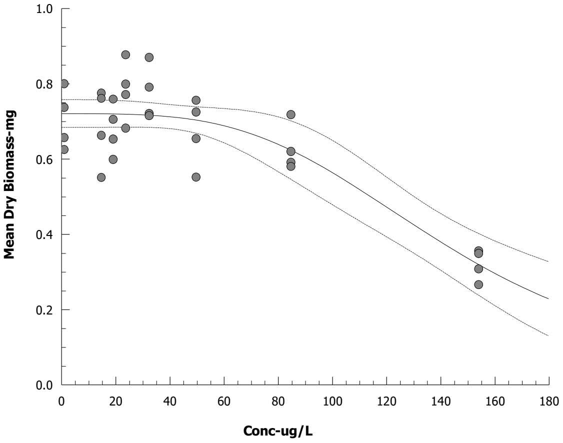
28-d Mean Dry Biomass-mg Summary

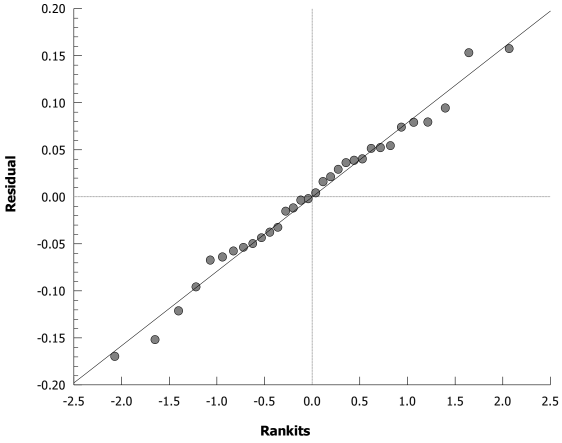
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	4	0.7048	0.625	0.8	0.03953	0.07906	11.22%	0.00%
14.7		4	0.6875	0.551	0.775	0.05187	0.1037	15.09%	2.45%
19.1		4	0.679	0.599	0.759	0.03434	0.06868	10.12%	3.65%
23.7		4	0.7823	0.682	0.877	0.04024	0.08049	10.29%	-11.00%
32.4		4	0.7743	0.715	0.87	0.03628	0.07256	9.37%	-9.86%
49.7		4	0.6717	0.552	0.756	0.04527	0.09053	13.48%	4.68%
84.7		4	0.6273	0.58	0.718	0.0314	0.06281	10.01%	11.00%
154		4	0.3198	0.266	0.356	0.02081	0.04162	13.02%	54.63%

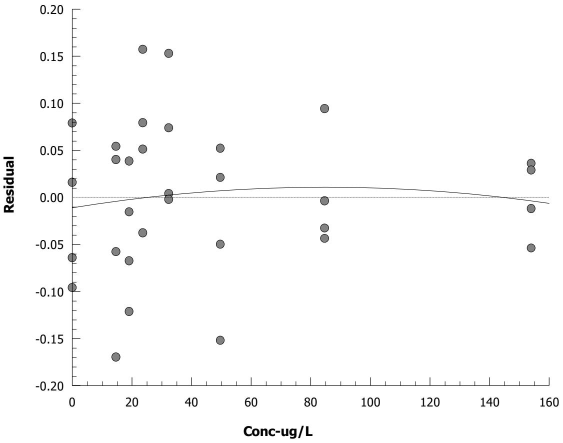
28-d Mean Dry Biomass-mg Detail

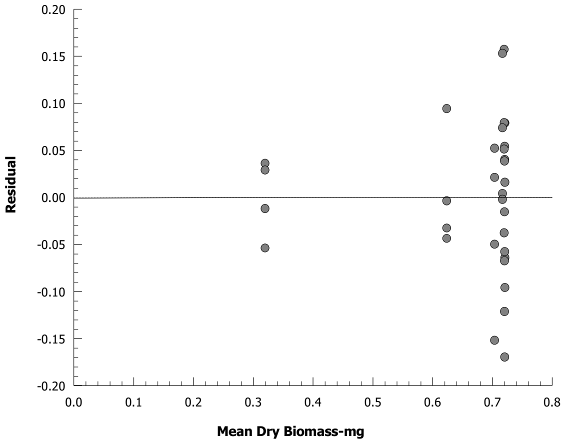
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.625	0.657	0.8	0.737
14.7		0.775	0.761	0.663	0.551
19.1		0.759	0.705	0.599	0.653
23.7		0.877	0.799	0.771	0.682
32.4		0.721	0.715	0.791	0.87
49.7		0.654	0.552	0.756	0.725
84.7		0.591	0.58	0.62	0.718
154		0.356	0.266	0.349	0.308

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 16 Aug-17 09:47 (p 1 of 2)
Test Code: SP1617-029 HA 2 | 03-1094-5659

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	16-9804-4853	**Endpoint:**	28-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:47	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	03-1012-0093	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	84.7	154	114.2		19.2%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	14.7	0.3171	2.482	0.135	6	CDF	0.7783	Non-Significant Effect
	19.1	0.4734	2.482	0.135	6	CDF	0.7184	Non-Significant Effect
	23.7	-1.425	2.482	0.135	6	CDF	0.9975	Non-Significant Effect
	32.4	-1.278	2.482	0.135	6	CDF	0.9959	Non-Significant Effect
	49.7	0.6066	2.482	0.135	6	CDF	0.6620	Non-Significant Effect
	84.7	1.425	2.482	0.135	6	CDF	0.2964	Non-Significant Effect
	154*	7.077	2.482	0.135	6	CDF	1.6E-06	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.017	2.938	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.591833	0.0845476	7	14.29	3.6E-07	Significant Effect
Error	0.142045	0.0059186	24			
Total	0.733879		31			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	2.425	18.48	0.9326	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9514	0.9081	0.1582	Normal Distribution

28-d Mean Dry Biomass-mg Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	4	0.7048	0.5789	0.8306	0.697	0.625	0.8	0.03953	11.22%	0.00%
14.7		4	0.6875	0.5224	0.8526	0.712	0.551	0.775	0.05187	15.09%	2.45%
19.1		4	0.679	0.5697	0.7883	0.679	0.599	0.759	0.03434	10.12%	3.65%
23.7		4	0.7823	0.6542	0.9103	0.785	0.682	0.877	0.04024	10.29%	-11.00%
32.4		4	0.7743	0.6588	0.8897	0.756	0.715	0.87	0.03628	9.37%	-9.86%
49.7		4	0.6717	0.5277	0.8158	0.6895	0.552	0.756	0.04527	13.48%	4.68%
84.7		4	0.6273	0.5273	0.7272	0.6055	0.58	0.718	0.0314	10.01%	11.00%
154		4	0.3198	0.2535	0.386	0.3285	0.266	0.356	0.02081	13.02%	54.63%

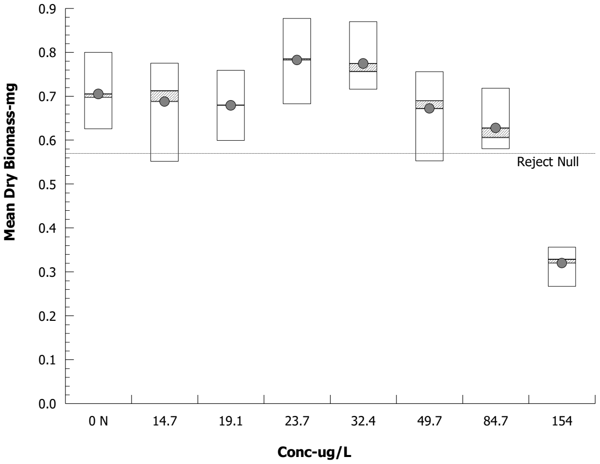
Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

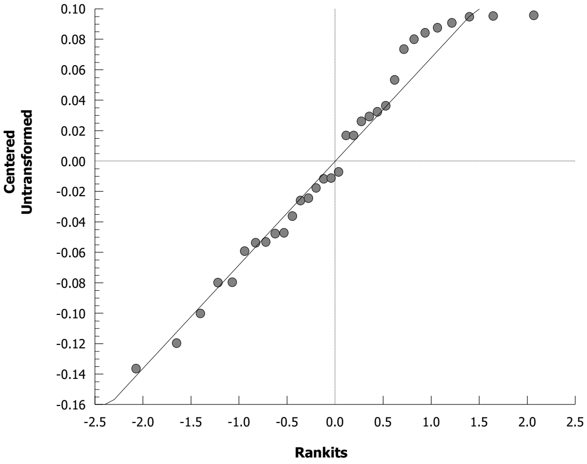
Analysis ID:	16-9804-4853	**Endpoint:**	28-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:47	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

28-d Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4
0	N	0.625	0.657	0.8	0.737
14.7		0.775	0.761	0.663	0.551
19.1		0.759	0.705	0.599	0.653
23.7		0.877	0.799	0.771	0.682
32.4		0.721	0.715	0.791	0.87
49.7		0.654	0.552	0.756	0.725
84.7		0.591	0.58	0.62	0.718
154		0.356	0.266	0.349	0.308

Graphics





CETIS Analytical Report

Report Date: 16 Aug-17 09:27 (p 1 of 2)
Test Code: SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	05-1874-4904	**Endpoint:**	42-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:25	**Analysis:**	Linear Interpolation (ICPIN)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	09-4919-8630	**Code:**	SP1617-029	**Client:**	
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1250822	200	Yes	Two-Point Interpolation

Test Acceptability Criteria

		TAC Limits			
Attribute	**Test Stat**	**Lower**	**Upper**	**Overlap**	**Decision**
Control Resp	0.8625	0.8	>>	Yes	Passes Acceptibility Criteria

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.357	3.224	1.0000	No Outliers Detected

Point Estimates

Level	ug/L	95% LCL	95% UCL
LC5	111.8	16.76	n/a
LC10	144.7	101.7	n/a
LC15	>160	n/a	n/a
LC20	>160	n/a	n/a
LC25	>160	n/a	n/a
LC40	>160	n/a	n/a
LC50	>160	n/a	n/a

42-d Survival Rate Summary

			Calculated Variate(A/B)								
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A**	**B**
0	N	8	0.8625	0.7000	1.0000	0.0324	0.0916	10.62%	0.00%	69	80
14.9		8	0.8625	0.7000	1.0000	0.0375	0.1061	12.30%	0.00%	69	80
19.8		8	0.8500	0.7000	1.0000	0.0378	0.1069	12.58%	1.45%	68	80
24.3		8	0.8500	0.6000	1.0000	0.0500	0.1414	16.64%	1.45%	68	80
33		8	0.8000	0.7000	1.0000	0.0378	0.1069	13.36%	7.25%	64	80
51.6		8	0.9250	0.8000	1.0000	0.0250	0.0707	7.64%	-7.25%	74	80
86.4		8	0.9125	0.8000	1.0000	0.0295	0.0835	9.15%	-5.80%	73	80
160		8	0.7625	0.6000	1.0000	0.0498	0.1408	18.46%	11.59%	61	80

42-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.8000	0.7000	0.9000	0.9000	0.9000	0.9000	1.0000	0.8000
14.9		0.9000	0.8000	0.7000	1.0000	1.0000	0.8000	0.8000	0.9000
19.8		0.7000	1.0000	0.7000	0.9000	0.9000	0.8000	0.9000	0.9000
24.3		0.8000	1.0000	0.9000	1.0000	0.9000	0.7000	0.9000	0.6000
33		0.9000	1.0000	0.7000	0.7000	0.8000	0.7000	0.8000	0.8000
51.6		0.9000	0.9000	0.8000	0.9000	1.0000	0.9000	1.0000	1.0000
86.4		0.9000	1.0000	0.8000	0.8000	0.9000	0.9000	1.0000	1.0000
160		0.8000	0.6000	0.8000	0.6000	0.7000	0.7000	0.9000	1.0000

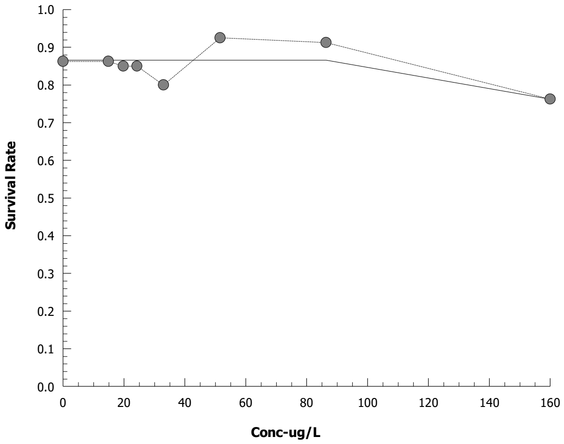
Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 05-1874-4904 **Endpoint:** 42-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:25 **Analysis:** Linear Interpolation (ICPIN) **Official Results:** Yes

42-d Survival Rate Binomials

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	8/10	7/10	9/10	9/10	9/10	9/10	10/10	8/10
14.9		9/10	8/10	7/10	10/10	10/10	8/10	8/10	9/10
19.8		7/10	10/10	7/10	9/10	9/10	8/10	9/10	9/10
24.3		8/10	10/10	9/10	10/10	9/10	7/10	9/10	6/10
33		9/10	10/10	7/10	7/10	8/10	7/10	8/10	8/10
51.6		9/10	9/10	8/10	9/10	10/10	9/10	10/10	10/10
86.4		9/10	10/10	8/10	8/10	9/10	9/10	10/10	10/10
160		8/10	6/10	8/10	6/10	7/10	7/10	9/10	10/10

Graphics



CETIS Analytical Report

Report Date: 16 Aug-17 09:28 (p 1 of 3)
Test Code: SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	15-2361-2716	**Endpoint:**	42-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	09-4919-8630	**Code:**	SP1617-029	**Client:**	
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Angular (Corrected)	C > T	n/a	n/a	n/a	160	> 160	n/a		15.6%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	14.9	-0.03513	2.399	0.18	14	CDF	0.8836	Non-Significant Effect
	19.8	0.1934	2.399	0.18	14	CDF	0.8199	Non-Significant Effect
	24.3	0.09687	2.399	0.18	14	CDF	0.8491	Non-Significant Effect
	33	1.096	2.399	0.18	14	CDF	0.4326	Non-Significant Effect
	51.6	-1.21	2.399	0.18	14	CDF	0.9955	Non-Significant Effect
	86.4	-0.9734	2.399	0.18	14	CDF	0.9901	Non-Significant Effect
	160	1.64	2.399	0.18	14	CDF	0.2113	Non-Significant Effect

Test Acceptability Criteria

		TAC Limits			
Attribute	**Test Stat**	**Lower**	**Upper**	**Overlap**	**Decision**
Control Resp	0.8625	0.8	>>	Yes	Passes Acceptibility Criteria

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.357	3.224	1.0000	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	0.281983	0.0402833	7	1.792	0.1071	Non-Significant Effect
Error	1.25916	0.022485	56			
Total	1.54115		63			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	3.015	18.48	0.8836	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.98	0.9488	0.3839	Normal Distribution

42-d Survival Rate Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	0.8625	0.7859	0.9391	0.9000	0.7000	1.0000	0.0324	10.62%	0.00%
14.9		8	0.8625	0.7738	0.9512	0.8500	0.7000	1.0000	0.0375	12.30%	0.00%
19.8		8	0.8500	0.7606	0.9394	0.9000	0.7000	1.0000	0.0378	12.58%	1.45%
24.3		8	0.8500	0.7318	0.9682	0.9000	0.6000	1.0000	0.0500	16.64%	1.45%
33		8	0.8000	0.7106	0.8894	0.8000	0.7000	1.0000	0.0378	13.36%	7.25%
51.6		8	0.9250	0.8659	0.9841	0.9000	0.8000	1.0000	0.0250	7.64%	-7.25%
86.4		8	0.9125	0.8427	0.9823	0.9000	0.8000	1.0000	0.0295	9.15%	-5.80%
160		8	0.7625	0.6448	0.8802	0.7500	0.6000	1.0000	0.0498	18.46%	11.59%

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 15-2361-2716 **Endpoint:** 42-d Survival Rate **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:27 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

Angular (Corrected) Transformed Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	1.202	1.094	1.309	1.249	0.9912	1.412	0.0454	10.68%	0.00%
14.9		8	1.204	1.076	1.332	1.178	0.9912	1.412	0.05412	12.71%	-0.22%
19.8		8	1.187	1.065	1.309	1.249	0.9912	1.412	0.0516	12.29%	1.21%
24.3		8	1.194	1.037	1.352	1.249	0.8861	1.412	0.0665	15.75%	0.60%
33		8	1.119	0.9962	1.243	1.107	0.9912	1.412	0.05214	13.17%	6.84%
51.6		8	1.292	1.2	1.384	1.249	1.107	1.412	0.0389	8.51%	-7.55%
86.4		8	1.275	1.168	1.382	1.249	1.107	1.412	0.04525	10.04%	-6.07%
160		8	1.079	0.9268	1.231	1.049	0.8861	1.412	0.06426	16.85%	10.23%

42-d Survival Rate Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.8000	0.7000	0.9000	0.9000	0.9000	0.9000	1.0000	0.8000
14.9		0.9000	0.8000	0.7000	1.0000	1.0000	0.8000	0.8000	0.9000
19.8		0.7000	1.0000	0.7000	0.9000	0.9000	0.8000	0.9000	0.9000
24.3		0.8000	1.0000	0.9000	1.0000	0.9000	0.7000	0.9000	0.6000
33		0.9000	1.0000	0.7000	0.7000	0.8000	0.7000	0.8000	0.8000
51.6		0.9000	0.9000	0.8000	0.9000	1.0000	0.9000	1.0000	1.0000
86.4		0.9000	1.0000	0.8000	0.8000	0.9000	0.9000	1.0000	1.0000
160		0.8000	0.6000	0.8000	0.6000	0.7000	0.7000	0.9000	1.0000

Angular (Corrected) Transformed Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	1.107	0.9912	1.249	1.249	1.249	1.249	1.412	1.107
14.9		1.249	1.107	0.9912	1.412	1.412	1.107	1.107	1.249
19.8		0.9912	1.412	0.9912	1.249	1.249	1.107	1.249	1.249
24.3		1.107	1.412	1.249	1.412	1.249	0.9912	1.249	0.8861
33		1.249	1.412	0.9912	0.9912	1.107	0.9912	1.107	1.107
51.6		1.249	1.249	1.107	1.249	1.412	1.249	1.412	1.412
86.4		1.249	1.412	1.107	1.107	1.249	1.249	1.412	1.412
160		1.107	0.8861	1.107	0.8861	0.9912	0.9912	1.249	1.412

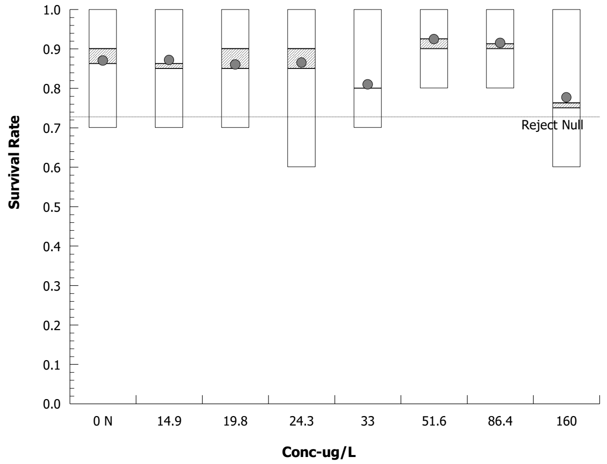
42-d Survival Rate Binomials

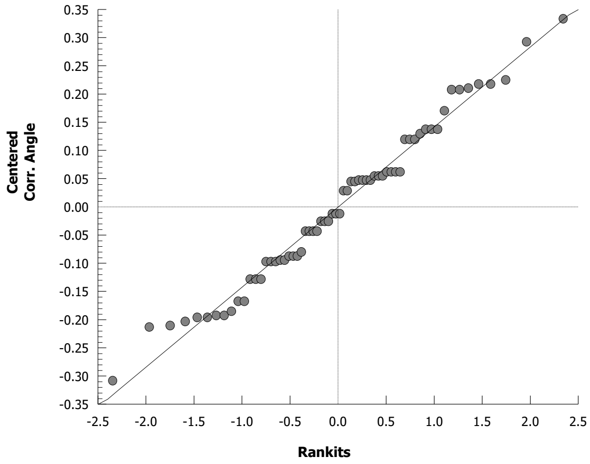
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	8/10	7/10	9/10	9/10	9/10	9/10	10/10	8/10
14.9		9/10	8/10	7/10	10/10	10/10	8/10	8/10	9/10
19.8		7/10	10/10	7/10	9/10	9/10	8/10	9/10	9/10
24.3		8/10	10/10	9/10	10/10	9/10	7/10	9/10	6/10
33		9/10	10/10	7/10	7/10	8/10	7/10	8/10	8/10
51.6		9/10	9/10	8/10	9/10	10/10	9/10	10/10	10/10
86.4		9/10	10/10	8/10	8/10	9/10	9/10	10/10	10/10
160		8/10	6/10	8/10	6/10	7/10	7/10	9/10	10/10

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	15-2361-2716	**Endpoint:**	42-d Survival Rate	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:27	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Graphics





CETIS Analytical Report

Report Date:	16 Aug-17 09:29 (p 1 of 2)
Test Code:	SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	07-5739-6086	**Endpoint:**	42-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:29	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	09-4919-8630	**Code:**	SP1617-029	**Client:**	
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
13	133.3	-260.1	-254.1	0.5602	Yes	0.8738	2.38	0.5046	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	57.79	n/a	75.68
IC10	72.89	45.14	91.86
IC15	85.25	62.78	104.2
IC20	96.55	76.83	114.9
IC25	107.4	89.51	125.1
IC40	140.6	122.2	160.5
IC50	165.3	140.2	194.9

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.9181	0.02061	0.8768	0.9593	44.54	<1.0E-37	Significant Parameter
γ	0.6391	0.1492	0.3408	0.9373	4.284	6.6E-05	Significant Parameter
δ	165.3	13.54	138.3	192.4	12.21	<1.0E-37	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	46.54	15.51	3	967.1	<1.0E-37	Significant
Lack of Fit	0.07082	0.01416	5	0.8738	0.5046	Non-Significant
Pure Error	0.9077	0.01621	56			
Residual	0.9785	0.01604	61			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.943	3.224	0.1504	No Outliers Detected
Variances	Bartlett Equality of Variance Test	6.045	14.07	0.5345	Equal Variances
	Mod Levene Equality of Variance	1.128	2.178	0.3591	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.976	0.9626	0.2466	Normal Distribution
	Anderson-Darling A2 Normality Te	0.2879	2.492	0.6489	Normal Distribution

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 07-5739-6086 **Endpoint:** 42-d Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:29 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

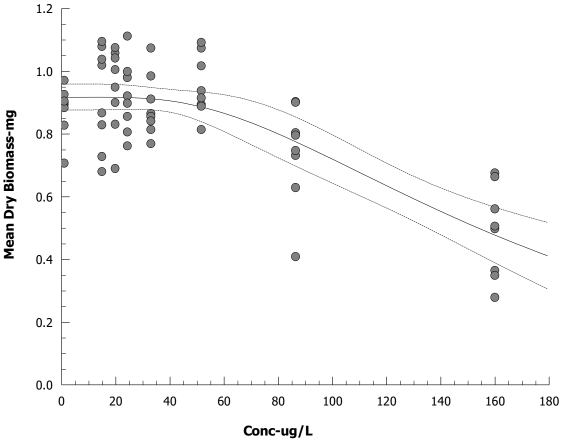
42-d Mean Dry Biomass-mg Summary

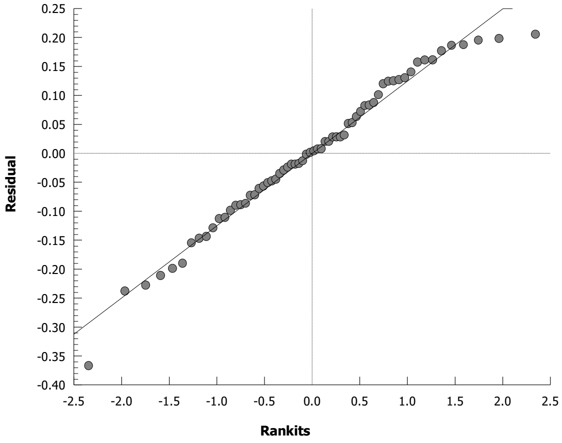
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	8	0.8766	0.707	0.971	0.02807	0.0794	9.06%	0.00%
14.9		8	0.9169	0.68	1.095	0.05749	0.1626	17.74%	-4.59%
19.8		8	0.9438	0.69	1.075	0.04681	0.1324	14.03%	-7.66%
24.3		8	0.9167	0.762	1.112	0.0399	0.1129	12.31%	-4.58%
33		8	0.8894	0.769	1.074	0.03483	0.0985	11.08%	-1.45%
51.6		8	0.954	0.814	1.092	0.03452	0.09765	10.24%	-8.83%
86.4		8	0.74	0.409	0.903	0.05697	0.1611	21.77%	15.59%
160		8	0.4872	0.279	0.676	0.05179	0.1465	30.06%	44.42%

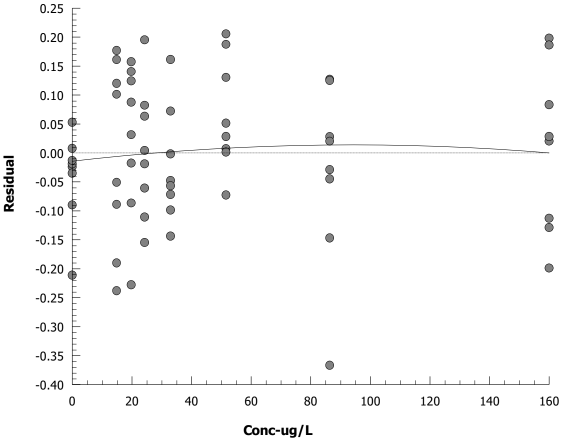
42-d Mean Dry Biomass-mg Detail

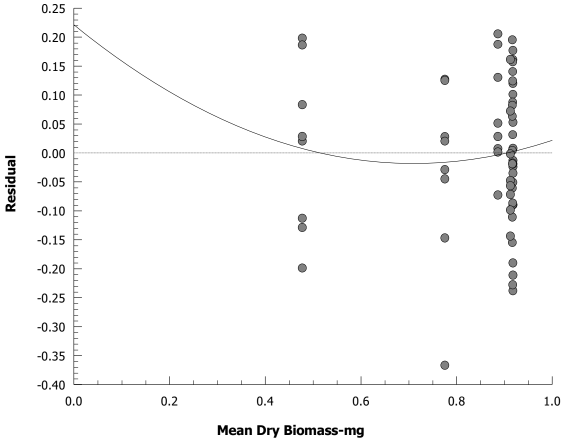
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.894	0.707	0.828	0.926	0.899	0.883	0.971	0.905
14.9		1.079	0.829	0.728	1.019	1.095	0.68	0.867	1.038
19.8		0.831	1.058	0.69	0.949	1.042	0.9	1.075	1.005
24.3		0.856	0.98	0.921	1.112	0.898	0.806	0.999	0.762
33		0.985	1.074	0.911	0.865	0.814	0.769	0.856	0.841
51.6		0.938	0.894	0.814	0.915	1.074	0.888	1.092	1.017
86.4		0.731	0.903	0.901	0.629	0.409	0.804	0.747	0.796
160		0.676	0.279	0.498	0.506	0.365	0.349	0.561	0.664

Graphics Model: 3P Cumulative Log-Normal: μ=α·[1- Φ[log[x/δ]/γ]] Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date: 16 Aug-17 09:30 (p 1 of 2)
Test Code: SP1617-029 HA | 13-1522-0967

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	01-3612-0734	**Endpoint:**	42-d Mean Dry Biomass-mg	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:30	**Analysis:**	Parametric-Control vs Treatments	**Official Results:**	Yes

Batch ID:	09-2303-4928	**Test Type:**	Survival-Growth	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	09-4919-8630	**Code:**	SP1617-029	**Client:**	
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	86.4	160	117.6		17.4%

Dunnett Multiple Comparison Test

Control vs	Conc-ug/L	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	14.9	-0.6323	2.399	0.153	14	CDF	0.9725	Non-Significant Effect
	19.8	-1.054	2.399	0.153	14	CDF	0.9924	Non-Significant Effect
	24.3	-0.6303	2.399	0.153	14	CDF	0.9723	Non-Significant Effect
	33	-0.2003	2.399	0.153	14	CDF	0.9184	Non-Significant Effect
	51.6	-1.215	2.399	0.153	14	CDF	0.9956	Non-Significant Effect
	86.4	2.146	2.399	0.153	14	CDF	0.0854	Non-Significant Effect
	160*	6.117	2.399	0.153	14	CDF	9.5E-07	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	2.758	3.224	0.2919	No Outliers Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.39016	0.198594	7	12.25	<1.0E-37	Significant Effect
Error	0.907723	0.0162093	56			
Total	2.29788		63			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	6.045	18.48	0.5345	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9761	0.9488	0.2486	Normal Distribution

42-d Mean Dry Biomass-mg Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	0.8766	0.8102	0.943	0.8965	0.707	0.971	0.02807	9.06%	0.00%
14.9		8	0.9169	0.7809	1.053	0.943	0.68	1.095	0.05749	17.74%	-4.59%
19.8		8	0.9438	0.8331	1.054	0.977	0.69	1.075	0.04681	14.03%	-7.66%
24.3		8	0.9167	0.8224	1.011	0.9095	0.762	1.112	0.0399	12.31%	-4.58%
33		8	0.8894	0.807	0.9717	0.8605	0.769	1.074	0.03483	11.08%	-1.45%
51.6		8	0.954	0.8724	1.036	0.9265	0.814	1.092	0.03452	10.24%	-8.83%
86.4		8	0.74	0.6053	0.8747	0.7715	0.409	0.903	0.05697	21.77%	15.59%
160		8	0.4872	0.3648	0.6097	0.502	0.279	0.676	0.05179	30.06%	44.42%

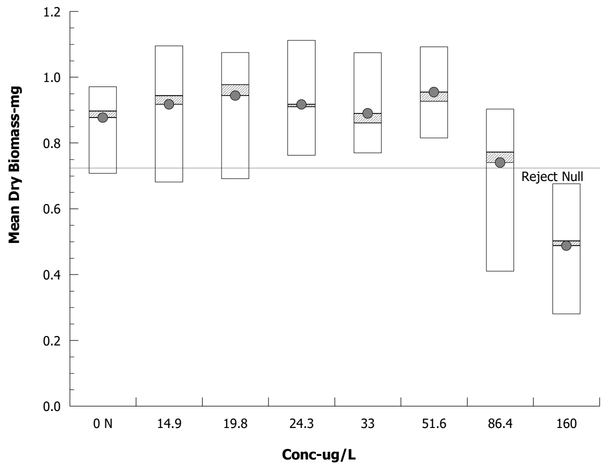
Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

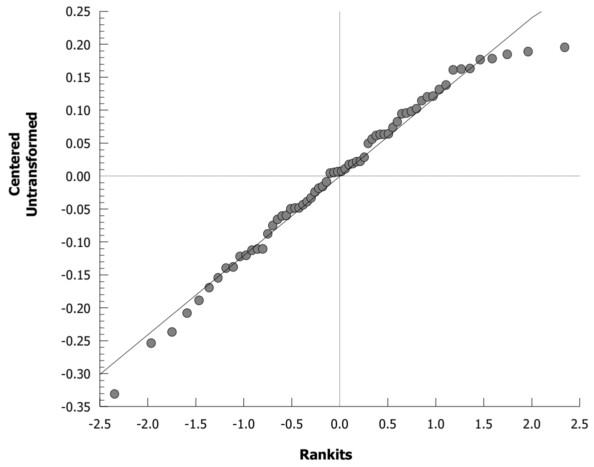
Analysis ID: 01-3612-0734 **Endpoint:** 42-d Mean Dry Biomass-mg **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:30 **Analysis:** Parametric-Control vs Treatments **Official Results:** Yes

42-d Mean Dry Biomass-mg Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	0.894	0.707	0.828	0.926	0.899	0.883	0.971	0.905
14.9		1.079	0.829	0.728	1.019	1.095	0.68	0.867	1.038
19.8		0.831	1.058	0.69	0.949	1.042	0.9	1.075	1.005
24.3		0.856	0.98	0.921	1.112	0.898	0.806	0.999	0.762
33		0.985	1.074	0.911	0.865	0.814	0.769	0.856	0.841
51.6		0.938	0.894	0.814	0.915	1.074	0.888	1.092	1.017
86.4		0.731	0.903	0.901	0.629	0.409	0.804	0.747	0.796
160		0.676	0.279	0.498	0.506	0.365	0.349	0.561	0.664

Graphics





CETIS Analytical Report

Report Date:	16 Aug-17 09:38 (p 1 of 2)
Test Code:	SP1617-029 Har | 10-1411-0638

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	12-4389-8096	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:37	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	20-1465-8193	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
9	-102.2	210.9	216.9	0.4479	Yes	1.91	2.383	0.1075	Non-Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	0.4234	n/a	3.92
IC10	1.011	n/a	6.096
IC15	1.732	n/a	8.697
IC20	2.598	n/a	11.53
IC25	3.632	n/a	14.46
IC40	8.14	2.278	22.79
IC50	13.05	6.105	27.9

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	17.68	1.82	14.04	21.33	9.715	<1.0E-37	Significant Parameter
γ	0.8589	0.3385	0.1817	1.536	2.537	0.0138	Significant Parameter
δ	13.05	5.605	1.839	24.26	2.328	0.0233	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	4309	1436	3	54.13	<1.0E-37	Significant
Lack of Fit	235.5	47.1	5	1.91	0.1075	Non-Significant
Pure Error	1357	24.66	55			
Residual	1592	26.53	60			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	4.996	3.218	2.0E-07	Outlier Detected
Variances	Mod Levene Equality of Variance	2.036	2.185	0.0671	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.8149	0.9621	1.9E-07	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	3.078	2.492	<1.0E-37	Non-Normal Distribution

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 12-4389-8096 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:37 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

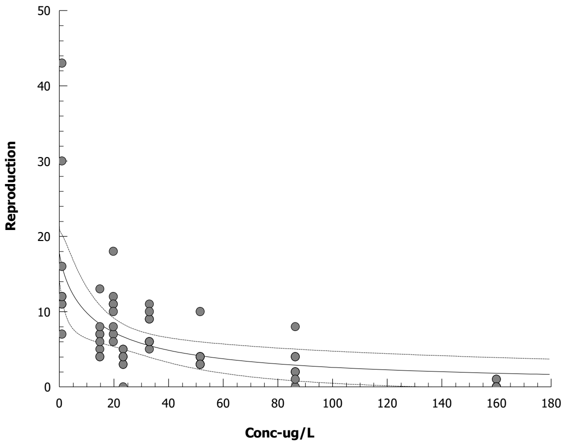
Reproduction Summary

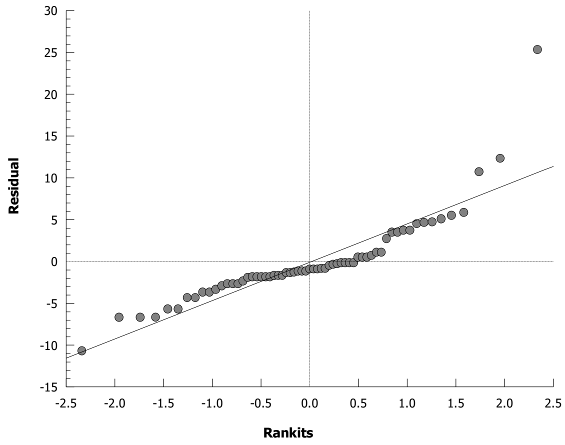
			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	N	8	17.75	7	43	4.358	12.33	69.44%	0.00%
14.9		8	6.75	4	13	1.031	2.915	43.19%	61.97%
19.8		8	10.38	6	18	1.322	3.739	36.04%	41.55%
23.4		8	3.5	0	5	0.5669	1.604	45.82%	80.28%
33		8	7.75	5	11	0.7962	2.252	29.06%	56.34%
51.6		8	4.375	3	10	0.8224	2.326	53.17%	75.35%
86.4		8	2.875	0	8	0.875	2.475	86.08%	83.80%
160		7	0.2857	0	1	0.1844	0.488	170.78%	98.39%

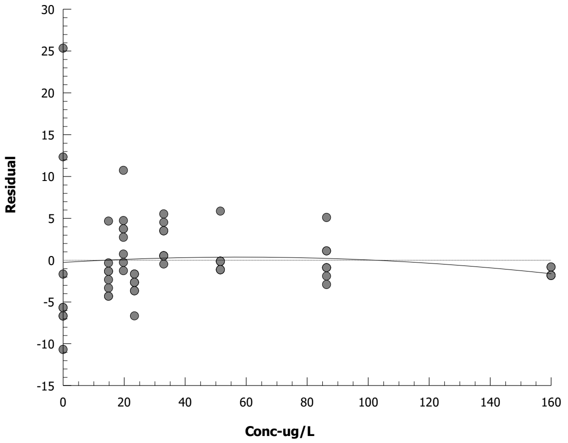
Reproduction Detail

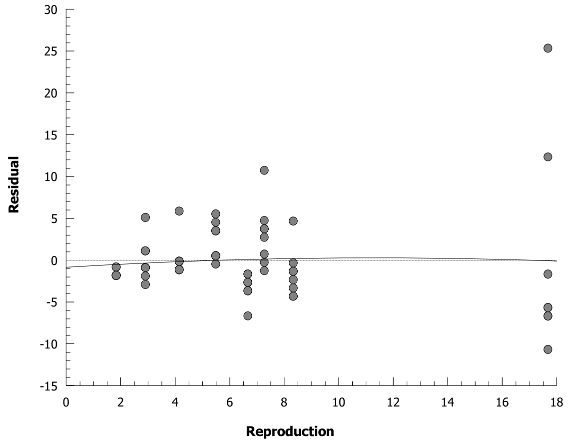
Conc-ug/L	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**
0	N	30	43	11	16	7	12	11	12
14.9		5	7	7	13	4	6	8	4
19.8		18	11	7	12	11	8	10	6
23.4		5	3	4	4	3	0	5	4
33		11	6	5	6	6	9	9	10
51.6		3	4	10	3	4	4	4	3
86.4		4	8	4	2	0	2	2	1
160		1	0	0	0	1	0	0	

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Normal [ω=1]









Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	00-6127-6629	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	16 Aug-17 9:38	**Analysis:**	Nonparametric-Multiple Comparison	**Official Results:**	Yes

Batch ID:	20-1465-8193	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	19.8	23.4	21.52		36.6%

Wilcoxon/Bonferroni Adj Test

Control vs	Control II	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	14.9*	43	NA	1	14	Exact	0.0250	Significant Effect
	19.8	52.5	NA	3	14	Exact	0.3742	Non-Significant Effect
	23.4*	36	NA	0	14	Exact	5.4E-04	Significant Effect
	33*	41	NA	1	14	Exact	0.0082	Significant Effect
	51.6*	37	NA	0	14	Exact	0.0011	Significant Effect
	86.4*	37	NA	0	14	Exact	0.0011	Significant Effect
	160*	28	NA	0	13	Exact	0.0011	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	5.398	3.218	2.3E-07	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1623.16	231.88	7	9.401	1.3E-07	Significant Effect
Error	1356.55	24.6646	55			
Total	2979.71		62			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	69.99	18.48	<1.0E-37	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.7527	0.9481	5.9E-09	Non-Normal Distribution

Reproduction Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	N	8	17.75	7.445	28.05		7	43	4.358	69.44%	0.00%
14.9		8	6.75	4.313	9.187		4	13	1.031	43.19%	61.97%
19.8		8	10.38	7.249	13.5		6	18	1.322	36.04%	41.55%
23.4		8	3.5	2.159	4.841		0	5	0.5669	45.82%	80.28%
33		8	7.75	5.867	9.633		5	11	0.7962	29.06%	56.34%
51.6		8	4.375	2.43	6.32		3	10	0.8224	53.17%	75.35%
86.4		8	2.875	0.806	4.944		0	8	0.875	86.08%	83.80%
160		7	0.2857	-0.1656	0.737		0	1	0.1844	170.78%	98.39%

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID: 00-6127-6629 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 16 Aug-17 9:38 **Analysis:** Nonparametric-Multiple Comparison **Official Results:** Yes

Reproduction Detail

Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
0	N	30	43	11	16	7	12	11	12
14.9		5	7	7	13	4	6	8	4
19.8		18	11	7	12	11	8	10	6
23.4		5	3	4	4	3	0	5	4
33		11	6	5	6	6	9	9	10
51.6		3	4	10	3	4	4	4	3
86.4		4	8	4	2	0	2	2	1
160		1	0	0	0	1	0	0	

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	06-1575-9035	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	27 Sep-17 10:52	**Analysis:**	Nonlinear Regression (NLR)	**Official Results:**	Yes

Batch ID:	20-1465-8193	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal: ω=1	Off: μ*=μ	None	None

Regression Summary

Iters	Log LL	AICc	BIC	Adj R2	Optimize	F Stat	Critical	P-Value	Decision(α:5%)
7	-60.93	128.3	133.9	0.3726	Yes	8.272	2.565	0.0000	Significant Lack of Fit

Point Estimates

Level	ug/L	95% LCL	95% UCL
IC5	21.27	n/a	38.85
IC10	28.35	n/a	43.15
IC15	33.86	n/a	50.04
IC20	38.71	n/a	56.72
IC25	43.23	17.53	62.88
IC40	56.42	36.46	80.07
IC50	65.94	46.08	94.35

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	7.511	1.013	5.478	9.544	7.413	<1.0E-37	Significant Parameter
γ	2.603	1.353	-0.1123	5.318	1.924	0.0599	Non-Significant Parameter
δ	65.94	14.51	36.81	95.06	4.543	3.3E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	1822	607.3	3	63.79	<1.0E-37	Significant
Lack of Fit	202	50.51	4	8.272	3.7E-05	Significant
Pure Error	293.1	6.105	48			
Residual	495.1	9.521	52			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.568	3.166	0.0080	Outlier Detected
Variances	Mod Levene Equality of Variance	1.364	2.299	0.2487	Equal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9206	0.9575	0.0014	Non-Normal Distribution
	Anderson-Darling A2 Normality Te	1.787	2.492	<1.0E-37	Non-Normal Distribution

Reproduction Summary

			Calculated Variate						
Conc-ug/L	**Code**	**Count**	**Mean**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
14.9	N	8	6.75	4	13	1.031	2.915	43.19%	0.00%
19.8		8	10.38	6	18	1.322	3.739	36.04%	-53.70%
23.4		8	3.5	0	5	0.5669	1.604	45.82%	48.15%
33		8	7.75	5	11	0.7962	2.252	29.06%	-14.81%
51.6		8	4.375	3	10	0.8224	2.326	53.17%	35.19%
86.4		8	2.875	0	8	0.875	2.475	86.08%	57.41%
160		7	0.2857	0	1	0.1844	0.488	170.78%	95.77%

Analysis ID: 06-1575-9035 **Endpoint:** Reproduction **CETIS Version:** CETISv1.9.0
Analyzed: 27 Sep-17 10:52 **Analysis:** Nonlinear Regression (NLR) **Official Results:** Yes

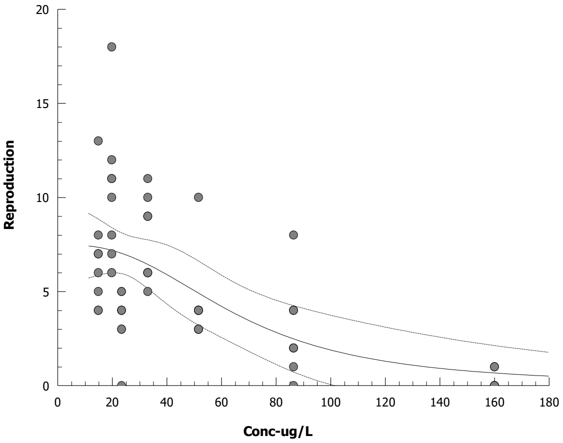
Reproduction Detail

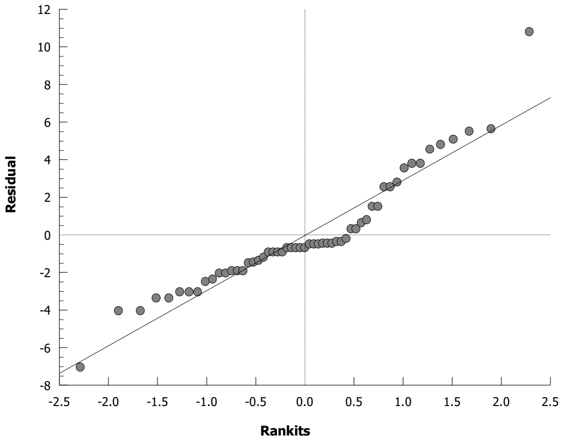
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
14.9	N	5	7	7	13	4	6	8	4
19.8		18	11	7	12	11	8	10	6
23.4		5	3	4	4	3	0	5	4
33		11	6	5	6	6	9	9	10
51.6		3	4	10	3	4	4	4	3
86.4		4	8	4	2	0	2	2	1
160		1	0	0	0	1	0	0	

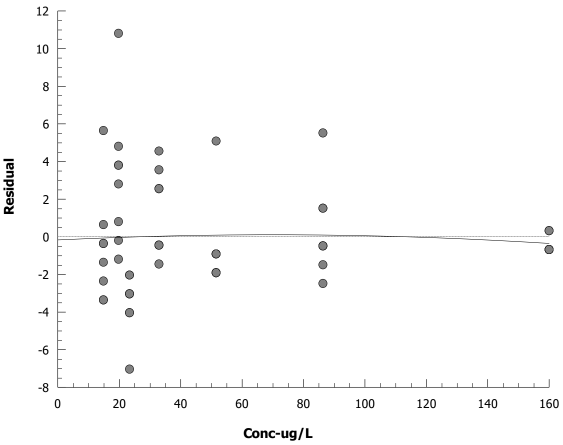
Graphics

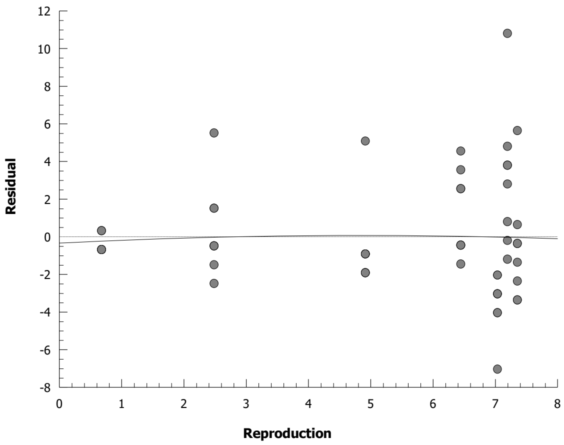
Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ]

Distribution: Normal [ω=1]









CETIS Analytical Report

Report Date:	27 Sep-17 10:56 (p 1 of 2)
Test Code:	SP1617-029 Har | 10-1411-0638

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	18-0810-7755	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	27 Sep-17 10:55	**Analysis:**	Nonparametric-Multiple Comparison	**Official Results:**	Yes

Batch ID:	20-1465-8193	**Test Type:**	Survival-Reproduction	**Analyst:**	Leila Oosterbroek
Start Date:	25 May-17	**Protocol:**	EPA/600/R-99/064 (2000)	**Diluent:**	Not Applicable
Ending Date:	06 Jul-17	**Species:**	Hyalella azteca	**Brine:**	
Duration:	42d 0h	**Source:**	Chesapeak Cultures	**Age:**	

Sample ID:	02-7886-7783	**Code:**	SP1617-029	**Client:**	Minnow Environmental
Sample Date:	05 May-17	**Material:**	Dissolved Copper	**Project:**	
Receipt Date:	12 May-17	**Source:**	Minnow Environmental		
Sample Age:	20d 0h (6 °C)	**Station:**	Minto		

Data Transform	Alt Hyp	Trials	Seed	TST b	NOEL	LOEL	TOEL	TU	PMSD
Untransformed	C > T	n/a	n/a	n/a	51.6	86.4	66.77		47.0%

Wilcoxon/Bonferroni Adj Test

Control vs	Conc-ug/L	Test Stat	Critical	Ties	DF	P-Type	P-Value	Decision(α:5%)
Negative Control	19.8	87	NA	3	14	Exact	1.0000	Non-Significant Effect
	23.4*	44	NA	2	14	Exact	0.0312	Significant Effect
	33	77	NA	2	14	Exact	1.0000	Non-Significant Effect
	51.6	47	NA	1	14	Exact	0.0639	Non-Significant Effect
	86.4*	44.5	NA	2	14	Exact	0.0340	Significant Effect
	160*	28	NA	0	13	Exact	9.3E-04	Significant Effect

Auxiliary Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:5%)
Extreme Value	Grubbs Extreme Value Test	3.273	3.166	0.0317	Outlier Detected

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	526.328	87.7214	6	14.37	<1.0E-37	Significant Effect
Error	293.054	6.10528	48			
Total	819.382		54			

Distributional Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variances	Bartlett Equality of Variance Test	18.49	16.81	0.0051	Unequal Variances
Distribution	Shapiro-Wilk W Normality Test	0.9119	0.9417	6.6E-04	Non-Normal Distribution

Reproduction Summary

Conc-ug/L	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
14.9	N	8	6.75	4.313	9.187	6.5	4	13	1.031	43.19%	0.00%
19.8		8	10.38	7.249	13.5	10.5	6	18	1.322	36.04%	-53.70%
23.4		8	3.5	2.159	4.841	4	0	5	0.5669	45.82%	48.15%
33		8	7.75	5.867	9.633	7.5	5	11	0.7962	29.06%	-14.81%
51.6		8	4.375	2.43	6.32	4	3	10	0.8224	53.17%	35.19%
86.4		8	2.875	0.806	4.944	2	0	8	0.875	86.08%	57.41%
160		7	0.2857	-0.1656	0.737	0	0	1	0.1844	170.78%	95.77%

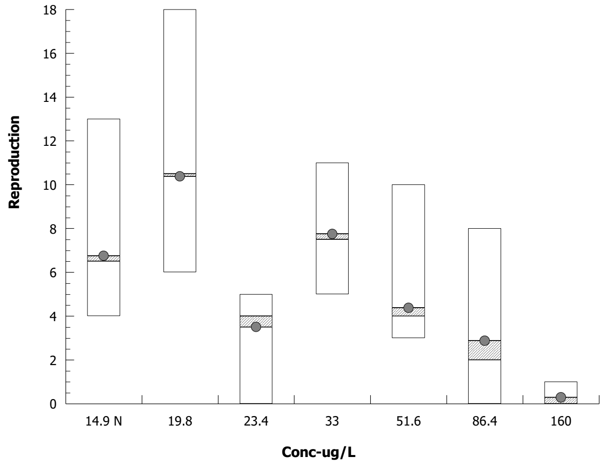
Reproduction Detail

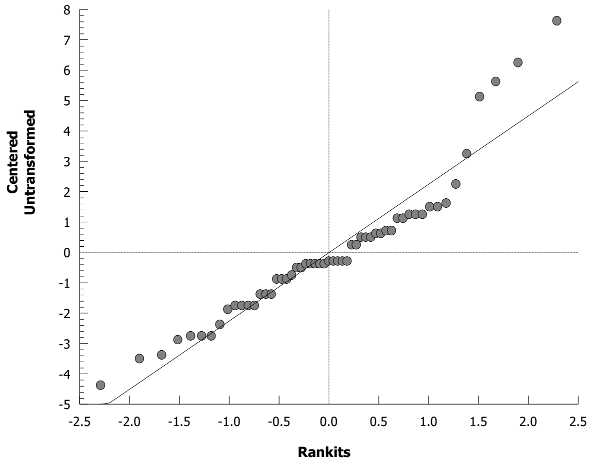
Conc-ug/L	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8
14.9	N	5	7	7	13	4	6	8	4
19.8		18	11	7	12	11	8	10	6
23.4		5	3	4	4	3	0	5	4
33		11	6	5	6	6	9	9	10
51.6		3	4	10	3	4	4	4	3
86.4		4	8	4	2	0	2	2	1
160		1	0	0	0	1	0	0	

Hyalella 42-d Survival, Growth, and Reproduction Sediment Test **Nautilus Environmental Calgary**

Analysis ID:	18-0810-7755	**Endpoint:**	Reproduction	**CETIS Version:**	CETISv1.9.0
Analyzed:	27 Sep-17 10:55	**Analysis:**	Nonparametric-Multiple Comparison	**Official Results:**	Yes

Graphics





APPENDIX E – Analytical Chemistry Data

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 25-MAY-17
Report Date: 01-JUN-17 18:14 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1931693
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

H McKenzie

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1931693-1	L1931693-2	L1931693-3	L1931693-4	L1931693-5
	Description	WATER	WATER	WATER	WATER	WATER
	Sampled Date	25-MAY-17	25-MAY-17	25-MAY-17	25-MAY-17	25-MAY-17
	Sampled Time					
	Client ID	MHW CONTROL	5 UG/L	10 UG/L	20 UG/L	40 UG/L
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.00054	0.0266	0.0323	0.0425	0.0615
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Copper (Cu)-Dissolved (mg/L)	0.00032	0.0249	0.0304	0.0394	0.0569

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1931693-6	L1931693-7	L1931693-8		
	Description	WATER	WATER	WATER		
	Sampled Date	25-MAY-17	25-MAY-17	25-MAY-17		
	Sampled Time					
	Client ID	80 UG/L	160 UG/L	SITE CONTROL		
Grouping	**Analyte**					
WATER						
Total Metals	Copper (Cu)-Total (mg/L)	0.0999	0.173	0.0231		
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB		
	Copper (Cu)-Dissolved (mg/L)	0.0897	0.173	0.0201		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1931693-7	160 UG/L	LPMB	Lab-Preserved for Total Metals. Sample received with pH > 2 and preserved at the lab. Total Metals results may be biased low.
L1931693-8	SITE CONTROL	LPMB	Lab-Preserved for Total Metals. Sample received with pH > 2 and preserved at the lab. Total Metals results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Copper (Cu)-Dissolved	MS-B	L1931693-1, -2, -3, -4, -5, -6

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

NAUTILUS ENVIRONMENTAL

TESTING LOCATION (Please Circle)

[✓ **Burnaby**
8664 Commerce Court
Burnaby, British Columbia, Canada
V5A 4N7
Phone 604.420.8773]

Calgary
#4, 6125 12 Street SE
Calgary, Alberta, Canada
T2H 2K1
Phone 403.253.7121

Chain of Custody

Date May 25/17 Page 1 of 1

Report to:

Company Nautilus Environmental
Address ①
City/Prov/PC
Contact Emma marus
Phone 604 420 8773
Email emma@nautilusenvironmental.ca

Invoice To:

Company same as report to
Address
City/Prov/PC
Contact
Phone
Email
PO No.

Sample Collection By:

Sample Type: Grab ○ OR Composite ○

	SAMPLE ID	DATE (DD/MM/YY)	TIME	MATRIX	# OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)	COMMENTS	Cu total (low levels)	Cu dissolved (low levels)
1	MHW control	25/05/17	n/a	water	1 x 125mL	test termination		
2	5 µg/L Cu	↓	↓	↓	↓	↓	X	X
3	10 µg/L Cu	↓	↓	↓	↓	↓	X	X
4	20 µg/L Cu	↓	↓	↓	↓	↓	X	X
5	40 µg/L Cu	↓	↓	↓	↓	↓	X	X
6	80 µg/L Cu	↓	↓	↓	↓	↓	X	X
7	160 µg/L Cu	↓	↓	↓	↓	↓	X	X
8	site control	↓	↓	↓	↓	↓	X	X
9								
10								

ANALYSES REQUIRED

Receipt Temperature (°C)

L1931693-COFC

SPECIAL INSTRUCTIONS/COMMENTS (CLIENT)

* (low levels)
* not filtered, not preserved

SAMPLE RECEIPT DETAILS (LABORATORY)

1. Total No. of Containers		4. Ice Present In Cooler?	Y / N
2. Courier		5. Seal Present?	Y / N
3. Good Condition?	Y / N	6. Initials Present on Seal?	Y / N

SAMPLE DESCRIPTION AND COMMENTS (LABORATORY)

RELINQUISHED BY (CLIENT)

Emma marus (Printed Name) (Signature)
Nautilus Environmental (Company) 25/05/17 @ 1600h (Date DD/MM/YY and Time)

RECEIVED BY (LABORATORY)

(Printed Name) 5/25/~~17~~17 17:15 (Signature)
(Company) 22°C (Date DD/MM/YY and Time)

Our liability is limited to the cost of the test requested. The test results only relate to the sample as received. No liability in whole or in part is assumed for the collection, handling, or transport of the sample, application or interpretation of the test data or results in part or in whole.

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

NAUTILUS ENVIRONMENTAL
ATTN: Emma Marcus
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 23-MAY-17
Report Date: 01-JUN-17 17:04 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1930018
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

H McKenzie

Heather McKenzie
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1930018-1 Water 10-MAY-17 MHW CONTROL	L1930018-2 Water 10-MAY-17 5 UG/L CU	L1930018-3 Water 10-MAY-17 10 UG/L CU	L1930018-4 Water 10-MAY-17 20 UG/L CU	L1930018-5 Water 10-MAY-17 40 UG/L CU
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	71				
	Chloride (Cl) (mg/L)	2.86				
	Sulfate (SO4) (mg/L)	21.6				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)					
Total Metals	Copper (Cu)-Total (mg/L)	0.00088	0.0301	0.0357	0.0447	0.0654
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB	LAB	LAB
	Copper (Cu)-Dissolved (mg/L)	0.00034	0.0242	0.0295	0.0386	0.0558

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1930018-6 Water 10-MAY-17 80 UG/L CU	L1930018-7 Water 10-MAY-17 160 UG/L CU	L1930018-8 Water 10-MAY-17 RATIO WATER		
Grouping	**Analyte**					
WATER						
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)			87		
	Chloride (Cl) (mg/L)			2.84		
	Sulfate (SO4) (mg/L)			21.4		
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)			25.5		
Total Metals	Copper (Cu)-Total (mg/L)	0.0953	0.186	0.0241		
Dissolved Metals	Dissolved Metals Filtration Location	LAB	LAB	LAB		
	Copper (Cu)-Dissolved (mg/L)	0.0909	0.163	0.0199		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
LPML	Lab-Preserved for Total Metals. Sample received with pH > 2 and preserved at the lab. Total Metals results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Dissolved Organic Carbon	MS-B	L1930018-8
Matrix Spike	Dissolved Organic Carbon	MS-B	L1930018-8
Matrix Spike	Sulfate (SO4)	MS-B	L1930018-1, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310B TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-VA	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-SCREEN-VA	Water	Conductivity Screen (Internal Use Only)	APHA 2510

Qualitative analysis of conductivity where required during preparation of other tests - e.g. TDS, metals, etc.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1930018-COFC

S
A L

TESTING LOCATION (Please Circle)

Burnaby
8664 Commerce Court
Burnaby, British Columbia, Canada
V5A 4N7
Phone 604.420.8773

Calgary
#4, 6125 12 Street SE
Calgary, Alberta, Canada
T2H 2K1
Phone 403.253.7121

Chain of Custody

Date May/17 Page 1 of 1

Report to:

Company Nautilus Environmental
Address +
City/Prov/PC
Contact Emma Marus
Phone emma@nautilusenvironmental.ca
Email 604 420 8773

Invoice To:

Company same as report to
Address
City/Prov/PC
Contact
Phone
Email
PO No.

Sample Collection By:

Sample Type: Grab ○ OR Composite ○

	SAMPLE ID	DATE (DD/MM/YY)	TIME	MATRIX	# OF CONTAINERS AND VOLUME (e.g. 1 x 20 L)	COMMENTS	Total Cu (low levels)	Dissolved Cu (low levels)	low level metals	alkalinity	Sulphate	Chloride	DOC				Receipt Temperature (°C)
1	MHW control	/05/17	n/a	water	One 125 mL plastic	Day 0 - test initiation	X	X	X	X	X	X					
2	5 µg/L Cu						X	X									
3	10 µg/L Cu						X	X									
4	20 µg/L Cu						X	X									
5	40 µg/L Cu						X	X									
6	80 µg/L Cu						X	X									
7	160 µg/L Cu						X	X									
8	ratio water				ONE 1-L plastic		X	X	X	X	X	X	X				
9																	
10																	

SPECIAL INSTRUCTIONS/COMMENTS (CLIENT)

* low levels
* not filtered, not preserved

SAMPLE RECEIPT DETAILS (LABORATORY)

1. Total No. of Containers		4. Ice Present in Cooler?	Y / N
2. Courier		5. Seal Present?	Y / N
3. Good Condition?	Y / N	6. Initials Present on Seal?	Y / N

SAMPLE DESCRIPTION AND COMMENTS (LABORATORY)

Short Holding Time
Rush Processing

RELINQUISHED BY (CLIENT)

(Printed Name) Emma Marus (Signature)
(Company) Nautilus Environmental (Date DD/MM/YY and Time) /05/17 @ 1600h

RECEIVED BY (LABORATORY)

(Printed Name) Moneer Shah (Signature)
(Company) 16:55 May 23/17 (Date DD/MM/YY and Time)

Our liability is limited to the cost of the test requested. The test results only relate to the sample as received. No liability in whole or in part is assumed for the collection, handling, or transport of the sample, application or interpretation of the test data or results in part or in whole.

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

Form 020; Version 1.2; Revised by CC 2016/10/06

Nautilus Environmental
ATTN: Leila Oosterbroek / Bryon Shore
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Date Received: 24-MAY-17
Report Date: 31-MAY-17 18:47 (MT)
Version: FINAL

Client Phone: 403-253-7121

Certificate of Analysis

Lab Work Order #: L1930675
Project P.O. #: 2016-1161
Job Reference:
C of C Numbers:
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1930675-1 SP1617-029; LAB CONTROL DA - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		30-MAY-17	R3735690
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	1.70		0.50	mg/L		25-MAY-17	R3735229
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735845
Calcium (Ca)-Dissolved	9.90		0.10	mg/L		30-MAY-17	R3735915
Magnesium (Mg)-Dissolved	10.7		0.10	mg/L		30-MAY-17	R3735915
Potassium (K)-Dissolved	2.22		0.50	mg/L		30-MAY-17	R3735915
Sodium (Na)-Dissolved	27.7		1.0	mg/L		30-MAY-17	R3735915
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		25-MAY-17	R3735229
Ion Balance Calculation							
Ion Balance	99.1			%		31-MAY-17	
TDS (Calculated)	156			mg/L		31-MAY-17	
Hardness (as CaCO3)	68.8			mg/L		31-MAY-17	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		25-MAY-17	R3735229
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		29-MAY-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		25-MAY-17	R3735229
Sulfate in Water by IC							
Sulfate (SO4)	68.5		0.30	mg/L		25-MAY-17	R3735229
pH, Conductivity and Total Alkalinity							
pH	7.90		0.10	pH		31-MAY-17	R3736730
Conductivity (EC)	245		2.0	uS/cm		31-MAY-17	R3736730
Bicarbonate (HCO3)	72.4		5.0	mg/L		31-MAY-17	R3736730
Carbonate (CO3)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Hydroxide (OH)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Alkalinity, Total (as CaCO3)	59.3		5.0	mg/L		31-MAY-17	R3736730
L1930675-2 SP1617-029; LAB CONTROL FM - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.00055		0.00020	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.00069		0.00050	mg/L		30-MAY-17	R3735690
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	14.2		0.50	mg/L		25-MAY-17	R3735229
Dissolved Metals by ICPOES							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1930675-2 SP1617-029; LAB CONTROL FM - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735845
Calcium (Ca)-Dissolved	59.4		0.10	mg/L		30-MAY-17	R3735915
Magnesium (Mg)-Dissolved	16.6		0.10	mg/L		30-MAY-17	R3735915
Potassium (K)-Dissolved	3.26		0.50	mg/L		30-MAY-17	R3735915
Sodium (Na)-Dissolved	11.4		1.0	mg/L		30-MAY-17	R3735915
Fluoride in Water by IC							
Fluoride (F)	0.135		0.020	mg/L		25-MAY-17	R3735229
Ion Balance Calculation							
Ion Balance	102			%		31-MAY-17	
TDS (Calculated)	269			mg/L		31-MAY-17	
Hardness (as CaCO3)	217			mg/L		31-MAY-17	
Nitrate in Water by IC							
Nitrate (as N)	0.077		0.020	mg/L		25-MAY-17	R3735229
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.077		0.050	mg/L		29-MAY-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		25-MAY-17	R3735229
Sulfate in Water by IC							
Sulfate (SO4)	84.8		0.30	mg/L		25-MAY-17	R3735229
pH, Conductivity and Total Alkalinity							
pH	8.41		0.10	pH		31-MAY-17	R3736730
Conductivity (EC)	411		2.0	uS/cm		31-MAY-17	R3736730
Bicarbonate (HCO3)	147		5.0	mg/L		31-MAY-17	R3736730
Carbonate (CO3)	6.2		5.0	mg/L		31-MAY-17	R3736730
Hydroxide (OH)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Alkalinity, Total (as CaCO3)	131		5.0	mg/L		31-MAY-17	R3736730
L1930675-3 SP1617-029; LAB CONTROL HA - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		30-MAY-17	R3735690
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	74.9		0.50	mg/L		25-MAY-17	R3735229
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735845
Calcium (Ca)-Dissolved	44.6		0.10	mg/L		30-MAY-17	R3735915
Magnesium (Mg)-Dissolved	6.45		0.10	mg/L		30-MAY-17	R3735915
Potassium (K)-Dissolved	2.51		0.50	mg/L		30-MAY-17	R3735915
Sodium (Na)-Dissolved	27.4		1.0	mg/L		30-MAY-17	R3735915
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		25-MAY-17	R3735229
Ion Balance Calculation							
Ion Balance	106			%		31-MAY-17	
TDS (Calculated)	215			mg/L		31-MAY-17	
Hardness (as CaCO3)	138			mg/L		31-MAY-17	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1930675-3 SP1617-029; LAB CONTROL HA - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		25-MAY-17	R3735229
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		29-MAY-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		25-MAY-17	R3735229
Sulfate in Water by IC							
Sulfate (SO4)	24.8		0.30	mg/L		25-MAY-17	R3735229
pH, Conductivity and Total Alkalinity							
pH	7.99		0.10	pH		31-MAY-17	R3736730
Conductivity (EC)	381		2.0	uS/cm		31-MAY-17	R3736730
Bicarbonate (HCO3)	69.7		5.0	mg/L		31-MAY-17	R3736730
Carbonate (CO3)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Hydroxide (OH)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Alkalinity, Total (as CaCO3)	57.1		5.0	mg/L		31-MAY-17	R3736730
L1930675-4 SP1617-029; SITE CONTROL DA,FM - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.0121	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0140	DLM	0.0025	mg/L		30-MAY-17	R3735690
Miscellaneous Parameters							
Dissolved Organic Carbon	32	DLM	10	mg/L		27-MAY-17	R3732892
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	2.40		0.50	mg/L		25-MAY-17	R3735229
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735845
Calcium (Ca)-Dissolved	26.7		0.10	mg/L		30-MAY-17	R3735915
Magnesium (Mg)-Dissolved	7.94		0.10	mg/L		30-MAY-17	R3735915
Potassium (K)-Dissolved	2.04		0.50	mg/L		30-MAY-17	R3735915
Sodium (Na)-Dissolved	7.2		1.0	mg/L		30-MAY-17	R3735915
Fluoride in Water by IC							
Fluoride (F)	0.126		0.020	mg/L		25-MAY-17	R3735229
Ion Balance Calculation							
Ion Balance	107			%		31-MAY-17	
TDS (Calculated)	118			mg/L		31-MAY-17	
Hardness (as CaCO3)	99.4			mg/L		31-MAY-17	
Nitrate in Water by IC							
Nitrate (as N)	0.571		0.020	mg/L		25-MAY-17	R3735229
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.587		0.050	mg/L		29-MAY-17	
Nitrite in Water by IC							
Nitrite (as N)	0.016		0.010	mg/L		25-MAY-17	R3735229
Sulfate in Water by IC							
Sulfate (SO4)	17.4		0.30	mg/L		25-MAY-17	R3735229
pH, Conductivity and Total Alkalinity							
pH	7.57		0.10	pH		31-MAY-17	R3736730
Conductivity (EC)	192		2.0	uS/cm		31-MAY-17	R3736730

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1930675-4 SP1617-029; SITE CONTROL DA,FM - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
pH, Conductivity and Total Alkalinity							
Bicarbonate (HCO3)	105		5.0	mg/L		31-MAY-17	R3736730
Carbonate (CO3)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Hydroxide (OH)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Alkalinity, Total (as CaCO3)	85.7		5.0	mg/L		31-MAY-17	R3736730
L1930675-5 SP1617-029; SITE CONTROL HA - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Miscellaneous Parameters							
Dissolved Organic Carbon	32	DLM	10	mg/L		27-MAY-17	R3732892
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	25.5		0.50	mg/L		25-MAY-17	R3735229
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735845
Calcium (Ca)-Dissolved	26.9		0.10	mg/L		30-MAY-17	R3735915
Magnesium (Mg)-Dissolved	8.00		0.10	mg/L		30-MAY-17	R3735915
Potassium (K)-Dissolved	2.05		0.50	mg/L		30-MAY-17	R3735915
Sodium (Na)-Dissolved	24.2		1.0	mg/L		30-MAY-17	R3735915
Fluoride in Water by IC							
Fluoride (F)	0.127		0.020	mg/L		25-MAY-17	R3735229
Ion Balance Calculation							
Ion Balance	110			%		31-MAY-17	
TDS (Calculated)	157			mg/L		31-MAY-17	
Hardness (as CaCO3)	100			mg/L		31-MAY-17	
Nitrate in Water by IC							
Nitrate (as N)	0.550		0.020	mg/L		25-MAY-17	R3735229
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.564		0.050	mg/L		29-MAY-17	
Nitrite in Water by IC							
Nitrite (as N)	0.014		0.010	mg/L		25-MAY-17	R3735229
Sulfate in Water by IC							
Sulfate (SO4)	17.2		0.30	mg/L		25-MAY-17	R3735229
pH, Conductivity and Total Alkalinity							
pH	7.60		0.10	pH		31-MAY-17	R3736730
Conductivity (EC)	265		2.0	uS/cm		31-MAY-17	R3736730
Bicarbonate (HCO3)	103		5.0	mg/L		31-MAY-17	R3736730
Carbonate (CO3)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Hydroxide (OH)	<5.0		5.0	mg/L		31-MAY-17	R3736730
Alkalinity, Total (as CaCO3)	84.2		5.0	mg/L		31-MAY-17	R3736730
L1930675-6 SP1617-029; 5 UG/L CU - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.0165	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0199	DLM	0.0025	mg/L		30-MAY-17	R3735690

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1930675-7 SP1617-029; 10 UG/L CU - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.0223	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0242	DLM	0.0025	mg/L		30-MAY-17	R3735690
L1930675-8 SP1617-029; 20 UG/L CU - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.0297	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0329	DLM	0.0025	mg/L		30-MAY-17	R3735690
L1930675-9 SP1617-029; 40 UG/L CU - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.0466	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0514	DLM	0.0025	mg/L		30-MAY-17	R3735690
L1930675-10 SP1617-029; 80 UG/L CU - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.0850	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0951	DLM	0.0025	mg/L		30-MAY-17	R3735690
L1930675-11 SP1617-029; 160 UG/L CU - WEEK 1							
Sampled By: CLIENT on 24-MAY-17 @ 12:00							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					30-MAY-17	R3735671
Copper (Cu)-Dissolved	0.144	DLM	0.0010	mg/L		30-MAY-17	R3735690
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.168	DLM	0.0025	mg/L		30-MAY-17	R3735690

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1930675-11	SP1617-029; 160 UG/L CU - WEEK 1							
Sampled By:	CLIENT on 24-MAY-17 @ 12:00							
Matrix:	WATER							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	DOC, MET-DISS - Sample was Filtered and Preserved at the laboratory
EXTEMP10	12C (SAME DAY SAMPLING) - Samples Received with temperature >10 Degrees C

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

IONBALANCE-CL	Water	Ion Balance Calculation	APHA 1030E
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	APHA 3030B/EPA 6010B

"This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (APHA Method 3030B) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-CL	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-N-CL	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample’s capacity to neutralize acid
Conductivity measurement is based on the sample’s capacity to convey an electric current

SO4-IC-N-CL	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Quality Control Report

Workorder: L1930675 Report Date: 31-MAY-17

Client:
Nautilus Environmental
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Contact: Leila Oosterbroek / Bryon Shore

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-CL	**Water**							
Batch R3732892								
WG2536271-10 LCS								
Dissolved Organic Carbon			102.9		%		80-120	27-MAY-17
WG2536271-6 LCS								
Dissolved Organic Carbon			101.7		%		80-120	27-MAY-17
WG2536271-5 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	27-MAY-17
WG2536271-9 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	27-MAY-17
CL-IC-N-CL	**Water**							
Batch R3735229								
WG2537022-3 DUP		**L1930675-3**						
Chloride (Cl)		74.9	75.0		mg/L	0.0	20	25-MAY-17
WG2537022-2 LCS								
Chloride (Cl)			97.0		%		90-110	25-MAY-17
WG2537022-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	25-MAY-17
WG2537022-4 MS		**L1930675-3**						
Chloride (Cl)			89.6		%		75-125	25-MAY-17
F-IC-N-CL	**Water**							
Batch R3735229								
WG2537022-3 DUP		**L1930675-3**						
Fluoride (F)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	25-MAY-17
WG2537022-2 LCS								
Fluoride (F)			91.8		%		90-110	25-MAY-17
WG2537022-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	25-MAY-17
WG2537022-4 MS		**L1930675-3**						
Fluoride (F)			85.6		%		75-125	25-MAY-17
MET-D-CCMS-CL	**Water**							
Batch R3735690								
WG2537603-8 DUP		**L1930675-1**						
Copper (Cu)-Dissolved		<0.00020	<0.00020	RPD-NA	mg/L	N/A	20	30-MAY-17
WG2537603-10 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.3		%		80-120	30-MAY-17
WG2537603-13 LCS		**TMRM**						
Copper (Cu)-Dissolved			90.7		%		80-120	30-MAY-17
WG2537603-16 LCS		**TMRM**						
Copper (Cu)-Dissolved			100.4		%		80-120	30-MAY-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R3735690								
WG2537603-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			99.0		%		80-120	30-MAY-17
WG2537603-7 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.8		%		80-120	30-MAY-17
WG2537603-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	30-MAY-17
WG2537603-12 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	30-MAY-17
WG2537603-6 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	30-MAY-17
WG2537603-9 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	30-MAY-17
MET-DIS-ICP-CL	**Water**							
Batch R3735915								
WG2537775-2 DUP		**L1930675-1**						
Calcium (Ca)-Dissolved		9.90	9.99		mg/L	0.9	20	30-MAY-17
Magnesium (Mg)-Dissolved		10.7	10.8		mg/L	1.0	20	30-MAY-17
Potassium (K)-Dissolved		2.22	2.23		mg/L	0.3	20	30-MAY-17
Sodium (Na)-Dissolved		27.7	28.0		mg/L	1.2	20	30-MAY-17
WG2537762-2 LCS		**TMRM**						
Calcium (Ca)-Dissolved			97.9		%		80-120	30-MAY-17
Magnesium (Mg)-Dissolved			93.7		%		80-120	30-MAY-17
Potassium (K)-Dissolved			95.4		%		80-120	30-MAY-17
Sodium (Na)-Dissolved			97.6		%		80-120	30-MAY-17
WG2537762-6 LCS		**TMRM**						
Calcium (Ca)-Dissolved			94.9		%		80-120	30-MAY-17
Magnesium (Mg)-Dissolved			100.2		%		80-120	30-MAY-17
Potassium (K)-Dissolved			99.2		%		80-120	30-MAY-17
Sodium (Na)-Dissolved			100.1		%		80-120	30-MAY-17
WG2537762-9 LCS		**TMRM**						
Calcium (Ca)-Dissolved			97.6		%		80-120	30-MAY-17
Magnesium (Mg)-Dissolved			95.4		%		80-120	30-MAY-17
Potassium (K)-Dissolved			96.7		%		80-120	30-MAY-17
Sodium (Na)-Dissolved			94.7		%		80-120	30-MAY-17
WG2537762-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	30-MAY-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	30-MAY-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-CL	**Water**							
Batch R3735915								
WG2537762-1 MB								
Potassium (K)-Dissolved			<0.50		mg/L		0.5	30-MAY-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	30-MAY-17
WG2537762-5 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	30-MAY-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	30-MAY-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	30-MAY-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	30-MAY-17
WG2537762-8 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	30-MAY-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	30-MAY-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	30-MAY-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	30-MAY-17
MET-T-CCMS-CL	**Water**							
Batch R3732362								
WG2535665-2 LCS		**TMRM**						
Copper (Cu)-Total			94.1		%		80-120	26-MAY-17
WG2535665-5 LCS		**TMRM**						
Copper (Cu)-Total			95.7		%		80-120	26-MAY-17
WG2535665-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	26-MAY-17
WG2535665-4 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	26-MAY-17
NO2-IC-N-CL	**Water**							
Batch R3735229								
WG2537022-3 DUP		**L1930675-3**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	25-MAY-17
WG2537022-2 LCS								
Nitrite (as N)			100.1		%		90-110	25-MAY-17
WG2537022-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	25-MAY-17
WG2537022-4 MS		**L1930675-3**						
Nitrite (as N)			92.8		%		75-125	25-MAY-17
NO3-IC-N-CL	**Water**							

Test		Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-IC-N-CL		**Water**							
Batch	**R3735229**								
WG2537022-3	**DUP**		**L1930675-3**						
Nitrate (as N)			<0.020	<0.020	RPD-NA	mg/L	N/A	20	25-MAY-17
WG2537022-2	**LCS**								
Nitrate (as N)				97.1		%		90-110	25-MAY-17
WG2537022-1	**MB**								
Nitrate (as N)				<0.020		mg/L		0.02	25-MAY-17
WG2537022-4	**MS**		**L1930675-3**						
Nitrate (as N)				90.4		%		75-125	25-MAY-17
PH/EC/ALK-CL		**Water**							
Batch	**R3736730**								
WG2538754-3	**DUP**		**L1930675-1**						
pH			7.90	7.94	J	pH	0.04	0.2	31-MAY-17
Conductivity (EC)			245	247		uS/cm	0.8	10	31-MAY-17
Bicarbonate (HCO3)			72.4	72.1		mg/L	0.3	20	31-MAY-17
Carbonate (CO3)			<5.0	<5.0	RPD-NA	mg/L	N/A	20	31-MAY-17
Hydroxide (OH)			<5.0	<5.0	RPD-NA	mg/L	N/A	20	31-MAY-17
Alkalinity, Total (as CaCO3)			59.3	59.1		mg/L	0.3	20	31-MAY-17
WG2538754-2	**LCS**								
pH				6.98		pH		6.9-7.1	31-MAY-17
Conductivity (EC)				97.5		%		90-110	31-MAY-17
Alkalinity, Total (as CaCO3)				102.5		%		85-115	31-MAY-17
WG2538754-1	**MB**								
Conductivity (EC)				<2.0		uS/cm		2	31-MAY-17
Bicarbonate (HCO3)				<5.0		mg/L		5	31-MAY-17
Carbonate (CO3)				<5.0		mg/L		5	31-MAY-17
Hydroxide (OH)				<5.0		mg/L		5	31-MAY-17
Alkalinity, Total (as CaCO3)				<5.0		mg/L		5	31-MAY-17
SO4-IC-N-CL		**Water**							
Batch	**R3735229**								
WG2537022-3	**DUP**		**L1930675-3**						
Sulfate (SO4)			24.8	24.8		mg/L	0.0	20	25-MAY-17
WG2537022-2	**LCS**								
Sulfate (SO4)				98.0		%		90-110	25-MAY-17
WG2537022-1	**MB**								
Sulfate (SO4)				<0.30		mg/L		0.3	25-MAY-17
WG2537022-4	**MS**		**L1930675-3**						
Sulfate (SO4)				90.9		%		75-125	25-MAY-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1930675-COFC

COC Number: 14 -

Page ____ of ____

Report To	
Company:	Nautilus Environmental
Contact:	Leila Oosterbroek
Address:	#4, 6125 12 St SE Calgary, AB T2H 2K1
Phone:	403-253-7121
Invoice To	Same as Report To ☑ Yes ☐ No
	Copy of Invoice with Report ☑ Yes ☐ No
Company:	
Contact:	
Project Information	
ALS Quote #:	Q55972
Job #:	
PO / AFE:	PO 206-1161
LSD:	
ALS Lab Work Order # (lab use only)	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax leila@nautilusenvironmental.ca
Email 2 bryon@nautilusenvironmental.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax abaccounts@nautilusenvironmental.ca
Email 2 leila@nautilusenvironmental.ca

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	
ALS Contact: Jesse Eagle	**Sampler:**

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

R ☑ Regular (Standard TAT if received by 3 pm - business days)
P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	C-DIS-ORG-CL (dissolved organic carbon)	ROU-CL (Ca, Mg, Na, S)4, Cl, alk)	MET-T-CCMS-1-CL (total copper in water) - (	MET-D-CCMS-1-CL(dissolved copper in wate	FILTER-CL (lab filtered and preserved)									Number of Containers
1	SP1617-029; Lab Control DA - Week 1	2017/05/24	1200	water		R	R	R	R									
2	SP1617-029; Lab Control FM - Week 1			water		R	R	R	R									
3	SP1617-029; Lab Control HA - Week 1			water		R	R	R	R									
4	SP1617-029; Site Control DA,FM - Week 1			water	R	R	R	R	R									
5	SP1617-029; Site Control HA - Week 1			water	R	R			R									
6	SP1617-029; 5 ug/L Cu - Week 1			water			R	R	R									
7	SP1617-029; 10 ug/L Cu - Week 1			water			R	R	R									
8	SP1617-029; 20 ug/L Cu - Week 1			water			R	R	R									
9	SP1617-029; 40 ug/L Cu - Week 1			water			R	R	R									
10	SP1617-029; 80 ug/L Cu - Week 1			water			R	R	R									
11	SP1617-029; 160 ug/L Cu - Wekk 1			water			R	R	R									

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☐ No
Are samples for human drinking water use?
☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

****For total metals, samples have been preserved. For dissolved parameters (DOC, dissolved metals), samples have not been filtered or preserved; please sub-sample and filter/preserve at the lab (SFPL).****

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice packs Yes ☑ No ☐
Cooling Initiated ☑
SIF Observations Yes ☐ No ☑
Custody seal intact Yes ☑ No ☐

INITIAL COOLER TEMPERATURES °C		FINAL COOLER TEMPERATURES °C		
12°C				

SHIPMENT RELEASE (client use)

Released by: Date: 2017/05/24 Time: 1230

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: Date: 05/24 Time: 1:55pm

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Nautilus Environmental
ATTN: Leila Oosterbroek / Bryon Shore
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Date Received: 31-MAY-17
Report Date: 07-JUN-17 16:16 (MT)
Version: FINAL

Client Phone: 403-253-7121

Certificate of Analysis

Lab Work Order #: L1934434
Project P.O. #: 2016-1166
Job Reference:
C of C Numbers:
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1934434-1 SP1617-029; LAB CONTROL DA - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		07-JUN-17	R3740827
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	1.68		0.50	mg/L		01-JUN-17	R3739045
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					01-JUN-17	R3737130
Calcium (Ca)-Dissolved	14.9		0.10	mg/L		01-JUN-17	R3737139
Magnesium (Mg)-Dissolved	11.8		0.10	mg/L		01-JUN-17	R3737139
Potassium (K)-Dissolved	2.18		0.50	mg/L		01-JUN-17	R3737139
Sodium (Na)-Dissolved	28.3		1.0	mg/L		01-JUN-17	R3737139
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		01-JUN-17	R3739045
Ion Balance Calculation							
Ion Balance	102			%		07-JUN-17	
TDS (Calculated)	178			mg/L		07-JUN-17	
Hardness (as CaCO3)	85.8			mg/L		07-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		01-JUN-17	R3739045
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		02-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		01-JUN-17	R3739045
Sulfate in Water by IC							
Sulfate (SO4)	84.2		0.30	mg/L		01-JUN-17	R3739045
pH, Conductivity and Total Alkalinity							
pH	8.07		0.10	pH		03-JUN-17	R3739944
Conductivity (EC)	289		2.0	uS/cm		03-JUN-17	R3739944
Bicarbonate (HCO3)	70.4		5.0	mg/L		03-JUN-17	R3739944
Carbonate (CO3)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Hydroxide (OH)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Alkalinity, Total (as CaCO3)	57.7		5.0	mg/L		03-JUN-17	R3739944
L1934434-2 SP1617-029; LAB CONTROL FM - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.00076		0.00020	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.00102		0.00050	mg/L		07-JUN-17	R3740827
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	13.7		0.50	mg/L		01-JUN-17	R3739045
Dissolved Metals by ICPOES							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1934434-2 SP1617-029; LAB CONTROL FM - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					01-JUN-17	R3737130
Calcium (Ca)-Dissolved	51.7		0.10	mg/L		01-JUN-17	R3737139
Magnesium (Mg)-Dissolved	15.7		0.10	mg/L		01-JUN-17	R3737139
Potassium (K)-Dissolved	3.24		0.50	mg/L		01-JUN-17	R3737139
Sodium (Na)-Dissolved	11.0		1.0	mg/L		01-JUN-17	R3737139
Fluoride in Water by IC							
Fluoride (F)	0.136		0.020	mg/L		01-JUN-17	R3739045
Ion Balance Calculation							
Ion Balance	106			%		07-JUN-17	
TDS (Calculated)	244			mg/L		07-JUN-17	
Hardness (as CaCO3)	194			mg/L		07-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.175		0.020	mg/L		01-JUN-17	R3739045
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.175		0.050	mg/L		02-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		01-JUN-17	R3739045
Sulfate in Water by IC							
Sulfate (SO4)	80.0		0.30	mg/L		01-JUN-17	R3739045
pH, Conductivity and Total Alkalinity							
pH	8.35		0.10	pH		03-JUN-17	R3739944
Conductivity (EC)	396		2.0	uS/cm		03-JUN-17	R3739944
Bicarbonate (HCO3)	130		5.0	mg/L		03-JUN-17	R3739944
Carbonate (CO3)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Hydroxide (OH)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Alkalinity, Total (as CaCO3)	113		5.0	mg/L		03-JUN-17	R3739944
L1934434-3 SP1617-029; LAB CONTROL HA - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		07-JUN-17	R3740827
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	70.8		0.50	mg/L		01-JUN-17	R3739045
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					01-JUN-17	R3737130
Calcium (Ca)-Dissolved	40.9		0.10	mg/L		01-JUN-17	R3737139
Magnesium (Mg)-Dissolved	5.95		0.10	mg/L		01-JUN-17	R3737139
Potassium (K)-Dissolved	2.19		0.50	mg/L		01-JUN-17	R3737139
Sodium (Na)-Dissolved	25.4		1.0	mg/L		01-JUN-17	R3737139
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		01-JUN-17	R3739045
Ion Balance Calculation							
Ion Balance	106			%		07-JUN-17	
TDS (Calculated)	199			mg/L		07-JUN-17	
Hardness (as CaCO3)	127			mg/L		07-JUN-17	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1934434-3 SP1617-029; LAB CONTROL HA - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		01-JUN-17	R3739045
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		02-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		01-JUN-17	R3739045
Sulfate in Water by IC							
Sulfate (SO4)	23.1		0.30	mg/L		01-JUN-17	R3739045
pH, Conductivity and Total Alkalinity							
pH	8.02		0.10	pH		03-JUN-17	R3739944
Conductivity (EC)	368		2.0	uS/cm		03-JUN-17	R3739944
Bicarbonate (HCO3)	61.5		5.0	mg/L		03-JUN-17	R3739944
Carbonate (CO3)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Hydroxide (OH)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Alkalinity, Total (as CaCO3)	50.4		5.0	mg/L		03-JUN-17	R3739944
L1934434-4 SP1617-029; SITE CONTROL DA, FM - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.0130	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0153	DLM	0.0025	mg/L		07-JUN-17	R3740827
Miscellaneous Parameters							
Dissolved Organic Carbon	25.3	DLA	5.0	mg/L		05-JUN-17	R3740834
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	<2.5	DLHC	2.5	mg/L		01-JUN-17	R3739045
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					01-JUN-17	R3737130
Calcium (Ca)-Dissolved	25.8		0.10	mg/L		01-JUN-17	R3737139
Magnesium (Mg)-Dissolved	7.83		0.10	mg/L		01-JUN-17	R3737139
Potassium (K)-Dissolved	1.92		0.50	mg/L		01-JUN-17	R3737139
Sodium (Na)-Dissolved	7.1		1.0	mg/L		01-JUN-17	R3737139
Fluoride in Water by IC							
Fluoride (F)	0.14	DLHC	0.10	mg/L		01-JUN-17	R3739045
Ion Balance Calculation							
Ion Balance	114	BL:INT		%		07-JUN-17	
TDS (Calculated)	112			mg/L		07-JUN-17	
Hardness (as CaCO3)	96.7			mg/L		07-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.97	DLHC	0.10	mg/L		01-JUN-17	R3739045
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.97		0.11	mg/L		02-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.050	DLHC	0.050	mg/L		01-JUN-17	R3739045
Sulfate in Water by IC							
Sulfate (SO4)	19.9	DLHC	1.5	mg/L		01-JUN-17	R3739045
pH, Conductivity and Total Alkalinity							
pH	8.02		0.10	pH		03-JUN-17	R3739944
Conductivity (EC)	196		2.0	uS/cm		03-JUN-17	R3739944

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1934434-4 SP1617-029; SITE CONTROL DA, FM - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
pH, Conductivity and Total Alkalinity							
Bicarbonate (HCO3)	92.2		5.0	mg/L		03-JUN-17	R3739944
Carbonate (CO3)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Hydroxide (OH)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Alkalinity, Total (as CaCO3)	75.6		5.0	mg/L		03-JUN-17	R3739944
L1934434-5 SP1617-029; SITE CONTROL HA - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Miscellaneous Parameters							
Dissolved Organic Carbon	24.4	DLA	5.0	mg/L		05-JUN-17	R3740834
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	18.0	DLHC	2.5	mg/L		01-JUN-17	R3739045
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					01-JUN-17	R3737130
Calcium (Ca)-Dissolved	26.0		0.10	mg/L		01-JUN-17	R3737139
Magnesium (Mg)-Dissolved	7.82		0.10	mg/L		01-JUN-17	R3737139
Potassium (K)-Dissolved	1.94		0.50	mg/L		01-JUN-17	R3737139
Sodium (Na)-Dissolved	19.1		1.0	mg/L		01-JUN-17	R3737139
Fluoride in Water by IC							
Fluoride (F)	<0.10	DLHC	0.10	mg/L		01-JUN-17	R3739045
Ion Balance Calculation							
Ion Balance	110			%		05-JUN-17	
TDS (Calculated)	142			mg/L		05-JUN-17	
Hardness (as CaCO3)	97.1			mg/L		05-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.60	DLHC	0.10	mg/L		01-JUN-17	R3739045
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.60		0.11	mg/L		02-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.050	DLHC	0.050	mg/L		01-JUN-17	R3739045
Sulfate in Water by IC							
Sulfate (SO4)	16.0	DLHC	1.5	mg/L		01-JUN-17	R3739045
pH, Conductivity and Total Alkalinity							
pH	8.01		0.10	pH		03-JUN-17	R3739944
Conductivity (EC)	250		2.0	uS/cm		03-JUN-17	R3739944
Bicarbonate (HCO3)	102		5.0	mg/L		03-JUN-17	R3739944
Carbonate (CO3)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Hydroxide (OH)	<5.0		5.0	mg/L		03-JUN-17	R3739944
Alkalinity, Total (as CaCO3)	83.9		5.0	mg/L		03-JUN-17	R3739944
L1934434-6 SP1617-029; 5 UG/L CU - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.0179	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0234	DLM	0.0025	mg/L		07-JUN-17	R3740827

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1934434-7 SP1617-029; 10 UG/L CU - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.0219	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0239	DLM	0.0025	mg/L		07-JUN-17	R3740827
L1934434-8 SP1617-029; 20 UG/L CU - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.0315	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0346	DLM	0.0025	mg/L		07-JUN-17	R3740827
L1934434-9 SP1617-029; 40 UG/L CU - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.0502	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0531	DLM	0.0025	mg/L		07-JUN-17	R3740827
L1934434-10 SP1617-029; 80 UG/L CU - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.0838	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0956	DLM	0.0025	mg/L		07-JUN-17	R3740827
L1934434-11 SP1617-029; 160 UG/L CU - WEEK 2							
Sampled By: CLIENT							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					06-JUN-17	R3740803
Copper (Cu)-Dissolved	0.154	DLM	0.0010	mg/L		07-JUN-17	R3740827
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.173	DLM	0.0025	mg/L		07-JUN-17	R3740827

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1934434-11	SP1617-029; 160 UG/L CU - WEEK 2							
Sampled By:	CLIENT							
Matrix:	WATER							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	DISSOLVED CU (EXCEPT FOR -5), DOC FOR -4-5 - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
BL:INT	Balance Reviewed: Interference Or Non-Measured Component
DLA	Detection Limit adjusted for required dilution
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

IONBALANCE-CL	Water	Ion Balance Calculation	APHA 1030E
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	APHA 3030B/EPA 6010B

"This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (APHA Method 3030B) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-CL	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-N-CL	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample's capacity to neutralize acid
Conductivity measurement is based on the sample's capacity to convey an electric current

SO4-IC-N-CL	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Quality Control Report

Workorder: L1934434 Report Date: 07-JUN-17

Client: Nautilus Environmental
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Contact: Leila Oosterbroek / Bryon Shore

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-CL	**Water**							
Batch R3740834								
WG2542500-2 LCS								
Dissolved Organic Carbon			86.7		%		80-120	05-JUN-17
WG2542500-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	05-JUN-17
CL-IC-N-CL	**Water**							
Batch R3739045								
WG2540495-3 DUP		**L1934434-3**						
Chloride (Cl)		70.8	71.1		mg/L	0.4	20	01-JUN-17
WG2540495-2 LCS								
Chloride (Cl)			100.2		%		90-110	01-JUN-17
WG2540495-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-JUN-17
WG2540495-4 MS		**L1934434-3**						
Chloride (Cl)			117.7		%		75-125	01-JUN-17
F-IC-N-CL	**Water**							
Batch R3739045								
WG2540495-3 DUP		**L1934434-3**						
Fluoride (F)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	01-JUN-17
WG2540495-2 LCS								
Fluoride (F)			97.6		%		90-110	01-JUN-17
WG2540495-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	01-JUN-17
WG2540495-4 MS		**L1934434-3**						
Fluoride (F)			114.7		%		75-125	01-JUN-17
MET-D-CCMS-CL	**Water**							
Batch R3740827								
WG2542512-11 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.7		%		80-120	07-JUN-17
WG2542512-14 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.3		%		80-120	07-JUN-17
WG2542512-17 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.4		%		80-120	07-JUN-17
WG2542512-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			98.0		%		80-120	06-JUN-17
WG2542512-20 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.6		%		80-120	07-JUN-17
WG2542512-5 LCS		**TMRM**						
Copper (Cu)-Dissolved			94.9		%		80-120	07-JUN-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R3740827								
WG2542512-8 LCS		**TMRM**						
Copper (Cu)-Dissolved			100.5		%		80-120	07-JUN-17
WG2542512-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	06-JUN-17
WG2542512-10 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	07-JUN-17
WG2542512-13 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	07-JUN-17
WG2542512-16 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	07-JUN-17
WG2542512-19 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	07-JUN-17
WG2542512-4 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	07-JUN-17
WG2542512-7 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	07-JUN-17
MET-DIS-ICP-CL	**Water**							
Batch R3737139								
WG2539249-2 LCS		**TMRM**						
Calcium (Ca)-Dissolved			98.3		%		80-120	01-JUN-17
Magnesium (Mg)-Dissolved			106.0		%		80-120	01-JUN-17
Potassium (K)-Dissolved			98.7		%		80-120	01-JUN-17
Sodium (Na)-Dissolved			104.0		%		80-120	01-JUN-17
WG2539249-6 LCS		**TMRM**						
Calcium (Ca)-Dissolved			98.3		%		80-120	01-JUN-17
Magnesium (Mg)-Dissolved			105.4		%		80-120	01-JUN-17
Potassium (K)-Dissolved			98.4		%		80-120	01-JUN-17
Sodium (Na)-Dissolved			101.7		%		80-120	01-JUN-17
WG2539249-9 LCS		**TMRM**						
Calcium (Ca)-Dissolved			96.9		%		80-120	01-JUN-17
Magnesium (Mg)-Dissolved			106.3		%		80-120	01-JUN-17
Potassium (K)-Dissolved			97.7		%		80-120	01-JUN-17
Sodium (Na)-Dissolved			102.4		%		80-120	01-JUN-17
WG2539249-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	01-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	01-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	01-JUN-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-CL	**Water**							
Batch R3737139								
WG2539249-1 MB								
Sodium (Na)-Dissolved			<1.0		mg/L		1	01-JUN-17
WG2539249-5 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	01-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	01-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	01-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	01-JUN-17
WG2539249-8 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	01-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	01-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	01-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	01-JUN-17
MET-T-CCMS-CL	**Water**							
Batch R3740827								
WG2541694-9 DUP		**L1934434-11**						
Copper (Cu)-Total		0.173	0.171		mg/L	1.2	20	07-JUN-17
WG2541694-2 LCS		**TMRM**						
Copper (Cu)-Total			98.8		%		80-120	07-JUN-17
WG2541694-5 LCS		**TMRM**						
Copper (Cu)-Total			97.7		%		80-120	07-JUN-17
WG2541694-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	07-JUN-17
WG2541694-4 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	07-JUN-17
NO2-IC-N-CL	**Water**							
Batch R3739045								
WG2540495-3 DUP		**L1934434-3**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	01-JUN-17
WG2540495-2 LCS								
Nitrite (as N)			107.2		%		90-110	01-JUN-17
WG2540495-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	01-JUN-17
WG2540495-4 MS		**L1934434-3**						
Nitrite (as N)			119.9		%		75-125	01-JUN-17
NO3-IC-N-CL	**Water**							

Quality Control Report

Workorder: L1934434 Report Date: 07-JUN-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-IC-N-CL	**Water**							
Batch R3739045								
WG2540495-3 DUP		**L1934434-3**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	01-JUN-17
WG2540495-2 LCS								
Nitrate (as N)			100.6		%		90-110	01-JUN-17
WG2540495-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	01-JUN-17
WG2540495-4 MS		**L1934434-3**						
Nitrate (as N)			118.1		%		75-125	01-JUN-17
PH/EC/ALK-CL	**Water**							
Batch R3739944								
WG2541404-11 LCS								
pH			7.01		pH		6.9-7.1	03-JUN-17
Conductivity (EC)			96.4		%		90-110	03-JUN-17
Alkalinity, Total (as CaCO3)			94.4		%		85-115	03-JUN-17
WG2541404-10 MB								
Conductivity (EC)			<2.0		uS/cm		2	03-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	03-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	03-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	03-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	03-JUN-17
SO4-IC-N-CL	**Water**							
Batch R3739045								
WG2540495-3 DUP		**L1934434-3**						
Sulfate (SO4)		23.1	23.2		mg/L	0.4	20	01-JUN-17
WG2540495-2 LCS								
Sulfate (SO4)			102.0		%		90-110	01-JUN-17
WG2540495-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	01-JUN-17
WG2540495-4 MS		**L1934434-3**						
Sulfate (SO4)			118.3		%		75-125	01-JUN-17

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1934434-COFC

:OC Number: 14 -

Page ____ of ____

Report To		**Report Format / Distribution**	
Company:	Nautilus Environmental	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Contact:	Leila Oosterbroek	Quality Control (QC) Report with Report	☑ Yes ☐ No
Address:	#4, 6125 12 St SE Calgary, AB T2H 2K1	☐ Criteria on Report - provide details below if box checked Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Phone:	403-253-7121	Email 1 or Fax	leila@nautilusenvironmental.ca
		Email 2	bryon@nautilusenvironmental.ca
Invoice To	Same as Report To ☑ Yes ☐ No	**Invoice Distribution**	
	Copy of Invoice with Report ☑ Yes ☐ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Company:		Email 1 or Fax	abaccounts@nautilusenvironmental.ca
Contact:		Email 2	leila@nautilusenvironmental.ca
Project Information		**Oil and Gas Required Fields (client use)**	
ALS Quote #:	Q55972	Approver ID:	Cost Center:
Job #:		GL Account:	Routing Code:
PO / AFE:	PO 2016-1106	Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		**ALS Contact:** Jesse Eagle	**Sampler:**

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

- R ☑ Regular (Standard TAT if received by 3 pm - business days)
- P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
- E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
- E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	C-DIS-ORG-CL (dissolved organic carbon)	ROU-CL (Ca, Mg, Na, S)4, Cl, alk)	MET-T-CCMS-1-CL (total copper in water) - (l	MET-D-CCMS-1-CL(dissolved copper in wate	FILTER-CL (lab filtered and preserved)									Number of Containers
1	SP1617-029; Lab Control DA - Week 2			water		R	R	R	R									
2	SP1617-029; Lab Control FM - Week 2			water		R	R	R	R									
3	SP1617-029; Lab Control HA - Week 2			water		R	R	R	R									
4	SP1617-029; Site Control DA,FM - Week 2			water	R	R	R	R	R									
5	SP1617-029; Site Control HA - Week 2			water	R	R			R									
6	SP1617-029; 5 ug/L Cu - Week 2			water			R	R	R									
7	SP1617-029; 10 ug/L Cu - Week 2			water			R	R	R									
8	SP1617-029; 20 ug/L Cu - Week 2			water			R	R	R									
9	SP1617-029; 40 ug/L Cu - Week 2			water			R	R	R									
10	SP1617-029; 80 ug/L Cu - Week 2			water			R	R	R									
11	SP1617-029; 160 ug/L Cu - Week 2			water			R	R	R									

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☐ No

Are samples for human drinking water use?
☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

****For total metals, samples have been preserved. For dissolved parameters (DOC, dissolved metals), samples have not been filtered or preserved; please sub-sample and filter/preserve at the lab (SFPL).****

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice packs Yes ☑ No ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9.8					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 2019/05/31	Time: 1130	Received by:	Date: 5/31	Time: 2:53	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW)** System, please submit using an **Authorized DW COC form.**

Nautilus Environmental
ATTN: Leila Oosterbroek / Bryon Shore
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Date Received:	08-JUN-17
Report Date:	19-JUN-17 12:14 (MT)
Version:	FINAL

Client Phone: 403-253-7121

Certificate of Analysis

Lab Work Order #:	L1939142
Project P.O. #:	2016-1171
Job Reference:	
C of C Numbers:	
Legal Site Desc:	

Nelson Kwan, B.Sc.
Account Manager

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1939142-1 SP1617-029; LAB CONTROL DA - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		15-JUN-17	R3748654
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	1.64		0.50	mg/L		09-JUN-17	R3747721
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3747677
Calcium (Ca)-Dissolved	14.6		0.10	mg/L		14-JUN-17	R3747514
Magnesium (Mg)-Dissolved	12.8		0.10	mg/L		14-JUN-17	R3747514
Potassium (K)-Dissolved	2.31		0.50	mg/L		14-JUN-17	R3747514
Sodium (Na)-Dissolved	29.6		1.0	mg/L		14-JUN-17	R3747514
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		09-JUN-17	R3747721
Ion Balance Calculation							
Ion Balance	108			%		15-JUN-17	
TDS (Calculated)	177			mg/L		15-JUN-17	
Hardness (as CaCO3)	89.2			mg/L		15-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		09-JUN-17	R3747721
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		14-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		09-JUN-17	R3747721
Sulfate in Water by IC							
Sulfate (SO4)	81.8		0.30	mg/L		09-JUN-17	R3747721
pH, Conductivity and Total Alkalinity							
pH	8.02		0.10	pH		11-JUN-17	R3745812
Conductivity (EC)	295		2.0	uS/cm		11-JUN-17	R3745812
Bicarbonate (HCO3)	70.5		5.0	mg/L		11-JUN-17	R3745812
Carbonate (CO3)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Hydroxide (OH)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Alkalinity, Total (as CaCO3)	57.8		5.0	mg/L		11-JUN-17	R3745812
L1939142-2 SP1617-029; LAB CONTROL FM - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.00075		0.00020	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.00088		0.00050	mg/L		15-JUN-17	R3748654
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	10.7		0.50	mg/L		09-JUN-17	R3747721
Dissolved Metals by ICPOES							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1939142-2 SP1617-029; LAB CONTROL FM - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3747677
Calcium (Ca)-Dissolved	55.2		0.10	mg/L		14-JUN-17	R3747514
Magnesium (Mg)-Dissolved	15.4		0.10	mg/L		14-JUN-17	R3747514
Potassium (K)-Dissolved	3.21		0.50	mg/L		14-JUN-17	R3747514
Sodium (Na)-Dissolved	8.4		1.0	mg/L		14-JUN-17	R3747514
Fluoride in Water by IC							
Fluoride (F)	0.153		0.020	mg/L		09-JUN-17	R3747721
Ion Balance Calculation							
Ion Balance	105			%		15-JUN-17	
TDS (Calculated)	236			mg/L		15-JUN-17	
Hardness (as CaCO3)	201			mg/L		15-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.149		0.020	mg/L		09-JUN-17	R3747721
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.149		0.050	mg/L		14-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		09-JUN-17	R3747721
Sulfate in Water by IC							
Sulfate (SO4)	65.9		0.30	mg/L		09-JUN-17	R3747721
pH, Conductivity and Total Alkalinity							
pH	8.39		0.10	pH		11-JUN-17	R3745812
Conductivity (EC)	385		2.0	uS/cm		11-JUN-17	R3745812
Bicarbonate (HCO3)	145		5.0	mg/L		11-JUN-17	R3745812
Carbonate (CO3)	5.8		5.0	mg/L		11-JUN-17	R3745812
Hydroxide (OH)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Alkalinity, Total (as CaCO3)	128		5.0	mg/L		11-JUN-17	R3745812
L1939142-3 SP1617-029; LAB CONTROL HA - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		15-JUN-17	R3748654
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	73.1		0.50	mg/L		09-JUN-17	R3747721
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3747677
Calcium (Ca)-Dissolved	44.9		0.10	mg/L		14-JUN-17	R3747514
Magnesium (Mg)-Dissolved	6.79		0.10	mg/L		14-JUN-17	R3747514
Potassium (K)-Dissolved	2.51		0.50	mg/L		14-JUN-17	R3747514
Sodium (Na)-Dissolved	27.8		1.0	mg/L		14-JUN-17	R3747514
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		09-JUN-17	R3747721
Ion Balance Calculation							
Ion Balance	109			%		15-JUN-17	
TDS (Calculated)	214			mg/L		15-JUN-17	
Hardness (as CaCO3)	140			mg/L		15-JUN-17	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1939142-3 SP1617-029; LAB CONTROL HA - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Nitrate in Water by IC							
Nitrate (as N)	<0.020		0.020	mg/L		09-JUN-17	R3747721
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		14-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		09-JUN-17	R3747721
Sulfate in Water by IC							
Sulfate (SO4)	24.0		0.30	mg/L		09-JUN-17	R3747721
pH, Conductivity and Total Alkalinity							
pH	8.01		0.10	pH		11-JUN-17	R3745812
Conductivity (EC)	411		2.0	uS/cm		11-JUN-17	R3745812
Bicarbonate (HCO3)	71.0		5.0	mg/L		11-JUN-17	R3745812
Carbonate (CO3)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Hydroxide (OH)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Alkalinity, Total (as CaCO3)	58.2		5.0	mg/L		11-JUN-17	R3745812
L1939142-4 SP1617-029; SITE CONTROL DA, FM - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.0162	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0205	DLM	0.0025	mg/L		15-JUN-17	R3748654
Miscellaneous Parameters							
Dissolved Organic Carbon	27.4		1.0	mg/L		18-JUN-17	R3750146
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	3.1	DLHC	2.5	mg/L		09-JUN-17	R3747721
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3747677
Calcium (Ca)-Dissolved	24.8	DLM	0.50	mg/L		14-JUN-17	R3747514
Magnesium (Mg)-Dissolved	7.63	DLM	0.50	mg/L		14-JUN-17	R3747514
Potassium (K)-Dissolved	<2.5	DLM	2.5	mg/L		14-JUN-17	R3747514
Sodium (Na)-Dissolved	6.6	DLM	5.0	mg/L		14-JUN-17	R3747514
Fluoride in Water by IC							
Fluoride (F)	<0.10	DLHC	0.10	mg/L		09-JUN-17	R3747721
Ion Balance Calculation							
Ion Balance	89.4	BL:INT		%		15-JUN-17	
TDS (Calculated)	123			mg/L		15-JUN-17	
Hardness (as CaCO3)	93.3			mg/L		15-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.60	DLHC	0.10	mg/L		09-JUN-17	R3747721
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.60		0.11	mg/L		14-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.050	DLHC	0.050	mg/L		09-JUN-17	R3747721
Sulfate in Water by IC							
Sulfate (SO4)	26.8	DLHC	1.5	mg/L		09-JUN-17	R3747721
pH, Conductivity and Total Alkalinity							
pH	7.98		0.10	pH		11-JUN-17	R3745812
Conductivity (EC)	202		2.0	uS/cm		11-JUN-17	R3745812

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1939142-4 SP1617-029; SITE CONTROL DA, FM - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
pH, Conductivity and Total Alkalinity							
Bicarbonate (HCO3)	105		5.0	mg/L		11-JUN-17	R3745812
Carbonate (CO3)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Hydroxide (OH)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Alkalinity, Total (as CaCO3)	85.7		5.0	mg/L		11-JUN-17	R3745812
L1939142-5 SP1617-029; SITE CONTROL HA - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Miscellaneous Parameters							
Dissolved Organic Carbon	28.3		1.0	mg/L		18-JUN-17	R3750146
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	20.1	DLHC	2.5	mg/L		09-JUN-17	R3747721
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3747677
Calcium (Ca)-Dissolved	24.5	DLM	0.50	mg/L		14-JUN-17	R3747514
Magnesium (Mg)-Dissolved	7.50	DLM	0.50	mg/L		14-JUN-17	R3747514
Potassium (K)-Dissolved	<2.5	DLM	2.5	mg/L		14-JUN-17	R3747514
Sodium (Na)-Dissolved	19.0	DLM	5.0	mg/L		14-JUN-17	R3747514
Fluoride in Water by IC							
Fluoride (F)	<0.10	DLHC	0.10	mg/L		09-JUN-17	R3747721
Ion Balance Calculation							
Ion Balance	99.7			%		14-JUN-17	
TDS (Calculated)	141			mg/L		14-JUN-17	
Hardness (as CaCO3)	92.1			mg/L		14-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.60	DLHC	0.10	mg/L		09-JUN-17	R3747721
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.60		0.11	mg/L		14-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.050	DLHC	0.050	mg/L		09-JUN-17	R3747721
Sulfate in Water by IC							
Sulfate (SO4)	15.7	DLHC	1.5	mg/L		09-JUN-17	R3747721
pH, Conductivity and Total Alkalinity							
pH	7.99		0.10	pH		11-JUN-17	R3745812
Conductivity (EC)	266		2.0	uS/cm		11-JUN-17	R3745812
Bicarbonate (HCO3)	106		5.0	mg/L		11-JUN-17	R3745812
Carbonate (CO3)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Hydroxide (OH)	<5.0		5.0	mg/L		11-JUN-17	R3745812
Alkalinity, Total (as CaCO3)	86.6		5.0	mg/L		11-JUN-17	R3745812
L1939142-6 SP1617-029; 5 UG/L CU - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.0196	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0249	DLM	0.0025	mg/L		15-JUN-17	R3748654

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1939142-7 SP1617-029; 10 UG/L CU - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.0241	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0288	DLM	0.0025	mg/L		15-JUN-17	R3748654
L1939142-8 SP1617-029; 20 UG/L CU - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.0328	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0392	DLM	0.0025	mg/L		15-JUN-17	R3748654
L1939142-9 SP1617-029; 40 UG/L CU - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.0503	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0570	DLM	0.0025	mg/L		15-JUN-17	R3748654
L1939142-10 SP1617-029; 80 UG/L CU - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.0820	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0920	DLM	0.0025	mg/L		15-JUN-17	R3748654
L1939142-11 SP1617-029; 160 UG/L CU - WEEK 3							
Sampled By: CLIENT on 07-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					14-JUN-17	R3748795
Copper (Cu)-Dissolved	0.150	DLM	0.0010	mg/L		15-JUN-17	R3748654
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.160	DLM	0.0025	mg/L		15-JUN-17	R3748654

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1939142-11	SP1617-029; 160 UG/L CU - WEEK 3							
Sampled By:	CLIENT on 07-JUN-17							
Matrix:	WATER							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EXTEMP	17C (SAME DAY SAMPLING) - Samples Received with temperature >15 Degrees C
SFPL	DISSOLVED CU (EXCEPT -5) - Sample was Filtered and Preserved at the laboratory
SFPL	DOC FOR -4-5 - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
BL:INT	Balance Reviewed: Interference Or Non-Measured Component
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

ALS Test Code	Matrix	Test Description	Method Reference**
CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
IONBALANCE-CL	Water	Ion Balance Calculation	APHA 1030E
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	APHA 3030B/EPA 6010B

"This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (APHA Method 3030B) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

ALS Test Code	Matrix	Test Description	Method Reference**
N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-CL	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
NO3-IC-N-CL	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

ALS Test Code	Matrix	Test Description	Method Reference**
PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample’s capacity to neutralize acid
Conductivity measurement is based on the sample’s capacity to convey an electric current

ALS Test Code	Matrix	Test Description	Method Reference**
SO4-IC-N-CL	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1939142 Report Date: 19-JUN-17

Client: Nautilus Environmental
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Contact: Leila Oosterbroek / Bryon Shore

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-CL	**Water**							
Batch R3750146								
WG2551177-10 LCS								
Dissolved Organic Carbon			90.4		%		80-120	18-JUN-17
WG2551177-9 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	18-JUN-17
CL-IC-N-CL	**Water**							
Batch R3747721								
WG2548793-23 DUP		**L1939142-1**						
Chloride (Cl)		1.64	1.63		mg/L	0.5	20	09-JUN-17
WG2548793-14 LCS								
Chloride (Cl)			98.5		%		90-110	09-JUN-17
WG2548793-22 LCS								
Chloride (Cl)			99.7		%		90-110	09-JUN-17
WG2548793-13 MB								
Chloride (Cl)			<0.50		mg/L		0.5	09-JUN-17
WG2548793-21 MB								
Chloride (Cl)			<0.50		mg/L		0.5	09-JUN-17
WG2548793-24 MS		**L1939142-1**						
Chloride (Cl)			106.0		%		75-125	09-JUN-17
F-IC-N-CL	**Water**							
Batch R3747721								
WG2548793-23 DUP		**L1939142-1**						
Fluoride (F)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	09-JUN-17
WG2548793-14 LCS								
Fluoride (F)			91.1		%		90-110	09-JUN-17
WG2548793-22 LCS								
Fluoride (F)			96.1		%		90-110	09-JUN-17
WG2548793-13 MB								
Fluoride (F)			<0.020		mg/L		0.02	09-JUN-17
WG2548793-21 MB								
Fluoride (F)			<0.020		mg/L		0.02	09-JUN-17
WG2548793-24 MS		**L1939142-1**						
Fluoride (F)			104.5		%		75-125	09-JUN-17
MET-D-CCMS-CL	**Water**							
Batch R3748654								
WG2549593-3 DUP		**L1939142-11**						
Copper (Cu)-Dissolved		0.150	0.143		mg/L	4.3	20	15-JUN-17
WG2549593-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			92.3		%		80-120	15-JUN-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-CCMS-CL	**Water**							
Batch R3748654								
WG2549593-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	15-JUN-17
MET-DIS-ICP-CL	**Water**							
Batch R3747514								
WG2548742-2 LCS		**TMRM**						
Calcium (Ca)-Dissolved			101.0		%		80-120	14-JUN-17
Magnesium (Mg)-Dissolved			104.2		%		80-120	14-JUN-17
Potassium (K)-Dissolved			101.9		%		80-120	14-JUN-17
Sodium (Na)-Dissolved			103.9		%		80-120	14-JUN-17
WG2548742-6 LCS		**TMRM**						
Calcium (Ca)-Dissolved			94.2		%		80-120	14-JUN-17
Magnesium (Mg)-Dissolved			99.4		%		80-120	14-JUN-17
Potassium (K)-Dissolved			95.1		%		80-120	14-JUN-17
Sodium (Na)-Dissolved			97.6		%		80-120	14-JUN-17
WG2548742-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	14-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	14-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	14-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	14-JUN-17
MET-T-CCMS-CL	**Water**							
Batch R3748654								
WG2547843-2 LCS		**TMRM**						
Copper (Cu)-Total			101.6		%		80-120	15-JUN-17
WG2547843-5 LCS		**TMRM**						
Copper (Cu)-Total			93.6		%		80-120	15-JUN-17
WG2547843-8 LCS		**TMRM**						
Copper (Cu)-Total			99.4		%		80-120	15-JUN-17
WG2547843-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	15-JUN-17
WG2547843-4 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	15-JUN-17
WG2547843-7 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	15-JUN-17
NO2-IC-N-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-IC-N-CL	**Water**							
Batch R3747721								
WG2548793-23 DUP		**L1939142-1**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	09-JUN-17
WG2548793-14 LCS								
Nitrite (as N)			98.7		%		90-110	09-JUN-17
WG2548793-22 LCS								
Nitrite (as N)			99.8		%		90-110	09-JUN-17
WG2548793-13 MB								
Nitrite (as N)			<0.010		mg/L		0.01	09-JUN-17
WG2548793-21 MB								
Nitrite (as N)			<0.010		mg/L		0.01	09-JUN-17
WG2548793-24 MS		**L1939142-1**						
Nitrite (as N)			105.3		%		75-125	09-JUN-17
NO3-IC-N-CL	**Water**							
Batch R3747721								
WG2548793-23 DUP		**L1939142-1**						
Nitrate (as N)		<0.020	<0.020	RPD-NA	mg/L	N/A	20	09-JUN-17
WG2548793-14 LCS								
Nitrate (as N)			98.4		%		90-110	09-JUN-17
WG2548793-22 LCS								
Nitrate (as N)			99.6		%		90-110	09-JUN-17
WG2548793-13 MB								
Nitrate (as N)			<0.020		mg/L		0.02	09-JUN-17
WG2548793-21 MB								
Nitrate (as N)			<0.020		mg/L		0.02	09-JUN-17
WG2548793-24 MS		**L1939142-1**						
Nitrate (as N)			107.9		%		75-125	09-JUN-17
PH/EC/ALK-CL	**Water**							
Batch R3745812								
WG2546566-18 DUP		**L1939142-1**						
pH		8.02	8.01	J	pH	0.01	0.2	11-JUN-17
Conductivity (EC)		295	295		uS/cm	0.0	10	11-JUN-17
Bicarbonate (HCO3)		70.5	72.6		mg/L	2.9	20	11-JUN-17
Carbonate (CO3)		<5.0	<5.0	RPD-NA	mg/L	N/A	20	11-JUN-17
Hydroxide (OH)		<5.0	<5.0	RPD-NA	mg/L	N/A	20	11-JUN-17
Alkalinity, Total (as CaCO3)		57.8	59.5		mg/L	2.9	20	11-JUN-17
WG2546566-14 LCS								
pH			6.98		pH		6.9-7.1	11-JUN-17
Conductivity (EC)			101.4		%		90-110	11-JUN-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-CL	**Water**							
Batch R3745812								
WG2546566-14 LCS								
Alkalinity, Total (as CaCO3)			98.0		%		85-115	11-JUN-17
WG2546566-17 LCS								
pH			6.98		pH		6.9-7.1	11-JUN-17
Conductivity (EC)			101.7		%		90-110	11-JUN-17
Alkalinity, Total (as CaCO3)			92.1		%		85-115	11-JUN-17
WG2546566-13 MB								
Conductivity (EC)			<2.0		uS/cm		2	11-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	11-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	11-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	11-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	11-JUN-17
WG2546566-16 MB								
Conductivity (EC)			<2.0		uS/cm		2	11-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	11-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	11-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	11-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	11-JUN-17
SO4-IC-N-CL	**Water**							
Batch R3747721								
WG2548793-23 DUP		**L1939142-1**						
Sulfate (SO4)		81.8	81.9		mg/L	0.1	20	09-JUN-17
WG2548793-14 LCS								
Sulfate (SO4)			99.5		%		90-110	09-JUN-17
WG2548793-22 LCS								
Sulfate (SO4)			100.8		%		90-110	09-JUN-17
WG2548793-13 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	09-JUN-17
WG2548793-21 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	09-JUN-17
WG2548793-24 MS		**L1939142-1**						
Sulfate (SO4)			104.1		%		75-125	09-JUN-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1939142-COFC

COC Number: 14 -

Page ____ of ____

Report To		**Report Format / Distribution**		**Select Service Level Below** (Rush Turnaround Time (TAT) is not available for all tests)	
Company:	Nautilus Environmental	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R	☑ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Leila Oosterbroek	Quality Control (QC) Report with Report	☑ Yes ☐ No	P	☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	#4, 6125 12 St SE Calgary, AB T2H 2K1	☐ Criteria on Report - provide details below if box checked Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E E2	☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	403-253-7121	Email 1 or Fax	leila@nautilusenvironmental.ca	Specify Date Required for E2,E or P:	
		Email 2	bryon@nautilusenvironmental.ca	**Analysis Request**	
Invoice To	Same as Report To ☑ Yes ☐ No	**Invoice Distribution**		Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below	
	Copy of Invoice with Report ☑ Yes ☐ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX		
Company:		Email 1 or Fax	abaccounts@nautilusenvironmental.ca		
Contact:		Email 2	leila@nautilusenvironmental.ca		
Project Information		**Oil and Gas Required Fields (client use)**			
ALS Quote #:	Q55972	Approver ID:	Cost Center:		
Job #:		GL Account:	Routing Code:		
PO / AFE:	PO 2016-1141	Activity Code:			
LSD:		Location:			
ALS Lab Work Order # (lab use only)		**ALS Contact:** Jesse Eagle	**Sampler:**		

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	C-DIS-ORG-CL (dissolved organic carbon)	ROU-CL (Ca, Mg, Na, S)4, Cl, alk)	MET-T-CCMS-1-CL (total copper in water) - (	MET-D-CCMS-1-CL(dissolved copper in wate	FILTER-CL (lab filtered and preserved)								Number of Containers
1	SP1617-029; Lab Control DA - Week 3	2017/06/07		water		R	R	R	R								
2	SP1617-029; Lab Control FM - Week 3			water		R	R	R	R								
3	SP1617-029; Lab Control HA - Week 3			water		R	R	R	R								
4	SP1617-029; Site Control DA,FM - Week 3			water	R	R	R	R	R								
5	SP1617-029; Site Control HA - Week 3			water	R	R			R								
6	SP1617-029; 5 ug/L Cu - Week 3			water			R	R	R								
7	SP1617-029; 10 ug/L Cu - Week 3			water			R	R	R								
8	SP1617-029; 20 ug/L Cu - Week 3			water			R	R	R								
9	SP1617-029; 40 ug/L Cu - Week 3			water			R	R	R								
10	SP1617-029; 80 ug/L Cu - Week 3			water			R	R	R								
11	SP1617-029; 160 ug/L Cu - Week 3			water			R	R	R								

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☐ No

Are samples for human drinking water use?
☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

****For total metals, samples have been preserved. For dissolved parameters (DOC, dissolved metals), samples have not been filtered or preserved; please sub-sample and filter/preserve at the lab (SFPL).****

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐ No ☐
Ice packs	Yes ☐ No ☐	Custody seal intact	Yes ☐ No ☐
Cooling Initiated	☐		
INITIAL COOLER TEMPERATURES °C	17	FINAL COOLER TEMPERATURES °C	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 2017/06/07	Time: 1130	Received by:	Date: 8/7	Time: 2:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION   WHITE - LABORATORY COPY   YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW)** System, please submit using an **Authorized DW COC form.**

Nautilus Environmental
ATTN: Leila Oosterbroek
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Date Received: 14-JUN-17
Report Date: 27-JUN-17 16:10 (MT)
Version: FINAL

Client Phone: 403-253-7121

Certificate of Analysis

Lab Work Order #: L1941966
Project P.O. #: PO 2016-1178
Job Reference:
C of C Numbers:
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1941966-1 SP1617-029; LAB CONTROL FM - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.00049		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.00058		0.00050	mg/L		24-JUN-17	R3755565
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	9.22		0.50	mg/L		14-JUN-17	R3748757
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					20-JUN-17	R3751591
Calcium (Ca)-Dissolved	53.3		0.10	mg/L		20-JUN-17	R3751650
Magnesium (Mg)-Dissolved	15.3		0.10	mg/L		20-JUN-17	R3751650
Potassium (K)-Dissolved	3.13		0.50	mg/L		20-JUN-17	R3751650
Sodium (Na)-Dissolved	7.3		1.0	mg/L		20-JUN-17	R3751650
Fluoride in Water by IC							
Fluoride (F)	0.161		0.020	mg/L		14-JUN-17	R3748757
Ion Balance Calculation							
Ion Balance	112	BL:INT		%		26-JUN-17	
TDS (Calculated)	224			mg/L		26-JUN-17	
Hardness (as CaCO3)	196			mg/L		26-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.166		0.020	mg/L		14-JUN-17	R3748757
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.166		0.050	mg/L		15-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		14-JUN-17	R3748757
Sulfate in Water by IC							
Sulfate (SO4)	60.3		0.30	mg/L		14-JUN-17	R3748757
pH, Conductivity and Total Alkalinity							
pH	8.40		0.10	pH		19-JUN-17	R3751830
Conductivity (EC)	385		2.0	uS/cm		19-JUN-17	R3751830
Bicarbonate (HCO3)	142		5.0	mg/L		19-JUN-17	R3751830
Carbonate (CO3)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Hydroxide (OH)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Alkalinity, Total (as CaCO3)	124		5.0	mg/L		19-JUN-17	R3751830
L1941966-2 SP1617-029; LAB CONTROL HA - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		24-JUN-17	R3755565
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	72.8		0.50	mg/L		14-JUN-17	R3748757
Dissolved Metals by ICPOES							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1941966-2 SP1617-029; LAB CONTROL HA - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					20-JUN-17	R3751591
Calcium (Ca)-Dissolved	43.7		0.10	mg/L		20-JUN-17	R3751650
Magnesium (Mg)-Dissolved	6.75		0.10	mg/L		20-JUN-17	R3751650
Potassium (K)-Dissolved	2.47		0.50	mg/L		20-JUN-17	R3751650
Sodium (Na)-Dissolved	26.4		1.0	mg/L		20-JUN-17	R3751650
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		14-JUN-17	R3748757
Ion Balance Calculation							
Ion Balance	106			%		26-JUN-17	
TDS (Calculated)	214			mg/L		26-JUN-17	
Hardness (as CaCO3)	137			mg/L		26-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.091		0.020	mg/L		14-JUN-17	R3748757
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.104		0.050	mg/L		15-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	0.012		0.010	mg/L		14-JUN-17	R3748757
Sulfate in Water by IC							
Sulfate (SO4)	29.1		0.30	mg/L		14-JUN-17	R3748757
pH, Conductivity and Total Alkalinity							
pH	8.03		0.10	pH		19-JUN-17	R3751830
Conductivity (EC)	407		2.0	uS/cm		19-JUN-17	R3751830
Bicarbonate (HCO3)	64.8		5.0	mg/L		19-JUN-17	R3751830
Carbonate (CO3)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Hydroxide (OH)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Alkalinity, Total (as CaCO3)	53.1		5.0	mg/L		19-JUN-17	R3751830
L1941966-3 SP1617-029; SITE CONTROL FM - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.0173		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0205		0.00050	mg/L		24-JUN-17	R3755565
Miscellaneous Parameters							
Dissolved Organic Carbon	30.1		1.0	mg/L		21-JUN-17	R3753275
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	2.31		0.50	mg/L		14-JUN-17	R3748757
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					20-JUN-17	R3751591
Calcium (Ca)-Dissolved	28.1		0.10	mg/L		20-JUN-17	R3751650
Magnesium (Mg)-Dissolved	8.63		0.10	mg/L		20-JUN-17	R3751650
Potassium (K)-Dissolved	2.12		0.50	mg/L		20-JUN-17	R3751650
Sodium (Na)-Dissolved	7.3		1.0	mg/L		20-JUN-17	R3751650
Fluoride in Water by IC							
Fluoride (F)	0.135		0.020	mg/L		14-JUN-17	R3748757
Ion Balance Calculation							
Ion Balance	117	BL:INT		%		26-JUN-17	
TDS (Calculated)	118			mg/L		26-JUN-17	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1941966-3 SP1617-029; SITE CONTROL FM - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Ion Balance Calculation							
Hardness (as CaCO3)	106			mg/L		26-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.590		0.020	mg/L		14-JUN-17	R3748757
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.601		0.050	mg/L		15-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	0.011		0.010	mg/L		14-JUN-17	R3748757
Sulfate in Water by IC							
Sulfate (SO4)	17.2		0.30	mg/L		14-JUN-17	R3748757
pH, Conductivity and Total Alkalinity							
pH	8.08		0.10	pH		19-JUN-17	R3751830
Conductivity (EC)	205		2.0	uS/cm		19-JUN-17	R3751830
Bicarbonate (HCO3)	101		5.0	mg/L		19-JUN-17	R3751830
Carbonate (CO3)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Hydroxide (OH)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Alkalinity, Total (as CaCO3)	82.4		5.0	mg/L		19-JUN-17	R3751830
L1941966-4 SP1617-029; SITE CONTROL HA - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Miscellaneous Parameters							
Dissolved Organic Carbon	30.4		1.0	mg/L		21-JUN-17	R3753275
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	25.3		0.50	mg/L		14-JUN-17	R3748757
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					20-JUN-17	R3751591
Calcium (Ca)-Dissolved	28.2		0.10	mg/L		27-JUN-17	R3751650
Magnesium (Mg)-Dissolved	8.02		0.10	mg/L		27-JUN-17	R3751650
Potassium (K)-Dissolved	2.01		0.50	mg/L		27-JUN-17	R3751650
Sodium (Na)-Dissolved	24.1		1.0	mg/L		27-JUN-17	R3751650
Fluoride in Water by IC							
Fluoride (F)	0.129		0.020	mg/L		14-JUN-17	R3748757
Ion Balance Calculation							
Ion Balance	116	RRV		%		27-JUN-17	
TDS (Calculated)	156			mg/L		27-JUN-17	
Hardness (as CaCO3)	103			mg/L		27-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.558		0.020	mg/L		14-JUN-17	R3748757
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.569		0.050	mg/L		15-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	0.011		0.010	mg/L		14-JUN-17	R3748757
Sulfate in Water by IC							
Sulfate (SO4)	17.0		0.30	mg/L		14-JUN-17	R3748757
pH, Conductivity and Total Alkalinity							
pH	8.06		0.10	pH		19-JUN-17	R3751830
Conductivity (EC)	286		2.0	uS/cm		19-JUN-17	R3751830
Bicarbonate (HCO3)	99.2		5.0	mg/L		19-JUN-17	R3751830
Carbonate (CO3)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Hydroxide (OH)	<5.0		5.0	mg/L		19-JUN-17	R3751830
Alkalinity, Total (as CaCO3)	81.3		5.0	mg/L		19-JUN-17	R3751830

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1941966-5 SP1617-029; 5 UG/L CU - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.0222		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0257		0.00050	mg/L		24-JUN-17	R3755565
L1941966-6 SP1617-029; 10 UG/L CU - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.0265		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0298		0.00050	mg/L		24-JUN-17	R3755565
L1941966-7 SP1617-029; 20 UG/L CU - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.0357		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0404		0.00050	mg/L		24-JUN-17	R3755565
L1941966-8 SP1617-029; 40 UG/L CU - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.0518		0.00020	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0562		0.00050	mg/L		24-JUN-17	R3755565
L1941966-9 SP1617-029; 80 UG/L CU - WEEK 4							
Sampled By: CLIENT on 14-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.0880	DLM	0.0010	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.101	DLM	0.0025	mg/L		24-JUN-17	R3755565

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1941966-9 SP1617-029; 80 UG/L CU - WEEK 4 Sampled By: CLIENT on 14-JUN-17 Matrix: WATER							
L1941966-10 SP1617-029; 160 UG/L CU - WEEK 4 Sampled By: CLIENT on 14-JUN-17 Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3755429
Copper (Cu)-Dissolved	0.166	DLM	0.0010	mg/L		24-JUN-17	R3755565
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.175	DLM	0.0025	mg/L		24-JUN-17	R3755565

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	DOC (-3, -4) Diss-Metals (except -4) - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
BL:INT	Balance Reviewed: Interference Or Non-Measured Component
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
RRV	Reported Result Verified By Repeat Analysis

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-DIS-ORG-CL	Water	Dissolved Organic Carbon	APHA 5310 B-Instrumental

This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.

CL-IC-N-CL	Water	Chloride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

F-IC-N-CL	Water	Fluoride in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

IONBALANCE-CL	Water	Ion Balance Calculation	APHA 1030E
MET-D-CCMS-CL	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

MET-DIS-ICP-CL	Water	Dissolved Metals by ICPOES	APHA 3030B/EPA 6010B

"This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (APHA Method 3030B) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-CL	Water	Total Metals in Water by CRC ICPMS	EPA 200.2/6020A (mod)

Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

N2N3-CALC-CL	Water	Nitrate+Nitrite	CALCULATION
NO2-IC-N-CL	Water	Nitrite in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

NO3-IC-N-CL	Water	Nitrate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

PH/EC/ALK-CL	Water	pH, Conductivity and Total Alkalinity	APHA 4500H,2510,2320

All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample’s capacity to neutralize acid
Conductivity measurement is based on the sample’s capacity to convey an electric current

SO4-IC-N-CL	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Quality Control Report

Workorder: L1941966 Report Date: 27-JUN-17

Client: Nautilus Environmental
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Contact: Leila Oosterbroek

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-CL	**Water**							
Batch R3753275								
WG2554499-2 LCS								
Dissolved Organic Carbon			104.2		%		80-120	21-JUN-17
WG2554499-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	21-JUN-17
CL-IC-N-CL	**Water**							
Batch R3748757								
WG2549700-3 DUP		**L1941966-1**						
Chloride (Cl)		9.22	9.49		mg/L	2.8	20	14-JUN-17
WG2549700-2 LCS								
Chloride (Cl)			100.9		%		90-110	14-JUN-17
WG2549700-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	14-JUN-17
WG2549700-4 MS		**L1941966-1**						
Chloride (Cl)			104.3		%		75-125	14-JUN-17
F-IC-N-CL	**Water**							
Batch R3748757								
WG2549700-3 DUP		**L1941966-1**						
Fluoride (F)		0.161	0.164		mg/L	1.5	20	14-JUN-17
WG2549700-2 LCS								
Fluoride (F)			100.3		%		90-110	14-JUN-17
WG2549700-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	14-JUN-17
WG2549700-4 MS		**L1941966-1**						
Fluoride (F)			106.0		%		75-125	14-JUN-17
MET-D-CCMS-CL	**Water**							
Batch R3755565								
WG2556159-5 LCS		**TMRM**						
Copper (Cu)-Dissolved			97.2		%		80-120	24-JUN-17
WG2556256-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			97.4		%		80-120	24-JUN-17
WG2556159-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	24-JUN-17
WG2556159-4 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	24-JUN-17
WG2556256-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	24-JUN-17
MET-DIS-ICP-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-CL	**Water**							
Batch R3751650								
WG2552874-2 LCS		**TMRM**						
Calcium (Ca)-Dissolved			101.7		%		80-120	20-JUN-17
Magnesium (Mg)-Dissolved			100.4		%		80-120	20-JUN-17
Potassium (K)-Dissolved			100.5		%		80-120	20-JUN-17
Sodium (Na)-Dissolved			103.8		%		80-120	20-JUN-17
WG2552874-5 LCS		**TMRM**						
Calcium (Ca)-Dissolved			100.2		%		80-120	20-JUN-17
Magnesium (Mg)-Dissolved			102.9		%		80-120	20-JUN-17
Potassium (K)-Dissolved			101.5		%		80-120	20-JUN-17
Sodium (Na)-Dissolved			103.3		%		80-120	20-JUN-17
WG2552874-9 LCS		**TMRM**						
Calcium (Ca)-Dissolved			98.1		%		80-120	20-JUN-17
Magnesium (Mg)-Dissolved			103.3		%		80-120	20-JUN-17
Potassium (K)-Dissolved			102.6		%		80-120	20-JUN-17
Sodium (Na)-Dissolved			101.6		%		80-120	20-JUN-17
WG2552874-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	20-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	20-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	20-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	20-JUN-17
WG2552874-4 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	20-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	20-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	20-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	20-JUN-17
WG2552874-8 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	20-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	20-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	20-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	20-JUN-17
MET-T-CCMS-CL	**Water**							
Batch R3752567								
WG2553139-2 LCS		**TMRM**						
Copper (Cu)-Total			96.9		%		80-120	21-JUN-17
WG2553139-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	21-JUN-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-CCMS-CL	**Water**							
Batch R3755565								
WG2553139-6 DUP		**L1941966-3**						
Copper (Cu)-Total		0.0205	0.0204		mg/L	0.4	20	24-JUN-17
WG2556256-2 LCS		**TMRM**						
Copper (Cu)-Total			98.1		%		80-120	24-JUN-17
WG2556256-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	24-JUN-17
Batch R3755647								
WG2553139-5 LCS		**TMRM**						
Copper (Cu)-Total			98.0		%		80-120	24-JUN-17
WG2553139-4 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	24-JUN-17
Batch R3756343								
WG2553139-8 LCS		**TMRM**						
Copper (Cu)-Total			103.4		%		80-120	26-JUN-17
WG2553139-7 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	26-JUN-17
NO2-IC-N-CL	**Water**							
Batch R3748757								
WG2549700-3 DUP		**L1941966-1**						
Nitrite (as N)		<0.010	<0.010	RPD-NA	mg/L	N/A	20	14-JUN-17
WG2549700-2 LCS								
Nitrite (as N)			103.1		%		90-110	14-JUN-17
WG2549700-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	14-JUN-17
WG2549700-4 MS		**L1941966-1**						
Nitrite (as N)			105.1		%		75-125	14-JUN-17
NO3-IC-N-CL	**Water**							
Batch R3748757								
WG2549700-3 DUP		**L1941966-1**						
Nitrate (as N)		0.166	0.150		mg/L	9.8	20	15-JUN-17
WG2549700-2 LCS								
Nitrate (as N)			101.0		%		90-110	14-JUN-17
WG2549700-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	14-JUN-17
WG2549700-4 MS		**L1941966-1**						
Nitrate (as N)			103.1		%		75-125	14-JUN-17
PH/EC/ALK-CL	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-CL	**Water**							
Batch R3751830								
WG2553023-11 LCS								
pH			7.02		pH		6.9-7.1	19-JUN-17
Conductivity (EC)			101.9		%		90-110	19-JUN-17
Alkalinity, Total (as CaCO3)			103.3		%		85-115	19-JUN-17
WG2553023-17 LCS								
pH			7.01		pH		6.9-7.1	19-JUN-17
Conductivity (EC)			102.5		%		90-110	19-JUN-17
Alkalinity, Total (as CaCO3)			97.8		%		85-115	19-JUN-17
WG2553023-10 MB								
Conductivity (EC)			<2.0		uS/cm		2	19-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	19-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	19-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	19-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	19-JUN-17
WG2553023-16 MB								
Conductivity (EC)			<2.0		uS/cm		2	19-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	19-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	19-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	19-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	19-JUN-17
SO4-IC-N-CL	**Water**							
Batch R3748757								
WG2549700-3 DUP		**L1941966-1**						
Sulfate (SO4)		60.3	60.8		mg/L	0.8	20	14-JUN-17
WG2549700-2 LCS								
Sulfate (SO4)			101.5		%		90-110	14-JUN-17
WG2549700-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	14-JUN-17
WG2549700-4 MS		**L1941966-1**						
Sulfate (SO4)			102.5		%		75-125	14-JUN-17

Quality Control Report

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label (lab use only)

L1941966-COFC

Report To
Company: Nautilus Environmental
Contact: Leila Oosterbroek
Address: #4, 6125 12 St SE
Calgary, AB T2H 2K1
Phone: 403-253-7121

Invoice To Same as Report To ☑ Yes ☐ No
Copy of Invoice with Report ☑ Yes ☐ No
Company:
Contact:

Project Information
ALS Quote #: Q55972
Job #:
PO / AFE: PO 2016 - 1178
LSD:

ALS Lab Work Order # (lab use only)

Report Format / Distribution
Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax leila@nautilusenvironmental.ca
Email 2 bryon@nautilusenvironmental.ca

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax abaccounts@nautilusenvironmental.ca
Email 2 leila@nautilusenvironmental.ca

Oil and Gas Required Fields (client use)
Approver ID:
Cost Center:
GL Account:
Routing Code:
Activity Code:
Location:

ALS Contact: Jesse Eagle
Sampler:

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
R ☑ Regular (Standard TAT if received by 3 pm - business days)
P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	C-DIS-ORG-CL (dissolved organic carbon)	ROU-CL (Ca, Mg, Na, S)4, Cl, alk)	MET-T-CCMS-1-CL (total copper in water) - (	MET-D-CCMS-1-CL(dissolved copper in wate	FILTER-CL (lab filtered and preserved)									Number of Containers
1	SP1617-029; Lab Control FM - Week 4	2017/06/14		water		R	R	R	R									
2	SP1617-029; Lab Control HA - Week 4			water		R	R	R	R									
3	SP1617-029; Site Control FM - Week 4			water	R	R	R	R	R									
4	SP1617-029; Site Control HA - Week 4			water	R	R	*	*	R	* Bottles rec'd – mm 14-Jun-17								
5	SP1617-029; 5 ug/L Cu - Week 4			water			R	R	R									
6	SP1617-029; 10 ug/L Cu - Week 4			water			R	R	R									
7	SP1617-029; 20 ug/L Cu - Week 4			water			R	R	R									
8	SP1617-029; 40 ug/L Cu - Week 4			water			R	R	R									
9	SP1617-029; 80 ug/L Cu - Week 4			water			R	R	R									
10	SP1617-029; 160 ug/L Cu - Week 4			water			R	R	R									

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No
Are samples for human drinking water use? ☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

****For total metals, samples have been preserved. For dissolved parameters (DOC, dissolved metals), samples have not been filtered or preserved; please sub-sample and filter/preserve at the lab (SFPL).****

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐
Ice packs Yes ☐ No ☐
Cooling Initiated ☐
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
9					

SHIPMENT RELEASE (client use)
Released by:
Date: 2017/06/14
Time: 1630

INITIAL SHIPMENT RECEPTION (lab use only)
Received by:
Date: 6/14
Time: 1234

FINAL SHIPMENT RECEPTION (lab use only)
Received by:
Date:
Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326a v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form.**

Nautilus Environmental
ATTN: Leila Oosterbroek
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Date Received: 21-JUN-17
Report Date: 30-JUN-17 14:15 (MT)
Version: FINAL

Client Phone: 403-253-7121

Certificate of Analysis

Lab Work Order #: L1946182
Project P.O. #: PO 2016-1182
Job Reference:
C of C Numbers:
Legal Site Desc:

Nelson Kwan, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1946182-1 SP1617-029; LAB CONTROL FM - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.00058		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.00070		0.00050	mg/L		27-JUN-17	R3756979
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	9.79		0.50	mg/L		22-JUN-17	R3756736
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3756811
Calcium (Ca)-Dissolved	54.1		0.10	mg/L		24-JUN-17	R3755547
Magnesium (Mg)-Dissolved	14.9		0.10	mg/L		24-JUN-17	R3755547
Potassium (K)-Dissolved	3.17		0.50	mg/L		24-JUN-17	R3755547
Sodium (Na)-Dissolved	7.9		1.0	mg/L		24-JUN-17	R3755547
Fluoride in Water by IC							
Fluoride (F)	0.151		0.020	mg/L		22-JUN-17	R3756736
Ion Balance Calculation							
Ion Balance	107			%		28-JUN-17	
TDS (Calculated)	226			mg/L		28-JUN-17	
Hardness (as CaCO3)	196			mg/L		28-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.179		0.020	mg/L		22-JUN-17	R3756736
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.179		0.050	mg/L		27-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		22-JUN-17	R3756736
Sulfate in Water by IC							
Sulfate (SO4)	59.0		0.30	mg/L		22-JUN-17	R3756736
pH, Conductivity and Total Alkalinity							
pH	8.47		0.10	pH		22-JUN-17	R3754910
Conductivity (EC)	401		2.0	uS/cm		22-JUN-17	R3754910
Bicarbonate (HCO3)	141		5.0	mg/L		22-JUN-17	R3754910
Carbonate (CO3)	6.7		5.0	mg/L		22-JUN-17	R3754910
Hydroxide (OH)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Alkalinity, Total (as CaCO3)	127		5.0	mg/L		22-JUN-17	R3754910
L1946182-2 SP1617-029; LAB CONTROL HA - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	<0.00050		0.00050	mg/L		27-JUN-17	R3756979
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	74.2		0.50	mg/L		22-JUN-17	R3756736
Dissolved Metals by ICPOES							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1946182-2 SP1617-029; LAB CONTROL HA - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3756811
Calcium (Ca)-Dissolved	43.0		0.10	mg/L		24-JUN-17	R3755547
Magnesium (Mg)-Dissolved	6.47		0.10	mg/L		24-JUN-17	R3755547
Potassium (K)-Dissolved	2.50		0.50	mg/L		24-JUN-17	R3755547
Sodium (Na)-Dissolved	28.2		1.0	mg/L		24-JUN-17	R3755547
Fluoride in Water by IC							
Fluoride (F)	0.022		0.020	mg/L		22-JUN-17	R3756736
Ion Balance Calculation							
Ion Balance	108			%		28-JUN-17	
TDS (Calculated)	211			mg/L		28-JUN-17	
Hardness (as CaCO3)	134			mg/L		28-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.030		0.020	mg/L		22-JUN-17	R3756736
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	<0.050		0.050	mg/L		27-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		22-JUN-17	R3756736
Sulfate in Water by IC							
Sulfate (SO4)	24.6		0.30	mg/L		22-JUN-17	R3756736
pH, Conductivity and Total Alkalinity							
pH	8.00		0.10	pH		22-JUN-17	R3754910
Conductivity (EC)	426		2.0	uS/cm		22-JUN-17	R3754910
Bicarbonate (HCO3)	65.3		5.0	mg/L		22-JUN-17	R3754910
Carbonate (CO3)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Hydroxide (OH)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Alkalinity, Total (as CaCO3)	53.5		5.0	mg/L		22-JUN-17	R3754910
L1946182-3 SP1617-029; SITE CONTROL FM - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.0177		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0204		0.00050	mg/L		30-JUN-17	R3756979
Miscellaneous Parameters							
Dissolved Organic Carbon	28.9		1.0	mg/L		28-JUN-17	R3758972
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	2.73		0.50	mg/L		22-JUN-17	R3756736
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3756811
Calcium (Ca)-Dissolved	25.4	DLM	0.50	mg/L		24-JUN-17	R3755547
Magnesium (Mg)-Dissolved	7.50	DLM	0.50	mg/L		24-JUN-17	R3755547
Potassium (K)-Dissolved	<2.5	DLM	2.5	mg/L		24-JUN-17	R3755547
Sodium (Na)-Dissolved	6.4	DLM	5.0	mg/L		24-JUN-17	R3755547
Fluoride in Water by IC							
Fluoride (F)	0.147		0.020	mg/L		22-JUN-17	R3756736
Ion Balance Calculation							
Ion Balance	102			%		30-JUN-17	
TDS (Calculated)	112			mg/L		30-JUN-17	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1946182-3 SP1617-029; SITE CONTROL FM - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Ion Balance Calculation							
Hardness (as CaCO3)	94.3			mg/L		30-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.659		0.020	mg/L		22-JUN-17	R3756736
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.659		0.050	mg/L		27-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		22-JUN-17	R3756736
Sulfate in Water by IC							
Sulfate (SO4)	18.1		0.30	mg/L		22-JUN-17	R3756736
pH, Conductivity and Total Alkalinity							
pH	7.87		0.10	pH		22-JUN-17	R3754910
Conductivity (EC)	214		2.0	uS/cm		22-JUN-17	R3754910
Bicarbonate (HCO3)	98.8		5.0	mg/L		22-JUN-17	R3754910
Carbonate (CO3)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Hydroxide (OH)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Alkalinity, Total (as CaCO3)	81.0		5.0	mg/L		22-JUN-17	R3754910
L1946182-4 SP1617-029; SITE CONTROL HA - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Miscellaneous Parameters							
Dissolved Organic Carbon	30.5		1.0	mg/L		28-JUN-17	R3758972
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	20.0		0.50	mg/L		22-JUN-17	R3756736
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					24-JUN-17	R3756811
Calcium (Ca)-Dissolved	25.4	DLM	0.50	mg/L		24-JUN-17	R3755547
Magnesium (Mg)-Dissolved	7.37	DLM	0.50	mg/L		24-JUN-17	R3755547
Potassium (K)-Dissolved	<2.5	DLM	2.5	mg/L		24-JUN-17	R3755547
Sodium (Na)-Dissolved	21.3	DLM	5.0	mg/L		24-JUN-17	R3755547
Fluoride in Water by IC							
Fluoride (F)	0.188		0.020	mg/L		22-JUN-17	R3756736
Ion Balance Calculation							
Ion Balance	108			%		27-JUN-17	
TDS (Calculated)	143			mg/L		27-JUN-17	
Hardness (as CaCO3)	93.8			mg/L		27-JUN-17	
Nitrate in Water by IC							
Nitrate (as N)	0.635		0.020	mg/L		22-JUN-17	R3756736
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.635		0.050	mg/L		27-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		22-JUN-17	R3756736
Sulfate in Water by IC							
Sulfate (SO4)	17.7		0.30	mg/L		22-JUN-17	R3756736
pH, Conductivity and Total Alkalinity							
pH	7.88		0.10	pH		22-JUN-17	R3754910
Conductivity (EC)	274		2.0	uS/cm		22-JUN-17	R3754910
Bicarbonate (HCO3)	98.0		5.0	mg/L		22-JUN-17	R3754910
Carbonate (CO3)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Hydroxide (OH)	<5.0		5.0	mg/L		22-JUN-17	R3754910
Alkalinity, Total (as CaCO3)	80.3		5.0	mg/L		22-JUN-17	R3754910

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1946182-5 SP1617-029; 5 UG/L CU - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.0242		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0265		0.00050	mg/L		27-JUN-17	R3756979
L1946182-6 SP1617-029; 10 UG/L CU - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.0278		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0315		0.00050	mg/L		27-JUN-17	R3756979
L1946182-7 SP1617-029; 20 UG/L CU - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.0371		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0453		0.00050	mg/L		27-JUN-17	R3756979
L1946182-8 SP1617-029; 40 UG/L CU - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.0554		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0602		0.00050	mg/L		27-JUN-17	R3756979
L1946182-9 SP1617-029; 80 UG/L CU - WEEK 5							
Sampled By: CLIENT on 21-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved	0.0955		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0947		0.00050	mg/L		27-JUN-17	R3756979

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters		Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1946182-9	SP1617-029; 80 UG/L CU - WEEK 5							
Sampled By:	CLIENT on 21-JUN-17							
Matrix:	WATER							
L1946182-10	SP1617-029; 160 UG/L CU - WEEK 5							
Sampled By:	CLIENT on 21-JUN-17							
Matrix:	WATER							
Individual Dissolved Metal by CCMS								
Dissolved Metals in Water by CRC ICPMS								
Dissolved Metals Filtration Location		LAB					27-JUN-17	R3757804
Copper (Cu)-Dissolved		0.178		0.00020	mg/L		27-JUN-17	R3756979
Individual Total Metal by CCMS								
Total Metals in Water by CRC ICPMS								
Copper (Cu)-Total		0.181		0.00050	mg/L		27-JUN-17	R3756979

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
SFPL	DOC (-3, -4) Diss-CU (all except -4) - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>C-DIS-ORG-CL</td><td>Water</td><td>Dissolved Organic Carbon</td><td>APHA 5310 B-Instrumental</td></tr>
<tr><td colspan="4">This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.</td></tr>
<tr><td>CL-IC-N-CL</td><td>Water</td><td>Chloride in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>F-IC-N-CL</td><td>Water</td><td>Fluoride in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>IONBALANCE-CL</td><td>Water</td><td>Ion Balance Calculation</td><td>APHA 1030E</td></tr>
<tr><td>MET-D-CCMS-CL</td><td>Water</td><td>Dissolved Metals in Water by CRC ICPMS</td><td>APHA 3030B/6020A (mod)</td></tr>
<tr><td colspan="4">Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.</td></tr>
<tr><td>MET-DIS-ICP-CL</td><td>Water</td><td>Dissolved Metals by ICPOES</td><td>APHA 3030B/EPA 6010B</td></tr>
<tr><td colspan="4">"This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (APHA Method 3030B) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).</td></tr>
<tr><td>MET-T-CCMS-CL</td><td>Water</td><td>Total Metals in Water by CRC ICPMS</td><td>EPA 200.2/6020A (mod)</td></tr>
<tr><td colspan="4">Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.</td></tr>
<tr><td>N2N3-CALC-CL</td><td>Water</td><td>Nitrate+Nitrite</td><td>CALCULATION</td></tr>
<tr><td>NO2-IC-N-CL</td><td>Water</td><td>Nitrite in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>NO3-IC-N-CL</td><td>Water</td><td>Nitrate in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>PH/EC/ALK-CL</td><td>Water</td><td>pH, Conductivity and Total Alkalinity</td><td>APHA 4500H,2510,2320</td></tr>
<tr><td colspan="4">All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample’s capacity to neutralize acid
Conductivity measurement is based on the sample’s capacity to convey an electric current</td></tr>
<tr><td>SO4-IC-N-CL</td><td>Water</td><td>Sulfate in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
</table>

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1946182 Report Date: 30-JUN-17

Client: Nautilus Environmental
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1
Contact: Leila Oosterbroek

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-CL	**Water**							
Batch R3758972								
WG2560016-2 LCS								
Dissolved Organic Carbon			99.0		%		80-120	28-JUN-17
WG2560016-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	28-JUN-17
CL-IC-N-CL	**Water**							
Batch R3756736								
WG2557676-2 LCS								
Chloride (Cl)			100.7		%		90-110	22-JUN-17
WG2557676-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	22-JUN-17
F-IC-N-CL	**Water**							
Batch R3756736								
WG2557676-2 LCS								
Fluoride (F)			99.6		%		90-110	22-JUN-17
WG2557676-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	22-JUN-17
MET-D-CCMS-CL	**Water**							
Batch R3756979								
WG2557938-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			95.7		%		80-120	27-JUN-17
WG2557938-5 LCS		**TMRM**						
Copper (Cu)-Dissolved			98.6		%		80-120	27-JUN-17
WG2557938-8 LCS		**TMRM**						
Copper (Cu)-Dissolved			105.0		%		80-120	27-JUN-17
WG2557938-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	27-JUN-17
WG2557938-4 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	27-JUN-17
WG2557938-7 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	27-JUN-17
MET-DIS-ICP-CL	**Water**							
Batch R3755547								
WG2557811-2 LCS		**TMRM**						
Calcium (Ca)-Dissolved			103.7		%		80-120	24-JUN-17
Magnesium (Mg)-Dissolved			112.1		%		80-120	24-JUN-17
Potassium (K)-Dissolved			106.3		%		80-120	24-JUN-17
Sodium (Na)-Dissolved			103.1		%		80-120	24-JUN-17

ALS Environmental

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-CL	**Water**							
Batch R3755547								
WG2557811-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	24-JUN-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	24-JUN-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	24-JUN-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	24-JUN-17
MET-T-CCMS-CL	**Water**							
Batch R3756343								
WG2557171-2 LCS		**TMRM**						
Copper (Cu)-Total			104.4		%		80-120	26-JUN-17
WG2557171-6 LCS		**TMRM**						
Copper (Cu)-Total			106.2		%		80-120	26-JUN-17
WG2557171-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	26-JUN-17
WG2557171-5 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	26-JUN-17
Batch R3756979								
WG2557171-10 LCS		**TMRMM**						
Copper (Cu)-Total			108.5		%		80-120	27-JUN-17
WG2557171-9 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	27-JUN-17
Batch R3758076								
WG2557171-13 LCS		**TMRM**						
Copper (Cu)-Total			98.8		%		80-120	28-JUN-17
WG2557171-12 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	28-JUN-17
NO2-IC-N-CL	**Water**							
Batch R3756736								
WG2557676-2 LCS								
Nitrite (as N)			102.3		%		90-110	22-JUN-17
WG2557676-1 MB								
Nitrite (as N)			<0.010		mg/L		0.01	22-JUN-17
NO3-IC-N-CL	**Water**							
Batch R3756736								
WG2557676-2 LCS								
Nitrate (as N)			101.0		%		90-110	22-JUN-17
WG2557676-1 MB								
Nitrate (as N)			<0.020		mg/L		0.02	22-JUN-17

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PH/EC/ALK-CL	**Water**							
Batch R3754910								
WG2555560-14 LCS								
pH			7.00		pH		6.9-7.1	22-JUN-17
Conductivity (EC)			105.4		%		90-110	22-JUN-17
Alkalinity, Total (as CaCO3)			100.6		%		85-115	22-JUN-17
WG2555560-13 MB								
Conductivity (EC)			<2.0		uS/cm		2	22-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	22-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	22-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	22-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	22-JUN-17
SO4-IC-N-CL	**Water**							
Batch R3756736								
WG2557676-2 LCS								
Sulfate (SO4)			102.0		%		90-110	22-JUN-17
WG2557676-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	22-JUN-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1946182-COFC

COC Number: 14 -

Page ____ of ____

Report To	
Company:	Nautilus Environmental
Contact:	Leila Oosterbroek
Address:	#4, 6125 12 St SE Calgary, AB T2H 2K1
Phone:	403-253-7121
Invoice To Same as Report To	☑ Yes ☐ No
Copy of Invoice with Report	☑ Yes ☐ No
Company:	
Contact:	
Project Information	
ALS Quote #:	Q55972
Job #:	
PO / AFE:	PO 2016-1182
LSD:	
ALS Lab Work Order # (lab use only)	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ Yes ☐ No

☐ Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax leila@nautilusenvironmental.ca

Email 2 bryon@nautilusenvironmental.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax abaccounts@nautilusenvironmental.ca

Email 2 leila@nautilusenvironmental.ca

Oil and Gas Required Fields (client use)

Approver ID:	Cost Center:
GL Account:	Routing Code:
Activity Code:	
Location:	

ALS Contact: Jesse Eagle **Sampler:**

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

- R ☑ Regular (Standard TAT if received by 3 pm - business days)
- P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
- E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
- E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	C-DIS-ORG-CL (dissolved organic carbon)	ROU-CL (Ca, Mg, Na, SO4, Cl, alk)	MET-T-CCMS-1-CL (total copper in water) - (	MET-D-CCMS-1-CL(dissolved copper in wate	FILTER-CL (lab filtered and preserved)	Number of Containers
1	SP1617-029; Lab Control FM - Week 5	2017/06/21		water		R	R	R	R	
2	SP1617-029; Lab Control HA - Week 5th			water		R	R	R	R	
3	SP1617-029; Site Control FM - Week 5			water	R	R	R	R	R	
4	SP1617-029; Site Control HA - Week 5			water	R	R			R	
5	SP1617-029; 5 ug/L Cu - Week 5			water			R	R	R	
6	SP1617-029; 10 ug/L Cu - Week 5			water			R	R	R	
7	SP1617-029; 20 ug/L Cu - Week 5			water			R	R	R	
8	SP1617-029; 40 ug/L Cu - Week 5			water			R	R	R	
9	SP1617-029; 80 ug/L Cu - Week 5			water			R	R	R	
10	SP1617-029; 160 ug/L Cu - Week 5			water			R	R	R	

* Bottles each - kept ap extra - min 21 June

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ Yes ☐ No

Are samples for human drinking water use? ☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

****For total metals, samples have been preserved. For dissolved parameters (DOC, dissolved metals), samples have not been filtered or preserved; please sub-sample and filter/preserve at the lab (SFPL).****

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☒

Ice packs Yes ☒ No ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☒

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
7.2					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 2017/06/21	Time: 1110	Received by: KC	Date: 21-Jun-17	Time: 12:32pm	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Nautilus Environmental
ATTN: Leila Oosterbroek
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1

Date Received: 28-JUN-17
Report Date: 25-JUL-17 15:56 (MT)
Version: FINAL REV. 2

Client Phone: 403-253-7121

Certificate of Analysis

Lab Work Order #: L1950474
Project P.O. #: PO 2016-1190
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 19-JUL-17 14:21

19-JUL-17
Additional analysis: as per Leila Oosterbroek, additional total + diss Cu analysis on sample -2, reg-TAT

Nelson Kwan, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1950474-1 SP1617-029; LAB CONTROL HA - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	<0.00020		0.00020	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.00053		0.00050	mg/L		04-JUL-17	R3765545
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	79.5		0.50	mg/L		28-JUN-17	R3758842
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Calcium (Ca)-Dissolved	40.9		0.10	mg/L		04-JUL-17	R3765545
Magnesium (Mg)-Dissolved	6.57		0.10	mg/L		04-JUL-17	R3765545
Potassium (K)-Dissolved	2.65		0.50	mg/L		04-JUL-17	R3765545
Sodium (Na)-Dissolved	26.1		1.0	mg/L		04-JUL-17	R3765545
Fluoride in Water by IC							
Fluoride (F)	<0.020		0.020	mg/L		28-JUN-17	R3758842
Ion Balance Calculation							
Ion Balance	96.9			%		05-JUL-17	
TDS (Calculated)	216			mg/L		05-JUL-17	
Hardness (as CaCO3)	129			mg/L		05-JUL-17	
Nitrate in Water by IC							
Nitrate (as N)	0.076		0.020	mg/L		28-JUN-17	R3758842
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.076		0.050	mg/L		29-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.010		0.010	mg/L		28-JUN-17	R3758842
Sulfate in Water by IC							
Sulfate (SO4)	25.9		0.30	mg/L		28-JUN-17	R3758842
pH, Conductivity and Total Alkalinity							
pH	8.12		0.10	pH		29-JUN-17	R3761310
Conductivity (EC)	435		2.0	uS/cm		29-JUN-17	R3761310
Bicarbonate (HCO3)	68.3		5.0	mg/L		29-JUN-17	R3761310
Carbonate (CO3)	<5.0		5.0	mg/L		29-JUN-17	R3761310
Hydroxide (OH)	<5.0		5.0	mg/L		29-JUN-17	R3761310
Alkalinity, Total (as CaCO3)	56.0		5.0	mg/L		29-JUN-17	R3761310
L1950474-2 SP1617-029; SITE CONTROL HA - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					21-JUL-17	R3780246
Copper (Cu)-Dissolved	0.0128		0.00020	mg/L		21-JUL-17	R3780316
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0141		0.00050	mg/L		24-JUL-17	R3780316
Miscellaneous Parameters							
Dissolved Organic Carbon	34.2	DLM	5.0	mg/L		02-JUL-17	R3760464
Routine Water Analysis							
Chloride in Water by IC							
Chloride (Cl)	26.9	DLHC	2.5	mg/L		28-JUN-17	R3758842

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1950474-2 SP1617-029; SITE CONTROL HA - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Dissolved Metals by ICPOES							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Calcium (Ca)-Dissolved	25.2		0.10	mg/L		04-JUL-17	R3765545
Magnesium (Mg)-Dissolved	7.87		0.10	mg/L		04-JUL-17	R3765545
Potassium (K)-Dissolved	2.06		0.50	mg/L		04-JUL-17	R3765545
Sodium (Na)-Dissolved	23.4		1.0	mg/L		04-JUL-17	R3765545
Fluoride in Water by IC							
Fluoride (F)	0.11	DLHC	0.10	mg/L		28-JUN-17	R3758842
Ion Balance Calculation							
Ion Balance	102			%		05-JUL-17	
TDS (Calculated)	161			mg/L		05-JUL-17	
Hardness (as CaCO3)	95.3			mg/L		05-JUL-17	
Nitrate in Water by IC							
Nitrate (as N)	0.69	DLHC	0.10	mg/L		28-JUN-17	R3758842
Nitrate+Nitrite							
Nitrate and Nitrite (as N)	0.69		0.11	mg/L		29-JUN-17	
Nitrite in Water by IC							
Nitrite (as N)	<0.050	DLHC	0.050	mg/L		28-JUN-17	R3758842
Sulfate in Water by IC							
Sulfate (SO4)	23.8	DLHC	1.5	mg/L		28-JUN-17	R3758842
pH, Conductivity and Total Alkalinity							
pH	7.76		0.10	pH		29-JUN-17	R3761310
Conductivity (EC)	292		2.0	uS/cm		29-JUN-17	R3761310
Bicarbonate (HCO3)	98.7		5.0	mg/L		29-JUN-17	R3761310
Carbonate (CO3)	<5.0		5.0	mg/L		29-JUN-17	R3761310
Hydroxide (OH)	<5.0		5.0	mg/L		29-JUN-17	R3761310
Alkalinity, Total (as CaCO3)	80.9		5.0	mg/L		29-JUN-17	R3761310
L1950474-3 SP1617-029; 5 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	0.0183		0.00020	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0186		0.00050	mg/L		04-JUL-17	R3765545
L1950474-4 SP1617-029; 10 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	0.0229		0.00020	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0232		0.00050	mg/L		04-JUL-17	R3765545
L1950474-5 SP1617-029; 20 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1950474-5 SP1617-029; 20 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	0.0310		0.00020	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0347		0.00050	mg/L		04-JUL-17	R3765545
L1950474-6 SP1617-029; 40 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	0.0555		0.00020	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0502		0.00050	mg/L		04-JUL-17	R3765545
L1950474-7 SP1617-029; 80 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	0.0841	DLM	0.0010	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.0906	DLM	0.0025	mg/L		04-JUL-17	R3765545
L1950474-8 SP1617-029; 160 UG/L CU - WEEK 6							
Sampled By: CLIENT on 28-JUN-17							
Matrix: WATER							
Individual Dissolved Metal by CCMS							
Dissolved Metals in Water by CRC ICPMS							
Dissolved Metals Filtration Location	LAB					04-JUL-17	R3765443
Copper (Cu)-Dissolved	0.165	DLM	0.0010	mg/L		04-JUL-17	R3765545
Individual Total Metal by CCMS							
Total Metals in Water by CRC ICPMS							
Copper (Cu)-Total	0.166	DLM	0.0025	mg/L		04-JUL-17	R3765545

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
EXTEMP10	12.3C (SAME DAY SAMPLING) - Samples Received with temperature >10 Degrees C
SFPL	DOC,MET-D - Sample was Filtered and Preserved at the laboratory

Sample Parameter Qualifier Key:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>C-DIS-ORG-CL</td><td>Water</td><td>Dissolved Organic Carbon</td><td>APHA 5310 B-Instrumental</td></tr>
<tr><td colspan="4">This method is applicable to the analysis of ground water, wastewater, and surface water samples. The form detected depends upon sample pretreatment: Unfiltered sample = TC, 0.45um filtered = TDC. Samples are injected into a combustion tube containing an oxidation catalyst. The carrier gas containing the combustion product from the combustion tube flows through an inorganic carbon reactor vessel and is then sent through a halogen scrubber into a sample cell set in a non-dispersive infrared gas analyzer (NDIR) where carbon dioxide is detected. For total inorganic carbon and dissolved inorganic carbon, the sample is injected into an IC reactor vessel where only the IC component is decomposed to become carbon dioxide.

The peak area generated by the NDIR indicates the TC/TDC or TIC/DIC as applicable. The total organic carbon content of the sample is calculated by subtracting the TIC from the TC.
TOC = TC-TIC, DOC = TDC-DIC, Particulate = Total - Dissolved.</td></tr>
<tr><td>CL-IC-N-CL</td><td>Water</td><td>Chloride in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>F-IC-N-CL</td><td>Water</td><td>Fluoride in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>IONBALANCE-CL</td><td>Water</td><td>Ion Balance Calculation</td><td>APHA 1030E</td></tr>
<tr><td>MET-D-CCMS-CL</td><td>Water</td><td>Dissolved Metals in Water by CRC ICPMS</td><td>APHA 3030B/6020A (mod)</td></tr>
<tr><td colspan="4">Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.</td></tr>
<tr><td>MET-DIS-ICP-CL</td><td>Water</td><td>Dissolved Metals by ICPOES</td><td>APHA 3030B/EPA 6010B</td></tr>
<tr><td colspan="4">"This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (APHA Method 3030B) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).</td></tr>
<tr><td>MET-T-CCMS-CL</td><td>Water</td><td>Total Metals in Water by CRC ICPMS</td><td>EPA 200.2/6020A (mod)</td></tr>
<tr><td colspan="4">Water samples are digested with nitric and hydrochloric acids, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.</td></tr>
<tr><td>N2N3-CALC-CL</td><td>Water</td><td>Nitrate+Nitrite</td><td>CALCULATION</td></tr>
<tr><td>NO2-IC-N-CL</td><td>Water</td><td>Nitrite in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>NO3-IC-N-CL</td><td>Water</td><td>Nitrate in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
<tr><td>PH/EC/ALK-CL</td><td>Water</td><td>pH, Conductivity and Total Alkalinity</td><td>APHA 4500H,2510,2320</td></tr>
<tr><td colspan="4">All samples analyzed by this method for pH will have exceeded the 15 minute recommended hold time from time of sampling (field analysis is recommended for pH where highly accurate results are needed)
pH measurement is determined from the activity of the hydrogen ions using a hydrogen electrode and a reference electrode.
Alkalinity measurement is based on the sample’s capacity to neutralize acid
Conductivity measurement is based on the sample’s capacity to convey an electric current</td></tr>
<tr><td>SO4-IC-N-CL</td><td>Water</td><td>Sulfate in Water by IC</td><td>EPA 300.1 (mod)</td></tr>
<tr><td colspan="4">Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.</td></tr>
</table>

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Workorder: L1950474 Report Date: 25-JUL-17

Client: Nautilus Environmental
#4, 6125 - 12 Street SE
Calgary AB T2H 2K1
Contact: Leila Oosterbroek

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
C-DIS-ORG-CL	**Water**							
Batch R3760464								
WG2561644-2 LCS								
Dissolved Organic Carbon			93.1		%		80-120	02-JUL-17
WG2561644-1 MB								
Dissolved Organic Carbon			<1.0		mg/L		1	02-JUL-17
CL-IC-N-CL	**Water**							
Batch R3758842								
WG2559844-6 LCS								
Chloride (Cl)			100.7		%		90-110	28-JUN-17
WG2559844-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	28-JUN-17
F-IC-N-CL	**Water**							
Batch R3758842								
WG2559844-6 LCS								
Fluoride (F)			98.6		%		90-110	28-JUN-17
WG2559844-5 MB								
Fluoride (F)			<0.020		mg/L		0.02	28-JUN-17
MET-D-CCMS-CL	**Water**							
Batch R3765545								
WG2563157-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			102.3		%		80-120	04-JUL-17
WG2563157-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	04-JUL-17
Batch R3780316								
WG2576078-2 LCS		**TMRM**						
Copper (Cu)-Dissolved			99.1		%		80-120	21-JUL-17
WG2576078-6 LCS		**TMRM**						
Copper (Cu)-Dissolved			102.3		%		80-120	21-JUL-17
WG2576078-9 LCS		**TMRM**						
Copper (Cu)-Dissolved			99.7		%		80-120	21-JUL-17
WG2576078-1 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	21-JUL-17
WG2576078-5 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	21-JUL-17
WG2576078-8 MB								
Copper (Cu)-Dissolved			<0.00020		mg/L		0.0002	21-JUL-17
MET-DIS-ICP-CL	**Water**							

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-DIS-ICP-CL	**Water**							
Batch R3765545								
WG2563157-2 LCS		**TMRM**						
Calcium (Ca)-Dissolved			104.5		%		80-120	04-JUL-17
Magnesium (Mg)-Dissolved			102.0		%		80-120	04-JUL-17
Potassium (K)-Dissolved			107.0		%		80-120	04-JUL-17
Sodium (Na)-Dissolved			107.5		%		80-120	04-JUL-17
WG2563157-1 MB								
Calcium (Ca)-Dissolved			<0.10		mg/L		0.1	04-JUL-17
Magnesium (Mg)-Dissolved			<0.10		mg/L		0.1	04-JUL-17
Potassium (K)-Dissolved			<0.50		mg/L		0.5	04-JUL-17
Sodium (Na)-Dissolved			<1.0		mg/L		1	04-JUL-17
MET-T-CCMS-CL	**Water**							
Batch R3765545								
WG2562509-2 LCS		**TMRM**						
Copper (Cu)-Total			97.3		%		80-120	04-JUL-17
WG2562509-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	04-JUL-17
Batch R3767347								
WG2562509-5 LCS		**TMRM**						
Copper (Cu)-Total			101.7		%		80-120	07-JUL-17
WG2562509-4 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	07-JUL-17
Batch R3780316								
WG2574779-2 LCS		**TMRM**						
Copper (Cu)-Total			94.0		%		80-120	21-JUL-17
WG2574779-1 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	21-JUL-17
Batch R3781287								
WG2574779-5 LCS		**TMRM**						
Copper (Cu)-Total			99.2		%		80-120	24-JUL-17
WG2574779-4 MB								
Copper (Cu)-Total			<0.00050		mg/L		0.0005	24-JUL-17
NO2-IC-N-CL	**Water**							
Batch R3758842								
WG2559844-6 LCS								
Nitrite (as N)			103.7		%		90-110	28-JUN-17
WG2559844-5 MB								
Nitrite (as N)			<0.010		mg/L		0.01	28-JUN-17

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-IC-N-CL	**Water**							
Batch R3758842								
WG2559844-6 LCS								
Nitrate (as N)			101.4		%		90-110	28-JUN-17
WG2559844-5 MB								
Nitrate (as N)			<0.020		mg/L		0.02	28-JUN-17
PH/EC/ALK-CL	**Water**							
Batch R3761310								
WG2561811-8 LCS								
pH			7.02		pH		6.9-7.1	29-JUN-17
Conductivity (EC)			108.3		%		90-110	29-JUN-17
Alkalinity, Total (as CaCO3)			100.3		%		85-115	29-JUN-17
WG2561811-7 MB								
Conductivity (EC)			<2.0		uS/cm		2	29-JUN-17
Bicarbonate (HCO3)			<5.0		mg/L		5	29-JUN-17
Carbonate (CO3)			<5.0		mg/L		5	29-JUN-17
Hydroxide (OH)			<5.0		mg/L		5	29-JUN-17
Alkalinity, Total (as CaCO3)			<5.0		mg/L		5	29-JUN-17
SO4-IC-N-CL	**Water**							
Batch R3758842								
WG2559844-6 LCS								
Sulfate (SO4)			101.5		%		90-110	28-JUN-17
WG2559844-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	28-JUN-17

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1950474-COFC

COC Number: 14 -

Page ___ of ___

Report To

Company: Nautilus Environmental
Contact: Leila Oosterbroek
Address: #4, 6125 12 St SE
Calgary, AB T2H 2K1
Phone: 403-253-7121

Invoice To Same as Report To ☑ Yes ☐ No
Copy of Invoice with Report ☑ Yes ☐ No
Company:
Contact:

Project Information

ALS Quote #: Q55972
Job #:
PO / AFE: PO 2016-1190
LSD:

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax leila@nautilusenvironmental.ca
Email 2 bryon@nautilusenvironmental.ca

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax abaccounts@nautilusenvironmental.ca
Email 2 leila@nautilusenvironmental.ca

Oil and Gas Required Fields (client use)

Approver ID:
Cost Center:
GL Account:
Routing Code:
Activity Code:
Location:

ALS Contact: Jesse Eagle
Sampler:

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

R ☑ Regular (Standard TAT if received by 3 pm - business days)
P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Specify Date Required for E2,E or P:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	C-DIS-ORG-CL (dissolved organic carbon)	ROU-CL (Ca, Mg, Na, S)4, Cl, alk)	MET-T-CCMS-1-CL (total copper in water) - (	MET-D-CCMS-1-CL(dissolved copper in wate	FILTER-CL (lab filtered and preserved)	Number of Containers
1	SP1617-029; Lab Control HA - Week 6	2017/06/28		water		R	R	R	R	
2	SP1617-029; Site Control HA - Week 6			water	R	R	X	X	R	
3	SP1617-029; 5 ug/L Cu - Week 6			water			R	R	R	
4	SP1617-029; 10 ug/L Cu - Week 6			water			R	R	R	
5	SP1617-029; 20 ug/L Cu - Week 6			water			R	R	R	
6	SP1617-029; 40 ug/L Cu - Week 6			water			R	R	R	
7	SP1617-029; 80 ug/L Cu - Week 6			water			R	R	R	
8	SP1617-029; 160 ug/L Cu - Week 6			water			R	R	R	

Reg-TAT
additional analysis
as per 19-JUL-17
Leila Oosterbroek

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ Yes ☐ No
Are samples for human drinking water use?
☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

****For total metals, samples have been preserved. For dissolved parameters (DOC, dissolved metals), samples have not been filtered or preserved; please sub-sample and filter/preserve at the lab (SFPL).****

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☑
Ice packs Yes ☑ No ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
12.3					

SHIPMENT RELEASE (client use)

Released by: Date: 2017/06/28 Time: 1110

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: KC Date: 28 Jun Time: 13:00

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

APPENDIX F – Chain of Custody Forms

Nautilus Environmental

4340 Vandever Ave.
San Diego, CA 92120
Phone 858.587.7333
Fax 858.587.3961

Chain of Custody

COC# 2017-05-09 A

2017/05/09 ____ Page_1_ of _1_

Sample Collection By: Shaun Roberts

Report to:

Company Minto Mine
Address PO Box 11, Whitehorse Central PO
City/State/Zip Whitehorse/YT/Y1A 5X9
Contact Emilie Bouchard/Todd Swenson
Phone 604-759-4659
Email todds@mintomine.com/deborahf@mintomine.com

Invoice To:

Company Nautilus Environmental
Address #4, 6125 12 St. SE
City/State/Zip Calgary, AB, T2H 2K1
Contact Leila Oosterbroek
Phone 403-253-7121
Email leila@nautilusenvironmental.ca

1617-0967

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	21-d Daphnia magna	42-d Hyalella azteca	48-h Brachionus calyciflorus	32-d Pimephales promelas	Receipt Temperature (°C)
1	✱ W2	2017/05/05	15:15	Water	200L Barrel	9 ✓	Please contact Leila for specific analysis required	×	×	×	×	
2	W16	2017/05/05	16:00	Water	200L Barrel	3	Please contact Leila for specific analysis required	×	×	×	×	
3												
4												
5												
6												
7												
8												
9												
10												

PROJECT INFORMATION

Client:	**Nautilus Environmental**
PO No.:	
Shipped Via:	**Manitoulin**

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

SPECIAL INSTRUCTIONS/COMMENTS:

CQ/EJ 2017/05/12 @ 1500
9x 200L DRUMS, 6°C
NO S/I, GOOD CONDITION

RELINQUISHED BY (CLIENT)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (COURIER)

(Signature) (Time)
(Printed Name) (Date)
(Company) MANITOULIN

RELINQUISHED BY (COURIER)

(Signature) (Time)
(Printed Name) (Date)
(Company)

RECEIVED BY (LABORATORY)

(Signature) (Time)
(Printed Name) ERIC J. (Date)
(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

Nautilus Environmental

4340 Vandever Ave.
San Diego, CA 92120
Phone 858.587.7333
Fax 858.587.3961

Chain of Custody

COC# 2017-05-09 A

2017/05/09 ____ Page_1_ of _1_

Sample Collection By: Shaun Roberts

Report to:
~~Company~~ ~~Minto Mine~~
Address PO Box 11, Whitehorse Central PO
City/State/Zip Whitehorse/YT/Y1A 5X9
Contact Emilie Bouchard/Todd Swenson
Phone 604-759-4659
Email todds@mintomine.com/deborahf@mintomine.com

Invoice To:
~~Company~~ ~~Nautilus Environmental~~
Address #4, 6125 12 St. SE
City/State/Zip Calgary, AB, T2H 2K1
Contact Leila Oosterbroek
Phone 403-253-7121
Email leila@nautilusenvironmental.ca

ANALYSES REQUIRED

	SAMPLE ID	DATE	TIME	MATRIX	CONTAINER TYPE	NO. OF CONTAINERS	COMMENTS	21-d Daphnia magna	42-d Hyalella azteca	48-h Brachionus calyciflorus	32-d Pimephales promelas							Receipt Temperature (°C)
1617-1	W2	2017/05/05	15:15	Water	200L Barrel	9	Please contact Leila for specific analysis required	x	x	x	x							
0969 2	W16	2017/05/05	16:00	Water	200L Barrel	3	Please contact Leila for specific analysis required	x	x	x	x							
3																		
4																		
5																		
6																		
7																		
8																		
9																		
10																		

PROJECT INFORMATION

Client:	**Nautilus Environmental**
PO No.:	
Shipped Via:	**Manitoulin**

SAMPLE RECEIPT

Total No. of Containers	
Received Good Condition?	
Matches Test Schedule?	

RELINQUISHED BY (CLIENT)
(Signature) (Time)
(Printed Name) (Date)
(Company)

RELINQUISHED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company)

SPECIAL INSTRUCTIONS/COMMENTS:
CQ/EJ 2017/05/12 @ 1500
3 x 200L DRUMS, 6°C
NO S/I, GOOD CONDITION

RECEIVED BY (COURIER)
(Signature) (Time)
(Printed Name) (Date)
(Company) MANATOULIN

RECEIVED BY (LABORATORY)
(Signature) (Time)
(Printed Name) ERIC. J. (Date)
(Company)

Additional costs may be required for sample disposal or storage. Payment net 30 unless otherwise contracted.

DISTRIBUTION: WHITE - Nautilus Environmental, COLOR - Originator

END OF REPORT

APPENDIX C

RE-ANALYSIS OF DATA REPORTED FOR REPRODUCTION IN THE 42-DAY TOXICITY TEST OF *HYALELLA AZTECA*

APPENDIX C – STATISTICAL RE-ANALYSIS OF THE 42-DAY *HYALELLA AZTECA* REPRODUCTION DATA (AS REPORTED IN APPENDIX B – NAUTILUS 2017)

C1 Background

Verification of the Minto Mine's Water Quality Objective (WQO) for copper in Minto Creek was undertaken on water collected from Minto Creek and the Minto Mine Water Storage Pond (WSP) on May 5th 2017. These waters were mixed in a proportion equivalent to those expected at the Mine's maximum permissible rate of discharge (one part WSP water to three parts Minto Creek water), spiked with copper at nominal concentrations of 5, 10, 20, 40, 80, and 160 µg/L, and tested for toxicity with four test organisms (Appendix B – Nautilus 2017). One of the test endpoints – reproduction of *Hyalella azteca* in a 42-day test – yielded Inhibitory Concentrations (10th, 20th, and 50th percentiles) that were all reported as a "less than" ("<") values (<14.9 µg/L dissolved copper and <17.5 µg/L total copper; Appendix B – Nautilus 2017).

Inhibitory concentrations associated with the *H. azteca* 42-d reproduction endpoint were generated by Nautilus using the Comprehensive Environmental Toxicity Information System (CETIS) software. Inhibitory concentrations were estimated using a three parameter log-logistic regression model of reproduction (number of young per test organism; n=8) on copper concentration (page 154 of Appendix B). The residuals plots (page 155 of Appendix B) show strong heterogeneity of variance in the residuals versus concentration (confirmed by a Levene's test on the residuals of the model using treatment group as a factor; $p < 0.001$), a violation of the assumption of homogeneity of variance required for defensible regression. A data transformation can be used to meet the assumptions of homogeneity of variance. In addition, the laboratory control data set had two unusually large values (30 and 43 young) which have a strong leveraging influence on the laboratory mean value used in the IC_{20} estimate. In comparison, previous testing under clear water conditions yielded a maximum reproductive output of 8 young per female (Minnow 2016) and recent published studies have indicated reproductive output between 0 young per female and 28.4 young per female (Soucek et al. 2016; Ivey et al. 2016).

C2 Approach

To address violation of the assumption of homogeneity of variance, Minnow conducted a regression analysis for the *H. azteca* 42-d toxicity test reproduction endpoint (i.e., number of young per female) versus concentrations of dissolved and total copper. The regressions were conducted by adding a value of 1 to the response variable and then $\log_{10}$-transforming the variable to homogenize the variances (confirmed by a Levene's test on the residuals of the model using treatment group as a factor). The following regression models were fit following guidance from Environment Canada (2005):

$$\text{Linear: } Y = \beta_0 + \beta_1 x + \epsilon$$

$$\text{Exponential: } Y = \beta_0 \exp(\beta_1 x) + \epsilon$$

$$\text{Gompertz: } Y = \beta_0 \exp(-\exp(\beta_1 - \beta_2 x)) + \epsilon$$

$$\text{Logistic: } Y = \beta_0/(1 + \exp\left(\frac{x-\beta_1}{\beta_2}\right)) + \epsilon$$

Outliers were assessed by comparing Standardized residuals to a cut-off of 3.5 (values based on sample size following formula in Dohoo et al. [2009] for a significance level of 0.05). The model of best fit was determined using Akaike's Information Criteria (AIC). A comparison of AIC values is used to determine which regression model is more likely to be correct (Motulsky and Christopoulos 2004) and is used to compare linear and non-linear models generated with the same response variable. A second order AIC (AIC_C) was used and was calculated as:

$$AIC_c = n \cdot ln(\widehat{\sigma^2}) + 2K + 2K(K+1)/(n-K-1)$$

> where n is the sample size, ln() is the natural logarithm, $\widehat{\sigma^2}$ is the residual sum of squares from the regression model divided by the sample size, and K is the number of parameters (including the constant and error term) in the model.

The AIC_C is recommended for small sample sizes (n/K < 40) and as n gets larger, the last term in the AIC_C formula approaches zero and the AIC_C approaches the general AIC formula (Burnham and Anderson 2002). The AIC_C is used to compare models that were generated with the same response variable data. The model with the smallest AIC_C is more likely to be correct (i.e., it is more likely that the data were generated by the model with the smallest AIC_C). The magnitude of the AIC_C cannot be interpreted and comparisons among AIC_C values can only be made when the values of the response variables are identical. Comparison of AIC_C values is therefore not appropriate for comparing models with different sample sizes (e.g., AIC_C values cannot be compared between models with and without outliers removed).

C3 Results

Inhibitory Concentration (IC) estimates were generated for a 20% decrease in the response variable (no. of young per female) relative to the laboratory control mean and the laboratory control median (Table C1) based on the regression models (Figures C1 and C2). The IC_{20} estimates relative to the laboratory control median remove the influence of the two unusually large values for the laboratory control group on the estimate of the IC_{20}. The best fit regression model for reproduction and dissolved copper was a linear regression model (Table C1; Figure C1), and the best-fit regression model for reproduction and total copper was also a linear regression model (Table C1; Figure C2). Based on these models, IC_{20} estimates of 15.9 µg/L dissolved copper and 17.8 µg/L total copper were obtained relative to the laboratory control mean (which was leveraged by two extreme values), and IC_{20} estimates of 27.6 µg/L dissolved copper and 30.1 µg/L total copper were obtained relative to the laboratory control median. It is noteworthy that there is evidence that the regression models reported in Table C1 do not fit the data based on the lack of fit test (Table C1). This is because the test results (mean reproduction) do not monotonically decrease at each increasing copper concentration (Table C2) as would be expected under an ideal dose-response curve. This results in the estimated means values of all regression models not fitting the observed mean values and suggests that factors other than copper may have influenced the observed responses.

C4 References

Burnham, K.P. and D.R. Anderson. 2002. Model Selection and Multi-model Inference: a Practical Information-Theoretic Approach, 2nd edition. Springer-Verlag, New York.

Dohoo, I.R., Martin W., and Stryhn, H. 2009. Veterinary Epidemiologic Research 2nd Edition. VER Inc., Charlottetown, PE.

Environment Canada. 2005. Guidance Document on Statistical Methods for Environmental Toxicity Tests. Report EPS 1/RM/46. March 2005 (with June 2007 amendments).

Ivey, C.D., C.G. Ingersoll, W.G. Brumbaugh, E. Hammer, D.R. Mount, J.R. Hockett, T.J. Norberg-King, D.J. Soucek and L. Taylor. 2016. Using an Inter-Laboratory Study to Revise Methods for Conducting 10-d to 42-d Water or Sediment Tests with *Hyalella Azteca*. Environ. Toxicol. Chem. 35(10): 2439-2447.

Minitab 17 Statistical Software. 2010. State College, PA: Minitab, Inc. URL https://www.minitab.com

Minnow (Minnow Environmental Inc.). 2016. Clear Flow Water Toxicity Testing to Verify the Minto Mine Water Quality Objective for Copper on Minto Creek. Letter Report from Pierre Stecko to Ryan Herbert (Minto Mine). May 2016.

Motulsky, H. and A. Christopoulos. 2004. Fitting Models to Biological Data using Linear and Non-linear Regression: A Practical Guide to Curve Fitting. Oxford University Press: New York, NY.

Nautilus (Nautilus Environmental Inc.). 2017. Copper Toxicity Testing for Minto Creek. Report prepared for Minnow Environmental Inc. November 2017.

Soucek, D.J., A. Dickenson, and K.M. Major. 2016. Selection of Food Combinations to Optimize Survival, Growth, and Reproduction of the Amphipod *Hyalella Azteca* in Static-Renewal, Water Only Laboratory Exposures. Environ. Toxicol. Chem. 35(10): 2407-2415.

Table C.1: Regression Models for *Hyalella azteca* 42-d Reproduction versus Concentration of Dissolved Copper and Total Copper, and Estimates of IC_{20} Relative to the Laboratory Control Mean and Median, Minto Turbid Flow, May 5th 2017

Regression Model	Response Variable Transformation	Predictor Variable	Levene's Test p-value [a]	Coefficient	Coefficient P-value	Lack of Fit Test P-value [b]	n	AIC_c	S	r^2	Regression Coefficients			Outliers [c]	IC_{20} (µg/L) (Based on the Mean Lab Control)	IC_{20} (µg/L) (Based on the Median Lab Control)
											b_0	b_1	b_2			
Linear	log(X+1)	Dissolved Copper	0.432	intercept	<0.001	<0.001	64	-	0.227	0.647	1.045	-0.006	-	-	12.8	24.8
			0.106	slope	<0.001	<0.001	63	-199.9	0.198	0.720	1.066	-0.006	-	(1)	15.9	27.6
Exponential			0.432	-	-	<0.001	64	-	0.228	-	1.149	-0.011	-	-	15.4	22.6
			0.106	-	-	0.001	63	-198.3	0.200	-	1.168	-0.011	-	(1)	17.1	24.2
Gompertz			0.432	-	-	<0.001	64	-	0.228	-	4.660	0.367	-0.0057	-	15.4	24.1
			0.106	-	-	0.001	63	-198.0	0.198	-	3.266	0.075	-0.0070	(1)	17.6	26.7
Logistic			0.432	-	-	<0.001	64	-	0.229	-	2.687	-22.818	66.428	-	15.6	23.7
			0.106	-	-	0.001	63	-197.2	0.200	-	1.987	14.527	57.828	(1)	17.8	26.5
Linear	log(X+1)	Total Copper	0.432	intercept	<0.001	<0.001	64	-	0.227	0.647	1.052	-0.006	-	-	14.6	27.1
			0.106	slope	<0.001	<0.001	63	-199.9	0.198	0.720	1.073	-0.006	-	(1)	17.8	30.1
Exponential			0.432	-	-	<0.001	64	-	0.229	-	1.158	-0.011	-	-	17.2	24.8
			0.106	-	-	0.001	63	-198.0	0.201	-	1.178	-0.011	-	(1)	18.9	26.5
Gompertz			0.432	-	-	<0.001	64	-	0.227	-	4.365	0.316	-0.0055	-	17.2	26.5
			0.106	-	-	0.001	63	-198.0	0.198	-	3.183	0.045	-0.0067	(1)	19.5	29.2
Logistic			0.432	-	-	<0.001	64	-	0.230	-	2.545	-16.512	68.949	-	17.4	26.1
			0.106	-	-	0.001	63	-197.0	0.200	-	1.964	17.736	60.658	(1)	19.8	29.0

▨ Model with smallest AIC_c (best fit).

[a] Levene's test for homogeneity of variances performed on the model residuals with copper treatment group as the factor. Values > 0.05 indicate within-treatment residual variances are not significantly different.

[b] P-value < α (0.05) implies that the model does not fit the data (the mean values at each copper treatment are not well estimated by the regression model).

[c] Outliers identified as observations with Standardized residuals greater than 3.5 (based on α = 0.05; Dohoo et al. 2009).

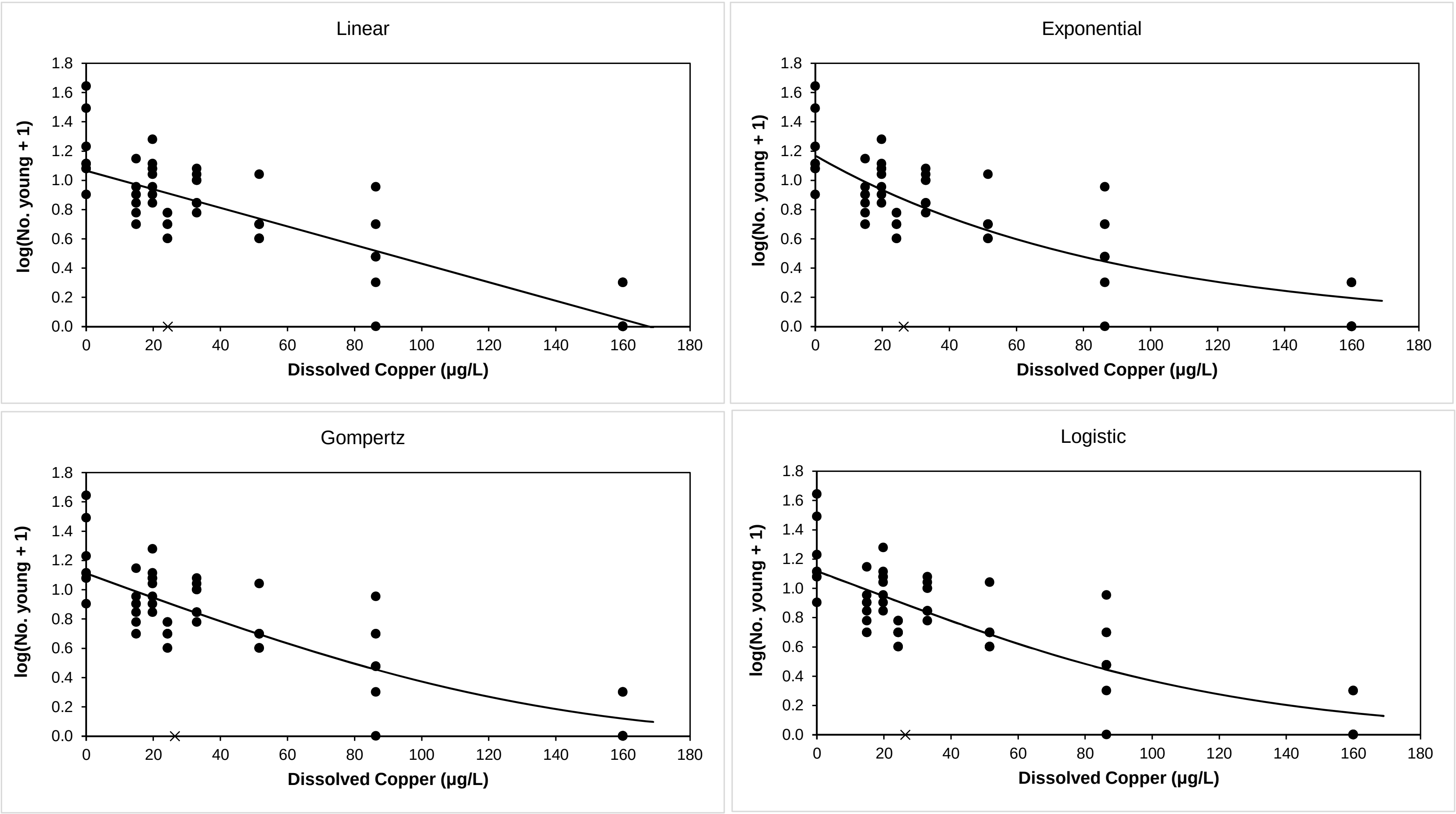


Figure C.1: **Scatterplots and Regression Models for *Hyalella azteca* 42-d Reproduction versus Concentration of Dissolved Copper, Minto Turbid Flow, May 5th 2017**

Notes: Outliers removed from analysis denoted by an ×.
Solid border indicates model with the best fit (lowest AIC_c value as reported in Table C.1).

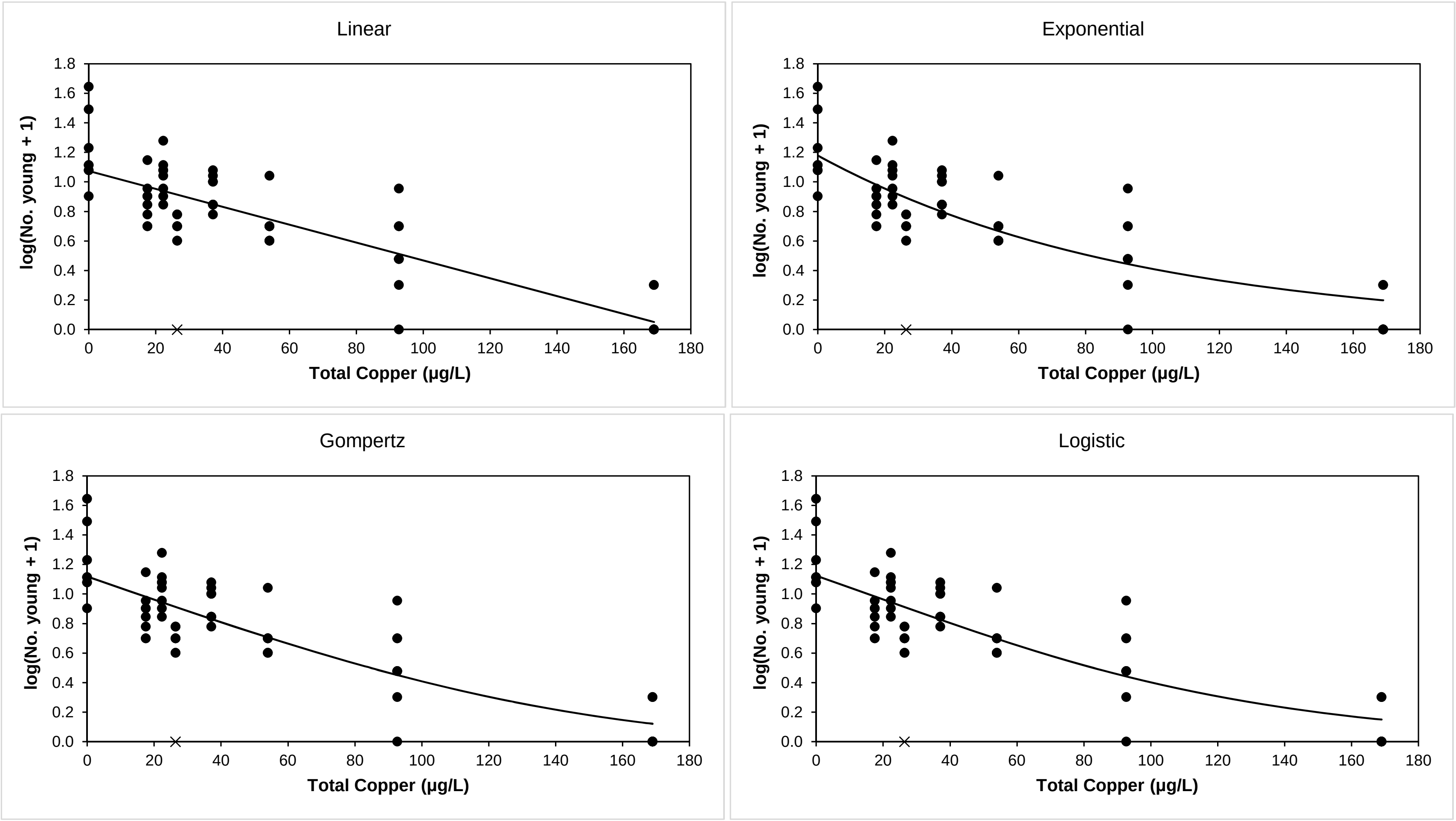


Figure C.2: **Scatterplots and Regression Models for *Hyalella azteca* 42-d Reproduction versus Concentration of Total Copper, Minto Turbid Flow, May 5th 2017**

Notes: Outliers removed from analysis denoted by an ×.
Solid border indicates model with the best fit (lowest AIC_c value as reported in Table C.1).

Table C.2: **Mean *Hyalella azteca* 42-d Reproduction by Treatment Group of Concentration Copper, Minto Turbid Flow, May 5th 2017**

Treatment Group	Total Copper (µg/L)	Dissolved Copper (µg/L)	Mean Reproduction	Mean Reproduction (outlier removed)
Lab Control	0	0	17.8	17.8
Site Control	17.5	14.9	6.8	6.8
5	22.3	19.8	10.4	10.4
10	26.4	24.3	3.5	4.0
20	37.1	33	7.8	7.8
40	54	51.6	4.4	4.4
80	92.7	86.4	2.9	2.9
160	169	160	0.25	0.25

🟦 Mean value exceeds the mean value of a treatment with lower copper concentration.

Appendix N – Waste Rock Verification Program Results

2017 Waste Rock Verification Results

Waste Dump Name	Sample ID	Date Sampled	Northing	Easting	Elevation	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
MPD	WRV-MPD -1701-01	26-Jun-17	6944787.938	384547.75	807.63	0.005	0.227	0.001	18.9091	0.03125	605.091	Pass
MPD	WRV-MPD -1701-02	26-Jun-17	6944772.445	384554.95	807.987	0.005	0.246	0.012	20.4918	0.375	54.645	Pass
MPD	WRV-MPD -1701-03	26-Jun-17	6944753.22	384566.109	807.296	0.020	0.174	0.020	14.4942	0.625	23.191	Pass
MPD	WRV-MPD -1702-01	26-Jun-17	6944696.09	384589.044	818.288	0.413	0.196	0.019	16.3268	0.59375	27.498	Pass
MPD	WRV-MPD -1702-02	26-Jun-17	6944711.829	384574.674	819.219	0.005	0.224	0.007	18.6592	0.21875	85.299	Pass
MPD	WRV-MPD -1702-03	26-Jun-17	6944731.386	384558.801	818.667	0.019	0.309	0.016	25.7397	0.5	51.479	Pass
MPD	WRV-MPD -1702-04	26-Jun-17	6944741.505	384551.475	818.523	0.040	0.192	0.014	15.9936	0.4375	36.557	Pass
MPD	WRV-MPD -1703-01	26-Jun-17	6944701.304	384682.671	818.038	0.034	0.179	0.014	14.9107	0.4375	34.082	Pass
MPD	WRV-MPD -1703-02	26-Jun-17	6944697.004	384669.599	819.345	0.135	0.114	0.016	9.4962	0.5	18.992	Pass
MPD	WRV-MPD -1703-03	26-Jun-17	6944691.672	384649.13	821.97	0.020	0.293	0.013	24.4069	0.40625	60.079	Pass
MPD	WRV-MPD -1703-04	26-Jun-17	6944685.996	384630.553	824.323	0.654	0.195	0.026	16.2435	0.8125	19.992	Pass
MPD	WRV-MPD -1703-05	26-Jun-17	6944672.579	384614.041	826.418	0.178	0.223	0.127	18.5759	3.96875	4.681	Pass
MPD	WRV-MPD -1704-01	26-Jun-17	6944807.332	384495.904	824.469	0.041	0.245	0.012	20.4085	0.375	54.423	Pass
MPD	WRV-MPD -1704-02	26-Jun-17	6944777.923	384511.547	824.763	0.010	0.129	0.009	10.7457	0.28125	38.207	Pass
MPD	WRV-MPD -1704-03	26-Jun-17	6944751.699	384525.276	823.784	0.005	0.247	0.005	20.5751	0.15625	131.681	Pass
MPD	WRV-MPD -1704-04	26-Jun-17	6944720.604	384541.704	823.312	0.015	0.186	0.006	15.4938	0.1875	82.634	Pass
118	WRV-118 -1704-01	26-Jun-17	6944209.631	384936.971	862.212	0.189	0.245	0.003	20.4085	0.09375	217.691	Pass
118	WRV-118 -1704-02	26-Jun-17	6944221.947	384924.93	862.666	0.095	0.200	0.003	16.6600	0.09375	177.707	Pass
118	WRV-118 -1704-03	26-Jun-17	6944228.677	384914.711	863.3	0.099	0.238	0.004	19.8254	0.125	158.603	Pass
118	WRV-118 -1704-04	26-Jun-17	6944220.32	384905.519	863.154	0.112	0.175	0.003	14.5775	0.09375	155.493	Pass
118	WRV-118 -1704-05	26-Jun-17	6944214.404	384915.654	862.706	0.138	0.168	0.003	13.9944	0.09375	149.274	Pass

Waste Dump Name	Sample ID	Date Sampled	Northing	Easting	Elevation	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
MPD	WRV-MPD -1705-01	26-Jun-17	6944794.791	384475.559	833.185	0.067	0.332	0.039	27.6556	1.21875	22.692	Pass
MPD	WRV-MPD -1705-02	26-Jun-17	6944771.33	384484.61	832.465	0.106	0.599	0.016	49.8967	0.5	99.793	Pass
MPD	WRV-MPD -1705-03	26-Jun-17	6944742.875	384484.852	832.158	0.027	0.455	0.017	37.9015	0.53125	71.344	Pass
MPD	WRV-MPD -1705-04	26-Jun-17	6944724.736	384496.087	832.056	0.029	0.404	0.023	33.6532	0.71875	46.822	Pass
MPD	WRV-MPD -1705-05	26-Jun-17	6944706.419	384507.841	832.144	0.108	0.499	0.016	41.5667	0.5	83.133	Pass
118	WRV-118 -1705-01	26-Jun-17	6944191.816	384889.943	867.851	0.105	0.371	0.002	30.9043	0.0625	494.469	Pass
118	WRV-118 -1705-02	26-Jun-17	6944208.883	384875.397	868.366	0.074	0.504	0.013	41.9832	0.40625	103.343	Pass
118	WRV-118 -1705-03	26-Jun-17	6944219.162	384856.972	868.634	0.176	0.045	0.001	3.7485	0.03125	119.952	Pass
118	WRV-118 -1705-04	26-Jun-17	6944229.054	384830.789	868.985	0.030	0.041	0.004	3.4153	0.125	27.322	Pass
118	WRV-118 -1705-05	26-Jun-17	6944205.392	384827.104	869.268	0.068	0.050	0.007	4.1650	0.21875	19.040	Pass
118	WRV-118 -1705-06	26-Jun-17	6944196.083	384850.184	868.97	0.105	0.381	0.005	31.7373	0.15625	203.119	Pass
MPD	WRV-MPD -1706-01	26-Jun-17	6944846.987	384369.079	838.186	0.227	0.301	0.022	25.0733	0.6875	36.470	Pass
MPD	WRV-MPD -1706-02	26-Jun-17	6944830.377	384375.593	838.299	0.324	0.301	0.145	25.0733	4.53125	5.533	Pass
MPD	WRV-MPD -1706-03	26-Jun-17	6944801.932	384387.587	838.51	0.170	0.136	0.031	11.3288	0.96875	11.694	Pass
MPD	WRV-MPD -1706-04	26-Jun-17	6944786.125	384393.805	838.561	0.080	0.130	0.033	10.8290	1.03125	10.501	Pass
MPD	WRV-MPD -1706-05	26-Jun-17	6944766.07	384402.059	838.679	0.112	0.132	0.022	10.9956	0.6875	15.994	Pass
MPD	WRV-MPD -1706-06	26-Jun-17	6944752.143	384407.304	838.882	0.428	0.310	0.299	25.8230	9.34375	2.764	Fail
118	WRV-118 -1706-01	26-Jun-17	6944130.391	384851.08	872.821	0.201	0.079	0.006	6.5807	0.1875	35.097	Pass
118	WRV-118 -1706-02	26-Jun-17	6944122.238	384826.223	872.724	0.090	0.023	0.008	1.9159	0.25	7.664	Pass
118	WRV-118 -1706-03	26-Jun-17	6944130.589	384803.952	872.621	0.213	0.055	0.002	4.5815	0.0625	73.304	Pass
118	WRV-118 -1706-04	26-Jun-17	6944118.281	384742.793	874.621	0.181	0.083	0.023	6.9139	0.71875	9.619	Pass
118	WRV-118 -1706-05	26-Jun-17	6944157.68	384738.272	873.229	0.040	0.011	0.003	0.9163	0.09375	9.774	Pass

Waste Dump Name	Sample ID	Date Sampled	Northing	Easting	Elevation	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
118	WRV-118 -1706-06	26-Jun-17	6944201.912	384773.796	871.724	0.016	0.018	0.006	1.4994	0.1875	7.997	Pass
118	WRV-118 -1706-07	26-Jun-17	6944178.152	384810.796	871.877	0.167	0.195	0.007	16.2435	0.21875	74.256	Pass
118	WRV-118 -1706-08	26-Jun-17	6944171.26	384836.096	871.746	0.086	0.165	0.001	13.7445	0.03125	439.824	Pass
118	WRV-118 -1706-09	26-Jun-17	6944166.938	384860.876	872.044	0.100	0.143	0.007	11.9119	0.21875	54.454	Pass
118	WRV-118 -1706-10	26-Jun-17	6944219.277	384804.946	870.582	0.005	0.011	0.005	0.9163	0.15625	5.864	Pass
MPD	WRV-MPD -1707-01	24-Jul-17	6944806.419	384403.615	848.628	0.371	0.433	0.147	36.0689	4.59375	7.852	Pass
MPD	WRV-MPD -1707-02	24-Jul-17	6944794.476	384388.82	848.597	0.180	0.352	0.071	29.3216	2.21875	13.215	Pass
MPD	WRV-MPD -1707-03	24-Jul-17	6944781.787	384373.527	848.563	0.223	0.528	0.132	43.9824	4.125	10.662	Pass
MPD	WRV-MPD -1707-04	24-Jul-17	6944758.481	384375.871	848.193	0.228	0.563	0.087	46.8979	2.71875	17.250	Pass
MPD	WRV-MPD -1707-05	24-Jul-17	6944770.6	384394.804	848.419	0.215	0.615	0.111	51.2295	3.46875	14.769	Pass
MPD	WRV-MPD -1707-06	24-Jul-17	6944781.363	384415.137	847.867	0.589	0.471	0.120	39.2343	3.75	10.462	Pass
MPD	WRV-MPD -1707-07	24-Jul-17	6944762.027	384425.628	847.629	0.802	0.491	0.135	40.9003	4.21875	9.695	Pass
MPD	WRV-MPD -1707-08	24-Jul-17	6944749.424	384407.155	848.029	0.215	0.487	0.226	40.5671	7.0625	5.744	Pass
MPD	WRV-MPD -1707-09	24-Jul-17	6944737.617	384427.135	847.456	0.443	0.481	0.186	40.0673	5.8125	6.893	Pass
MPD	WRV-MPD -1707-10	24-Jul-17	6944723.467	384446.267	845.282	0.479	0.360	0.201	29.9880	6.28125	4.774	Pass
MPD	WRV-MPD -1708-01	20-Aug-17	6944761.407	384358.959	847.677	0.261	0.684	0.134	56.9772	4.1875	13.606	Pass
MPD	WRV-MPD -1708-02	20-Aug-17	6944775.979	384339.405	847.476	0.210	0.457	0.119	38.0681	3.71875	10.237	Pass
MPD	WRV-MPD -1708-03	20-Aug-17	6944787.039	384321.443	847.547	0.152	0.396	0.104	32.9868	3.25	10.150	Pass
MPD	WRV-MPD -1708-04	20-Aug-17	6944721.626	384366.802	843.467	0.233	0.759	0.114	63.2247	3.5625	17.747	Pass
MPD	WRV-MPD -1708-05	20-Aug-17	6944705.415	384357.541	843.767	0.084	0.309	0.070	25.7397	2.1875	11.767	Pass
MPD	WRV-MPD -1708-06	20-Aug-17	6944694.436	384384.856	843.031	0.018	0.160	0.008	13.3280	0.25	53.312	Pass
MPD	WRV-MPD -1708-07	20-Aug-17	6944714.482	384398.702	842.524	0.330	0.473	0.146	39.4009	4.5625	8.636	Pass

Waste Dump Name	Sample ID	Date Sampled	Northing	Easting	Elevation	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
MPD	WRV-MPD -1708-08	20-Aug-17	6944704.841	384425.722	841.605	0.197	0.449	0.092	37.4017	2.875	13.009	Pass
MPD	WRV-MPD -1708-09	20-Aug-17	6944680.4	384422.516	841.404	0.051	0.303	0.045	25.2399	1.40625	17.948	Pass
MPD	WRV-MPD -1708-10	20-Aug-17	6944668.316	384443.501	841.083	0.150	0.311	0.054	25.9063	1.6875	15.352	Pass
MPD	WRV-MPD -1708-11	20-Aug-17	6944687.257	384456.752	840.96	0.245	0.137	0.045	11.4121	1.40625	8.115	Pass
MPD	WRV-MPD -1709-01	11-Dec-17	6944672.821	384507.812	836.789	0.185	0.283	0.025	23.5739	0.78125	30.175	Pass
MPD	WRV-MPD -1709-02	11-Dec-17	6944680.995	384499.257	836.702	0.015	0.056	0.002	4.6648	0.0625	74.637	Pass
MPD	WRV-MPD -1709-03	11-Dec-17	6944698.028	384495.946	837.232	0.011	0.020	0.001	1.6660	0.03125	53.312	Pass
MPD	WRV-MPD -1709-04	11-Dec-17	6944689.85	384510.086	837.377	0.023	0.063	0.002	5.2479	0.0625	83.966	Pass
MPD	WRV-MPD -1709-05	11-Dec-17	6944679.098	384521.98	837.953	0.030	0.069	0.001	5.7477	0.03125	183.926	Pass
MPD	WRV-MPD -1709-06	11-Dec-17	6944670.574	384537.969	837.494	0.087	0.406	0.054	33.8198	1.6875	20.041	Pass
MPD	WRV-MPD -1709-07	11-Dec-17	6944667.295	384552.194	837.136	0.133	0.452	0.118	37.6516	3.6875	10.211	Pass
MPD	WRV-MPD -1709-08	11-Dec-17	6944666.192	384525.43	837.081	0.089	0.367	0.071	30.5711	2.21875	13.779	Pass
MPD	WRV-MPD -1710-01	11-Dec-17	6944898.968	384383.839	836.789	0.156	0.456	0.019	37.9971	0.582682	65.211	Pass
MPD	WRV-MPD -1710-02	11-Dec-17	6944910.346	384368.009	836.702	0.136	0.293	0.089	24.3886	2.78860931	8.746	Pass
MPD	WRV-MPD -1710-03	11-Dec-17	6944922.4	384351.228	837.232	0.106	0.315	0.082	26.2051	2.55381232	10.261	Pass
MPD	WRV-MPD -1710-04	11-Dec-17	6944930.282	384331.731	837.377	0.098	0.216	0.021	17.9650	0.64102374	28.025	Pass
MPD	WRV-MPD -1710-05	11-Dec-17	6944939.313	384312.082	837.953	0.037	0.208	0.002	17.3110	0.0684374	252.946	Pass
MPD	WRV-MPD -1710-06	11-Dec-17	6944918.955	384301.192	837.494	0.083	0.149	0.007	12.3824	0.22420889	55.227	Pass
MPD	WRV-MPD -1710-07	11-Dec-17	6944908.433	384317.719	837.136	0.242	0.167	0.008	13.9232	0.23689361	58.774	Pass
MPD	WRV-MPD -1710-08	11-Dec-17	6944893.23	384333.305	837.081	0.060	0.240	0.003	20.0137	0.08421188	237.659	Pass
MPD	WRV-MPD -1710-09	11-Dec-17	6944876.392	384364.284	836.775	0.322	0.233	0.153	19.4362	4.79367411	4.055	Pass
MWDW	WRV-MWDW -1711-01	11-Dec-17	6944910.197	383959.65	868.352	0.340	0.123	0.011	10.2693	0.34433101	29.824	Pass

Waste Dump Name	Sample ID	Date Sampled	Northing	Easting	Elevation	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
MWDW	WRV-MWDW -1711-02	11-Dec-17	6944916.832	383939.256	869.805	0.380	0.092	0.021	7.6452	0.65715861	11.634	Pass
MWDW	WRV-MWDW -1711-03	11-Dec-17	6944924.181	383918.498	871.463	0.308	0.081	0.011	6.7745	0.35655082	19.000	Pass
MWDW	WRV-MWDW -1711-04	11-Dec-17	6944935.272	383898.634	872.973	0.321	0.076	0.019	6.3150	0.5976044	10.567	Pass
MWDW	WRV-MWDW -1711-05	11-Dec-17	6944949.327	383881.073	875.098	0.304	0.095	0.025	7.8917	0.78817391	10.013	Pass
MWDW	WRV-MWDW -1711-06	11-Dec-17	6944962.548	383864.426	877.148	0.554	0.144	0.028	11.9973	0.87883989	13.651	Pass
MPD	WRV-MPD-1711-01	11-Dec-17	6944580.077	384410.496	853.16	0.044	0.081	0.001	6.7136	0.01652677	406.223	Pass
MPD	WRV-MPD-1711-02	11-Dec-17	6944580.303	384432.681	853.162	0.096	0.041	0.014	3.4048	0.43952286	7.747	Pass
MPD	WRV-MPD-1711-03	11-Dec-17	6944583.145	384461.986	853.7	0.702	0.131	0.058	10.9127	1.80275706	6.053	Pass
MPD	WRV-MPD-1711-04	11-Dec-17	6944578.443	384485.653	854.084	0.640	0.061	0.002	5.1045	0.04729576	107.926	Pass
MPD	WRV-MPD-1711-05	11-Dec-17	6944581.528	384509.465	854.467	0.690	0.066	0.004	5.4880	0.10954581	50.098	Pass
MPD	WRV-MPD-1711-06	11-Dec-17	6944600.546	384489.873	853.512	0.585	0.056	0.001	4.6461	0.02561255	181.397	Pass
MPD	WRV-MPD-1711-07	11-Dec-17	6944615.291	384467.032	852.477	0.277	0.339	0.009	28.2365	0.28862006	97.833	Pass
MPD	WRV-MPD-1711-08	11-Dec-17	6944616.293	384444.443	852.375	0.321	0.151	0.008	12.5533	0.2367733	53.018	Pass
MPD	WRV-MPD-1711-09	11-Dec-17	6944605.776	384424.564	852.797	0.139	0.194	0.003	16.1602	0.09375	172.375	Pass

Appendix O – ABA Report 2017 GMP Annual Report

Minto Mine
Water Licence QZ14-031 & Quartz Mining Licence QML-0001
2017 Annual Report
Geochemical Monitoring Report

Prepared by:
Minto Explorations Ltd.
Minto Mine
March 2018

Table of Contents

List of Tables

List of Figures

List of Appendices

1 Geochemical Monitoring Program Objectives

This report is submitted to meet requirements under Minto Explorations Ltd., (a subsidiary of Capstone Mining Corporation), Minto Mine (Minto) Type "A" Water Licence QZ14-031-1 (WUL) and Quartz Mining Licence QML-0001.

The WUL specifically addresses the requirement in clause 95 which states "*The Licensee shall implement the updated Geochemical Monitoring Program, including the Waste Rock Verification Program, and the results from this program are to be included in the Annual Report."*

The QML addresses the requirement in Schedule D – Annual Reporting Requirements, under the Environmental Monitoring section, subsection a) which states *"a summary of the programs undertaken for environmental monitoring and surveillance as outlined in the Environmental Monitoring, Surveillance and Reporting Plan".*

Details regarding the Geochemical Monitoring Program can be found in Minto's Environmental Monitoring, Surveillance and Reporting Plan (EMSRP) that was approved by the Yukon Water Board and Yukon Government, Energy Mines and Resources Branch on October 4th, 2016 and December 13th, 2016 respectively. In general, the Geochemical Monitoring Program is comprised of the following components:

- The Acid Base Accounting (ABA) Program, the primary focus of this document;
- The Waste Rock Management Verification Program; and
- Low Grade and Oxide Ore Metals Leaching Characterization Program (currently not implemented).

The objective of the ABA Program is to determine the Neutralization Potential Ratio, otherwise referred to as the NPR (Neutralizing Potential divided by Acid Potential [NP/AP]) for overburden and waste rock. An NPR value of 3 or greater generally indicates non-acid generating material. During 2017, 265 waste rock and overburden samples were collected and analyzed from the Area 2 Stage 3 Pit, and another 19 samples of waste rock was sampled from the Minto East and Area 2 underground development.

A separate, parallel ABA program was administered to determine the NPR of the tailings solids. During 2017, 15 Tailing samples were collected and analyzed. A sample was analyzed for each month except January 2017. April 2017 had one composition and one supplimentary tailing sample collected on April 10th and May 2017 had 2 separate tailings sample. June composition was not a mixture but rather a weekly tailings sample. The third and fourth quarter months were sampled as per scheduled.

The objective of the Waste Rock Management Verification Program is to verify that the on-site waste rock segregation system is preforming as expected. The results of the Waste Rock Management Verification Program are available in a separate report and will therefore not be discussed further in this document.

There are currently no details or results for the Low Grade and Oxide Ore Metals Leaching Characterization Program. The leach pad structures were built in August 2017, and ore was added in November 2017 and January 2018. Results from this program are expected in 2018 and will not be discussed further in this document.

2 ABA Program - Waste Rock and Overburden

2.1 Internal Frequency of Sampling – On-site Analysis

On-site total carbon (C(T)) and total sulphur (S(T)) analysis are carried out on drill cuttings from every blast hole. Samples are collected for grade control purposes, and a portion of each sample is sent for S(T) and total carbon C(T) analyses at the on-site laboratory.

2.2 External Frequency of Sampling

External laboratory analysis were completed for composites samples from open pit mining. A sample of drill cuttings was collected from waste blasts with a frequency of approximately one sample for every seven holes drilled. Composite samples from each waste class for each blast are formed from approximately 4-5 individual samples.

External analysis were also carried out for underground ABA samples. The sampling procedure assembles a composite sample every 3300 tonnes (equivalent to approximately 50 m of development) using a grab sample or wall chipping technique.

2.3 Sample Preparation

All composite samples were reduced to 1-2 kg in mass using a riffle splitter. The resulting split sample was labeled according to the ABA Program sample naming standards and shipped to an accredited laboratory. The labeling methodology was consistent with the Mine Environmental ABA Database throughout the reporting period.

2.4 Test Work and Evaluation

Internal samples are analyzed for S(T) and C(T) using an Eltra CS-800 induciton furnace with infrared detectors. The resultant S(T) and C(T) data are converted to equivalent acid and neutralization potential and ultimately, NP:AP ratios are calculated. The calculated NP:AP ratios are used for characterization and segregation of waste rock on-site. This data is used for internal classification and waste rock segregation only, therefore, the results of that program will not be reported in this report.

In 2017, ALS Minerals conducted ABA analysis using the MEND (1991) Modified NP method as detailed in the EMSRP for all external samples. Reported results were entered into the Mine Environmental ABA Database. Waste rock and overburden composite samples were also analyzed for total metals for the entire duration of the reporting period.

For the reporting period, the results obtained from ALS were compared against past results found in the Mine Environmental ABA Database and the results are presented in Section 2.5. Sulphide sulphur ($S(S^{-2})$) results from ALS Minerals were calculated using the difference between total sulphur and sulphate sulphur (HCl Leach). In the event that the $S(S^{-2})$ value was zero or negative, the detection limit of <0.01% was used. The acid potential (AP) results from ALS Mineral were calculated using the calculated $S(S^{-2})$ value.

2.5 Discussion

Blasts are numbered by bench (denoted by the toe elevation) and by the sequential blast number for that bench (e.g. 784-01; 784 being the toe elevation of the bench and 01 being the first blast of the bench). Images depicting the location of all surface samples collecting during the reporting period are provided in Appendix A.

The primary lithology of the deposit is granodiorite. The graniodiorite is divided into sub-units and classified as equigranular granodiorite (eG), porphyroblastic granodiorite (pG), and foliated granodiorite (fG). Locally, very highly-weathered granodiorite near the surface is described as residuum, and surface materials comprised of organics and soil is termed overburden. Other minor lithological units are described as pegmatite (Peg), Andesite (And) and Aplite (Ap).

2.6 Results

The 304 samples collected in the reporting period were analyzed by ALS Minerals and results were reported according to the Modified NP method (MEND 1991). In the reporting period, the NPR values ranged from 0.67 to 208.0 with a mean NP/mean AP of 41.09 and a median of 28.80. A summary of the results for ABA analysis are attached as Appendix B. Additionally, the ALS raw lab result files are provided in Appendix C.

2.6.1 NPR

The 2017 NPR results are compared to the results from 2014-2016 in Table 1, below.

Table 1. NPR Results Summary for 2014 to 2017.

NPR Values				
Period Ending	**Minimum (NPR)**	**Maximum (NPR)**	**(Mean NP)/(Mean AP)**	**Median (NPR)**
2014 (January to December, 2014)	0.60	167.20	5.31	23.80
2015 (January to December, 2015)	-6.10	102.10	5.08	18.70
2016 (January to December, 2016)	0.80	134.40	14.49	35.20
2017 (January to December, 2017)	0.67	208.0	15.26	28.80

During the reporting period, 33 samples returned NPR values below the threshold of 3.0. Of the 33 samples with a NPR value less than 3:

- 17 were found to have an increased sulphide sulphur content (and therefore AP) consequently decreasing the NPR;

And of the remaining samples:

- 5 samples represented material classified as NAG (or waste);
- 7 samples represented material that was placed in the SAT dump;
- 4 samples represented material that was placed in the overburden;

All waste rock and overburden was dispatched based on Minto's *Waste Rock and Overburden Management Plan*.

2.6.2 Paste pH

The paste pH results for 2017 were between 7.50 and 9.20 with a mean value of 8.50 and a median value of 8.50. The paste pH results for 2017 are compared to 2014-2016 and displayed in Table 2, below.

Table 2. Paste pH Results Summary for 2014 to 2017.

Paste pH from SGS (2014-2016) and from ALS (2016-2017)				
Period Ending	**Minimum (pH)**	**Maximum (pH)**	**Mean (pH)**	**Median (pH)**
2014 (January to December, 2014)	6.44	9.43	8.56	8.66
2015 (January to December, 2015)	5.23	9.47	8.70	8.78
2016 (January to December, 2016)	7.61	9.39	8.75	8.77
2017 (January to December, 2017)	7.50	9.20	8.50	8.50

The results from 2017 are comparable to previous years results.

2.6.3 Sulphide Sulphur

The sulphide sulphur content $S(S^{-2})$ results for 2017 ranged from <0.01 to 1.38%, with a mean value of 0.082% and a median value of 0.03% as summarized and compared with 2014-2016 values in Table 3.

Table 3. Sulphide Sulphur Results Summary for 2014 to 2017

Sulphide-Sulphur % from SGS (2014-2016) and from ALS (2016-2017)				
Period Ending	**Minimum ($S(S^{2-})$)**	**Maximum ($S(S^{2-})$)**	**Mean ($S(S^{2-})$)**	**Median ($S(S^{2-})$)**
2014 (January to December, 2014)	0.01	3.26	0.12	0.02
2015 (January to December, 2015)	<0.01	1.09	0.09	0.02
2016 (January to December, 2016)	<0.01	0.75	0.05	0.02
2017 (January to December, 2017)	<0.01	1.38	0.082	0.03

A total of 21 samples exceeded the sulphide sulphur threshold for construction rock of 0.3% during 2017. Furthermore, 17 samples also had a NPR of less than 3 and therefore represented SAT material. The 4 remaining samples had an NPR greater than 3 and exceeded the sulphide sulphur threshold (2 MEUG and 2 A2S3).

Figure 1, below, is a plot of sulphide sulphur versus (vs) NPR for all samples analyzed during 2017. Figure 1 illustrates that 21 samples had sulphide sulphur content greater than 0.3% and 33 samples had a NPR threshold of less than 3.

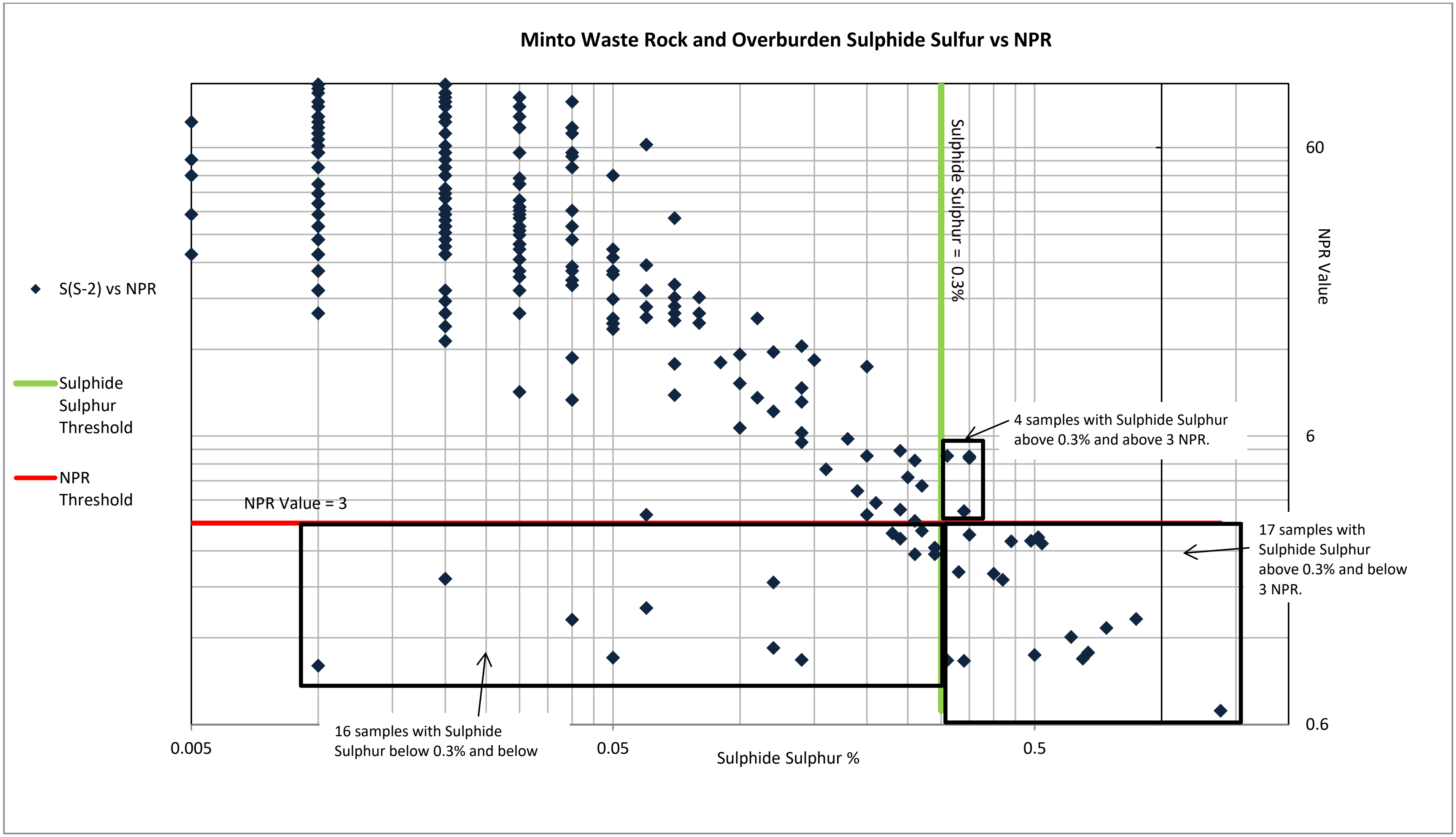


Figure 1. Minto Waste Rock and Overburden Sulphide Sulfur vs NPR, 2017

3 Tailings

3.1 Frequency of Sampling and Sample Preparation

Minto collects a weekly sample of final tailings. The weekly samples have been filtered and dried in the onsite lab and then combined into a monthly sample which is then riffled down to produce a 1-2 kg composite. Samples are labelled according to the labeling protocol established in the Mine Environmental ABA Database.

3.2 Test work and Evaluation

Mirroring the waste rock and overburden analysis, ALS Minerals conducted ABA analysis using the MEND (1991) Modified NP method as detailed in the EMSRP. Reported results were entered into the Mine Environmental ABA Database. Monthly tailings composite samples were also analyzed for total metals for the 11 months of available samples.

3.3 Results

The results from the ALS Minerals laboratory analyses indicate that 2017 tailings samples were within the threshold of NPR greater than 4 and contain lower than 0.3% sulphide sulphur content as presented in Figure 2, below. The tailings results are summarized in Appendix D and the raw lab results are presented in Appendix C.

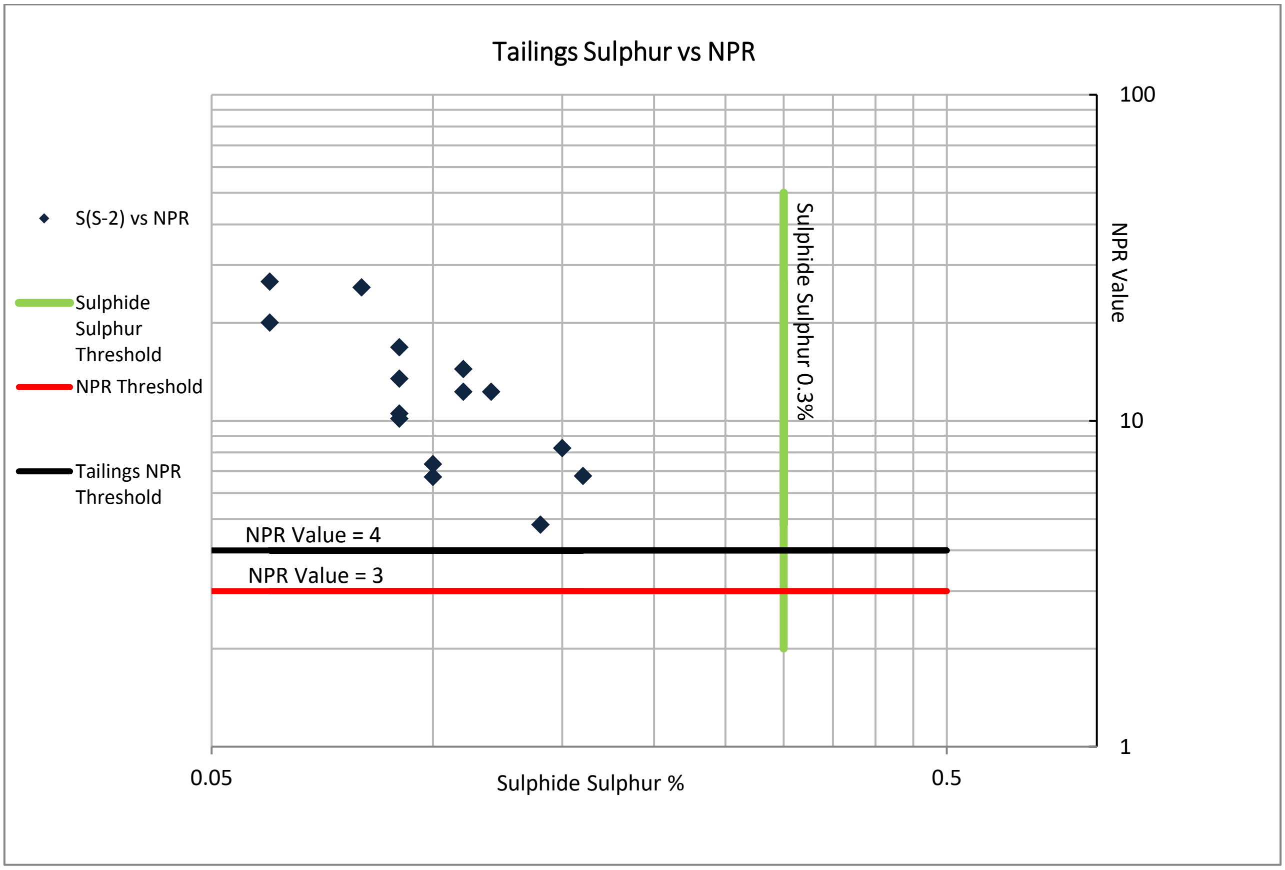


Figure 2. Tailings Sulphide Sulphur vs NPR, 2017

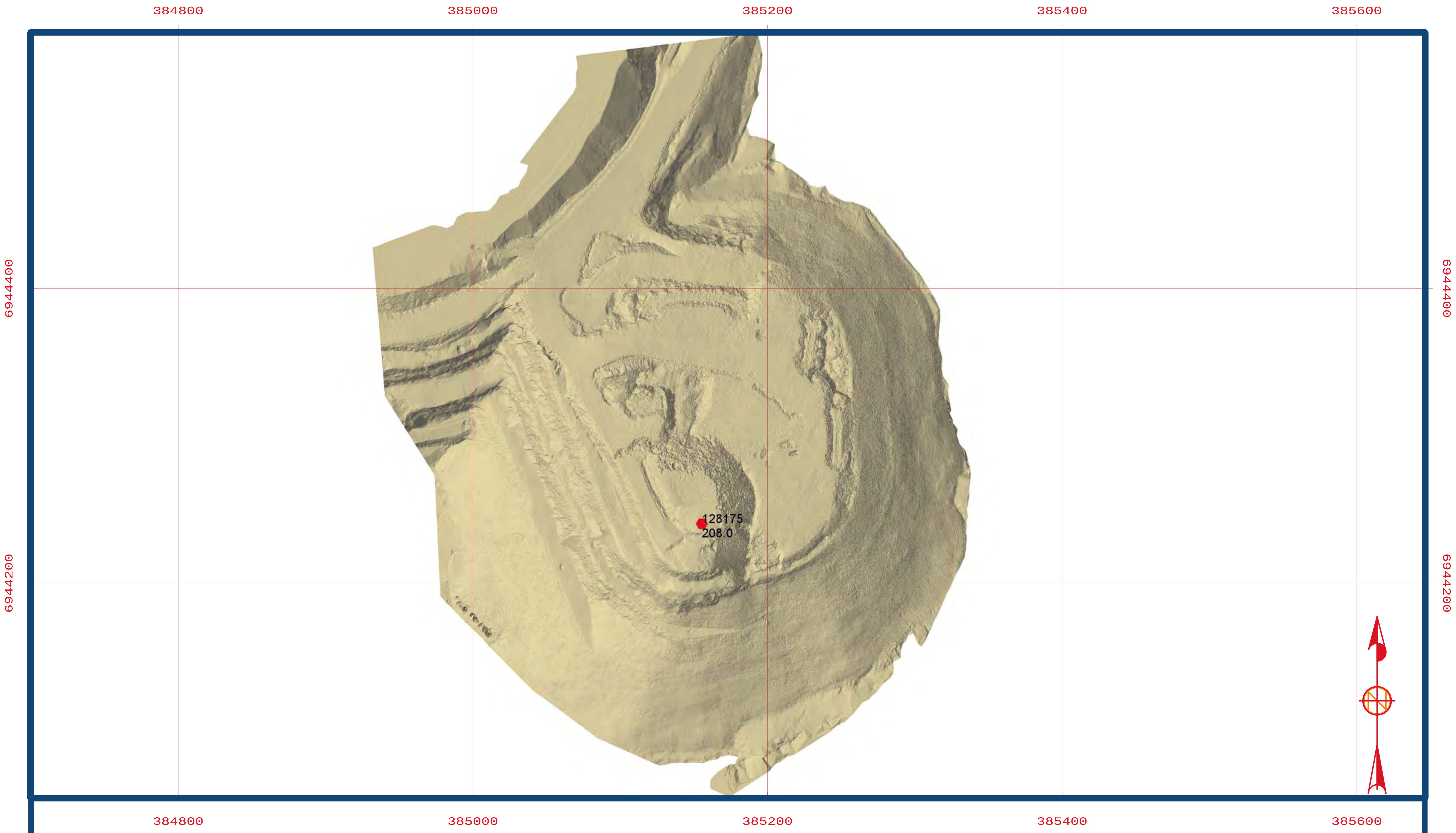
4 Conclusion

The results displayed in this report combined with the previous reporting periods are the foundation for the Mine Environmental ABA Database. Overburden and waste rock development will continue through the subsequent phases of mining and milling and will be sampled, analyzed and reported as required by the WUL and QML and in accordance with the EMSRP.

5 References

MEND. (1991). *Mine Environment Neutral Drainage Program: Acid Rock Drainage Prediciton Manual, MEND Project 1.16.1 (b). Prepared by Coastech Research Inc., North Vancouver, B.C. March 1991.*

Appendix A: Sample Location Images

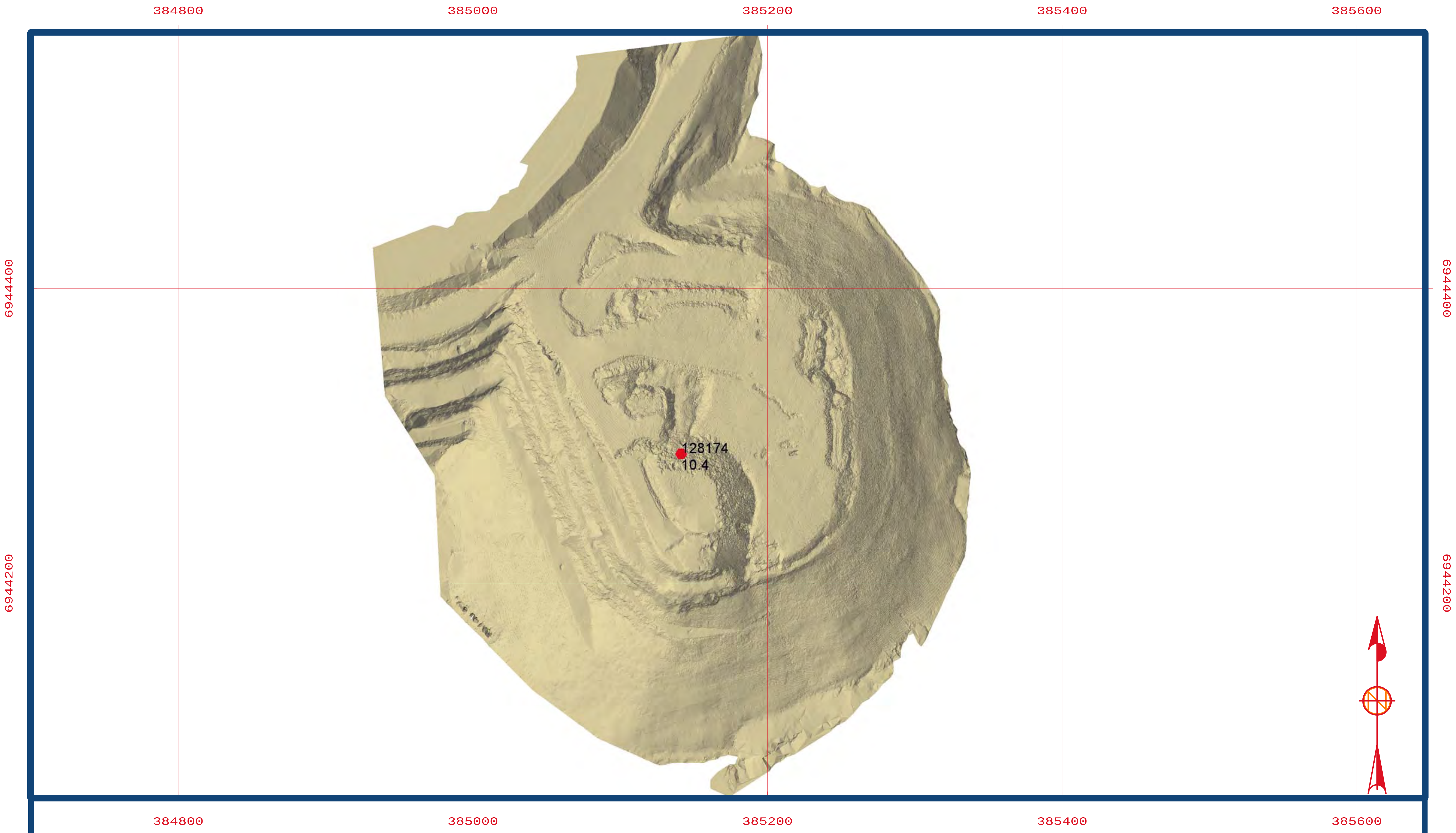


A2S3/S3ext ABA Loc. 745 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

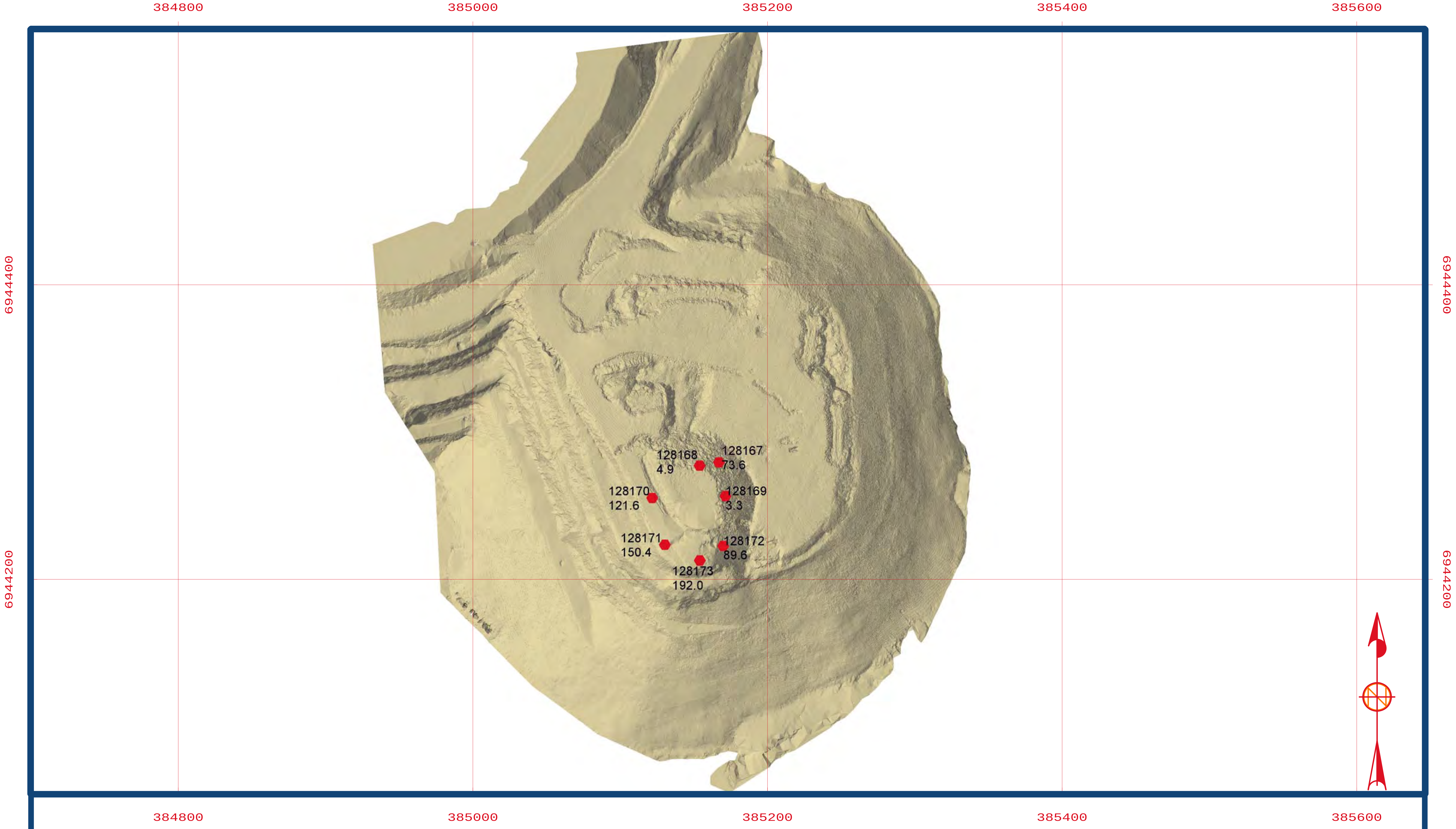
capstone
MINTO MINE



A2S3/S3ext ABA Loc. 751 elev.

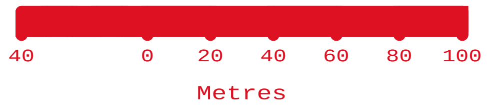
DATE: 24-Feb-2018	DRAWN BY: MS

capstone
MINTO MINE

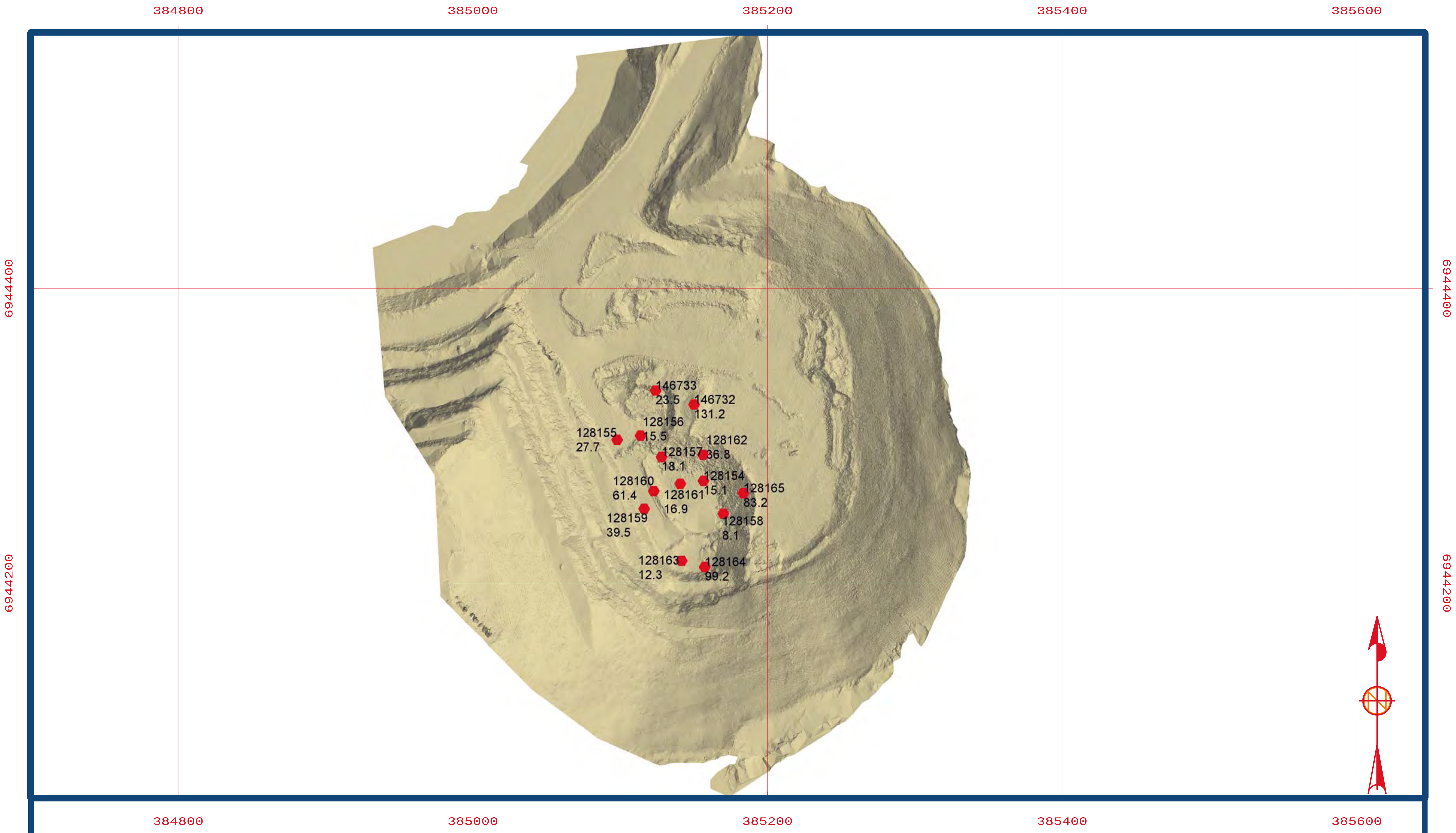


A2S3/S3ext ABA Loc. 757 elev.

DATE:	DRAWN BY:
24-Feb-2018	MS



capstone
MINTO MINE

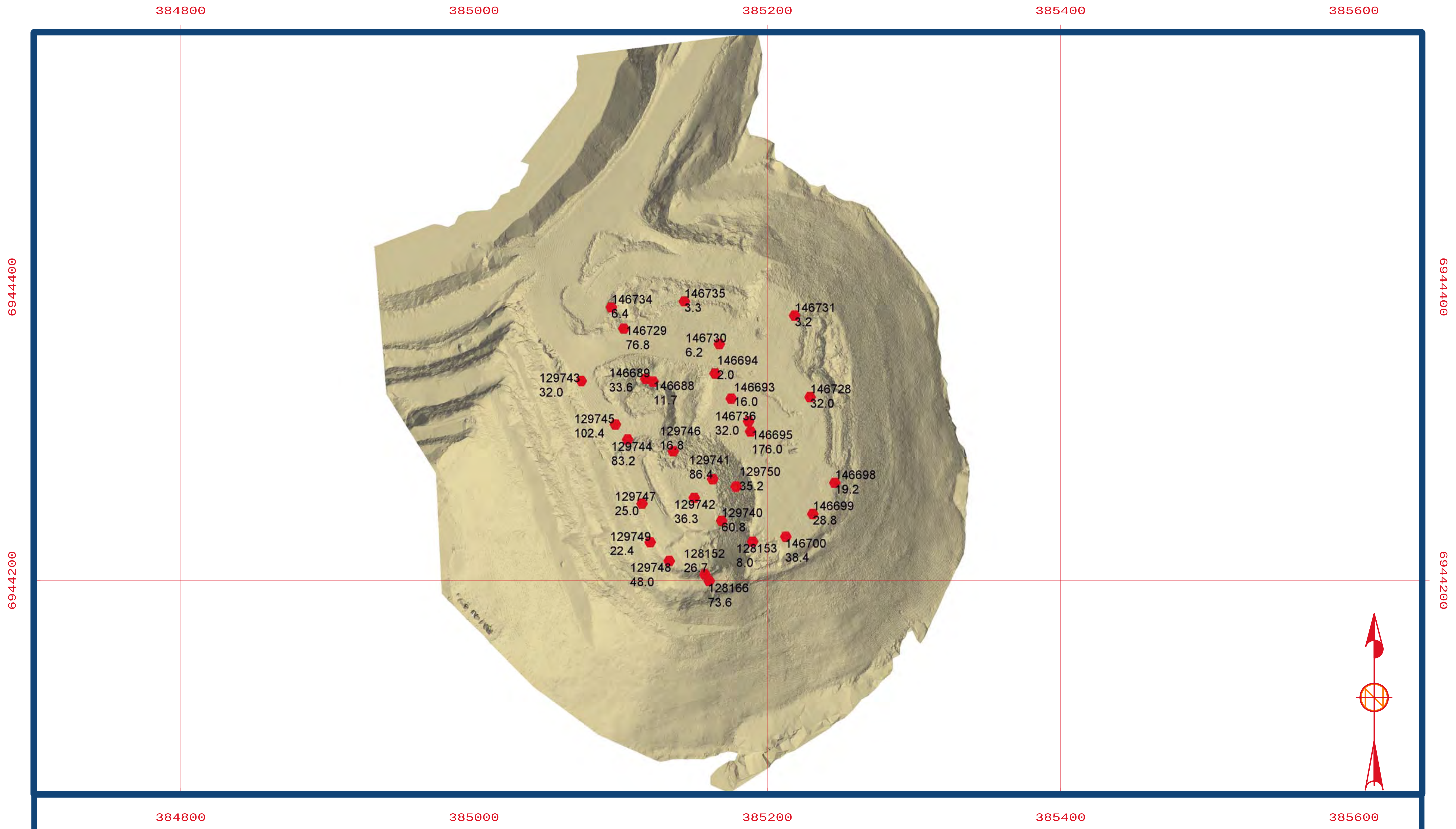


A2S3/S3ext ABA Loc. 763 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

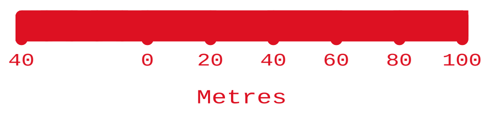
capstone
MINTO MINE



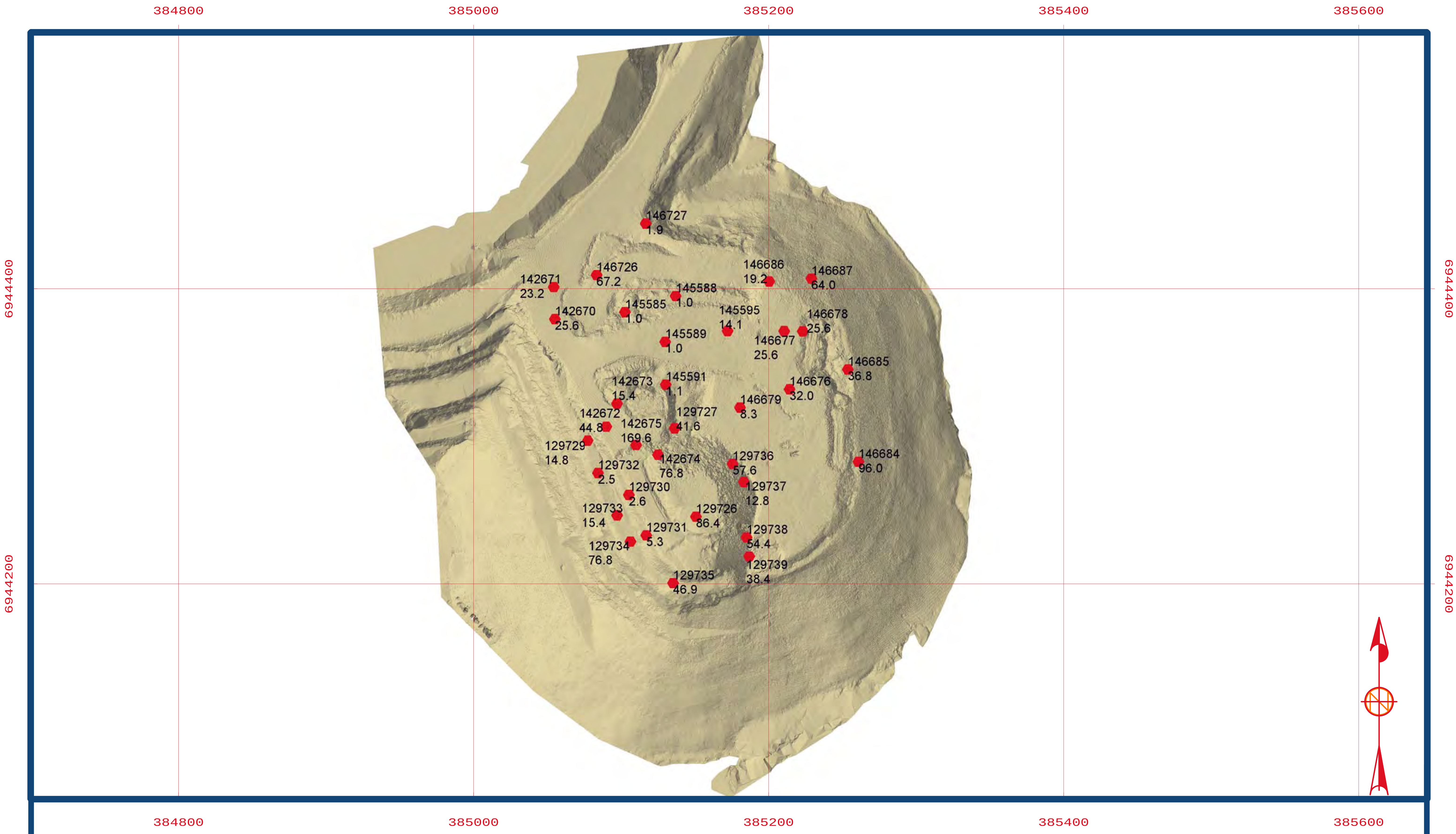
A2S3/S3ext ABA Loc. 769 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS



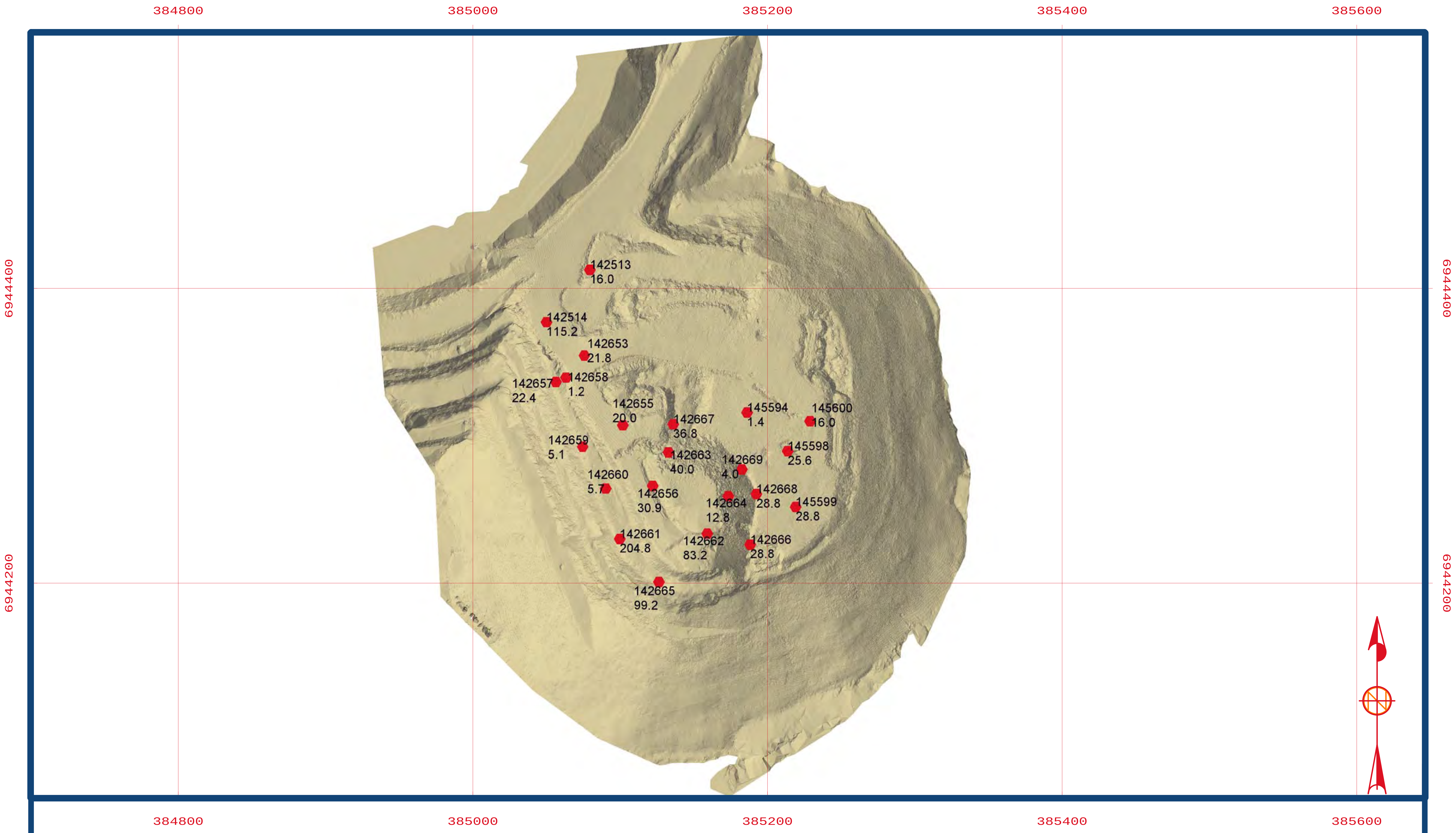
capstone
MINTO MINE



A2S3/S3ext ABA Loc. 775 elev.

DATE: 24-Feb-2018	DRAWN BY: MS

capstone
MINTO MINE



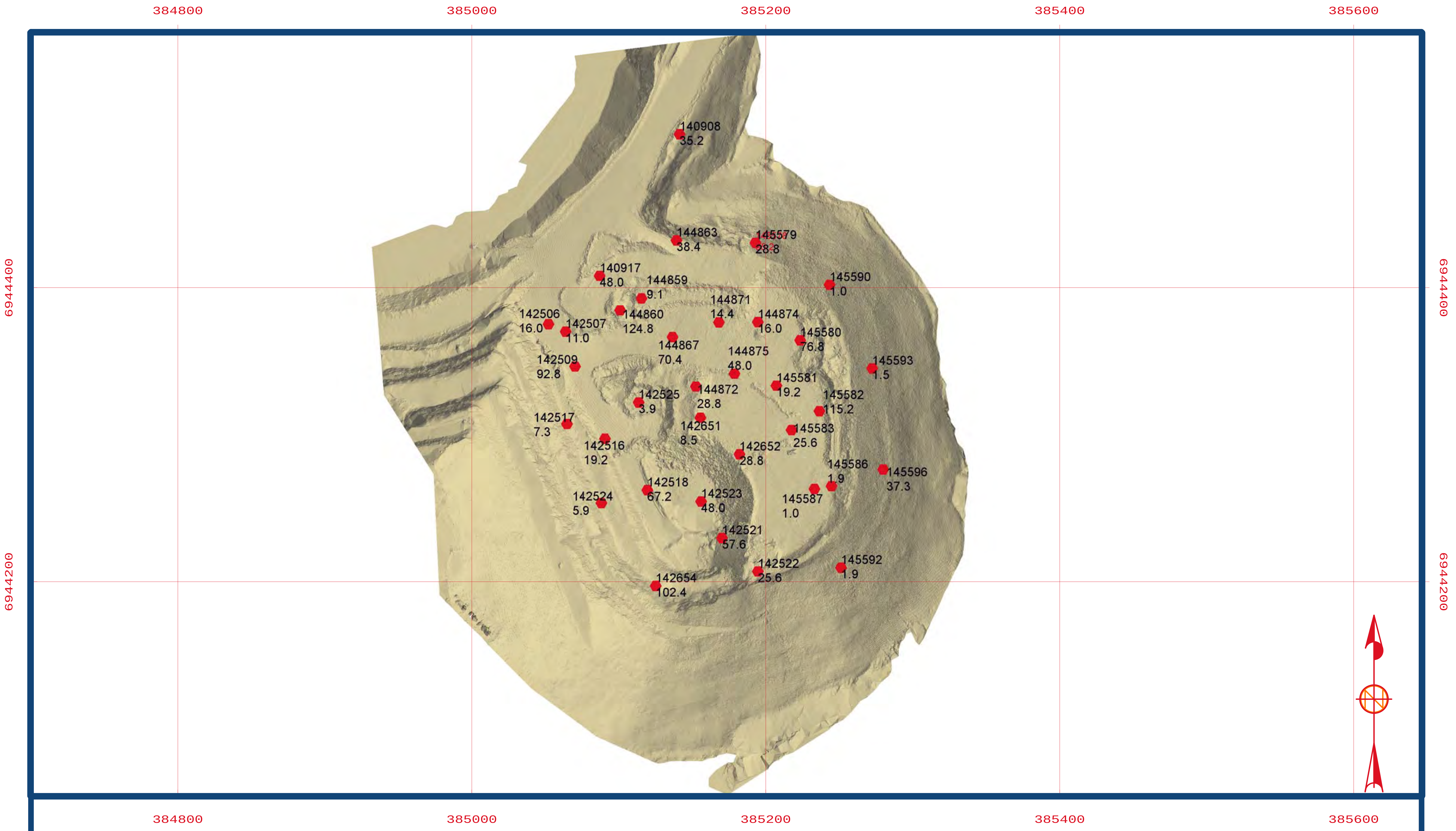
A2S3/S3ext ABA Loc. 781 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

40 0 20 40 60 80 100
Metres

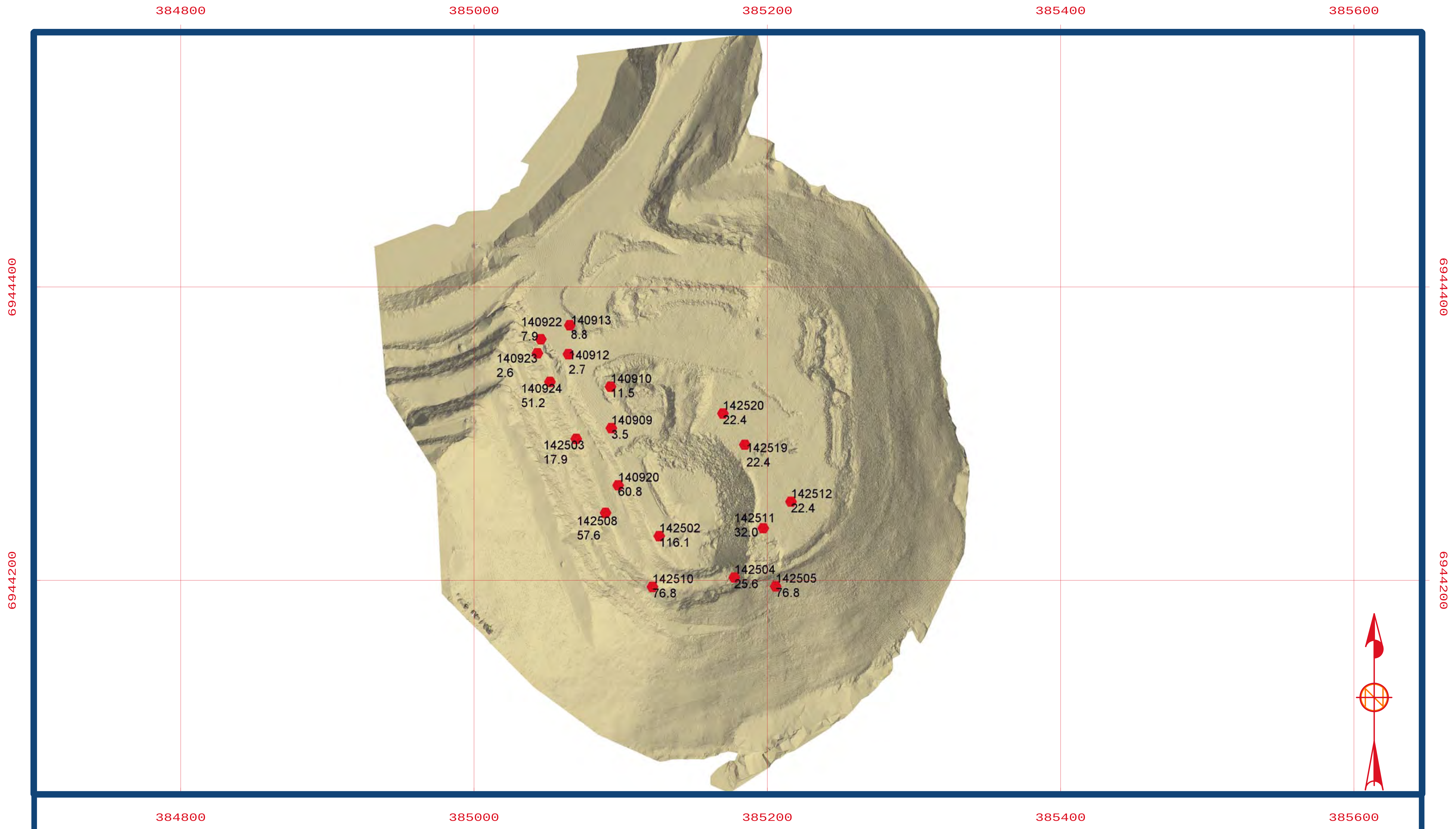
capstone
MINTO MINE



A2S3/S3ext ABA Loc. 787 elev.

DATE:	DRAWN BY:
24-Feb-2018	MS

capstone
MINTO MINE



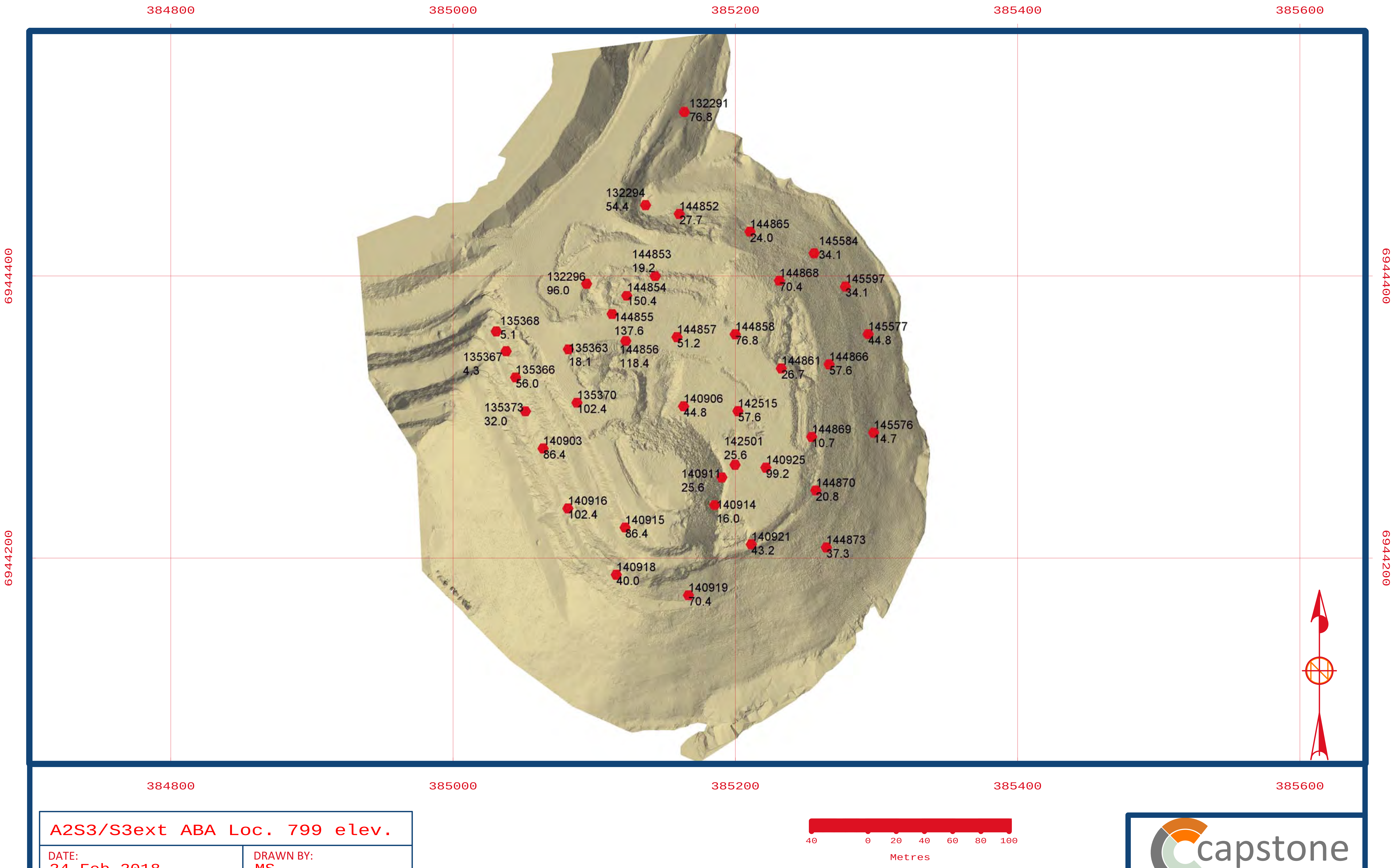
A2S3/S3ext ABA Loc. 793 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

40 0 20 40 60 80 100
Metres

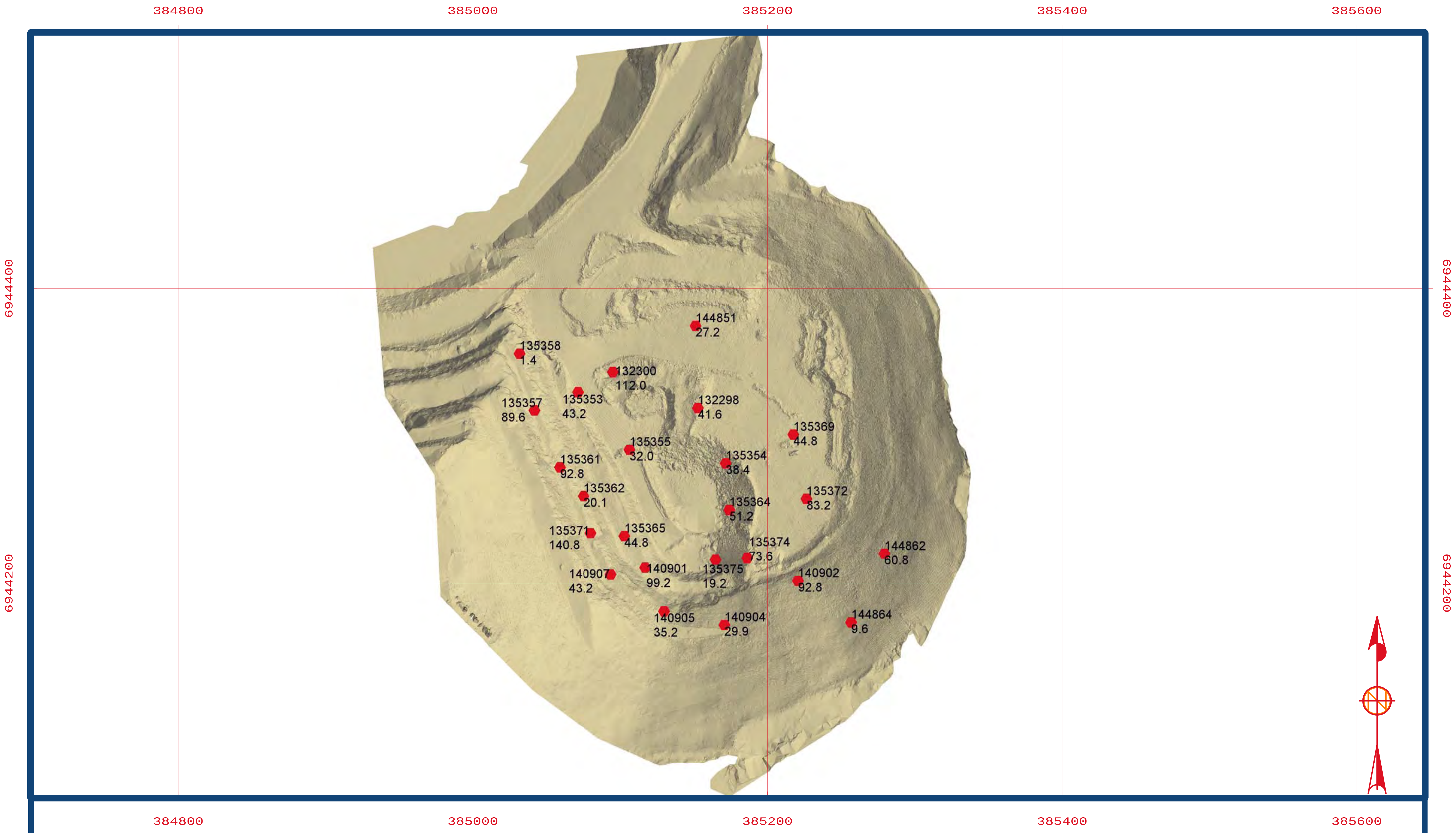
capstone
MINTO MINE



A2S3/S3ext ABA Loc. 799 elev.

DATE:	DRAWN BY:
24-Feb-2018	MS

capstone
MINTO MINE



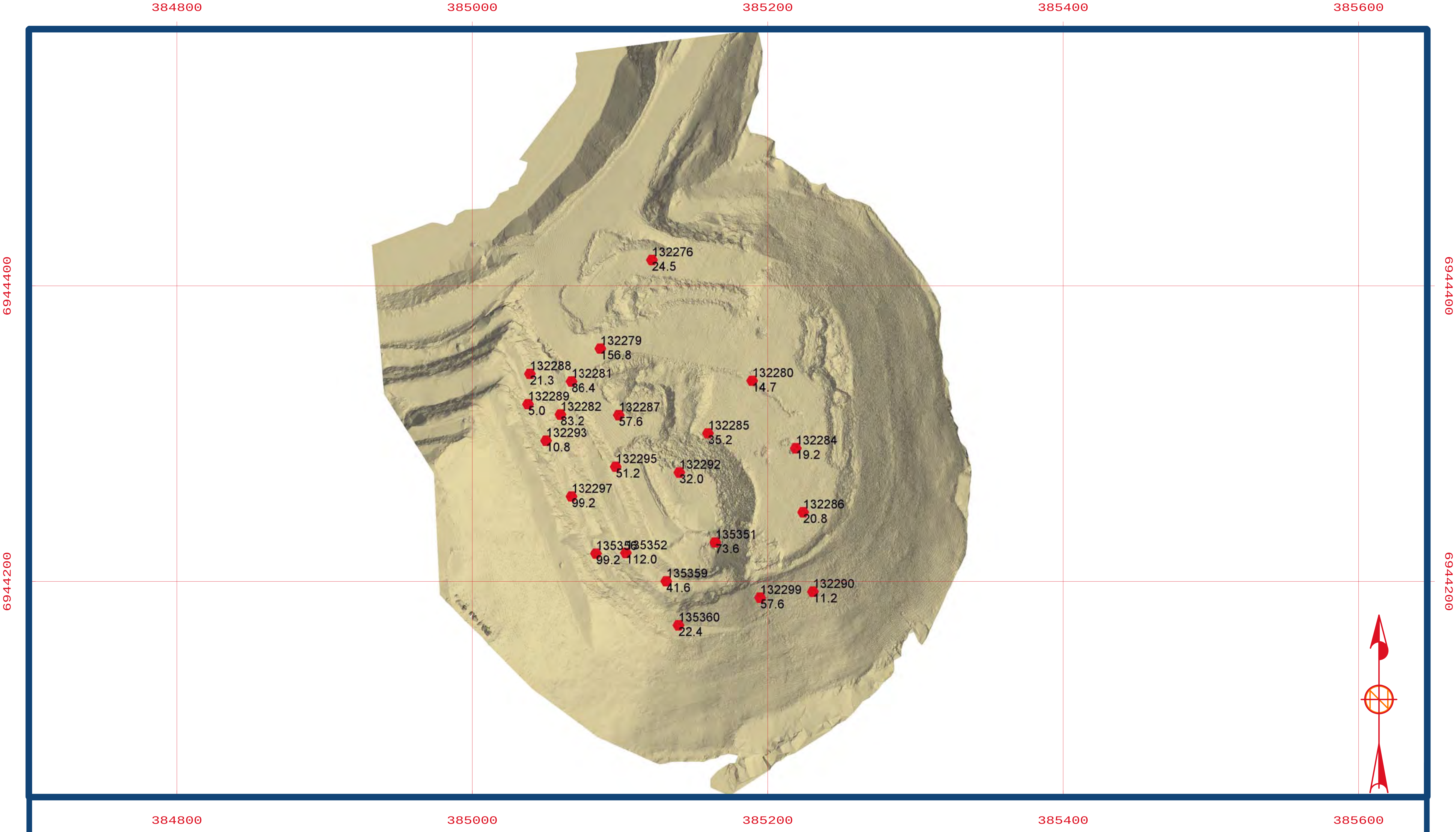
A2S3/S3ext ABA Loc. 805 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

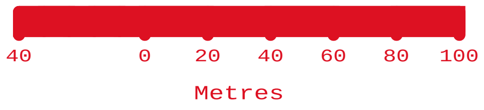
40 0 20 40 60 80 100
Metres

capstone
MINTO MINE

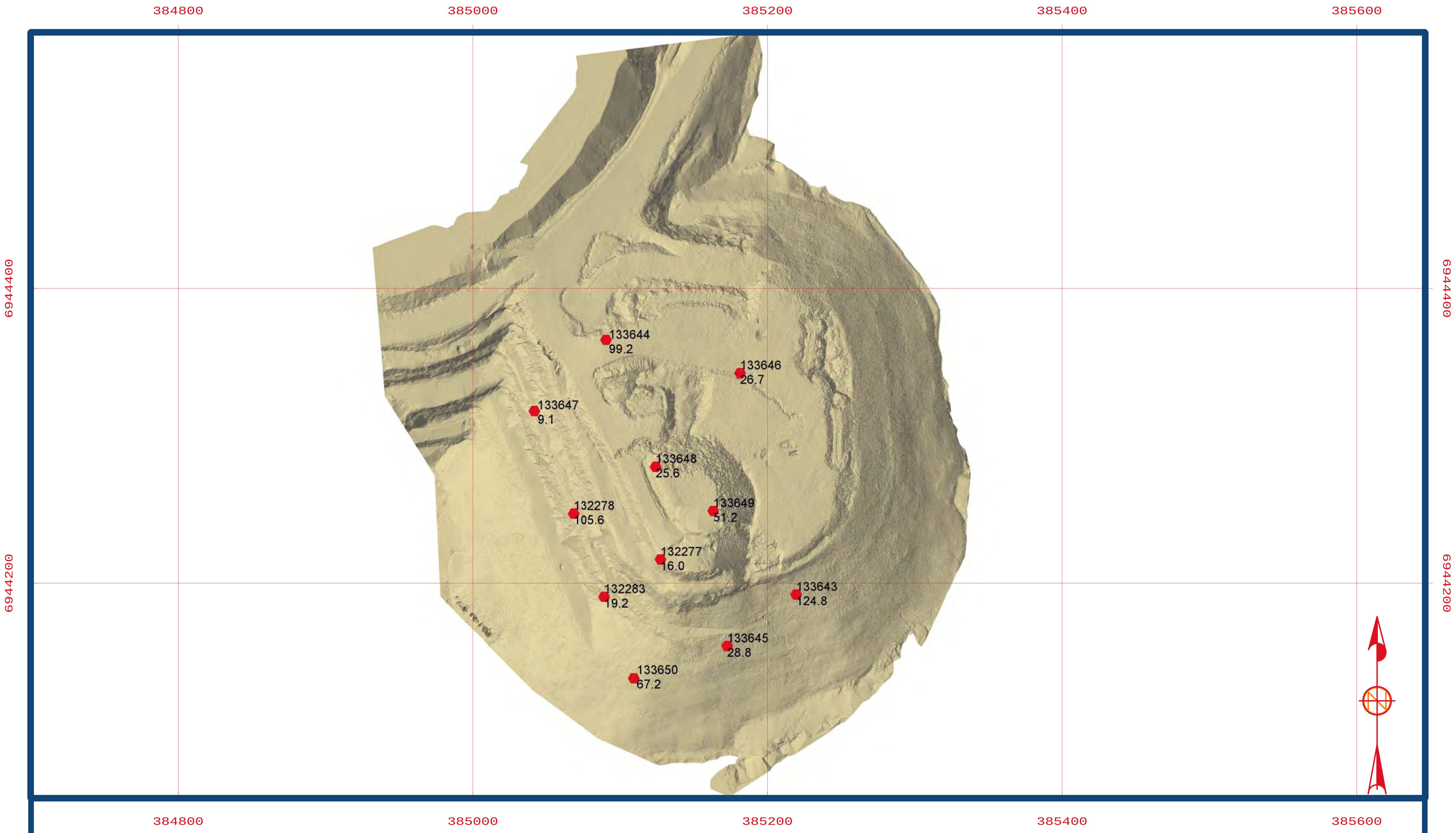


A2S3/S3ext ABA Loc. 811 elev.

DATE: 24-Feb-2018	DRAWN BY: MS



capstone
MINTO MINE

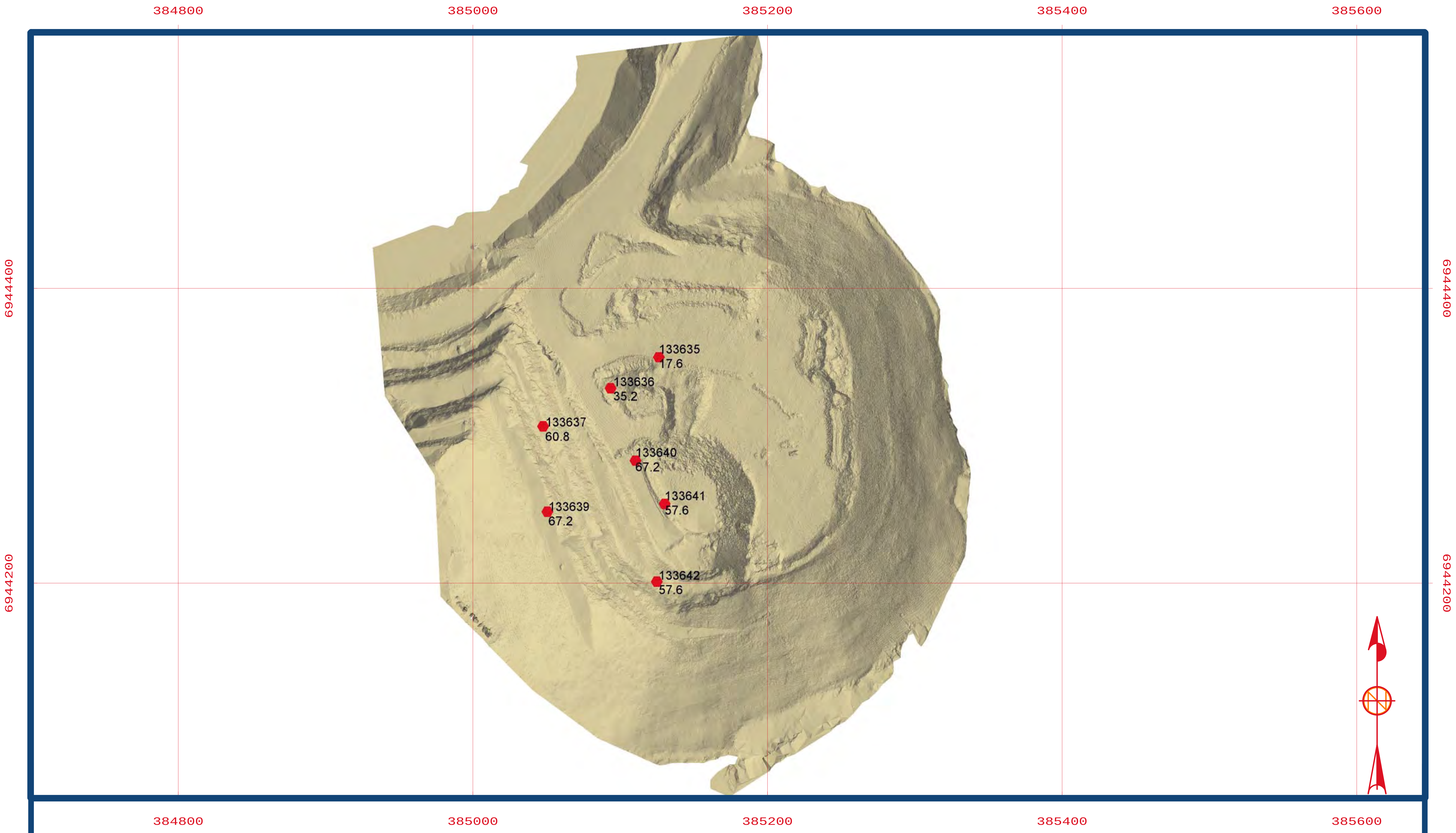


40 0 20 40 60 80 100
Metres

A2S3/S3ext ABA Loc. 817 elev.

DATE:	DRAWN BY:
24-Feb-2018	MS

capstone
MINTO MINE



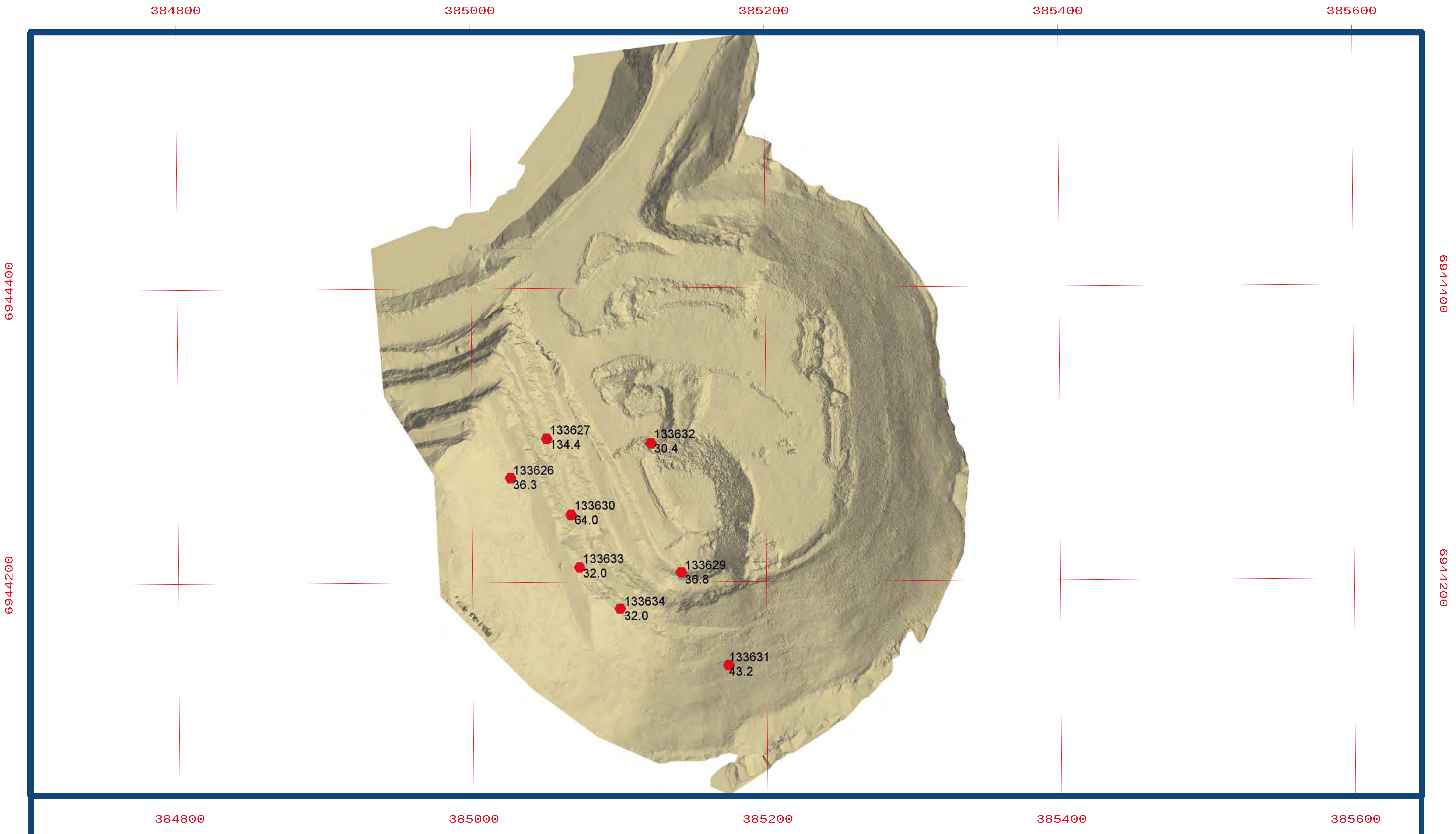
A2S3/S3ext ABA Loc. 823 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

40 0 20 40 60 80 100
Metres

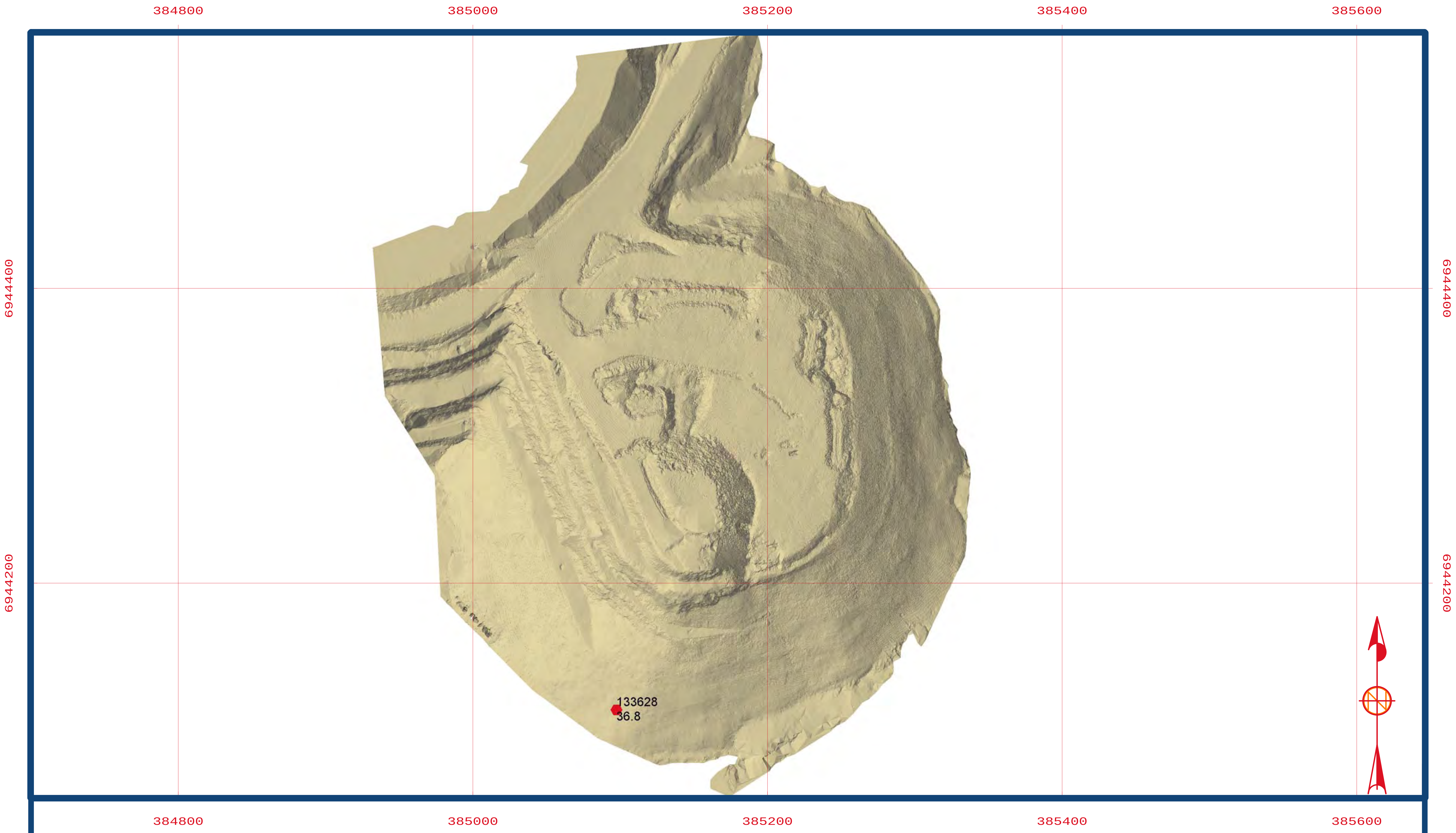
capstone
MINTO MINE



A2S3/S3ext ABA Loc. 829 elev.

DATE: 24-Feb-2018	DRAWN BY: MS

capstone
MINTO MINE



A2S3/S3ext ABA Loc. 841 elev.

DATE:
24-Feb-2018

DRAWN BY:
MS

capstone
MINTO MINE

Appendix B: 2017 Modified NP Method (MEND 1991) ABA Results for Waste Rock and Overburden

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017												
Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	S(SO_4)	S(S^{2-})	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	$CaCO_3$ kg / tonne	NP	(NP/AP)	Modified
1/23/2017	133627	A2S3	NAG	8.6	0.15	<0.01	0.01	<0.01	0.3125	21	134.40	21
1/26/2017	133628	A2S3	NAG	8.3	0.18	0.02	0.02	<0.01	0.3125	22	36.80	23
1/26/2017	133626	A2S3	NAG	8.3	0.33	0.03	0.01	0.02	0.625	33	36.27	34
1/27/2017	133629	A2S3	NAG	8.2	0.2	0.02	0.02	<0.01	0.3125	22	36.80	23
1/30/2017	133630	A2S3	NAG	8	0.15	0.01	<0.01	0.01	0.3125	20	64.00	20
2/1/2017	133631	A2S3	NAG	8.3	0.23	0.02	0.02	<0.01	0.3125	26	43.20	27
2/1/2017	133632	A2S3	NAG	7.9	0.17	0.02	0.01	0.01	0.3125	18	30.40	19
2/3/2017	133633	A2S3	NAG	8.1	0.16	0.02	<0.01	0.02	0.625	19	32.00	20
2/5/2017	133634	A2S3	NAG	8.2	0.16	0.02	<0.01	0.02	0.625	19	32.00	20
2/9/2017	133636	A2S3	NAG	8.7	<0.05	<0.01	<0.01	<0.01	0.3125	11	35.20	11
2/9/2017	133635	A2S3	NAG	8	0.07	0.02	<0.01	0.02	0.625	10	17.60	11
2/11/2017	133637	A2S3	NAG	8.6	0.13	0.01	<0.01	0.01	0.3125	19	60.80	19
2/18/2017	133640	A2S3	NAG	7.9	0.19	0.01	0.01	<0.01	0.3125	21	67.20	21
2/18/2017	133639	A2S3	NAG	8.2	0.48	0.04	0.02	0.02	0.625	41	67.20	42
2/23/2017	133641	A2S3	NAG	7.9	0.19	0.01	0.01	<0.01	0.3125	18	57.60	18
2/27/2017	133642	A2S3	NAG	7.8	0.17	0.02	0.02	<0.01	0.3125	17	57.60	18
3/4/2017	133643	A2S3	NAG	8.2	0.47	0.02	0.03	<0.01	0.3125	38	124.80	39
3/9/2017	133644	A2S3	NAG	8.6	0.29	0.01	0.02	<0.01	0.3125	31	99.20	31
3/12/2017	133645	A2S3	NAG	7.5	0.21	0.04	0.02	0.02	0.625	17	28.80	18
3/14/2017	133646	A2S3	NAG	7.8	0.3	0.05	0.02	0.03	0.9375	23	26.67	25
3/16/2017	133647	A2S3	SAT	8.5	0.19	0.1	0.03	0.07	2.1875	17	9.14	20
3/17/2017	133648	A2S3	NAG	8.3	0.14	0.02	<0.01	0.02	0.625	15	25.60	16
3/20/2017	133649	A2S3	NAG	7.9	0.14	0.02	0.03	<0.01	0.3125	15	51.20	16
3/24/2017	132276	A2S3	NAG	8.1	0.24	0.03	<0.01	0.03	0.9375	22	24.53	23
3/26/2017	133650	A2S3	NAG	7.9	0.22	0.02	0.02	<0.01	0.3125	20	67.20	21
3/27/2017	132277	A2S3	NAG	8.1	0.07	0.02	<0.01	0.02	0.625	9	16.00	10
3/28/2017	132278	A2S3	NAG	8.5	0.32	0.01	<0.01	0.01	0.3125	33	105.60	33

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	$S(SO_4)$	$S(S^{2-})$	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	$CaCO_3$ kg / tonne	NP	(NP/AP)	Modified
3/29/2017	132279	A2S3	NAG	8.5	0.52	0.01	0.02	<0.01	0.3125	49	156.80	49
3/31/2017	132280	A2S3	NAG	8	0.27	0.05	<0.01	0.05	1.5625	21	14.72	23
4/2/2017	132282	A2S3	NAG	8.8	0.25	0.02	0.04	<0.01	0.3125	25	83.20	26
4/2/2017	132283	A2S3	NAG	8.5	0.11	0.02	<0.01	0.02	0.625	11	19.20	12
4/2/2017	132281	A2S3	NAG	8.7	0.23	0.04	0.04	<0.01	0.3125	26	86.40	27
4/3/2017	132284	A2S3	NAG	7.9	0.15	0.03	<0.01	0.03	0.9375	17	19.20	18
4/4/2017	132285	A2S3	NAG	8.2	0.06	0.02	0.01	0.01	0.3125	10	35.20	11
4/6/2017	132286	A2S3	NAG	8	0.28	0.04	<0.01	0.04	1.25	25	20.80	26
4/7/2017	132287	A2S3	NAG	8.5	0.13	0.02	0.02	<0.01	0.3125	17	57.60	18
4/7/2017	132289	A2S3	NAG	8.4	0.69	0.35	<0.01	0.35	10.9375	44	5.03	55
4/7/2017	132288	A2S3	NAG	8.6	0.19	0.03	<0.01	0.03	0.9375	19	21.33	20
4/8/2017	132290	A2S3	NAG	7.9	0.16	0.04	<0.01	0.04	1.25	13	11.20	14
4/12/2017	132291	A2S3	NAG	7.9	0.22	0.03	0.02	0.01	0.3125	23	76.80	24
4/12/2017	132293	A2S3	NAG	8.6	0.26	0.09	0.01	0.08	2.5	24	10.80	27
4/13/2017	132294	A2S3	NAG	8.2	0.13	0.02	0.02	<0.01	0.3125	16	54.40	17
4/14/2017	132295	A2S3	NAG	8.8	0.1	0.02	0.03	<0.01	0.3125	15	51.20	16
4/14/2017	132292	A2S3	NAG	8.2	0.05	0.01	0.03	<0.01	0.3125	10	32.00	10
4/15/2017	132297	A2S3	NAG	8.5	0.29	0.01	0.02	<0.01	0.3125	31	99.20	31
4/15/2017	132296	A2S3	NAG	8.7	0.3	0.01	0.02	<0.01	0.3125	30	96.00	30
4/16/2017	132298	A2S3	NAG	8.5	0.07	0.01	<0.01	0.01	0.3125	13	41.60	13
4/17/2017	132299	A2S3	NAG	7.8	0.2	0.04	0.04	<0.01	0.3125	17	57.60	18
4/18/2017	132300	A2S3	NAG	8.5	0.34	0.01	0.02	<0.01	0.3125	35	112.00	35
4/19/2017	135352	A2S3	NAG	8.8	0.36	0.01	<0.01	0.01	0.3125	35	112.00	35
4/19/2017	135351	A2S3	NAG	8.1	0.22	0.02	0.02	<0.01	0.3125	22	73.60	23
4/20/2017	135353	A2S3	NAG	8.5	0.24	0.02	<0.01	0.02	0.625	26	43.20	27
4/21/2017	135354	A2S3	NAG	8.2	0.06	0.01	0.02	<0.01	0.3125	12	38.40	12
4/21/2017	135355	A2S3	NAG	8.6	0.05	0.01	<0.01	0.01	0.3125	10	32.00	10

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	S(T) %	$S(SO_4)$ %	$S(S^{2-})$ %	AP $CaCO_3$ kg / tonne	Net NP	NP:AP Ratio (NP/AP)	NP Modified
4/23/2017	135356	A2S3	NAG	8.6	0.33	0.02	0.01	0.01	0.3125	30	99.20	31
4/24/2017	135357	A2S3	SAT	8.7	0.27	0.02	0.01	0.01	0.3125	27	89.60	28
4/24/2017	135358	A2S3	SAT	8.5	0.41	0.87	0.02	0.85	26.5625	10	1.39	37
4/26/2017	135361	A2S3	CGW	8.8	0.23	0.01	0.01	<0.01	0.3125	29	92.80	29
4/26/2017	135359	A2S3	NAG	7.8	0.3	0.01	<0.01	0.01	0.3125	13	41.60	13
4/26/2017	135362	A2S3	NAG	8.4	0.43	0.07	<0.01	0.07	2.1875	42	20.11	44
4/26/2017	135360	A2S3	NAG	8.1	0.19	0.03	<0.01	0.03	0.9375	20	22.40	21
4/28/2017	135363	A2S3	NAG	8.6	0.33	0.07	0.01	0.06	1.875	32	18.13	34
4/29/2017	135364	A2S3	NAG	8.3	0.13	0.01	0.02	<0.01	0.3125	16	51.20	16
4/29/2017	135365	A2S3	NAG	8.7	0.43	0.01	0.01	<0.01	0.3125	14	44.80	14
4/30/2017	135366	A2S3	NAG	8.7	0.32	0.04	0.02	0.02	0.625	34	56.00	35
4/30/2017	135367	A2S3	SAT	8.7	0.39	0.25	0.02	0.23	7.1875	23	4.31	31
4/30/2017	135368	A2S3	NAG	8.5	0.54	0.35	0.03	0.32	10	40	5.10	51
5/2/2017	135370	A2S3	NAG	8.6	0.3	0.03	0.02	0.01	0.3125	31	102.40	32
5/2/2017	135371	A2S3	NAG	8.7	0.5	0.01	0.01	<0.01	0.3125	44	140.80	44
5/2/2017	135369	A2S3	NAG	7.9	0.27	0.03	0.01	0.02	0.625	27	44.80	28
5/3/2017	135372	A2S3	NAG	8	0.23	0.03	0.03	<0.01	0.3125	25	83.20	26
5/4/2017	135373	A2S3	NAG	8.8	0.26	0.04	0.01	0.03	0.9375	29	32.00	30
5/5/2017	140902	A2S3	NAG	8.2	0.26	0.02	0.04	<0.01	0.3125	28	92.80	29
5/5/2017	135374	A2S3	NAG	8.3	0.21	0.02	0.03	<0.01	0.3125	22	73.60	23
5/5/2017	135375	A2S3	NAG	8.2	<0.05	0.01	<0.01	0.01	0.3125	6	19.20	6
5/5/2017	140901	A2S3	NAG	8.7	0.25	0.01	<0.01	0.01	0.3125	31	99.20	31
5/6/2017	140903	A2S3	NAG	8.7	0.23	0.02	0.01	0.01	0.3125	26	86.40	27
5/8/2017	140904	A2S3	NAG	8.3	0.27	0.03	<0.01	0.03	0.9375	27	29.87	28
5/8/2017	140905	A2S3	NAG	8.5	0.08	0.01	<0.01	0.01	0.3125	11	35.20	11
5/9/2017	140906	A2S3	NAG	8.5	0.07	0.01	0.02	<0.01	0.3125	14	44.80	14
5/10/2017	140907	A2S3	NAG	8.6	0.27	0.02	<0.01	0.02	0.625	26	43.20	27

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	S(T) %	$S(SO_4)$ %	$S(S^{2-})$ %	AP $CaCO_3$ kg / tonne	Net NP	NP:AP Ratio (NP/AP)	NP Modified
5/11/2017	140908	A2S3	NAG	8.4	0.16	0.03	0.01	0.02	0.625	21	35.20	22
5/12/2017	140910	A2S3	NAG	8.7	0.36	0.1	<0.01	0.1	3.125	33	11.52	36
5/12/2017	140909	A2S3	SAT	8.8	0.14	0.21	0.01	0.2	6.25	15	3.52	22
5/13/2017	140911	A2S3	NAG	8	0.1	0.01	0.01	<0.01	0.3125	8	25.60	8
5/14/2017	140913	A2S3	NAG	8.8	0.35	0.14	0.02	0.12	3.75	29	8.80	33
5/14/2017	140912	A2S3	SAT	8.4	0.52	0.51	0.02	0.49	15.3125	25	2.68	41
5/15/2017	140914	A2S3	NAG	8.3	0.05	0.02	<0.01	0.02	0.625	9	16.00	10
5/15/2017	140915	A2S3	NAG	8.3	0.27	0.02	0.02	<0.01	0.3125	26	86.40	27
5/16/2017	140916	A2S3	NAG	8.7	0.31	0.02	0.01	0.01	0.3125	31	102.40	32
5/17/2017	140917	A2S3	NAG	8.4	0.3	0.05	0.03	0.02	0.625	28	48.00	30
5/18/2017	140921	A2S3	NAG	8.5	0.29	0.02	<0.01	0.02	0.625	26	43.20	27
5/18/2017	140918	A2S3	NAG	8.5	0.26	0.02	<0.01	0.02	0.625	24	40.00	25
5/21/2017	140919	A2S3	NAG	8.2	0.22	0.03	0.02	0.01	0.3125	21	70.40	22
5/22/2017	140920	A2S3	NAG	8.9	0.11	0.02	0.02	<0.01	0.3125	18	60.80	19
5/24/2017	140923	A2S3	SAT	8.6	0.38	0.44	0.02	0.42	13.125	20	2.59	34
5/24/2017	140924	A2S3	NAG	8.8	0.34	0.04	0.02	0.02	0.625	31	51.20	32
5/24/2017	140922	A2S3	NAG	8.6	0.39	0.14	0.01	0.13	4.0625	28	7.88	32
5/25/2017	140925	A2S3	NAG	8.3	0.31	0.02	0.02	<0.01	0.3125	30	99.20	31
5/25/2017	142501	A2S3	NAG	8.1	0.06	0.01	0.01	<0.01	0.3125	8	25.60	8
5/26/2017	142503	A2S3	NAG	8.6	0.24	0.05	<0.01	0.05	1.5625	26	17.90	28
5/27/2017	142502	A2S3	NAG	8.4	0.38	<0.01	0.01	<0.01	0.31	36	116.10	36
5/29/2017	142506	A2S3	NAG	8.7	0.42	0.07	<0.01	0.07	2.1875	33	16.00	35
5/29/2017	142504	A2S3	NAG	8.2	<0.05	0.01	<0.01	0.01	0.3125	8	25.60	8
5/29/2017	142505	A2S3	NAG	8.4	0.21	0.02	0.02	<0.01	0.3125	23	76.80	24
5/29/2017	142507	A2S3	SAT	8.5	0.65	0.15	<0.01	0.15	4.375	43	11.00	48
5/30/2017	142508	A2S3	NAG	8.5	0.36	0.03	0.01	0.02	0.625	35	57.60	36
5/31/2017	142509	A2S3	NAG	8.8	0.24	0.02	0.01	0.01	0.3125	28	92.80	29

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	S(SO$_4$)	S(S^{2-})	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	CaCO$_3$ kg / tonne	NP	(NP/AP)	Modified
6/1/2017	142510	A2S3	NAG	8.5	0.21	0.01	<0.01	0.01	0.3125	24	76.80	24
6/2/2017	142513	A2S3	NAG	8.6	0.47	0.08	<0.01	0.08	2.5	38	16.00	40
6/2/2017	142511	A2S3	NAG	8.2	<0.05	0.01	0.01	<0.01	0.3125	10	32.00	10
6/2/2017	142512	A2S3	NAG	8.2	0.08	0.01	0.01	<0.01	0.3125	7	22.40	7
6/4/2017	142514	A2S3	NAG	8.7	0.37	0.1	<0.01	0.01	0.3125	33	115.20	36
6/6/2017	142517	A2S3	SAT	8.9	0.22	0.12	<0.01	0.12	3.4375	21	7.30	25
6/6/2017	142516	A2S3	NAG	8.9	0.34	0.06	0.01	0.05	1.5625	28	19.20	30
6/6/2017	142515	A2S3	NAG	8.3	0.14	0.01	<0.01	0.01	0.3125	18	57.60	18
6/7/2017	142518	A2S3	NAG	8.7	0.19	0.01	<0.01	0.01	0.3125	21	67.20	21
6/8/2017	142519	A2S3	NAG	8.2	<0.05	0.01	<0.01	0.01	0.3125	7	22.40	7
6/9/2017	142520	A2S3	NAG	8.2	0.05	0.01	<0.01	0.01	0.3125	7	22.40	7
6/11/2017	142522	A2S3	NAG	8.2	<0.05	<0.01	<0.01	<0.01	0.3125	8	25.60	8
6/11/2017	142521	A2S3	NAG	8.3	0.12	0.01	<0.01	0.01	0.3125	18	57.60	18
6/12/2017	142523	A2S3	NAG	8.5	0.10	<0.01	<0.01	<0.01	0.3125	15	48.00	15
6/14/2017	142524	A2S3	SAT	8.5	0.38	0.18	<0.01	0.18	5.625	27	5.87	33
6/14/2017	142525	A2S3	NAG	8.5	0.25	0.19	<0.01	0.19	5.9375	17	3.87	23
6/15/2017	142651	A2S3	NAG	8.3	<0.05	0.03	<0.01	0.03	0.9375	7	8.53	8
6/16/2017	142652	A2S3	NAG	8.3	0.05	0.01	<0.01	0.01	0.3125	9	28.80	9
6/18/2017	142653	A2S3	NAG	8.5	0.41	0.05	<0.01	0.05	1.5625	32	21.76	34
6/19/2017	142654	A2S3	NAG	8.4	0.34	0.01	0.03	<0.01	0.3125	32	102.40	32
6/20/2017	142655	A2S3	NAG	8.5	0.23	0.04	<0.01	0.04	1.25	24	20.00	25
6/21/2017	142656	A2S3	NAG	8.5	0.33	0.03	<0.01	0.03	0.9375	28	30.93	29
6/24/2017	142657	A2S3	NAG	8.7	0.29	0.04	<0.01	0.04	1.25	27	22.40	28
6/24/2017	142658	A2S3	SAT	8.6	0.19	0.61	<0.01	0.61	19.0625	4	1.21	23
6/25/2017	142659	A2S3	NAG	8.5	0.38	0.20	<0.01	0.2	6.25	26	5.12	32
6/26/2017	142660	A2S3	NAG	8.7	0.27	0.14	<0.01	0.14	4.375	21	5.71	25
6/26/2017	142661	A2S3	NAG	8.5	0.69	0.01	<0.01	0.01	0.3125	64	204.80	64

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	S(SO_4)	S(S^{2-})	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	$CaCO_3$ kg / tonne	NP	(NP/AP)	Modified
6/28/2017	142664	A2S3	NAG	8.6	0.05	0.02	<0.01	0.02	0.625	7	12.80	8
6/28/2017	142662	A2S3	NAG	8.4	0.2	0.01	<0.01	0.01	0.3125	26	83.20	26
6/28/2017	142663	A2S3	NAG	8.6	0.2	0.02	<0.01	0.02	0.625	24	40.00	25
6/28/2017	142665	A2S3	NAG	8.4	0.3	0.01	<0.01	0.01	0.3125	31	99.20	31
6/30/2017	142666	A2S3	NAG	8.5	<0.05	0.01	<0.01	0.01	0.3125	9	28.80	9
7/2/2017	142667	A2S3	NAG	8.8	0.2	0.02	<0.01	0.02	0.625	22	36.80	23
7/2/2017	142668	A2S3	NAG	8.3	<0.05	0.01	<0.01	0.01	0.3125	9	28.80	9
7/2/2017	142669	A2S3	NAG	8.3	0.29	0.27	<0.01	0.27	8.4375	26	4.03	34
7/4/2017	142671	A2S3	NAG	8.7	0.35	0.04	<0.01	0.04	1.25	28	23.20	29
7/4/2017	142670	A2S3	CGW	8.8	<0.05	0.01	<0.01	0.01	0.3125	8	25.60	8
7/6/2017	142672	A2S3	CGW	9.1	0.27	0.03	0.01	0.02	0.625	27	44.80	28
7/6/2017	142673	A2S3	NAG	9	0.23	0.05	<0.01	0.05	1.5625	22	15.36	24
7/7/2017	142674	A2S3	NAG	9.1	0.22	0.02	0.02	<0.01	0.3125	23	76.80	24
7/7/2017	142675	A2S3	CGW	8.7	0.56	0.01	0.02	<0.01	0.3125	53	169.60	53
7/12/2017	129726	A2S3	NAG	8.7	0.25	0.02	0.02	<0.01	0.3125	26	86.40	27
7/14/2017	142728	A2S3	SAT	9.1	0.13	0.5	0.01	0.49	15.3125	0.4	1.04	16
7/14/2017	129729	A2S3	NAG	9.2	0.43	0.08	<0.01	0.08	2.5	35	14.80	37
7/15/2017	129727	A2S3	NAG	9.1	0.28	0.02	<0.01	0.02	0.625	25	41.60	26
7/16/2017	129736	A2S3	NAG	9	0.17	0.01	0.01	<0.01	0.3125	18	57.60	18
7/16/2017	129738	A2S3	NAG	8.9	0.11	<0.01	<0.01	<0.01	0.3125	17	54.40	17
7/16/2017	129737	A2S3	CGW	8.8	<0.05	0.02	<0.01	0.02	0.625	7	12.80	8
7/17/2017	129734	A2S3	CGW	9	0.23	0.01	<0.01	0.01	0.3125	24	76.80	24
7/17/2017	129732	A2S3	SAT	8.8	0.68	0.52	0.03	0.49	15.3125	23	2.55	39
7/17/2017	129733	A2S3	NAG	8.8	0.74	0.11	0.01	0.1	3.125	45	15.36	48
7/17/2017	129730	A2S3	SAT	8.9	0.56	0.49	0.01	0.48	15	24	2.60	39
7/17/2017	129731	A2S3	NAG	9.1	0.59	0.24	0.03	0.21	6.5625	28	5.33	35
7/19/2017	129735	A2S3	NAG	8.7	0.48	0.03	<0.01	0.03	0.9375	43	46.93	44

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	S(SO_4)	S(S^{2-})	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	$CaCO_3$ kg / tonne	NP	(NP/AP)	Modified
7/23/2017	129739	A2S3	NAG	9	0.07	0.01	<0.01	0.01	0.3125	12	38.40	12
7/25/2017	129741	A2S3	CGW	8.7	0.28	0.01	0.01	<0.01	0.3125	27	86.40	27
7/25/2017	129742	A2S3	NAG	8.7	0.47	0.04	0.01	0.03	0.9375	33	36.27	34
7/27/2017	129740	A2S3	NAG	8.7	0.15	0.01	0.01	<0.01	0.3125	19	60.80	19
7/29/2017	129743	A2S3	NAG	8.8	0.15	0.03	0.01	0.02	0.625	19	32.00	20
7/30/2017	129745	A2S3	CGW	8.8	0.3	0.01	<0.01	0.01	0.3125	32	102.40	32
7/30/2017	129744	A2S3	NAG	9	0.23	0.02	0.03	<0.01	0.3125	25	83.20	26
7/31/2017	129746	A2S3	NAG	8.9	0.19	0.06	0.02	0.04	1.25	19	16.80	21
8/3/2017	129747	A2S3	NAG	9.2	0.52	0.05	<0.01	0.05	1.5625	37	24.96	39
8/4/2017	129749	A2S3	CGW	8.9	0.35	0.05	0.01	0.04	1.25	26	22.40	28
8/4/2017	129748	A2S3	NAG	8.9	0.38	0.02	<0.01	0.02	0.625	29	48.00	30
8/5/2017	129750	A2S3	NAG	8.9	0.19	0.02	<0.01	0.02	0.625	21	35.20	22
8/5/2017	129751	A2S3	CGW	8.9	<0.05	0.02	<0.01	0.02	0.625	10	17.60	11
8/6/2017	128153	A2S3	NAG	9.1	0.06	0.04	<0.01	0.04	1.25	9	8.00	10
8/6/2017	128152	A2S3	NAG	8.7	0.25	0.03	<0.01	0.03	0.9375	24	26.67	25
8/10/2017	128157	A2S3	SAT	8.7	0.36	0.08	0.02	0.06	1.875	32	18.13	34
8/10/2017	128156	A2S3	NAG	9.1	0.28	0.06	<0.01	0.06	1.875	27	15.47	29
8/10/2017	128155	A2S3	CGW	9.1	0.24	0.03	<0.01	0.03	0.9375	25	27.73	26
8/10/2017	128154	A2S3	CGW	8.8	0.34	0.07	<0.01	0.07	2.1875	31	15.09	33
8/11/2017	128158	A2S3	NAG	9.1	0.33	0.11	<0.01	0.11	3.4375	25	8.15	28
8/14/2017	128159	A2S3	NAG	9	0.51	0.03	<0.01	0.03	0.9375	36	39.47	37
8/14/2017	128160	A2S3	NAG	8.9	1.29	0.06	0.01	0.05	1.5625	94	61.44	96
8/14/2017	128161	A2S3	NAG	8.8	0.4	0.07	<0.01	0.07	2.1875	35	16.91	37
8/15/2017	128162	A2S3	NAG	9	0.23	0.02	<0.01	0.02	0.625	22	36.80	23
8/16/2017	128165	A2S3	NAG	8.6	0.27	0.02	0.02	<0.01	0.3125	25	83.20	26
8/16/2017	128164	A2S3	NAG	9	0.33	0.01	0.01	<0.01	0.3125	31	99.20	31
8/16/2017	128163	A2S3	NAG	8.7	0.84	0.14	0.01	0.13	4.0625	46	12.31	50

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	S(SO_4)	S(S^{2-})	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	$CaCO_3$ kg / tonne	NP	(NP/AP)	Modified
8/19/2017	128166	A2S3	NAG	8.6	0.22	<0.01	0.02	<0.01	0.3125	23	73.60	23
8/20/2017	128167	A2S3	NAG	9	0.24	0.01	0.01	<0.01	0.3125	23	73.60	23
8/20/2017	128168	A2S3	NAG	8.6	0.51	0.26	0.02	0.24	7.5	29	4.93	37
8/21/2017	128169	A2S3	NAG	8.7	0.47	0.34	0.01	0.33	10.3125	23	3.30	34
8/24/2017	128171	A2S3	CGW	8.7	0.93	0.03	0.02	0.01	0.3125	46	150.40	47
8/24/2017	128170	A2S3	CGW	8.8	0.67	0.05	0.04	0.01	0.3125	36	121.60	38
8/25/2017	128173	A2S3	CGW	8.8	1.02	0.01	0.01	<0.01	0.3125	60	192.00	60
8/25/2017	128172	A2S3	NAG	9	0.38	0.03	0.02	0.01	0.3125	27	89.60	28
8/30/2017	128174	A2S3	SAT	9	1.04	0.2	0.01	0.19	5.9375	56	10.44	62
9/6/2017	128175	A2S3	NAG	8.9	0.96	0.02	0.01	0.01	0.3125	64	208.00	65
9/10/2017	144851	A2S3	NAG	8.8	0.13	0.02	<0.01	0.02	0.625	16	27.20	17
9/20/2017	144852	A2S3	CGW	8.5	0.25	0.03	<0.01	0.03	0.9375	25	27.73	26
9/23/2017	144855	A2S3	CGW	8.8	0.44	0.01	<0.01	0.01	0.3125	43	137.60	43
9/23/2017	144853	A2S3	CGW	9.2	0.06	0.02	<0.01	0.02	0.625	11	19.20	12
9/23/2017	144854	A2S3	NAG	8.9	0.51	0.01	<0.01	0.01	0.3125	47	150.40	47
9/25/2017	144856	A2S3	NAG	9	0.34	0.01	<0.01	0.01	0.3125	37	118.40	37
9/25/2017	144857	A2S3	CGW	8.7	0.1	0.01	<0.01	0.01	0.3125	16	51.20	16
9/30/2017	144858	A2S3	OVB	8.2	0.22	0.02	0.03	<0.01	0.3125	23	76.80	24
10/3/2017	144860	A2S3	CGW	8.8	0.44	0.01	<0.01	0.01	0.3125	39	124.80	39
10/3/2017	144859	A2S3	NAG	8.9	0.19	0.1	0.03	0.07	2.1875	17	9.14	20
10/7/2017	144861	A2S3	OVB	7.9	0.31	0.05	0.02	0.03	0.9375	23	26.67	25
10/9/2017	144862	A2S3	OVB	7.8	0.22	0.04	0.03	0.01	0.3125	18	60.80	19
10/10/2017	144863	A2S3	NAG	8.6	0.08	0.02	0.01	0.01	0.3125	11	38.40	12
10/12/2017	144864	A2S3	OVB	7.5	0.19	0.05	0.01	0.04	1.25	10	9.60	12
10/14/2017	144865	A2S3	OVB	7.9	0.3	0.05	0.01	0.04	1.25	28	24.00	30
10/15/2017	144866	A2S3	OVB	7.7	0.2	0.04	0.03	0.01	0.3125	17	57.60	18
10/16/2017	144867	A2S3	NAG	8.6	0.19	0.01	<0.01	0.01	0.3125	70.4	70.40	22

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste	TIC	S(T)	S(SO_4)	S(S^{2-})	AP	Net	NP:AP Ratio	NP
				pH	%	%	%	%	$CaCO_3$ kg / tonne	NP	(NP/AP)	Modified
10/18/2017	144868	A2S3	OVB	8	0.23	0.04	0.05	<0.01	0.3125	18.4	70.40	22
10/19/2017	144869	A2S3	OVB	7.9	0.24	0.07	0.01	0.06	1.875	10.06	10.67	20
10/21/2017	144870	A2S3	OVB	8.2	0.28	0.04	<0.01	0.04	1.25	21.6	20.80	26
10/22/2017	144872	A2S3	NAG	8.6	0.15	0.02	<0.01	0.02	0.625	30.4	28.80	18
10/22/2017	144871	A2S3	CGW	8.5	<0.05	0.02	<0.01	0.02	0.625	16	14.40	9
10/24/2017	144874	A2S3	OVB/Waste	8.5	<0.05	0.01	0.03	<0.01	0.3125	16	16.00	5
10/24/2017	144875	A2S3	CGW	8.8	0.1	0.02	0.01	0.01	0.3125	25.6	48.00	15
10/25/2017	144873	A2S3	OVB	8.5	0.36	0.03	<0.01	0.03	0.9375	38.4	37.33	35
10/27/2017	145576	A2S3	OVB	7.9	0.27	0.05	<0.01	0.05	1.5625	21	14.72	23
10/27/2017	145577	A2S3	OVB	8.1	0.44	0.03	<0.01	0.03	0.9375	41	44.80	42
10/29/2017	145578	A2S3	OVB	8.3	0.2	0.02	<0.01	0.02	0.625	21	35.20	22
10/29/2017	145579	A2S3	NAG	8.3	<0.05	0.01	<0.01	0.01	0.3125	9	28.80	9
10/30/2017	145580	A2S3	OVB/Waste	8.4	0.22	0.01	<0.01	0.01	0.3125	24	76.80	24
10/30/2017	145581	A2S3	NAG	8.2	<0.05	0.01	<0.01	0.01	0.3125	6	19.20	6
11/1/2017	145582	A2S3	OVB/Waste	8.4	0.36	0.02	0.01	0.01	0.3125	35	115.20	36
11/1/2017	145583	A2S3	NAG	8.3	<0.05	0.01	0.01	<0.01	0.3125	8	25.60	8
11/2/2017	145587	A2S3	NAG	8.1	0.15	0.01	0.01	<0.01	0.3125	12	0.96	0.3
11/2/2017	145586	A2S3	OVB/Waste	8.4	0.35	0.02	0.02	<0.01	0.3125	32	1.92	0.6
11/4/2017	145584	A2S3	OVB	8.2	0.29	0.03	<0.01	0.03	0.9375	31	34.13	32
11/5/2017	145592	A2S3	OVB	8.3	0.38	0.02	0.01	0.01	0.3125	35	1.92	0.6
11/5/2017	145585	A2S3	NAG	8.6	0.66	0.31	<0.01	0.31	9.6875	38	1.00	9.7
11/6/2017	145589	A2S3	NAG	8.6	0.7	0.34	<0.01	0.34	10.625	46	1.00	10.6
11/6/2017	145588	A2S3	NAG	8.5	0.62	0.14	<0.01	0.14	4.375	39	1.01	4.4
11/9/2017	145596	A2S3	OVB	8.1	0.39	0.03	<0.01	0.03	0.9375	34	37.33	35
11/11/2017	145590	A2S3	OVB	8	0.35	0.05	<0.01	0.05	1.5625	31	1.02	1.6
11/13/2017	145591	A2S3	NAG	8.6	0.44	0.12	0.01	0.11	3.4375	33	1.11	3.8
11/14/2017	145594	A2S3	NAG	8.3	0.09	0.04	0.01	0.03	0.9375	11	1.39	1.3

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	S(T) %	$S(SO_4)$ %	$S(S^{2-})$ %	AP $CaCO_3$ kg / tonne	Net NP	NP:AP Ratio (NP/AP)	NP Modified
11/17/2017	145593	A2S3	OVB	7.7	0.34	0.06	0.02	0.04	1.25	28	1.52	1.9
11/19/2017	145595	A2S3	NAG	8.5	0.24	0.05	<0.01	0.05	1.5625	20	14.08	22
11/23/2017	145597	A2S3	OVB	7.9	0.26	0.07	0.04	0.03	0.9375	30	34.13	32
11/24/2017	146677	A2S3	NAG	8.3	<0.05	0.02	0.01	0.01	0.3125	7	25.60	8
11/24/2017	146676	A2S3	NAG	8.5	<0.05	0.02	0.03	<0.01	0.3125	9	32.00	10
11/24/2017	146678	A2S3	NAG	8.6	<0.05	0.01	0.02	<0.01	0.3125	8	25.60	8
11/25/2017	146679	A2S3	NAG	8.4	0.11	0.07	0.02	0.05	1.5625	11	8.32	13
11/26/2017	145598	A2S3	NAG	8.2	<0.05	0.02	0.04	<0.01	0.3125	7	25.60	8
11/26/2017	145599	A2S3	NAG	8.4	<0.05	0.02	0.02	<0.01	0.3125	8	28.80	9
11/26/2017	145600	A2S3	NAG	8.3	<0.05	0.01	0.01	<0.01	0.3125	5	16.00	5
12/6/2017	146684	A2S3	OVB/Waste	8.4	0.29	0.01	<0.01	0.01	0.3125	30	96.00	30
12/8/2017	146685	A2S3	NAG	8.5	0.22	0.02	<0.01	0.02	0.625	22	36.80	23
12/10/2017	146688	A2S3	NAG	8.8	0.56	0.12	<0.01	0.12	3.75	40	11.73	44
12/10/2017	146689	A2S3	CGW	9.1	0.23	0.02	<0.01	0.02	0.625	20	33.60	21
12/11/2017	146687	A2S3	CGW	8.6	0.16	0.01	<0.01	0.01	0.3125	20	64.00	20
12/11/2017	146686	A2S3	NAG	8.4	<0.05	0.01	<0.01	0.01	0.3125	6	19.20	6
12/15/2017	146694	A2S3	SAT	9	0.56	0.4	<0.01	0.4	12.5	2.96	2.00	25
12/15/2017	146695	A2S3	NAG	8.3	0.61	0.01	<0.01	0.01	0.3125	176	176.00	55
12/15/2017	146693	A2S3	NAG	8.8	0.17	0.03	<0.01	0.03	0.9375	17.07	16.00	15
12/17/2017	146700	A2S3	NAG	8.6	0.07	0.01	<0.01	0.01	0.3125	12	38.40	12
12/17/2017	146699	A2S3	CGW	8.6	<0.05	0.01	<0.01	0.01	0.3125	9	28.80	9
12/17/2017	146698	A2S3	NAG	8.3	<0.05	0.01	<0.01	0.01	0.3125	6	19.20	6
12/21/2017	146726	A2S3	NAG	9	0.18	0.01	0.01	<0.01	0.3125	67.2	67.20	21
12/21/2017	146727	A2S3	NAG	8.4	0.07	0.12	<0.01	0.12	3.75	2.93	1.87	7
12/22/2017	146728	A2S3	NAG	8.9	0.09	0.01	<0.01	0.01	0.3125	32	32.00	10
12/23/2017	146730	A2S3	NAG	9	0.41	0.14	0.01	0.13	4.0625	6.63	6.15	25
12/23/2017	146729	A2S3	CGW	9	0.29	0.01	<0.01	0.01	0.3125	76.8	76.80	24

Appendix B. Summary A2S3 and A2S4 Pits ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	S(T) %	$S(SO_4)$ %	$S(S^{2-})$ %	AP $CaCO_3$ kg / tonne	Net NP	NP:AP Ratio (NP/AP)	NP Modified
12/24/2017	146731	A2S3	NAG	8.5	0.05	0.06	<0.01	0.06	1.875	4.27	3.20	6
12/26/2017	146732	A2S3	CGW	8.9	0.65	<0.01	0.01	<0.01	0.3125	262.4	131.20	41
12/26/2017	146733	A2S3	NAG	8.8	0.62	0.06	<0.01	0.06	1.875	24.53	23.47	44
12/28/2017	146735	A2S3	NAG	8.9	0.49	0.24	<0.01	0.24	7.5	4.27	3.33	25
12/28/2017	146734	A2S3	CGW	9	0.27	0.1	<0.01	0.1	3.125	7.36	6.40	20
12/30/2017	146736	A2S3	NAG	9.1	0.19	0.02	<0.01	0.02	0.625	33.6	32.00	20

Appendix B. Summary Minto East and Area 2 Underground ABA Analysis Results from ALS Mineral for 2017

Sample Date	ABA ID	Sample	Waste	Paste	TIC	S(T)	$S(SO_4)$	$S(S^{2-})$	AP	Net	NP:AP Ratio	NP
		Source	Type	pH	%	%	%	%	$CaCO_3$kg / tonne	NP	(NP/AP)	Modified
8/12/2017	128565	SAT	A2 UG	9.1	0.21	0.24	0.01	0.23	7.1875	12	2.643478	19
8/12/2017	128564	SAT	A2 UG	9.1	0.2	0.23	0.01	0.22	6.875	12	2.763636	19
8/12/2017	128563	SAT	A2 UG	8.7	0.2	0.29	0.03	0.26	8.125	10	2.338462	19
8/12/2017	128562	SAT	A2 UG	8.8	0.2	0.26	0.05	0.21	6.5625	12	3.047619	20
8/12/2017	128561	SAT	A2 UG	9.1	0.16	0.2	0.03	0.17	5.3125	11	3.2	17
8/12/2017	128560	SAT	A2 UG	9.1	0.21	0.33	0.03	0.3	9.375	9	2.026667	19
8/12/2017	128569	SAT	ME UG	9.1	0.18	0.26	<0.01	0.26	8.125	11	2.338462	19
8/12/2017	128568	SAT	ME UG	9.1	0.18	0.24	0.01	0.23	7.1875	12	2.643478	19
8/12/2017	128567	SAT	ME UG	9	0.23	0.27	0.02	0.25	7.8125	14	2.816	22
8/12/2017	128566	SAT	ME UG	9	0.2	0.29	0.03	0.26	8.125	11	2.461538	20
11/7/2017	144599	SAT	ME UG	8.8	0.42	0.34	<0.01	0.34	10.625	24	3.294118	35
11/7/2017	144598	SAT	ME UG	8.8	0.34	0.35	0.01	0.34	10.625	18	2.729412	29
11/7/2017	144849	SAT	ME UG	8	0.27	1.38	0.33	1.05	32.8125	-21	0.670476	22
11/7/2017	144848	SAT	ME UG	8.8	0.25	0.65	0.02	0.63	19.6875	0	1.015873	20
11/7/2017	144850	SAT	ME UG	8.8	0.3	0.42	<0.01	0.42	13.125	12	1.904762	25
11/7/2017	144250	SAT	ME UG	8.7	0.38	0.74	<0.01	0.74	23.125	7	1.297297	30
11/7/2017	144249	SAT	ME UG	8.5	0.26	0.16	**<0.01**	0.16	5	18	4.6	23
11/7/2017	144248	SAT	ME UG	8.2	0.28	0.67	0.01	0.66	20.625	1	1.066667	22
11/7/2017	144600	SAT	ME UG	8.4	0.52	0.31	0.01	0.3	9.375	38	5.12	48

Appendix C: ALS Minerals Raw Lab Results

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-FEB-17
Report Date: 24-MAR-17 16:21 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1895090

Project P.O. #: 220826
Job Reference:
C of C Numbers: 15-13
Legal Site Desc:

Comments: Mar 24 2017: Please note, the results from ALS Minerals division can be found at the end of this attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1895090-1	L1895090-2	L1895090-3	L1895090-4	L1895090-5
	Description	TAILS	TAILS	TAILS	TAILS	TAILS
	Sampled Date	01-OCT-16	15-JAN-17	15-JAN-17	15-JAN-17	15-JAN-17
	Sampled Time					
	Client ID	TAILS OCT 2016	ABA FT THICKENER U/F DEC 5 2016	ABA FT THICKENER U/F DEC 26 2016	ABA FT THICKENER U/F DEC 19 2016	ABA FT NOV 2016
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	7.9	7.9	8.1	8.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.19	0.14	0.13	0.13	0.13
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	1.9	3.8	5.3	2.5	3.8
	Neutralization Potential (NP) (tCaCO3/1Kt)	15	16	15	15	15
	NNP (tCaCO3/1Kt)	13	12	10	13	11
	Ratio (NP/MPA) (Unity)	8.00	4.27	2.82	6.00	4.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.04	0.08	0.03	0.06
	Sulfate Sulfur (HCl leach) (%)	0.01	0.02	0.07	<0.01	0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.05	0.08	0.09	0.05	0.06
	Total Sulfur (combustion) (%)	0.06	0.12	0.17	0.08	0.12
Total Metals	Aluminum (Al) (%)	0.90	1.25	1.10	0.99	1.12
	Antimony (Sb) (ppm)	0.05	0.05	0.06	<0.05	0.05
	Arsenic (As) (ppm)	1.4	1.4	1.0	0.8	1.3
	Barium (Ba) (ppm)	110	230	230	140	230
	Beryllium (Be) (ppm)	0.21	0.26	0.20	0.17	0.21
	Bismuth (Bi) (ppm)	0.32	0.37	0.27	0.25	0.26
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.33	0.26	0.27	0.27	0.27
	Calcium (Ca) (%)	0.61	0.76	0.76	0.65	0.71
	Cerium (Ce) (ppm)	7.70	13.70	13.45	10.65	12.80
	Cesium (Cs) (ppm)	0.27	0.45	0.38	0.28	0.38
	Chromium (Cr) (ppm)	6	6	6	6	6
	Cobalt (Co) (ppm)	6.9	7.3	7.6	6.3	7.3
	Copper (Cu) (ppm)	1095	2020	1840	1090	1800
	Gallium (Ga) (ppm)	8.78	8.45	7.99	7.83	7.63
	Germanium (Ge) (ppm)	0.06	0.07	0.07	0.05	0.06
	Gold (Au) (ppm)	1.1	0.6	0.2	0.3	0.3
	Hafnium (Hf) (ppm)	0.03	0.05	0.05	0.04	0.05
	Indium (In) (ppm)	0.086	0.083	0.071	0.070	0.071
	Iron (Fe) (%)	5.00	4.08	4.43	4.18	4.04
	Lanthanum (La) (ppm)	4.1	6.9	7.1	5.5	6.7
	Lead (Pb) (ppm)	4.5	4.6	3.9	3.5	3.4
	Lithium (Li) (ppm)	4.6	6.0	4.9	4.5	4.9
	Magnesium (Mg) (%)	0.46	0.65	0.59	0.50	0.58
	Manganese (Mn) (ppm)	621	627	602	550	602

	Sample ID	L1895090-6	L1895090-7	L1895090-8	L1895090-9	L1895090-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	29-JAN-17	29-JAN-17	29-JAN-17	29-JAN-17	18-FEB-17
	Sampled Time					
	Client ID	133626	133627	133628	133629	133630
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.3	8.6	8.3	8.2	8.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.33	0.15	0.18	0.20	0.15
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.9	<0.3	0.6	0.6	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	34	21	23	23	20
	NNP (tCaCO3/1Kt)	33	21	22	22	20
	Ratio (NP/MPA) (Unity)	36.27	134.40	36.80	36.80	64.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	0.02	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.01	0.02	0.02	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	<0.01	<0.01	0.02	0.01
	Total Sulfur (combustion) (%)	0.03	<0.01	0.02	0.02	0.01
Total Metals	Aluminum (Al) (%)	0.71	1.01	1.25	1.12	1.08
	Antimony (Sb) (ppm)	0.09	0.06	0.35	0.61	0.41
	Arsenic (As) (ppm)	4.8	1.7	4.2	6.1	6.7
	Barium (Ba) (ppm)	650	310	300	320	360
	Beryllium (Be) (ppm)	0.44	0.33	0.38	0.44	0.50
	Bismuth (Bi) (ppm)	3.16	0.06	0.08	0.10	0.11
	Boron (B) (ppm)	10	<10	<10	<10	10
	Cadmium (Cd) (ppm)	0.45	0.07	0.17	0.24	0.21
	Calcium (Ca) (%)	1.29	0.90	1.16	1.20	0.96
	Cerium (Ce) (ppm)	13.75	20.4	25.3	26.9	22.2
	Cesium (Cs) (ppm)	0.66	0.36	0.59	0.81	0.75
	Chromium (Cr) (ppm)	4	5	17	25	18
	Cobalt (Co) (ppm)	9.7	5.8	7.0	8.1	8.0
	Copper (Cu) (ppm)	8380	1640	210	66.2	389
	Gallium (Ga) (ppm)	5.79	5.26	4.81	3.87	4.90
	Germanium (Ge) (ppm)	0.09	0.06	0.06	0.06	0.06
	Gold (Au) (ppm)	0.3	<0.2	<0.2	<0.2	<0.2
	Hafnium (Hf) (ppm)	0.04	0.07	0.16	0.23	0.14
	Indium (In) (ppm)	0.131	0.040	0.022	0.022	0.038
	Iron (Fe) (%)	4.34	2.34	2.19	2.24	2.54
	Lanthanum (La) (ppm)	7.8	10.0	12.8	13.4	11.4
	Lead (Pb) (ppm)	4.5	2.1	4.6	5.8	5.3
	Lithium (Li) (ppm)	4.5	5.7	6.5	7.8	6.7
	Magnesium (Mg) (%)	0.24	0.48	0.52	0.53	0.40
	Manganese (Mn) (ppm)	644	530	475	458	520

	Sample ID	L1895090-11	L1895090-12			
	Description	WASTE	WASTE			
	Sampled Date	18-FEB-17	18-FEB-17			
	Sampled Time					
	Client ID	133631	133632			
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.3	7.9			
Organic / Inorganic Carbon	Carbon (C) (%)	0.23	0.17			
Acid Base Accounting	FIZZ RATING (Unity)	2	2			
	MPA (tCaCO3/1Kt)	0.6	0.6			
	Neutralization Potential (NP) (tCaCO3/1Kt)	27	19			
	NNP (tCaCO3/1Kt)	26	18			
	Ratio (NP/MPA) (Unity)	43.20	30.40			
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.02			
	Sulfate Sulfur (HCl leach) (%)	0.02	0.01			
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	<0.01			
	Total Sulfur (combustion) (%)	0.02	0.02			
Total Metals	Aluminum (Al) (%)	1.02	1.37			
	Antimony (Sb) (ppm)	0.58	0.61			
	Arsenic (As) (ppm)	6.7	6.3			
	Barium (Ba) (ppm)	300	360			
	Beryllium (Be) (ppm)	0.39	0.56			
	Bismuth (Bi) (ppm)	0.08	0.11			
	Boron (B) (ppm)	<10	<10			
	Cadmium (Cd) (ppm)	0.20	0.26			
	Calcium (Ca) (%)	1.27	1.01			
	Cerium (Ce) (ppm)	23.9	27.3			
	Cesium (Cs) (ppm)	0.68	1.07			
	Chromium (Cr) (ppm)	22	27			
	Cobalt (Co) (ppm)	7.4	9.3			
	Copper (Cu) (ppm)	36.6	229			
	Gallium (Ga) (ppm)	3.51	5.84			
	Germanium (Ge) (ppm)	0.05	0.18			
	Gold (Au) (ppm)	<0.2	<0.2			
	Hafnium (Hf) (ppm)	0.21	0.65			
	Indium (In) (ppm)	0.019	0.027			
	Iron (Fe) (%)	2.20	2.52			
	Lanthanum (La) (ppm)	12.2	13.5			
	Lead (Pb) (ppm)	6.1	6.3			
	Lithium (Li) (ppm)	6.7	9.4			
	Magnesium (Mg) (%)	0.50	0.55			
	Manganese (Mn) (ppm)	490	484			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1895090-1	L1895090-2	L1895090-3	L1895090-4	L1895090-5
	Description	TAILS	TAILS	TAILS	TAILS	TAILS
	Sampled Date	01-OCT-16	15-JAN-17	15-JAN-17	15-JAN-17	15-JAN-17
	Sampled Time					
	Client ID	TAILS OCT 2016	ABA FT THICKENER U/F DEC 5 2016	ABA FT THICKENER U/F DEC 26 2016	ABA FT THICKENER U/F DEC 19 2016	ABA FT NOV 2016
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	0.01	0.01	0.02
	Molybdenum (Mo) (ppm)	0.55	1.78	1.27	0.66	1.39
	Nickel (Ni) (ppm)	3.0	2.9	2.9	2.8	3.0
	Niobium (Nb) (ppm)	0.14	0.20	0.24	0.25	0.28
	Phosphorus (P) (ppm)	360	640	600	470	590
	Potassium (K) (%)	0.36	0.61	0.56	0.43	0.55
	Rhenium (Re) (ppm)	<0.001	0.002	0.001	0.001	0.001
	Rubidium (Rb) (ppm)	18.0	32.0	27.6	21.4	26.4
	Scandium (Sc) (ppm)	2.4	3.8	3.3	2.6	3.3
	Selenium (Se) (ppm)	1.2	1.6	1.6	1.2	1.6
	Silver (Ag) (ppm)	1.08	0.93	0.86	0.80	0.84
	Sodium (Na) (%)	0.05	0.06	0.06	0.07	0.07
	Strontium (Sr) (ppm)	50.0	65.6	66.6	55.9	60.2
	Sulfur (S) (%)	0.06	0.13	0.18	0.09	0.13
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.27	0.29	0.22	0.20	0.24
	Thallium (Tl) (ppm)	0.12	0.22	0.17	0.15	0.17
	Thorium (Th) (ppm)	2.9	3.4	2.8	3.2	2.9
	Tin (Sn) (ppm)	0.6	0.9	0.8	0.6	0.8
	Titanium (Ti) (%)	0.068	0.115	0.112	0.083	0.106
	Tungsten (W) (ppm)	0.06	0.06	0.08	0.07	0.08
	Uranium (U) (ppm)	0.22	0.31	0.31	0.23	0.32
	Vanadium (V) (ppm)	77	74	77	68	71
	Yttrium (Y) (ppm)	2.39	4.81	4.39	3.18	4.34
	Zinc (Zn) (ppm)	129	120	111	110	109
	Zirconium (Zr) (ppm)	0.9	1.2	1.0	0.9	1.1
Permanent Gases	Carbon Dioxide (CO2) (%)	0.7	0.5	0.5	0.5	0.5

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1895090-6	L1895090-7	L1895090-8	L1895090-9	L1895090-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	29-JAN-17	29-JAN-17	29-JAN-17	29-JAN-17	18-FEB-17
	Sampled Time					
	Client ID	133626	133627	133628	133629	133630
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	0.02	0.04	0.02
	Molybdenum (Mo) (ppm)	1.04	0.48	1.15	1.29	1.41
	Nickel (Ni) (ppm)	2.9	2.9	12.8	21.7	16.7
	Niobium (Nb) (ppm)	0.10	0.25	0.40	0.37	0.43
	Phosphorus (P) (ppm)	720	660	780	860	720
	Potassium (K) (%)	0.40	0.41	0.30	0.18	0.26
	Rhenium (Re) (ppm)	<0.001	<0.001	0.001	0.001	<0.001
	Rubidium (Rb) (ppm)	19.8	19.3	14.8	9.9	14.3
	Scandium (Sc) (ppm)	3.1	4.2	4.3	4.2	5.3
	Selenium (Se) (ppm)	4.6	0.9	0.8	0.9	0.6
	Silver (Ag) (ppm)	6.80	0.30	0.13	0.11	0.12
	Sodium (Na) (%)	0.04	0.09	0.08	0.06	0.05
	Strontium (Sr) (ppm)	37.8	47.6	70.1	55.7	48.6
	Sulfur (S) (%)	0.03	0.01	0.03	0.02	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	1.02	0.07	0.01	0.02	0.05
	Thallium (Tl) (ppm)	0.10	0.11	0.11	0.11	0.12
	Thorium (Th) (ppm)	2.9	2.0	3.2	3.5	2.8
	Tin (Sn) (ppm)	0.9	0.6	0.5	0.4	0.6
	Titanium (Ti) (%)	0.056	0.081	0.091	0.078	0.067
	Tungsten (W) (ppm)	0.30	0.44	0.16	0.19	0.32
	Uranium (U) (ppm)	0.28	0.21	0.51	0.62	0.39
	Vanadium (V) (ppm)	98	46	47	47	56
	Yttrium (Y) (ppm)	5.13	9.67	8.77	9.65	10.00
	Zinc (Zn) (ppm)	103	65	58	57	65
	Zirconium (Zr) (ppm)	1.3	1.2	5.6	8.1	5.6
Permanent Gases	Carbon Dioxide (CO2) (%)	1.2	0.6	0.7	0.7	0.6

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1895090-11	L1895090-12			
	Description	WASTE	WASTE			
	Sampled Date	18-FEB-17	18-FEB-17			
	Sampled Time					
	Client ID	133631	133632			
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.03	0.04			
	Molybdenum (Mo) (ppm)	1.14	1.52			
	Nickel (Ni) (ppm)	18.6	23.1			
	Niobium (Nb) (ppm)	0.28	1.66			
	Phosphorus (P) (ppm)	830	770			
	Potassium (K) (%)	0.17	0.25			
	Rhenium (Re) (ppm)	0.001	0.001			
	Rubidium (Rb) (ppm)	9.2	19.6			
	Scandium (Sc) (ppm)	4.0	7.3			
	Selenium (Se) (ppm)	0.6	0.7			
	Silver (Ag) (ppm)	0.08	0.16			
	Sodium (Na) (%)	0.07	0.07			
	Strontium (Sr) (ppm)	61.5	65.4			
	Sulfur (S) (%)	0.02	0.02			
	Tantalum (Ta) (ppm)	<0.01	0.09			
	Tellurium (Te) (ppm)	0.01	0.02			
	Thallium (Tl) (ppm)	0.10	0.16			
	Thorium (Th) (ppm)	3.2	3.6			
	Tin (Sn) (ppm)	0.4	0.6			
	Titanium (Ti) (%)	0.078	0.078			
	Tungsten (W) (ppm)	0.25	0.31			
	Uranium (U) (ppm)	0.61	0.66			
	Vanadium (V) (ppm)	45	55			
	Yttrium (Y) (ppm)	8.83	9.95			
	Zinc (Zn) (ppm)	51	64			
	Zirconium (Zr) (ppm)	7.3	10.1			
Permanent Gases	Carbon Dioxide (CO2) (%)	0.9	0.6			

Reference Information

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>ABA-OA-VOL08-AX</td><td>Soil</td><td>Acid Base Accounting</td><td>OA-VOL08</td></tr>
<tr><td>CARBON-C-GAS05-AX</td><td>Soil</td><td>Carbon, TOC and CO2</td><td>C-GAS05</td></tr>
<tr><td>ME-MS41-AX</td><td>Soil</td><td>Aqua Regia ICPMS</td><td>Aqua Regia ICPMS</td></tr>
<tr><td colspan="4">A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.</td></tr>
<tr><td>PH-OA-ELE07-AX</td><td>Soil</td><td>pH</td><td>OA-ELE07</td></tr>
<tr><td>SULPHUR-S-CAL06-AX</td><td>Soil</td><td>Sulfide Sulfur Calc from Carbonate Leach</td><td>ALS Minerals S-CAL06</td></tr>
<tr><td colspan="4">Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.</td></tr>
<tr><td>SULPHUR-S-GRA06-AX</td><td>Soil</td><td>Sulfate Sulfur in Soil (Carbonate Leach)</td><td>ALS Minerals S-GRA06</td></tr>
<tr><td colspan="4">A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).</td></tr>
<tr><td>SULPHUR-S-GRA06A-AX</td><td>Soil</td><td>Sulfate Sulfur in Soil (HCl Leach)</td><td>ALS Minerals S-GRA06A</td></tr>
<tr><td colspan="4">A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).</td></tr>
<tr><td>SULPHUR-S-IR08-AX</td><td>Soil</td><td>Total Sulfur in Soil by Combustion</td><td>ALS Minerals S-IR08</td></tr>
<tr><td colspan="4">The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.</td></tr>
</table>

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

15-13

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 23-MAR-2017
Account: APN

CERTIFICATE VA17039951

Project: L1895090

P.O. No.: ALSM-CW16-102-APN

This report is for 12 Other samples submitted to our lab in Vancouver, BC, Canada on 2-MAR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895090

CERTIFICATE OF ANALYSIS VA17039951

Sample Description	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41
Analyte	Recvd Wt.	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al
Units	kg	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
LOR	0.02	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01
L1895090-1 TAILS OCT 2016	1.36	1.9	2	13	15	8.2	8.00	0.06	0.01	0.01	0.05	0.19	0.7	1.08	0.90
L1895090-2 ABA FT THICKENER U/F DEC 5/16	0.58	3.8	2	12	16	7.9	4.27	0.12	0.04	0.02	0.08	0.14	0.5	0.93	1.25
L1895090-3 ABA FT THICKENER U/F DEC 26	0.70	5.3	2	10	15	7.9	2.82	0.17	0.08	0.07	0.09	0.13	0.5	0.86	1.10
L1895090-4 ABA FT THICKENER U/F DEC 19	0.56	2.5	2	13	15	8.1	6.00	0.08	0.03	<0.01	0.05	0.13	0.5	0.80	0.99
L1895090-5 ABA FT NOV 2016	1.04	3.8	2	11	15	8.0	4.00	0.12	0.06	0.01	0.06	0.13	0.5	0.84	1.12
L1895090-6 133626	1.08	0.9	2	33	34	8.3	36.27	0.03	0.01	0.01	0.02	0.33	1.2	6.80	0.71
L1895090-7 133627	1.08	<0.3	2	21	21	8.6	134.40	<0.01	<0.01	0.01	<0.01	0.15	0.6	0.30	1.01
L1895090-8 133628	1.08	0.6	2	22	23	8.3	36.80	0.02	0.02	0.02	<0.01	0.18	0.7	0.13	1.25
L1895090-9 133629	1.08	0.6	2	22	23	8.2	36.80	0.02	<0.01	0.02	0.02	0.20	0.7	0.11	1.12
L1895090-10 133630	1.20	0.3	2	20	20	8.0	64.00	0.01	<0.01	<0.01	0.01	0.15	0.6	0.12	1.08
L1895090-11 133631	1.04	0.6	2	26	27	8.3	43.20	0.02	0.01	0.02	0.01	0.23	0.9	0.08	1.02
L1895090-12 133632	1.06	0.6	2	18	19	7.9	30.40	0.02	0.02	0.01	<0.01	0.17	0.6	0.16	1.37

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895090

CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method Analyte Units LOR	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.2	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
L1895090-1 TAILS OCT 2016		1.4	1.1	<10	110	0.21	0.32	0.61	0.33	7.70	6.9	6	0.27	1095	5.00	8.78
L1895090-2 ABA FT THICKENER U/F DEC 5/16		1.4	0.6	<10	230	0.26	0.37	0.76	0.26	13.70	7.3	6	0.45	2020	4.08	8.45
L1895090-3 ABA FT THICKENER U/F DEC 26		1.0	0.2	<10	230	0.20	0.27	0.76	0.27	13.45	7.6	6	0.38	1840	4.43	7.99
L1895090-4 ABA FT THICKENER U/F DEC 19		0.8	0.3	<10	140	0.17	0.25	0.65	0.27	10.65	6.3	6	0.28	1090	4.18	7.83
L1895090-5 ABA FT NOV 2016		1.3	0.3	<10	230	0.21	0.26	0.71	0.27	12.80	7.3	6	0.38	1800	4.04	7.63
L1895090-6 133626		4.8	0.3	10	650	0.44	3.16	1.29	0.45	13.75	9.7	4	0.66	8380	4.34	5.79
L1895090-7 133627		1.7	<0.2	<10	310	0.33	0.06	0.90	0.07	20.4	5.8	5	0.36	1640	2.34	5.26
L1895090-8 133628		4.2	<0.2	<10	300	0.38	0.08	1.16	0.17	25.3	7.0	17	0.59	210	2.19	4.81
L1895090-9 133629		6.1	<0.2	<10	320	0.44	0.10	1.20	0.24	26.9	8.1	25	0.81	66.2	2.24	3.87
L1895090-10 133630		6.7	<0.2	10	360	0.50	0.11	0.96	0.21	22.2	8.0	18	0.75	389	2.54	4.90
L1895090-11 133631		6.7	<0.2	<10	300	0.39	0.08	1.27	0.20	23.9	7.4	22	0.68	36.6	2.20	3.51
L1895090-12 133632		6.3	<0.2	<10	360	0.56	0.11	1.01	0.26	27.3	9.3	27	1.07	229	2.52	5.84

Project: L1895090

CERTIFICATE OF ANALYSIS VA17039951

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2
L1895090-1 TAILS OCT 2016	0.06	0.03	<0.01	0.086	0.36	4.1	4.6	0.46	621	0.55	0.05	0.14	3.0	360	4.5
L1895090-2 ABA FT THICKENER U/F DEC 5/16	0.07	0.05	0.01	0.083	0.61	6.9	6.0	0.65	627	1.78	0.06	0.20	2.9	640	4.6
L1895090-3 ABA FT THICKENER U/F DEC 26	0.07	0.05	0.01	0.071	0.56	7.1	4.9	0.59	602	1.27	0.06	0.24	2.9	600	3.9
L1895090-4 ABA FT THICKENER U/F DEC 19	0.05	0.04	0.01	0.070	0.43	5.5	4.5	0.50	550	0.66	0.07	0.25	2.8	470	3.5
L1895090-5 ABA FT NOV 2016	0.06	0.05	0.02	0.071	0.55	6.7	4.9	0.58	602	1.39	0.07	0.28	3.0	590	3.4
L1895090-6 133626	0.09	0.04	0.01	0.131	0.40	7.8	4.5	0.24	644	1.04	0.04	0.10	2.9	720	4.5
L1895090-7 133627	0.06	0.07	0.01	0.040	0.41	10.0	5.7	0.48	530	0.48	0.09	0.25	2.9	660	2.1
L1895090-8 133628	0.06	0.16	0.02	0.022	0.30	12.8	6.5	0.52	475	1.15	0.08	0.40	12.8	780	4.6
L1895090-9 133629	0.06	0.23	0.04	0.022	0.18	13.4	7.8	0.53	458	1.29	0.06	0.37	21.7	860	5.8
L1895090-10 133630	0.06	0.14	0.02	0.038	0.26	11.4	6.7	0.40	520	1.41	0.05	0.43	16.7	720	5.3
L1895090-11 133631	0.05	0.21	0.03	0.019	0.17	12.2	6.7	0.50	490	1.14	0.07	0.28	18.6	830	6.1
L1895090-12 133632	0.18	0.65	0.04	0.027	0.25	13.5	9.4	0.55	484	1.52	0.07	1.66	23.1	770	6.3

CERTIFICATE OF ANALYSIS VA17039951

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Sample Description / **LOR**	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
L1895090-1 TAILS OCT 2016	18.0	<0.001	0.06	0.05	2.4	1.2	0.6	50.0	<0.01	0.27	2.9	0.068	0.12	0.22	77
L1895090-2 ABA FT THICKENER U/F DEC 5/16	32.0	0.002	0.13	0.05	3.8	1.6	0.9	65.6	<0.01	0.29	3.4	0.115	0.22	0.31	74
L1895090-3 ABA FT THICKENER U/F DEC 26	27.6	0.001	0.18	0.06	3.3	1.6	0.8	66.6	<0.01	0.22	2.8	0.112	0.17	0.31	77
L1895090-4 ABA FT THICKENER U/F DEC 19	21.4	0.001	0.09	<0.05	2.6	1.2	0.6	55.9	<0.01	0.20	3.2	0.083	0.15	0.23	68
L1895090-5 ABA FT NOV 2016	26.4	0.001	0.13	0.05	3.3	1.6	0.8	60.2	<0.01	0.24	2.9	0.106	0.17	0.32	71
L1895090-6 133626	19.8	<0.001	0.03	0.09	3.1	4.6	0.9	37.8	<0.01	1.02	2.9	0.056	0.10	0.28	98
L1895090-7 133627	19.3	<0.001	0.01	0.06	4.2	0.9	0.6	47.6	<0.01	0.07	2.0	0.081	0.11	0.21	46
L1895090-8 133628	14.8	0.001	0.03	0.35	4.3	0.8	0.5	70.1	<0.01	0.01	3.2	0.091	0.11	0.51	47
L1895090-9 133629	9.9	0.001	0.02	0.61	4.2	0.9	0.4	55.7	<0.01	0.02	3.5	0.078	0.11	0.62	47
L1895090-10 133630	14.3	<0.001	0.01	0.41	5.3	0.6	0.6	48.6	<0.01	0.05	2.8	0.067	0.12	0.39	56
L1895090-11 133631	9.2	0.001	0.02	0.58	4.0	0.6	0.4	61.5	<0.01	0.01	3.2	0.078	0.10	0.61	45
L1895090-12 133632	19.6	0.001	0.02	0.61	7.3	0.7	0.6	65.4	0.09	0.02	3.6	0.078	0.16	0.66	55

CERTIFICATE OF ANALYSIS VA17039951

Sample Description / **Method** **Analyte** **Units** **LOR**	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1895090-1 TAILS OCT 2016	0.06	2.39	129	0.9
L1895090-2 ABA FT THICKENER U/F DEC 5/16	0.06	4.81	120	1.2
L1895090-3 ABA FT THICKENER U/F DEC 26	0.08	4.39	111	1.0
L1895090-4 ABA FT THICKENER U/F DEC 19	0.07	3.18	110	0.9
L1895090-5 ABA FT NOV 2016	0.08	4.34	109	1.1
L1895090-6 133626	0.30	5.13	103	1.3
L1895090-7 133627	0.44	9.67	65	1.2
L1895090-8 133628	0.16	8.77	58	5.6
L1895090-9 133629	0.19	9.65	57	8.1
L1895090-10 133630	0.32	10.00	65	5.6
L1895090-11 133631	0.25	8.83	51	7.3
L1895090-12 133632	0.31	9.95	64	10.1

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895090

CERTIFICATE OF ANALYSIS VA17039951

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	LOG-22	ME-MS41	OA-ELE07
OA-VOL08m	PUL-31	PUL-QC	S-CAL06
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-MAR-2017
Account: APN

QC CERTIFICATE VA17039951

Project: L1895090

P.O. No.: ALSM-CW16-102-APN

This report is for 12 Other samples submitted to our lab in Vancouver, BC, Canada on 2-MAR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1895090

QC CERTIFICATE OF ANALYSIS VA17039951

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description / LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
STANDARDS															
Buffer pH6					6.1										
Buffer pH6					6.1										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CO-ASSAY											0.50	1.8			
Target Range - Lower Bound											0.42	1.5			
Upper Bound											0.64	2.4			
DS-1							2.55								
Target Range - Lower Bound							2.51								
Upper Bound							2.71								
GS310-10							0.27								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								
KZK-1	25.0	2	31	56		2.24									
KZK-1	25.0	2	31	56		2.24									
Target Range - Lower Bound	22.9	<1	30	54		2.18									
Upper Bound	27.1	>4	38	64		2.53									
MA-3a											2.33	8.5			
Target Range - Lower Bound											2.31	8.4			
Upper Bound											2.77	10.2			
MP-1b							14.00								
Target Range - Lower Bound							13.30								
Upper Bound							14.30								
MRGeo08													4.39	2.59	34.2
MRGeo08													4.44	2.61	33.3
Target Range - Lower Bound													4.00	2.44	29.6
Upper Bound													4.92	3.00	36.4
OREAS 905													0.50	0.73	33.1
OREAS 905													0.53	0.76	32.7
Target Range - Lower Bound													0.45	0.73	28.4
Upper Bound													0.58	0.91	35.0
SY-4											0.86	3.2			
SY-4											0.90	3.3			
Target Range - Lower Bound											0.84	3.0			
Upper Bound											1.08	4.0			
UTS-1								0.88							
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.87						

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
	STANDARDS														
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MP-1b															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	<0.2	<10	440	0.81	0.68	1.06	2.21	73.2	17.8	89	10.65	608	3.45	9.52	0.14
MRGeo08	<0.2	<10	440	0.79	0.68	1.07	2.23	73.6	19.0	89	10.70	616	3.57	9.30	0.14
Target Range - Lower Bound	<0.2	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07
Upper Bound	0.4	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29
OREAS 905	0.4	<10	230	0.98	5.43	0.32	0.36	75.3	12.8	16	1.17	1485	3.24	5.83	0.09
OREAS 905	0.4	<10	240	0.90	5.73	0.33	0.33	79.7	13.9	18	1.16	1530	3.38	6.00	0.10
Target Range - Lower Bound	<0.2	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05
Upper Bound	0.8	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22
SY-4															
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MP-1b															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.73	0.08	0.158	1.27	37.2	32.1	1.13	411	14.35	0.32	0.85	680	980	1045	148.0
MRGeo08	0.77	0.07	0.149	1.27	36.5	34.2	1.12	413	13.60	0.33	0.97	678	1000	1070	140.0
Target Range - Lower Bound	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0
Upper Bound	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0
OREAS 905	1.16	0.10	0.556	0.30	38.6	4.5	0.14	332	2.95	0.08	0.25	8.5	240	16.1	18.4
OREAS 905	1.12	0.02	0.569	0.31	39.3	4.5	0.14	340	2.85	0.09	0.33	9.3	230	15.8	18.0
Target Range - Lower Bound	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3
Upper Bound	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3
SY-4															
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															

ALS Minerals

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895090

QC CERTIFICATE OF ANALYSIS VA17039951

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description **LOR**	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
	STANDARDS														
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MP-1b															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.008	0.30	2.99	7.2	1.3	3.3	79.1	0.01	0.02	22.1	0.373	0.84	5.41	98	2.91
MRGeo08	0.007	0.31	3.13	7.0	1.4	3.2	78.9	0.01	0.02	20.9	0.371	0.77	5.29	99	2.87
Target Range - Lower Bound	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44
Upper Bound	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42
OREAS 905	<0.001	0.07	0.98	1.6	2.6	1.2	12.2	<0.01	0.07	8.3	0.019	0.10	2.13	5	0.66
OREAS 905	<0.001	0.07	1.15	1.7	2.9	1.2	12.6	<0.01	0.07	8.8	0.019	0.11	2.17	6	0.57
Target Range - Lower Bound	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44
Upper Bound	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76
SY-4															
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17039951

STANDARDS

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
DS-1				
Target Range - Lower Bound				
Upper Bound				
GS310-10				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-3a				
Target Range - Lower Bound				
Upper Bound				
MP-1b				
Target Range - Lower Bound				
Upper Bound				
MRGeo08		19.80	775	21.7
MRGeo08		19.50	780	22.2
Target Range - Lower Bound		17.50	708	18.1
Upper Bound		21.5	870	25.7
OREAS 905		6.64	63	45.2
OREAS 905		7.24	64	43.6
Target Range - Lower Bound		6.32	58	39.9
Upper Bound		7.84	76	55.1
SY-4				
SY-4				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
STANDARDS																
Target Range - Lower Bound										0.81						
Upper Bound										0.95						
UTS-4									1.76							
Target Range - Lower Bound									1.64							
Upper Bound									1.84							
UTS-4										1.74						
Target Range - Lower Bound										1.61						
Upper Bound										1.87						
BLANKS																
BLANK												<0.05	<0.2			
BLANK												<0.05	<0.2			
Target Range - Lower Bound												<0.05	<0.2			
Upper Bound												0.10	0.4			
BLANK														<0.01	<0.01	0.1
BLANK														<0.01	<0.01	<0.1
Target Range - Lower Bound														<0.01	<0.01	<0.1
Upper Bound														0.02	0.02	0.2
BLANK						6.1										
Target Range - Lower Bound						5.5										
Upper Bound						6.9										
BLANK									<0.01							
Target Range - Lower Bound									<0.01							
Upper Bound									0.02							
BLANK										<0.01						
Target Range - Lower Bound										<0.01						
Upper Bound										0.02						
BLANK								<0.01								
Target Range - Lower Bound								<0.01								
Upper Bound								0.02								

ALS Minerals
ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-MAR-2017
Account: APN

Project: L1895090

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
	LOR	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.2	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	0.2	<0.01	<0.05	<0.05
BLANK		<0.2	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Target Range - Lower Bound		<0.2	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound		0.4	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description **Method** / **Analyte** / **Units** / **LOR**	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
BLANK	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	0.01	<0.05	<0.2	<10	<0.2	<0.1
Target Range - Lower Bound	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

Project: L1895090

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
									STANDARDS							
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
									BLANKS							
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
BLANK		<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound		<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound		0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-MAR-2017
Account: APN

Project: L1895090

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
BLANKS				
BLANK				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK		<0.05	<2	<0.5
BLANK		<0.05	<2	<0.5
Target Range - Lower Bound		<0.05	<2	<0.5
Upper Bound		0.10	4	1.0
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description **Method** **Analyte** **Units** **LOR**	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-CAL06 S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1
	DUPLICATES														
ORIGINAL													0.14	0.27	1300
DUP													0.14	0.27	1295
Target Range - Lower Bound													0.12	0.25	1235
Upper Bound													0.16	0.29	1360
ORIGINAL									0.02		0.07	0.3			
DUP									0.02		0.07	0.3			
Target Range - Lower Bound									<0.01		<0.05	<0.2			
Upper Bound									0.03		0.10	0.4			
L1895090-8 133628													0.13	1.25	4.2
DUP													0.12	1.30	4.4
Target Range - Lower Bound													0.11	1.20	4.0
Upper Bound													0.14	1.35	4.6
L1895090-10 133630	0.3	2	20	20	8.0	64.00	0.01	<0.01		0.01					
DUP	0.3	2	19	19	8.0	60.80	0.01	<0.01		0.01					
Target Range - Lower Bound	<0.3	<1	18	18	7.5	59.27	<0.01	<0.01		<0.01					
Upper Bound	0.6	3	21	21	8.5	65.53	0.02	0.02		0.02					
L1895095-4 133636											<0.05	<0.2			
DUP											<0.05	<0.2			
Target Range - Lower Bound											<0.05	<0.2			
Upper Bound											0.10	0.4			

***** See Appendix Page for comments regarding this certificate *****

Project: L1895090

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
								DUPLICATES							
ORIGINAL	0.2	10	40	0.86	0.04	6.10	0.35	17.70	14.4	19	8.34	45.9	3.59	0.93	0.06
DUP	0.2	10	40	0.80	0.09	6.12	0.31	17.40	14.2	16	8.43	46.1	3.56	0.90	0.06
Target Range - Lower Bound	<0.2	<10	30	0.74	0.05	5.79	0.30	16.65	13.5	16	7.92	44.2	3.39	0.82	<0.05
Upper Bound	0.4	20	50	0.92	0.08	6.43	0.36	18.45	15.1	19	8.85	47.8	3.76	1.01	0.10
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895090-8 133628	<0.2	<10	300	0.38	0.08	1.16	0.17	25.3	7.0	17	0.59	210	2.19	4.81	0.06
DUP	<0.2	<10	300	0.40	0.12	1.20	0.16	25.0	7.0	18	0.60	207	2.24	4.90	0.06
Target Range - Lower Bound	<0.2	<10	270	0.32	0.09	1.11	0.15	23.9	6.6	16	0.52	201	2.09	4.56	<0.05
Upper Bound	0.4	20	330	0.46	0.12	1.25	0.18	26.4	7.5	19	0.67	216	2.34	5.15	0.10
L1895090-10 133630															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-4 133636															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
DUPLICATES															
ORIGINAL	0.10	20.3	0.034	0.13	7.3	1.1	2.69	442	5.27	0.01	0.06	37.0	1630	6.7	7.3
DUP	0.10	21.5	0.032	0.13	7.2	1.1	2.67	444	5.12	0.01	0.06	36.9	1600	7.6	7.4
Target Range - Lower Bound	0.08	19.30	0.026	0.11	6.7	0.9	2.54	416	4.89	<0.01	<0.05	34.9	1520	6.6	6.9
Upper Bound	0.13	22.5	0.040	0.15	7.8	1.3	2.82	470	5.50	0.02	0.10	39.0	1710	7.7	7.8
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895090-8 133628	0.16	0.02	0.022	0.30	12.8	6.5	0.52	475	1.15	0.08	0.40	12.8	780	4.6	14.8
DUP	0.17	0.02	0.023	0.31	12.8	6.9	0.54	479	1.18	0.08	0.35	13.1	780	4.7	14.7
Target Range - Lower Bound	0.14	<0.01	0.016	0.28	12.0	6.3	0.49	448	1.06	0.07	0.31	12.1	730	4.2	13.9
Upper Bound	0.19	0.03	0.029	0.33	13.6	7.1	0.57	506	1.27	0.09	0.44	13.8	830	5.1	15.6
L1895090-10 133630															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-4 133636															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
								DUPLICATES								
ORIGINAL		0.002	2.02	13.30	7.3	2.0	0.3	95.7	<0.01	1.31	2.2	<0.005	4.40	1.12	22	36.7
DUP		0.003	2.00	13.20	7.1	1.5	0.3	93.4	<0.01	1.43	2.1	<0.005	4.35	1.06	22	32.8
Target Range - Lower Bound		<0.001	1.90	12.20	6.7	1.5	<0.2	89.6	<0.01	1.29	1.8	<0.005	4.03	0.99	20	32.1
Upper Bound		0.004	2.12	14.30	7.7	2.0	0.4	99.5	0.02	1.45	2.5	0.010	4.72	1.19	24	37.4
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1895090-8 133628		0.001	0.03	0.35	4.3	0.8	0.5	70.1	<0.01	0.01	3.2	0.091	0.11	0.51	47	0.16
DUP		0.001	0.03	0.35	4.2	0.6	0.5	71.0	<0.01	0.02	3.3	0.095	0.11	0.51	49	0.15
Target Range - Lower Bound		<0.001	0.02	0.27	3.9	0.5	0.3	66.8	<0.01	<0.01	2.9	0.083	0.08	0.43	45	0.09
Upper Bound		0.002	0.04	0.43	4.6	0.9	0.7	74.3	0.02	0.02	3.6	0.103	0.14	0.59	51	0.22
L1895090-10 133630																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1895095-4 133636																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17039951

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
DUPLICATES				
ORIGINAL		12.30	91	4.3
DUP		11.30	84	4.0
Target Range - Lower Bound		11.15	81	3.3
Upper Bound		12.45	94	5.0
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1895090-8 133628		8.77	58	5.6
DUP		8.76	58	5.6
Target Range - Lower Bound		8.28	53	4.7
Upper Bound		9.25	63	6.5
L1895090-10 133630				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1895095-4 133636				
DUP				
Target Range - Lower Bound				
Upper Bound				

QC CERTIFICATE OF ANALYSIS VA17039951

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05 LOG-22 ME-MS41 OA-ELE07
OA-VOL08m PUL-31 PUL-QC S-CAL06
S-GRA06 S-GRA06a S-IR08 SPL-21
WEI-21

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1895090-COFC

COC Number: 15 - 13

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
1	TAILS OCT 2014	OCT 2016		~~Tailings~~	R	R	R	R	R	R	
2	✓ABA ~~TANKS~~ FT THICKENER U/F DEC. 5, 2016	JAN 15, 2017		TAILS							
3	✓ABA FT THICKENER U/F DEC. 26, 2016	15 JAN. 17		TAILS							
4	✓ABA FT THICKENER U/F DEC. 19, 2016	15-JAN-17		TAILS							
5	✓ABA FT NOV. 2016	15-JAN-17		TAILS							
6	✓133626	JAN. 29/17		WASTE							
7	✓133627	|		WASTE							
8	✓133628	|		WASTE							
9	✓133629	|		WASTE							
10	✓133630	Feb 18/17		WASTE							
11	✓133631	Feb 18/17		waste							
12	✓133632	Feb 18/17		waste							

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling initiated ☐

INITIAL COOLER TEMPERATURES °C: —

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)

Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: VD Date: Feb 27/17 Time: 9:30

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

Failure to complete all portions of this form may delay analyses. Please fill in this form LEGIBLY. By the use of this form

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

1. If any water samples are taken fr

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 27-FEB-17
Report Date: 31-MAR-17 10:03 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1895095
Project P.O. #: 220826
Job Reference:
C of C Numbers: 15-14
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1895095-1	L1895095-2	L1895095-3	L1895095-4	L1895095-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	18-FEB-17	18-FEB-17	18-FEB-17	18-FEB-17	18-FEB-17
	Sampled Time					
	Client ID	133633	133634	133635	133636	133637
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.1	8.2	8.0	8.7	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	0.16	0.16	0.07	<0.05	0.13
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	0.6	0.6	<0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	20	20	11	11	19
	NNP (tCaCO3/1Kt)	19	19	10	11	19
	Ratio (NP/MPA) (Unity)	32.00	32.00	17.60	70.40	60.80
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.02	0.02	<0.01	0.01
	Total Sulfur (combustion) (%)	0.02	0.02	0.02	<0.01	0.01
Total Metals	Aluminum (Al) (%)	1.49	1.37	1.25	1.37	1.14
	Antimony (Sb) (ppm)	0.77	0.56	0.32	0.05	0.05
	Arsenic (As) (ppm)	9.6	6.8	4.7	2.5	1.0
	Barium (Ba) (ppm)	380	330	300	320	270
	Beryllium (Be) (ppm)	0.52	0.46	0.45	0.25	0.29
	Bismuth (Bi) (ppm)	0.12	0.08	0.08	0.06	0.03
	Boron (B) (ppm)	10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.32	0.24	0.19	0.14	0.09
	Calcium (Ca) (%)	1.08	1.07	0.60	0.41	0.82
	Cerium (Ce) (ppm)	28.6	27.2	27.5	20.2	20.9
	Cesium (Cs) (ppm)	1.00	0.86	0.83	0.71	0.39
	Chromium (Cr) (ppm)	30	28	17	7	5
	Cobalt (Co) (ppm)	9.5	8.8	8.4	6.9	6.2
	Copper (Cu) (ppm)	95.3	48.2	406	2620	651
	Gallium (Ga) (ppm)	5.12	4.63	4.98	6.39	5.79
	Germanium (Ge) (ppm)	0.11	<0.05	0.05	0.06	0.06
	Gold (Au) (ppm)	<0.2	<0.2	<0.2	<0.2	<0.2
	Hafnium (Hf) (ppm)	0.25	0.27	0.16	0.06	0.06
	Indium (In) (ppm)	0.030	0.022	0.035	0.074	0.033
	Iron (Fe) (%)	2.69	2.43	2.59	3.13	2.32
	Lanthanum (La) (ppm)	14.4	13.9	14.6	11.5	10.9
	Lead (Pb) (ppm)	9.3	6.1	6.5	3.1	3.6
	Lithium (Li) (ppm)	9.4	8.2	6.3	5.4	6.5
	Magnesium (Mg) (%)	0.55	0.54	0.43	0.54	0.54
	Manganese (Mn) (ppm)	541	466	532	609	555

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1895095-1	L1895095-2	L1895095-3	L1895095-4	L1895095-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	18-FEB-17	18-FEB-17	18-FEB-17	18-FEB-17	18-FEB-17
	Sampled Time					
	Client ID	133633	133634	133635	133636	133637
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.04	0.03	0.02	0.01	0.01
	Molybdenum (Mo) (ppm)	1.51	1.48	1.49	1.43	0.97
	Nickel (Ni) (ppm)	25.8	22.9	14.8	3.3	2.3
	Niobium (Nb) (ppm)	0.32	0.53	0.34	0.22	0.13
	Phosphorus (P) (ppm)	800	840	700	820	590
	Potassium (K) (%)	0.30	0.23	0.31	0.78	0.44
	Rhenium (Re) (ppm)	0.001	<0.001	0.001	<0.001	<0.001
	Rubidium (Rb) (ppm)	17.1	13.5	17.3	39.2	21.3
	Scandium (Sc) (ppm)	5.2	5.2	5.5	6.3	4.1
	Selenium (Se) (ppm)	0.7	0.8	0.9	1.3	1.0
	Silver (Ag) (ppm)	0.16	0.11	0.19	0.28	0.16
	Sodium (Na) (%)	0.07	0.07	0.05	0.08	0.09
	Strontium (Sr) (ppm)	60.8	61.9	41.5	41.1	46.4
	Sulfur (S) (%)	0.02	0.02	0.02	0.01	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.04	0.01	0.05	0.09	0.03
	Thallium (Tl) (ppm)	0.15	0.12	0.13	0.25	0.12
	Thorium (Th) (ppm)	3.7	3.8	3.5	3.0	2.0
	Tin (Sn) (ppm)	0.6	0.5	0.6	1.0	0.7
	Titanium (Ti) (%)	0.089	0.085	0.062	0.129	0.077
	Tungsten (W) (ppm)	0.46	0.48	0.14	0.08	0.26
	Uranium (U) (ppm)	0.61	0.75	0.38	0.20	0.20
	Vanadium (V) (ppm)	59	54	56	69	48
	Yttrium (Y) (ppm)	10.35	10.45	9.73	7.67	8.09
	Zinc (Zn) (ppm)	70	57	68	74	65
	Zirconium (Zr) (ppm)	8.6	9.0	5.8	1.5	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	0.6	0.6	0.3	<0.2	0.5

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

15-14

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17039953

Project: L1895095

P.O. No.: ALSM-CW16-102-APN

This report is for 5 Other samples submitted to our lab in Vancouver, BC, Canada on 2-MAR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE
SOFTWARE DEVELOPMENT GROUP
SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1895095

CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41
	Analyte	Recvd Wt.	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al
	Units	kg	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
	LOR	0.02	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01
L1895095-1 133633		0.48	0.6	2	19	20	8.1	32.00	0.02	<0.01	<0.01	0.02	0.16	0.6	0.16	1.49
L1895095-2 133634		1.08	0.6	2	19	20	8.2	32.00	0.02	<0.01	<0.01	0.02	0.16	0.6	0.11	1.37
L1895095-3 133635		1.04	0.6	2	10	11	8.0	17.60	0.02	<0.01	<0.01	0.02	0.07	0.3	0.19	1.25
L1895095-4 133636		1.04	<0.3	2	11	11	8.7	70.40	<0.01	<0.01	<0.01	<0.01	<0.05	<0.2	0.28	1.37
L1895095-5 133637		1.06	0.3	2	19	19	8.6	60.80	0.01	<0.01	<0.01	0.01	0.13	0.5	0.16	1.14

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.2	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
L1895095-1 133633		9.6	<0.2	10	380	0.52	0.12	1.08	0.32	28.6	9.5	30	1.00	95.3	2.69	5.12
L1895095-2 133634		6.8	<0.2	<10	330	0.46	0.08	1.07	0.24	27.2	8.8	28	0.86	48.2	2.43	4.63
L1895095-3 133635		4.7	<0.2	<10	300	0.45	0.08	0.60	0.19	27.5	8.4	17	0.83	406	2.59	4.98
L1895095-4 133636		2.5	<0.2	<10	320	0.25	0.06	0.41	0.14	20.2	6.9	7	0.71	2620	3.13	6.39
L1895095-5 133637		1.0	<0.2	<10	270	0.29	0.03	0.82	0.09	20.9	6.2	5	0.39	651	2.32	5.79

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 29-MAR-2017
Account: APN

Project: L1895095

CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1895095-1 133633		0.11	0.25	0.04	0.030	0.30	14.4	9.4	0.55	541	1.51	0.07	0.32	25.8	800	9.3
L1895095-2 133634		<0.05	0.27	0.03	0.022	0.23	13.9	8.2	0.54	466	1.48	0.07	0.53	22.9	840	6.1
L1895095-3 133635		0.05	0.16	0.02	0.035	0.31	14.6	6.3	0.43	532	1.49	0.05	0.34	14.8	700	6.5
L1895095-4 133636		0.06	0.06	0.01	0.074	0.78	11.5	5.4	0.54	609	1.43	0.08	0.22	3.3	820	3.1
L1895095-5 133637		0.06	0.06	0.01	0.033	0.44	10.9	6.5	0.54	555	0.97	0.09	0.13	2.3	590	3.6

CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1
L1895095-1 133633		17.1	0.001	0.02	0.77	5.2	0.7	0.6	60.8	<0.01	0.04	3.7	0.089	0.15	0.61	59
L1895095-2 133634		13.5	<0.001	0.02	0.56	5.2	0.8	0.5	61.9	<0.01	0.01	3.8	0.085	0.12	0.75	54
L1895095-3 133635		17.3	0.001	0.02	0.32	5.5	0.9	0.6	41.5	<0.01	0.05	3.5	0.062	0.13	0.38	56
L1895095-4 133636		39.2	<0.001	0.01	0.05	6.3	1.3	1.0	41.1	<0.01	0.09	3.0	0.129	0.25	0.20	69
L1895095-5 133637		21.3	<0.001	0.01	0.05	4.1	1.0	0.7	46.4	<0.01	0.03	2.0	0.077	0.12	0.20	48

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 29-MAR-2017
Account: APN

Project: L1895095

CERTIFICATE OF ANALYSIS VA17039953

Sample Description	**Method Analyte Units LOR**	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1895095-1 133633		0.46	10.35	70	8.6
L1895095-2 133634		0.48	10.45	57	9.0
L1895095-3 133635		0.14	9.73	68	5.8
L1895095-4 133636		0.08	7.67	74	1.5
L1895095-5 133637		0.26	8.09	65	1.0

***** See Appendix Page for comments regarding this certificate *****

ALS Minerals
ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 29-MAR-2017
Account: APN

Project: L1895095

CERTIFICATE OF ANALYSIS VA17039953

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-VOL08m
S-GRA06
WEI-21
LOG-22
PUL-31
S-GRA06a
ME-MS41
PUL-QC
S-IR08
OA-ELE07
S-CAL06
SPL-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 29-MAR-2017
Account: APN

QC CERTIFICATE VA17039953

Project: L1895095

P.O. No.: ALSM-CW16-102-APN

This report is for 5 Other samples submitted to our lab in Vancouver, BC, Canada on 2-MAR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.2
							STANDARDS									
Buffer pH6						6.1										
Buffer pH6						6.0										
Target Range - Lower Bound						5.3										
Upper Bound						6.7										
CO-ASSAY											0.46	1.7				
CO-ASSAY											0.50	1.8				
CO-ASSAY											0.48	1.8				
Target Range - Lower Bound											0.42	1.5				
Upper Bound											0.64	2.4				
DS-1								2.60								
Target Range - Lower Bound								2.51								
Upper Bound								2.71								
GS310-10								0.28								
Target Range - Lower Bound								0.25								
Upper Bound								0.29								
KZK-1		25.0	2	31	56		2.24									
KZK-1		25.0	2	30	55		2.20									
Target Range - Lower Bound		22.9	<1	30	54		2.18									
Upper Bound		27.1	>4	38	64		2.53									
MA-2c											1.56	5.7				
Target Range - Lower Bound											1.50	5.5				
Upper Bound											1.84	6.8				
MRGeo08													4.55	2.64	33.6	<0.2
Target Range - Lower Bound													4.00	2.44	29.6	<0.2
Upper Bound													4.92	3.00	36.4	0.4
OGGeo08													20.9	2.20	123.0	<0.2
Target Range - Lower Bound													18.15	2.05	107.0	<0.2
Upper Bound													22.2	2.53	131.0	0.4
OREAS 905													0.52	0.80	32.8	0.4
Target Range - Lower Bound													0.45	0.73	28.4	<0.2
Upper Bound													0.58	0.91	35.0	0.8
OREAS 920													0.10	2.43	4.6	<0.2
Target Range - Lower Bound													0.07	2.18	3.8	<0.2
Upper Bound													0.12	2.68	4.9	0.4
SY-4											0.90	3.3				
Target Range - Lower Bound											0.84	3.0				
Upper Bound											1.08	4.0				
UTS-1									0.83							

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
CO-ASSAY																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		<10	450	0.77	0.68	1.08	2.30	76.3	19.9	90	10.95	627	3.60	9.41	0.19	0.66
Target Range - Lower Bound		<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07	0.64
Upper Bound		20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29	0.83
OGGeo08		10	100	0.71	9.92	0.89	19.30	61.3	96.6	81	9.49	8380	5.07	8.18	0.16	0.77
Target Range - Lower Bound		<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21	0.72
Upper Bound		30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45	0.92
OREAS 905		<10	240	0.88	5.69	0.33	0.35	80.8	14.5	17	1.25	1550	3.41	6.01	0.16	1.15
Target Range - Lower Bound		<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05	1.08
Upper Bound		20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22	1.36
OREAS 920		<10	80	0.70	0.83	0.32	0.06	73.3	15.1	42	1.90	113.5	3.61	6.54	0.09	0.58
Target Range - Lower Bound		<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05	0.53
Upper Bound		20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22	0.69
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
CO-ASSAY																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		0.08	0.159	1.26	38.3	35.2	1.15	410	13.70	0.33	0.84	698	1020	1070	148.0	0.008
Target Range - Lower Bound		0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0	0.006
Upper Bound		0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0	0.010
OGGeo08		0.49	1.435	1.04	30.0	31.9	0.95	386	875	0.28	1.03	8800	810	7150	120.0	1.390
Target Range - Lower Bound		0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5	1.295
Upper Bound		0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5	1.585
OREAS 905		0.02	0.590	0.31	40.9	4.2	0.15	335	2.94	0.09	0.29	8.6	250	16.4	19.6	<0.001
Target Range - Lower Bound		<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3	<0.001
Upper Bound		0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3	0.002
OREAS 920		0.01	0.030	0.41	37.0	22.3	1.08	508	0.36	0.02	0.33	38.2	720	20.7	24.1	<0.001
Target Range - Lower Bound		<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2	<0.001
Upper Bound		0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4	0.002
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
CO-ASSAY																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		0.31	2.85	7.7	1.6	3.3	80.5	0.01	0.02	21.6	0.374	0.83	5.67	101	2.52	20.5
Target Range - Lower Bound		0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44	17.50
Upper Bound		0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42	21.5
OGGeo08		2.79	18.55	6.2	11.0	12.8	64.0	0.01	0.15	16.8	0.305	1.39	4.87	80	3.02	16.95
Target Range - Lower Bound		2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58	15.35
Upper Bound		3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60	18.85
OREAS 905		0.07	0.95	1.7	2.7	1.2	13.5	<0.01	0.08	9.0	0.020	0.12	2.31	5	0.55	7.64
Target Range - Lower Bound		0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44	6.32
Upper Bound		0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76	7.84
OREAS 920		0.03	0.53	2.8	1.2	1.0	17.4	0.01	0.02	16.0	0.123	0.15	2.11	25	0.48	18.20
Target Range - Lower Bound		<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31	16.85
Upper Bound		0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61	20.7
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 29-MAR-2017
Account: APN

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS			
Buffer pH6			
Buffer pH6			
Target Range - Lower Bound			
Upper Bound			
CO-ASSAY			
CO-ASSAY			
CO-ASSAY			
Target Range - Lower Bound			
Upper Bound			
DS-1			
Target Range - Lower Bound			
Upper Bound			
GS310-10			
Target Range - Lower Bound			
Upper Bound			
KZK-1			
KZK-1			
Target Range - Lower Bound			
Upper Bound			
MA-2c			
Target Range - Lower Bound			
Upper Bound			
MRGeo08		770	22.3
Target Range - Lower Bound		708	18.1
Upper Bound		870	25.7
OGGeo08		6980	23.1
Target Range - Lower Bound		6500	19.5
Upper Bound		7950	27.5
OREAS 905		64	45.5
Target Range - Lower Bound		58	39.9
Upper Bound		76	55.1
OREAS 920		104	22.3
Target Range - Lower Bound		93	17.6
Upper Bound		119	25.0
SY-4			
Target Range - Lower Bound			
Upper Bound			
UTS-1			

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.2
STANDARDS															
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.91						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-4								1.68							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.76						
Target Range - Lower Bound									1.61						
Upper Bound									1.87						
BLANKS															
BLANK										<0.05	<0.2				
BLANK										<0.05	<0.2				
BLANK										<0.05	<0.2				
Target Range - Lower Bound										<0.05	<0.2				
Upper Bound										0.10	0.4				
BLANK												<0.01	<0.01	<0.1	<0.2
BLANK												<0.01	<0.01	<0.1	<0.2
Target Range - Lower Bound												<0.01	<0.01	<0.1	<0.2
Upper Bound												0.02	0.02	0.2	0.4
BLANK					6.1										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										
BLANK								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
BLANK									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						
BLANK							0.01								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	<10	<0.05	0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	0.2	<0.01	<0.05	0.05	<0.02
BLANK	<10	<10	<0.05	0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Target Range - Lower Bound	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Upper Bound	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17039953

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	0.2	<0.1	<0.001
BLANK	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Target Range - Lower Bound	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Upper Bound	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2	0.002
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17039953

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
BLANK	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Target Range - Lower Bound	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Upper Bound	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
BLANKS			
BLANK			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK		<2	<0.5
BLANK		<2	<0.5
Target Range - Lower Bound		<2	<0.5
Upper Bound		4	1.0
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 29-MAR-2017
Account: APN

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.2
DUPLICATES															
ORIGINAL												0.04	0.29	9.3	<0.2
DUP												0.04	0.29	9.5	<0.2
Target Range - Lower Bound												0.03	0.27	8.8	<0.2
Upper Bound												0.05	0.31	10.0	0.4
ORIGINAL												2.00	1.86	328	<0.2
DUP												1.99	1.88	332	<0.2
Target Range - Lower Bound												1.89	1.77	313	<0.2
Upper Bound												2.10	1.97	347	0.4
ORIGINAL								0.05	0.12						
DUP								0.07	0.12						
Target Range - Lower Bound								0.05	0.10						
Upper Bound								0.07	0.14						
L1895095-4 133636										<0.05	<0.2				
DUP										<0.05	<0.2				
Target Range - Lower Bound										<0.05	<0.2				
Upper Bound										0.10	0.4				
L1895095-5 133637	0.3	2	19	19		60.80				0.13	0.5				
DUP	0.3	2	18	18		57.60				0.13	0.5				
Target Range - Lower Bound	<0.3	<1	17	17		56.23				0.07	0.3				
Upper Bound	0.6	3	20	20		62.17				0.19	0.7				
ORIGINAL					9.0										
DUP					9.0										
Target Range - Lower Bound					8.5										
Upper Bound					9.6										
ORIGINAL							8.58								
DUP							8.69								
Target Range - Lower Bound							8.41								
Upper Bound							8.86								

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description / Method / Analyte / Units / LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
								DUPLICATES							
ORIGINAL	10	190	0.80	0.16	12.20	0.08	14.50	3.7	39	5.36	5.0	2.27	1.29	0.07	0.07
DUP	10	190	0.85	0.16	12.05	0.09	13.35	3.8	38	5.47	6.0	2.23	1.32	0.07	0.06
Target Range - Lower Bound	<10	170	0.73	0.14	11.50	0.07	13.20	3.5	36	5.09	5.1	2.13	1.19	<0.05	0.04
Upper Bound	20	210	0.92	0.18	12.75	0.10	14.65	4.0	41	5.74	5.9	2.37	1.42	0.10	0.09
ORIGINAL	10	160	1.89	0.05	6.13	4.78	24.8	50.0	38	3.21	25.2	1.17	1.59	0.13	0.09
DUP	<10	170	2.01	0.05	6.28	4.81	25.7	51.4	39	3.30	27.0	1.18	1.64	0.14	0.09
Target Range - Lower Bound	<10	140	1.80	0.04	5.88	4.55	24.0	48.1	36	3.04	25.0	1.11	1.48	0.08	0.07
Upper Bound	20	190	2.10	0.06	6.53	5.04	26.5	53.3	41	3.47	27.2	1.24	1.75	0.19	0.11
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-4 133636															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-5 133637															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001
DUPLICATES															
ORIGINAL	0.01	0.033	0.04	21.7	2.7	0.10	336	0.47	<0.01	0.10	6.6	10	12.2	6.4	<0.001
DUP	0.01	0.033	0.04	21.9	2.8	0.10	330	0.63	<0.01	0.09	8.7	10	14.2	6.6	<0.001
Target Range - Lower Bound	<0.01	0.026	0.03	20.5	2.5	0.09	311	0.47	<0.01	<0.05	7.1	<10	12.3	6.1	<0.001
Upper Bound	0.02	0.040	0.05	23.1	3.0	0.12	355	0.63	0.02	0.10	8.2	20	14.1	6.9	0.002
ORIGINAL	2.74	0.010	0.20	26.8	8.6	0.07	337	5.51	0.03	<0.05	227	>10000	8.9	11.9	0.001
DUP	2.71	0.012	0.20	27.7	9.5	0.07	346	5.67	0.03	<0.05	231	>10000	8.9	12.2	<0.001
Target Range - Lower Bound	2.51	<0.005	0.18	25.7	8.5	0.06	319	5.26	0.02	<0.05	217	9490	8.3	11.3	<0.001
Upper Bound	2.94	0.017	0.22	28.8	9.6	0.08	364	5.92	0.04	0.10	241	>10000	9.5	12.8	0.002
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-4 133636															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-5 133637															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description / Method / Analyte / Units / LOR	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05
DUPLICATES															
ORIGINAL	<0.01	0.48	6.8	1.0	1.1	31.7	<0.01	0.03	4.5	0.011	0.04	0.20	32	0.27	18.75
DUP	<0.01	0.48	6.9	0.9	1.1	31.9	<0.01	0.02	4.5	0.010	0.04	0.20	32	0.26	18.80
Target Range - Lower Bound	<0.01	0.39	6.4	0.7	0.8	30.0	<0.01	<0.01	4.1	<0.005	<0.02	0.14	29	0.20	17.80
Upper Bound	0.02	0.57	7.3	1.2	1.4	33.6	0.02	0.04	4.9	0.016	0.06	0.26	35	0.33	19.75
ORIGINAL	0.10	12.90	2.7	3.2	0.3	187.0	<0.01	0.02	2.4	<0.005	15.00	14.00	18	3.20	91.0
DUP	0.11	13.20	2.7	3.0	0.3	189.5	<0.01	0.02	2.5	<0.005	15.20	14.05	18	3.29	92.1
Target Range - Lower Bound	0.09	12.00	2.5	2.7	<0.2	178.5	<0.01	<0.01	2.1	<0.005	13.95	13.25	16	2.95	86.9
Upper Bound	0.12	14.10	2.9	3.5	0.4	198.0	0.02	0.03	2.8	0.010	16.25	14.80	20	3.54	96.2
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-4 133636															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1895095-5 133637															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17039953

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
DUPLICATES			
ORIGINAL		7	1.6
DUP		8	1.6
Target Range - Lower Bound		5	1.0
Upper Bound		10	2.2
ORIGINAL		478	2.1
DUP		488	2.1
Target Range - Lower Bound		457	1.4
Upper Bound		509	2.8
ORIGINAL			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1895095-4 133636			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1895095-5 133637			
DUP			
Target Range - Lower Bound			
Upper Bound			
ORIGINAL			
DUP			
Target Range - Lower Bound			
Upper Bound			
ORIGINAL			
DUP			
Target Range - Lower Bound			
Upper Bound			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 29-MAR-2017
Account: APN

Project: L1895095

QC CERTIFICATE OF ANALYSIS VA17039953

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	LOG-22	ME-MS41	OA-ELE07
OA-VOL08m	PUL-31	PUL-QC	S-CAL06
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1895095-COFC

COC Number: 15 - 14

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #

Job #:

PO / AFE TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals - Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)								Number of Containers
13 1	1336633	18-Feb-17		WASTE	R	R	R	R	R	R								
14 2	133634	18-Feb-17		WASTE														
15 3	133635	18-Feb-17		WASTE														
16 4	133636	18-Feb-17		WASTE														
17 5	133637	18-Feb-17		WASTE														

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: VD Date: Feb 27/17 Time: 9:30

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 31-MAR-17
Report Date: 24-APR-17 16:34 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1908256

Project P.O. #: 220826
Job Reference:
C of C Numbers: 15-15
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1908256-1	L1908256-2	L1908256-3	L1908256-4	L1908256-5
	Sample ID	L1908256-1	L1908256-2	L1908256-3	L1908256-4	L1908256-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date					
	Sampled Time					
	Client ID	ABA COMP MM 133640	ABA COMP MM 133641	ABA COMP MM 133639	ABA COMP MM 133645	ABA COMP MM 133642
SOIL						
Physical Tests	pH (Unity)	7.9	7.9	8.2	7.5	7.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.19	0.19	0.48	0.21	0.17
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.3	1.3	1.3	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	21	18	42	18	18
	NNP (tCaCO3/1Kt)	21	18	41	17	17
	Ratio (NP/MPA) (Unity)	67.20	57.60	33.60	14.40	28.80
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.01	0.02	0.02	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.01	0.04	0.04	0.02
	Total Sulfur (combustion) (%)	0.01	0.01	0.04	0.04	0.02
Total Metals	Aluminum (Al) (%)	1.14	1.01	0.55	1.15	1.16
	Antimony (Sb) (ppm)	0.48	0.56	0.14	0.59	0.56
	Arsenic (As) (ppm)	5.9	6.4	5.9	7.0	6.3
	Barium (Ba) (ppm)	360	310	880	290	300
	Beryllium (Be) (ppm)	0.43	0.47	0.56	0.48	0.44
	Bismuth (Bi) (ppm)	0.08	0.11	1.04	0.11	0.11
	Boron (B) (ppm)	<10	<10	10	<10	<10
	Cadmium (Cd) (ppm)	0.22	0.23	0.20	0.31	0.25
	Calcium (Ca) (%)	1.05	0.92	1.83	1.02	0.96
	Cerium (Ce) (ppm)	26.2	23.4	6.99	27.0	26.1
	Cesium (Cs) (ppm)	0.88	0.90	0.55	0.91	0.92
	Chromium (Cr) (ppm)	19	21	4	27	27
	Cobalt (Co) (ppm)	9.0	8.8	6.8	9.4	8.9
	Copper (Cu) (ppm)	475	150.5	3150	95.3	87.3
	Gallium (Ga) (ppm)	4.56	4.24	4.66	4.06	4.08
	Germanium (Ge) (ppm)	0.06	0.06	0.05	0.05	0.05
	Gold (Au) (ppm)	<0.02	<0.02	0.29	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.20	0.19	0.07	0.25	0.22
	Indium (In) (ppm)	0.031	0.032	0.068	0.023	0.023
	Iron (Fe) (%)	2.69	2.57	3.60	2.54	2.53
	Lanthanum (La) (ppm)	13.5	12.1	3.9	13.8	13.2
	Lead (Pb) (ppm)	5.3	6.0	6.6	6.7	6.5
	Lithium (Li) (ppm)	7.8	7.7	3.1	8.8	8.5
	Magnesium (Mg) (%)	0.54	0.46	0.14	0.61	0.56
	Manganese (Mn) (ppm)	588	529	654	550	504

Grouping	Analyte					
	Sample ID	L1908256-6	L1908256-7	L1908256-8	L1908256-9	L1908256-10
	Description	Waste	Waste	Waste	Waste	Tails
	Sampled Date					28-MAR-17
	Sampled Time					
	Client ID	ABA COMP MM 133644	ABA COMP MM 133643	ABA COMP MM 133647	ABA COMP MM 133646	TAILS COMP FEB 2017
SOIL						
Physical Tests	pH (Unity)	8.6	8.2	8.5	7.8	8.2
Organic / Inorganic Carbon	Carbon (C) (%)	0.29	0.47	0.19	0.30	0.26
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.6	3.1	1.6	1.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	31	39	20	25	25
	NNP (tCaCO3/1Kt)	31	38	17	23	23
	Ratio (NP/MPA) (Unity)	99.20	62.40	6.40	16.00	13.33
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.02	0.03	0.03	0.02	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.02	0.10	0.05	0.06
	Total Sulfur (combustion) (%)	0.01	0.02	0.10	0.05	0.06
Total Metals	Aluminum (Al) (%)	1.02	1.01	1.37	1.20	1.47
	Antimony (Sb) (ppm)	<0.05	0.69	<0.05	0.58	<0.05
	Arsenic (As) (ppm)	1.2	8.1	0.8	9.3	1.7
	Barium (Ba) (ppm)	220	320	310	330	200
	Beryllium (Be) (ppm)	0.27	0.38	0.25	0.47	0.30
	Bismuth (Bi) (ppm)	0.02	0.09	0.07	0.12	0.20
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.04	0.26	0.15	0.33	0.22
	Calcium (Ca) (%)	1.29	1.85	0.86	1.32	1.24
	Cerium (Ce) (ppm)	26.4	24.7	32.3	30.4	22.6
	Cesium (Cs) (ppm)	0.48	0.82	0.53	0.99	0.57
	Chromium (Cr) (ppm)	4	23	5	27	6
	Cobalt (Co) (ppm)	5.4	7.6	7.1	10.2	6.3
	Copper (Cu) (ppm)	155.5	56.9	2130	450	1420
	Gallium (Ga) (ppm)	5.08	3.31	7.41	4.24	7.61
	Germanium (Ge) (ppm)	0.06	<0.05	0.07	0.05	0.06
	Gold (Au) (ppm)	<0.02	<0.02	0.04	0.02	0.08
	Hafnium (Hf) (ppm)	0.03	0.22	0.03	0.22	0.04
	Indium (In) (ppm)	0.024	0.023	0.082	0.040	0.086
	Iron (Fe) (%)	2.25	2.48	3.26	2.79	3.19
	Lanthanum (La) (ppm)	14.1	12.3	16.9	15.2	11.9
	Lead (Pb) (ppm)	2.7	9.0	3.0	8.3	2.8
	Lithium (Li) (ppm)	5.3	7.2	7.5	8.4	7.6
	Magnesium (Mg) (%)	0.55	0.58	0.79	0.63	0.80
	Manganese (Mn) (ppm)	580	555	589	585	615

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1908256-11	L1908256-12
	Description	Waste	Waste
	Sampled Date	28-MAR-17	28-MAR-17
	Sampled Time		
	Client ID	ABA COMP MM 133649	ABA COMP MM 133650
Grouping	**Analyte**		
SOIL			
Physical Tests	pH (Unity)	7.9	7.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.14	0.22
Acid Base Accounting	FIZZ RATING (Unity)	2	2
	MPA (tCaCO3/1Kt)	0.6	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	16	21
	NNP (tCaCO3/1Kt)	15	20
	Ratio (NP/MPA) (Unity)	25.60	33.60
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.03	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.02
	Total Sulfur (combustion) (%)	0.02	0.02
Total Metals	Aluminum (Al) (%)	1.10	1.14
	Antimony (Sb) (ppm)	0.58	0.59
	Arsenic (As) (ppm)	7.0	6.5
	Barium (Ba) (ppm)	290	270
	Beryllium (Be) (ppm)	0.46	0.48
	Bismuth (Bi) (ppm)	0.11	0.10
	Boron (B) (ppm)	<10	<10
	Cadmium (Cd) (ppm)	0.24	0.25
	Calcium (Ca) (%)	0.91	1.08
	Cerium (Ce) (ppm)	27.7	27.2
	Cesium (Cs) (ppm)	0.82	0.95
	Chromium (Cr) (ppm)	27	26
	Cobalt (Co) (ppm)	9.0	9.0
	Copper (Cu) (ppm)	201	74.5
	Gallium (Ga) (ppm)	4.12	4.24
	Germanium (Ge) (ppm)	0.05	0.05
	Gold (Au) (ppm)	0.05	<0.02
	Hafnium (Hf) (ppm)	0.25	0.26
	Indium (In) (ppm)	0.023	0.023
	Iron (Fe) (%)	2.54	2.47
	Lanthanum (La) (ppm)	14.2	13.9
	Lead (Pb) (ppm)	6.4	7.3
	Lithium (Li) (ppm)	8.6	8.8
	Magnesium (Mg) (%)	0.52	0.60
	Manganese (Mn) (ppm)	504	519

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1908256-1	L1908256-2	L1908256-3	L1908256-4	L1908256-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date					
	Sampled Time					
	Client ID	ABA COMP MM 133640	ABA COMP MM 133641	ABA COMP MM 133639	ABA COMP MM 133645	ABA COMP MM 133642
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02	0.03	0.01	0.05	0.03
	Molybdenum (Mo) (ppm)	1.33	1.22	1.41	1.21	1.38
	Nickel (Ni) (ppm)	16.3	19.4	2.9	24.4	23.9
	Niobium (Nb) (ppm)	0.46	0.35	0.07	0.99	0.68
	Phosphorus (P) (ppm)	1020	760	430	830	870
	Potassium (K) (%)	0.37	0.22	0.24	0.18	0.19
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.001	0.001
	Rubidium (Rb) (ppm)	18.6	12.9	13.6	11.4	11.4
	Scandium (Sc) (ppm)	5.1	5.3	4.5	4.7	4.6
	Selenium (Se) (ppm)	0.5	0.5	1.4	0.8	0.7
	Silver (Ag) (ppm)	0.08	0.10	0.85	0.10	0.10
	Sodium (Na) (%)	0.04	0.03	0.02	0.04	0.04
	Strontium (Sr) (ppm)	46.2	40.8	64.2	51.8	48.2
	Sulfur (S) (%)	0.02	0.02	0.03	0.03	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.03	0.65	0.01	0.03
	Thallium (Tl) (ppm)	0.14	0.12	0.09	0.13	0.12
	Thorium (Th) (ppm)	3.3	3.5	1.3	4.2	4.0
	Tin (Sn) (ppm)	0.6	0.6	0.8	0.5	0.5
	Titanium (Ti) (%)	0.081	0.060	0.032	0.068	0.071
	Tungsten (W) (ppm)	0.56	0.60	0.18	0.45	0.69
	Uranium (U) (ppm)	0.56	0.47	0.25	0.96	0.76
	Vanadium (V) (ppm)	56	53	74	53	52
	Yttrium (Y) (ppm)	11.30	9.87	7.42	9.55	9.28
	Zinc (Zn) (ppm)	69	66	84	70	63
	Zirconium (Zr) (ppm)	6.1	6.1	2.2	8.3	7.7
Permanent Gases	Carbon Dioxide (CO2) (%)	0.7	0.7	1.8	0.8	0.6

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1908256-6 Waste ABA COMP MM 133644	L1908256-7 Waste ABA COMP MM 133643	L1908256-8 Waste ABA COMP MM 133647	L1908256-9 Waste ABA COMP MM 133646	L1908256-10 Tails 28-MAR-17 TAILS COMP FEB 2017
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.03	<0.01	0.03	0.01
	Molybdenum (Mo) (ppm)	0.51	2.81	1.54	2.64	0.94
	Nickel (Ni) (ppm)	2.1	19.9	2.5	25.1	3.0
	Niobium (Nb) (ppm)	0.10	0.22	0.19	0.53	0.23
	Phosphorus (P) (ppm)	620	900	820	970	1060
	Potassium (K) (%)	0.45	0.14	0.68	0.18	0.67
	Rhenium (Re) (ppm)	<0.001	0.001	0.002	0.003	0.001
	Rubidium (Rb) (ppm)	20.5	7.5	32.2	10.6	37.1
	Scandium (Sc) (ppm)	4.0	3.9	4.5	5.2	4.3
	Selenium (Se) (ppm)	0.3	0.5	1.5	1.1	1.2
	Silver (Ag) (ppm)	0.03	0.11	0.54	0.20	0.53
	Sodium (Na) (%)	0.05	0.06	0.05	0.05	0.05
	Strontium (Sr) (ppm)	48.2	72.8	35.1	62.4	103.0
	Sulfur (S) (%)	<0.01	0.02	0.13	0.06	0.06
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.02	0.10	0.03	0.23
	Thallium (Tl) (ppm)	0.13	0.09	0.25	0.12	0.24
	Thorium (Th) (ppm)	3.3	3.7	3.9	4.2	5.3
	Tin (Sn) (ppm)	0.5	0.4	1.2	0.6	1.0
	Titanium (Ti) (%)	0.065	0.068	0.123	0.071	0.117
	Tungsten (W) (ppm)	0.17	0.31	0.12	0.37	0.06
	Uranium (U) (ppm)	0.22	0.64	0.24	0.70	0.37
	Vanadium (V) (ppm)	46	44	66	57	68
	Yttrium (Y) (ppm)	7.70	10.35	6.86	11.40	7.52
	Zinc (Zn) (ppm)	62	53	73	69	97
	Zirconium (Zr) (ppm)	0.7	7.1	0.7	7.8	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	1.1	1.7	0.7	1.1	1.0

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1908256-11	L1908256-12			
	Description	Waste	Waste			
	Sampled Date	28-MAR-17	28-MAR-17			
	Sampled Time					
	Client ID	ABA COMP MM 133649	ABA COMP MM 133650			
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.03	0.04			
	Molybdenum (Mo) (ppm)	1.37	1.20			
	Nickel (Ni) (ppm)	24.8	23.8			
	Niobium (Nb) (ppm)	0.80	0.65			
	Phosphorus (P) (ppm)	820	820			
	Potassium (K) (%)	0.17	0.19			
	Rhenium (Re) (ppm)	0.001	0.001			
	Rubidium (Rb) (ppm)	10.6	11.8			
	Scandium (Sc) (ppm)	4.8	4.8			
	Selenium (Se) (ppm)	0.6	0.7			
	Silver (Ag) (ppm)	0.12	0.10			
	Sodium (Na) (%)	0.04	0.04			
	Strontium (Sr) (ppm)	45.3	49.8			
	Sulfur (S) (%)	0.01	0.01			
	Tantalum (Ta) (ppm)	<0.01	<0.01			
	Tellurium (Te) (ppm)	0.02	0.02			
	Thallium (Tl) (ppm)	0.11	0.13			
	Thorium (Th) (ppm)	4.4	4.3			
	Tin (Sn) (ppm)	0.5	0.5			
	Titanium (Ti) (%)	0.069	0.065			
	Tungsten (W) (ppm)	0.91	0.77			
	Uranium (U) (ppm)	0.77	0.94			
	Vanadium (V) (ppm)	53	51			
	Yttrium (Y) (ppm)	9.69	9.50			
	Zinc (Zn) (ppm)	60	62			
	Zirconium (Zr) (ppm)	7.9	7.7			
Permanent Gases	Carbon Dioxide (CO2) (%)	0.5	0.8			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS
A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.			
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06
Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.			
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06
A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).			
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A
A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).			
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08
The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

15-15

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17065185

Project: L1908256

P.O. No.: ALSM-CW16-102-APN

This report is for 12 Other samples submitted to our lab in Vancouver, BC, Canada on 4-APR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1908256

CERTIFICATE OF ANALYSIS VA17065185

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05
L1908256-1 ABA COMP MM 133640		1.10	0.08	1.14	5.9	<0.02	<10	360	0.43	0.08	1.05	0.22	26.2	9.0	19	0.88
L1908256-2 ABA COMP MM 133641		1.12	0.10	1.01	6.4	<0.02	<10	310	0.47	0.11	0.92	0.23	23.4	8.8	21	0.90
L1908256-3 ABA COMP MM 133639		1.10	0.85	0.55	5.9	0.29	10	880	0.56	1.04	1.83	0.20	6.99	6.8	4	0.55
L1908256-4 ABA COMP MM 133645		1.14	0.10	1.15	7.0	<0.02	<10	290	0.48	0.11	1.02	0.31	27.0	9.4	27	0.91
L1908256-5 ABA COMP MM 133642		1.14	0.10	1.16	6.3	<0.02	<10	300	0.44	0.11	0.96	0.25	26.1	8.9	27	0.92
L1908256-6 ABA COMP MM 133644		1.14	0.03	1.02	1.2	<0.02	<10	220	0.27	0.02	1.29	0.04	26.4	5.4	4	0.48
L1908256-7 ABA COMP MM 133643		1.14	0.11	1.01	8.1	<0.02	<10	320	0.38	0.09	1.85	0.26	24.7	7.6	23	0.82
L1908256-8 ABA COMP MM 133647		1.06	0.54	1.37	0.8	0.04	<10	310	0.25	0.07	0.86	0.15	32.3	7.1	5	0.53
L1908256-9 ABA COMP MM 133646		1.14	0.20	1.20	9.3	0.02	<10	330	0.47	0.12	1.32	0.33	30.4	10.2	27	0.99
L1908256-10 TAILS COMP FEB2017		0.46	0.53	1.47	1.7	0.08	<10	200	0.30	0.20	1.24	0.22	22.6	6.3	6	0.57
L1908256-11 ABA COMP MM 133649		1.12	0.12	1.10	7.0	0.05	<10	290	0.46	0.11	0.91	0.24	27.7	9.0	27	0.82
L1908256-12 ABA COMP MM 133650		1.10	0.10	1.14	6.5	<0.02	<10	270	0.48	0.10	1.08	0.25	27.2	9.0	26	0.95

Project: L1908256

CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05
L1908256-1 ABA COMP MM 133640	475	2.69	4.56	0.06	0.20	0.02	0.031	0.37	13.5	7.8	0.54	588	1.33	0.04	0.46
L1908256-2 ABA COMP MM 133641	150.5	2.57	4.24	0.06	0.19	0.03	0.032	0.22	12.1	7.7	0.46	529	1.22	0.03	0.35
L1908256-3 ABA COMP MM 133639	3150	3.60	4.66	0.05	0.07	0.01	0.068	0.24	3.9	3.1	0.14	654	1.41	0.02	0.07
L1908256-4 ABA COMP MM 133645	95.3	2.54	4.06	0.05	0.25	0.05	0.023	0.18	13.8	8.8	0.61	550	1.21	0.04	0.99
L1908256-5 ABA COMP MM 133642	87.3	2.53	4.08	0.05	0.22	0.03	0.023	0.19	13.2	8.5	0.56	504	1.38	0.04	0.68
L1908256-6 ABA COMP MM 133644	155.5	2.25	5.08	0.06	0.03	<0.01	0.024	0.45	14.1	5.3	0.55	580	0.51	0.05	0.10
L1908256-7 ABA COMP MM 133643	56.9	2.48	3.31	<0.05	0.22	0.03	0.023	0.14	12.3	7.2	0.58	555	2.81	0.06	0.22
L1908256-8 ABA COMP MM 133647	2130	3.26	7.41	0.07	0.03	<0.01	0.082	0.68	16.9	7.5	0.79	589	1.54	0.05	0.19
L1908256-9 ABA COMP MM 133646	450	2.79	4.24	0.05	0.22	0.03	0.040	0.18	15.2	8.4	0.63	585	2.64	0.05	0.53
L1908256-10 TAILS COMP FEB2017	1420	3.19	7.61	0.06	0.04	0.01	0.086	0.67	11.9	7.6	0.80	615	0.94	0.05	0.23
L1908256-11 ABA COMP MM 133649	201	2.54	4.12	0.05	0.25	0.03	0.023	0.17	14.2	8.6	0.52	504	1.37	0.04	0.80
L1908256-12 ABA COMP MM 133650	74.5	2.47	4.24	0.05	0.26	0.04	0.023	0.19	13.9	8.8	0.60	519	1.20	0.04	0.65

Project: L1908256

CERTIFICATE OF ANALYSIS VA17065185

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description LOR	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
L1908256-1 ABA COMP MM 133640	16.3	1020	5.3	18.6	<0.001	0.02	0.48	5.1	0.5	0.6	46.2	<0.01	0.01	3.3	0.081
L1908256-2 ABA COMP MM 133641	19.4	760	6.0	12.9	<0.001	0.02	0.56	5.3	0.5	0.6	40.8	<0.01	0.03	3.5	0.060
L1908256-3 ABA COMP MM 133639	2.9	430	6.6	13.6	<0.001	0.03	0.14	4.5	1.4	0.8	64.2	<0.01	0.65	1.3	0.032
L1908256-4 ABA COMP MM 133645	24.4	830	6.7	11.4	0.001	0.03	0.59	4.7	0.8	0.5	51.8	<0.01	0.01	4.2	0.068
L1908256-5 ABA COMP MM 133642	23.9	870	6.5	11.4	0.001	0.01	0.56	4.6	0.7	0.5	48.2	<0.01	0.03	4.0	0.071
L1908256-6 ABA COMP MM 133644	2.1	620	2.7	20.5	<0.001	<0.01	<0.05	4.0	0.3	0.5	48.2	<0.01	0.01	3.3	0.065
L1908256-7 ABA COMP MM 133643	19.9	900	9.0	7.5	0.001	0.02	0.69	3.9	0.5	0.4	72.8	<0.01	0.02	3.7	0.068
L1908256-8 ABA COMP MM 133647	2.5	820	3.0	32.2	0.002	0.13	<0.05	4.5	1.5	1.2	35.1	<0.01	0.10	3.9	0.123
L1908256-9 ABA COMP MM 133646	25.1	970	8.3	10.6	0.003	0.06	0.58	5.2	1.1	0.6	62.4	<0.01	0.03	4.2	0.071
L1908256-10 TAILS COMP FEB2017	3.0	1060	2.8	37.1	0.001	0.06	<0.05	4.3	1.2	1.0	103.0	<0.01	0.23	5.3	0.117
L1908256-11 ABA COMP MM 133649	24.8	820	6.4	10.6	0.001	0.01	0.58	4.8	0.6	0.5	45.3	<0.01	0.02	4.4	0.069
L1908256-12 ABA COMP MM 133650	23.8	820	7.3	11.8	0.001	0.01	0.59	4.8	0.7	0.5	49.8	<0.01	0.02	4.3	0.065

CERTIFICATE OF ANALYSIS VA17065185

Sample Description	Method Analyte Units LOR	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01
L1908256-1 ABA COMP MM 133640		0.14	0.56	56	0.56	11.30	69	6.1	0.3	2	21	21	7.9	67.20	0.01	<0.01
L1908256-2 ABA COMP MM 133641		0.12	0.47	53	0.60	9.87	66	6.1	0.3	2	18	18	7.9	57.60	0.01	<0.01
L1908256-3 ABA COMP MM 133639		0.09	0.25	74	0.18	7.42	84	2.2	1.3	2	41	42	8.2	33.60	0.04	<0.01
L1908256-4 ABA COMP MM 133645		0.13	0.96	53	0.45	9.55	70	8.3	1.3	2	17	18	7.5	14.40	0.04	<0.01
L1908256-5 ABA COMP MM 133642		0.12	0.76	52	0.69	9.28	63	7.7	0.6	2	17	18	7.8	28.80	0.02	<0.01
L1908256-6 ABA COMP MM 133644		0.13	0.22	46	0.17	7.70	62	0.7	0.3	2	31	31	8.6	99.20	0.01	<0.01
L1908256-7 ABA COMP MM 133643		0.09	0.64	44	0.31	10.35	53	7.1	0.6	2	38	39	8.2	62.40	0.02	<0.01
L1908256-8 ABA COMP MM 133647		0.25	0.24	66	0.12	6.86	73	0.7	3.1	2	17	20	8.5	6.40	0.10	<0.01
L1908256-9 ABA COMP MM 133646		0.12	0.70	57	0.37	11.40	69	7.8	1.6	2	23	25	7.8	16.00	0.05	<0.01
L1908256-10 TAILS COMP FEB2017		0.24	0.37	68	0.06	7.52	97	1.0	1.9	2	23	25	8.2	13.33	0.06	<0.01
L1908256-11 ABA COMP MM 133649		0.11	0.77	53	0.91	9.69	60	7.9	0.6	2	15	16	7.9	25.60	0.02	<0.01
L1908256-12 ABA COMP MM 133650		0.13	0.94	51	0.77	9.50	62	7.7	0.6	2	20	21	7.9	33.60	0.02	<0.01

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 24-APR-2017
Account: APN

Project: L1908256

CERTIFICATE OF ANALYSIS VA17065185

Sample Description / **Method**	S-GRA06a	S-CAL06	C-GAS05	C-GAS05
Analyte	S	S	C	CO2
Units	%	%	%	%
LOR	0.01	0.01	0.05	0.2
L1908256-1 ABA COMP MM 133640	0.01	0.01	0.19	0.7
L1908256-2 ABA COMP MM 133641	0.01	0.01	0.19	0.7
L1908256-3 ABA COMP MM 133639	0.02	0.04	0.48	1.8
L1908256-4 ABA COMP MM 133645	0.02	0.04	0.21	0.8
L1908256-5 ABA COMP MM 133642	0.02	0.02	0.17	0.6
L1908256-6 ABA COMP MM 133644	0.02	0.01	0.29	1.1
L1908256-7 ABA COMP MM 133643	0.03	0.02	0.47	1.7
L1908256-8 ABA COMP MM 133647	0.03	0.10	0.19	0.7
L1908256-9 ABA COMP MM 133646	0.02	0.05	0.30	1.1
L1908256-10 TAILS COMP FEB2017	0.02	0.06	0.26	1.0
L1908256-11 ABA COMP MM 133649	0.03	0.02	0.14	0.5
L1908256-12 ABA COMP MM 133650	0.02	0.02	0.22	0.8

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1908256

CERTIFICATE OF ANALYSIS VA17065185

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-VOL08m
S-GRA06
WEI-21
LOG-22
PUL-31
S-GRA06a
ME-MS41
PUL-QC
S-IR08
OA-ELE07
S-CAL06
SPL-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

QC CERTIFICATE VA17065185

Project: L1908256

P.O. No.: ALSM-CW16-102-APN

This report is for 12 Other samples submitted to our lab in Vancouver, BC, Canada on 4-APR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method Analyte Units LOR	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	4.39	2.57	32.0	<0.02	<10	430	0.78	0.67	1.07	2.10	70.0	17.6	90	10.35	601
MRGeo08	4.20	2.74	33.8	<0.02	<10	470	0.74	0.71	1.16	2.28	78.6	19.0	97	11.60	624
Target Range - Lower Bound	4.00	2.44	29.6	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587
Upper Bound	4.92	3.00	36.4	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675
NBM-1															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	0.50	0.84	34.9	0.40	<10	260	0.86	6.32	0.37	0.37	83.8	14.5	19	1.30	1620
Target Range - Lower Bound	0.45	0.73	28.4	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450
Upper Bound	0.58	0.91	35.0	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-2															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	3.52	9.13	0.13	0.75	0.06	0.145	1.23	34.8	31.1	1.12	405	13.60	0.33	0.69	683
MRGeo08	3.88	9.92	0.15	0.74	0.06	0.154	1.33	40.8	32.0	1.25	438	14.55	0.35	1.01	751
Target Range - Lower Bound	3.22	8.73	0.07	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622
Upper Bound	3.96	10.80	0.29	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760
NBM-1															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	3.79	6.20	0.10	1.20	0.01	0.608	0.33	43.5	4.3	0.17	371	2.96	0.10	0.32	9.0
Target Range - Lower Bound	3.14	5.74	<0.05	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8
Upper Bound	3.86	7.12	0.22	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-2															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method Analyte Units LOR	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	1000	1015	136.0	0.008	0.28	2.80	6.8	1.3	3.1	77.0	0.01	0.02	21.4	0.358	0.81
MRGeo08	1070	1125	152.0	0.007	0.33	3.66	7.2	1.3	3.6	82.4	0.02	0.02	23.0	0.394	0.84
Target Range - Lower Bound	900	959	132.0	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64
Upper Bound	1130	1175	162.0	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92
NBM-1															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	260	17.6	19.2	<0.001	0.08	1.24	1.6	2.5	1.4	13.4	<0.01	0.07	9.1	0.021	0.11
Target Range - Lower Bound		15.2	17.3	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06
Upper Bound		19.0	21.3	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-2															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 24-APR-2017
Account: APN

Project: L1908256

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description	Method Analyte Units LOR	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01
STANDARDS																
Buffer pH6												6.0				
Buffer pH6												6.1				
Target Range - Lower Bound												5.3				
Upper Bound												6.7				
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
GS313-8														1.26		
Target Range - Lower Bound														1.19		
Upper Bound														1.29		
KZK-1								25.0	2	32	57		2.28			
Target Range - Lower Bound								22.9	<1	30	54		2.18			
Upper Bound								27.1	>4	38	64		2.53			
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		5.73	100	2.80	18.70	756	21.3									
MRGeo08		6.05	107	3.08	20.4	824	20.5									
Target Range - Lower Bound		4.93	90	2.44	17.50	708	18.1									
Upper Bound		6.13	112	3.42	21.5	870	25.7									
NBM-1								9.3	2	41	50		5.37			
Target Range - Lower Bound								8.4	<1	33	42		4.64			
Upper Bound								10.3	>4	42	51		5.37			
OREAS 905		2.41	6	0.67	7.39	69	43.0									
Target Range - Lower Bound		2.08	4	0.44	6.32	58	39.9									
Upper Bound		2.66	8	0.76	7.84	76	55.1									
UTS-1															0.88	
Target Range - Lower Bound															0.83	
Upper Bound															0.93	
UTS-1																0.89
UTS-1																0.90
Target Range - Lower Bound																0.81
Upper Bound																0.95
UTS-2														3.27		
Target Range - Lower Bound														3.11		
Upper Bound														3.35		
UTS-4															1.70	

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 24-APR-2017
Account: APN

Project: L1908256

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description	Method Analyte Units LOR	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
STANDARDS			
Buffer pH6			
Buffer pH6			
Target Range - Lower Bound			
Upper Bound			
CO-ASSAY		0.53	1.9
Target Range - Lower Bound		0.42	1.5
Upper Bound		0.64	2.4
GS313-8			
Target Range - Lower Bound			
Upper Bound			
KZK-1			
Target Range - Lower Bound			
Upper Bound			
MA-2c		1.61	5.9
Target Range - Lower Bound		1.50	5.5
Upper Bound		1.84	6.8
MRGeo08			
MRGeo08			
Target Range - Lower Bound			
Upper Bound			
NBM-1			
Target Range - Lower Bound			
Upper Bound			
OREAS 905			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-2			
Target Range - Lower Bound			
Upper Bound			
UTS-4			

QC CERTIFICATE OF ANALYSIS   VA17065185

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
Sample Description															
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	0.01	<0.01	0.2	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
BLANK	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	0.2
Target Range - Lower Bound	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound	0.02	0.02	0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description																
	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
BLANK		<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound		<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound		0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / **Method** / **Analyte** / **Units** / **LOR**	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
BLANK	<10	0.2	<0.1	<0.001	0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound	<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound	20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17065185

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a
	Analyte	U	V	W	Y	Zn	Zr	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S
	Units	ppm	ppm	ppm	ppm	ppm	ppm	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
Sample Description	**LOR**	0.05	1	0.05	0.05	2	0.5	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01
								STANDARDS								
Target Range - Lower Bound															1.64	
Upper Bound															1.84	
UTS-4																1.77
UTS-4																1.77
Target Range - Lower Bound																1.61
Upper Bound																1.87
								BLANKS								
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.05	<1	<0.05	<0.05	<2	<0.5									
BLANK		<0.05	<1	<0.05	<0.05	<2	<0.5									
Target Range - Lower Bound		<0.05	<1	<0.05	<0.05	<2	<0.5									
Upper Bound		0.10	2	0.10	0.10	4	1.0									
BLANK												6.0				
Target Range - Lower Bound												5.5				
Upper Bound												6.9				
BLANK															<0.01	
Target Range - Lower Bound															<0.01	
Upper Bound															0.02	
BLANK																<0.01
BLANK																<0.01
Target Range - Lower Bound																<0.01
Upper Bound																0.02
BLANK														<0.01		
Target Range - Lower Bound														<0.01		
Upper Bound														0.02		

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1908256

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description	Method Analyte Units LOR	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
STANDARDS			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
BLANKS			
BLANK		<0.05	<0.2
Target Range - Lower Bound		<0.05	<0.2
Upper Bound		0.10	0.4
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
DUPLICATES															
ORIGINAL	0.18	1.99	0.6	<0.02	<10	40	0.17	0.01	1.42	0.03	7.19	16.0	16	0.08	88.9
DUP	0.16	2.06	0.6	<0.02	<10	40	0.15	0.01	1.47	0.03	7.09	15.3	17	0.09	88.1
Target Range - Lower Bound	0.15	1.91	0.5	<0.02	<10	30	0.10	<0.01	1.36	0.02	6.76	14.8	15	<0.05	85.2
Upper Bound	0.19	2.14	0.7	0.04	20	50	0.22	0.02	1.53	0.04	7.52	16.5	18	0.10	91.8
L1908256-3 ABA COMP MM 133639	0.85	0.55	5.9	0.29	10	880	0.56	1.04	1.83	0.20	6.99	6.8	4	0.55	3150
DUP	0.82	0.52	5.4	0.14	10	830	0.55	1.02	1.74	0.20	6.85	6.6	4	0.53	3010
Target Range - Lower Bound	0.78	0.50	5.3	0.18	<10	780	0.48	0.97	1.69	0.18	6.55	6.3	3	0.46	2970
Upper Bound	0.89	0.57	6.0	0.25	20	930	0.63	1.09	1.88	0.22	7.29	7.1	5	0.62	3190
L1908256-7 ABA COMP MM 133643															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-8 ABA COMP MM 133647															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-10 TAILS COMP FEB2017															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-12 ABA COMP MM 133650															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
DUPLICATES															
ORIGINAL	2.92	5.75	<0.05	0.10	<0.01	0.006	0.07	3.0	12.4	1.62	799	0.93	0.05	0.08	12.5
DUP	2.99	5.54	<0.05	0.10	<0.01	0.007	0.08	3.0	11.2	1.64	811	1.01	0.05	0.09	12.4
Target Range - Lower Bound	2.80	5.31	<0.05	0.08	<0.01	<0.005	0.06	2.7	11.1	1.54	760	0.87	0.04	<0.05	11.6
Upper Bound	3.11	5.98	0.10	0.13	0.02	0.010	0.09	3.4	12.5	1.72	850	1.07	0.06	0.10	13.3
L1908256-3 ABA COMP MM 133639	3.60	4.66	0.05	0.07	0.01	0.068	0.24	3.9	3.1	0.14	654	1.41	0.02	0.07	2.9
DUP	3.44	4.57	0.05	0.07	0.01	0.069	0.23	3.8	3.0	0.14	623	1.33	0.02	0.07	2.9
Target Range - Lower Bound	3.33	4.33	<0.05	0.05	<0.01	0.060	0.21	3.5	2.8	0.12	602	1.25	<0.01	<0.05	2.6
Upper Bound	3.71	4.90	0.10	0.09	0.02	0.077	0.26	4.2	3.3	0.16	675	1.49	0.03	0.10	3.2
L1908256-7 ABA COMP MM 133643															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-8 ABA COMP MM 133647															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-10 TAILS COMP FEB2017															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-12 ABA COMP MM 133650															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17065185

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
DUPLICATES															
ORIGINAL	570	1.0	1.5	<0.001	0.03	0.24	3.0	0.2	0.3	49.4	<0.01	<0.01	1.7	0.181	<0.02
DUP	570	1.6	1.6	<0.001	0.03	0.25	3.0	0.3	0.3	51.8	<0.01	<0.01	1.4	0.193	<0.02
Target Range - Lower Bound	530	1.0	1.4	<0.001	0.02	0.18	2.8	<0.2	<0.2	47.9	<0.01	<0.01	1.3	0.173	<0.02
Upper Bound	610	1.6	1.7	0.002	0.04	0.31	3.3	0.4	0.4	53.3	0.02	0.02	1.8	0.201	0.04
L1908256-3 ABA COMP MM 133639	430	6.6	13.6	<0.001	0.03	0.14	4.5	1.4	0.8	64.2	<0.01	0.65	1.3	0.032	0.09
DUP	420	6.5	13.3	<0.001	0.03	0.12	4.3	1.4	0.8	63.6	<0.01	0.65	1.2	0.030	0.08
Target Range - Lower Bound	390	6.0	12.7	<0.001	0.02	0.07	4.1	1.1	0.6	60.5	<0.01	0.61	1.0	0.024	0.06
Upper Bound	460	7.1	14.2	0.002	0.04	0.19	4.7	1.7	1.0	67.3	0.02	0.69	1.5	0.038	0.11
L1908256-7 ABA COMP MM 133643															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-8 ABA COMP MM 133647															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-10 TAILS COMP FEB2017															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1908256-12 ABA COMP MM 133650															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a
Analyte	U	V	W	Y	Zn	Zr	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S
Units	ppm	ppm	ppm	ppm	ppm	ppm	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
LOR	0.05	1	0.05	0.05	2	0.5	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01
DUPLICATES															
ORIGINAL	0.60	51	0.21	6.10	89	1.0									
DUP	0.55	53	0.21	6.20	90	1.4									
Target Range - Lower Bound	0.50	48	0.14	5.79	83	0.6									
Upper Bound	0.65	56	0.28	6.51	96	1.8									
L1908256-3 ABA COMP MM 133639	0.25	74	0.18	7.42	84	2.2									
DUP	0.24	71	0.16	7.18	78	2.1									
Target Range - Lower Bound	0.18	68	0.11	6.89	75	1.5									
Upper Bound	0.31	77	0.23	7.72	87	2.8									
L1908256-7 ABA COMP MM 133643															0.03
DUP															0.03
Target Range - Lower Bound															0.02
Upper Bound															0.04
L1908256-8 ABA COMP MM 133647													0.10		
DUP													0.11		
Target Range - Lower Bound													0.09		
Upper Bound													0.12		
L1908256-10 TAILS COMP FEB2017							1.9	2	23	25	8.2	13.33		<0.01	
DUP							1.9	2	23	25	8.2	13.33		<0.01	
Target Range - Lower Bound							1.5	<1	21	23	7.7	12.65		<0.01	
Upper Bound							2.3	3	25	27	8.7	14.01		0.02	
L1908256-12 ABA COMP MM 133650															0.02
DUP															0.02
Target Range - Lower Bound															<0.01
Upper Bound															0.03

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1908256

QC CERTIFICATE OF ANALYSIS VA17065185

Sample Description	**Method** **Analyte** **Units** **LOR**	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
DUPLICATES			
ORIGINAL			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1908256-3 ABA COMP MM 133639			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1908256-7 ABA COMP MM 133643			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1908256-8 ABA COMP MM 133647			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1908256-10 TAILS COMP FEB2017		0.26	1.0
DUP		0.26	0.9
Target Range - Lower Bound		0.20	0.7
Upper Bound		0.32	1.2
L1908256-12 ABA COMP MM 133650			
DUP			
Target Range - Lower Bound			
Upper Bound			

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17065185

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1908256-COFC

COC Number: 15 - 15

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd
Contact:	Ruth Cayetano

Report Format / D

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

.. all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh.mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #

Job #:

PO / AFE: TBD

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F) Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	ABA COMP. mm 133640			WASTE Composite	R	R	R	R	R	R	
	ABA Comp mm 133641			WASTE							
	ABA COMP. mm 133639			WASTE							
	ABA Comp. mm 133645			WASTE							
	ABA Comp. mm 133642			WASTE							
	ABA Comp. mm 133644			WASTE							
	ABA Comp. mm 133643			WASTE							
	ABA Comp mm 1333647			WASTE							
	ABA Comp mm 1333646			WASTE							
	TAILS COMP. FEB 2017	MARCH 28/17		WASTE TAILS							
	ABA COMP - mm 133649	MARCH 28/17		WASTE							
	ABA COMP. mm 133650	MARCH 28/17		WASTE							

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: 9.0°

FINAL COOLER TEMPERATURES °C: 5

SHIPMENT RELEASE (client use)

Released by: JOEY M Date: MARCH 29/17 Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF Date: 31 March 2017 Time: 16:18

FINAL SHIPMENT RECEPTION (lab use only)

Received by: JK Date: 04/04/2017 Time: 14:35

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	18-APR-17
Report Date:	09-MAY-17 17:20 (MT)
Version:	FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #:	L1914704
Project P.O. #:	220826
Job Reference:	
C of C Numbers:	15-16
Legal Site Desc:	

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1914704-1	L1914704-2	L1914704-3	L1914704-4	L1914704-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	28-MAR-17	01-APR-17	13-APR-17	13-APR-17	13-APR-17
	Sampled Time					
	Client ID	132276	133648	132277	132279	132280
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.1	8.3	8.1	8.5	8.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.24	0.14	0.07	0.52	0.27
Acid Base Accounting	FIZZ RATING (Unity)	1	1	1	2	1
	MPA (tCaCO3/1Kt)	0.9	0.6	0.6	0.3	1.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	23	16	10	49	23
	NNP (tCaCO3/1Kt)	22	15	9	49	21
	Ratio (NP/MPA) (Unity)	24.53	25.60	16.00	156.80	14.72
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.02	0.02	0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	0.02	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	<0.01	<0.01	<0.01	0.04
	Total Sulfur (combustion) (%)	0.03	0.02	0.02	0.01	0.05
Total Metals	Aluminum (Al) (%)	1.20	1.04	0.97	0.77	1.30
	Antimony (Sb) (ppm)	0.29	0.25	0.40	<0.05	0.66
	Arsenic (As) (ppm)	3.2	5.0	6.4	1.3	6.6
	Barium (Ba) (ppm)	240	300	260	140	310
	Beryllium (Be) (ppm)	0.44	0.43	0.56	0.46	0.57
	Bismuth (Bi) (ppm)	0.06	0.10	0.12	0.08	0.12
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.14	0.16	0.19	0.06	0.22
	Calcium (Ca) (%)	1.14	0.80	0.58	2.14	1.20
	Cerium (Ce) (ppm)	34.2	25.0	23.5	28.1	29.5
	Cesium (Cs) (ppm)	0.80	0.67	0.76	0.69	0.93
	Chromium (Cr) (ppm)	13	12	16	5	28
	Cobalt (Co) (ppm)	8.8	7.9	8.3	6.7	10.4
	Copper (Cu) (ppm)	334	1310	747	352	317
	Gallium (Ga) (ppm)	5.78	5.24	5.32	4.16	4.85
	Germanium (Ge) (ppm)	0.06	0.06	0.05	0.05	0.06
	Gold (Au) (ppm)	0.04	0.02	0.07	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.12	0.10	0.15	0.05	0.21
	Indium (In) (ppm)	0.035	0.038	0.043	0.040	0.031
	Iron (Fe) (%)	2.78	2.43	2.55	2.51	2.57
	Lanthanum (La) (ppm)	17.4	12.5	12.1	14.6	14.8
	Lead (Pb) (ppm)	5.2	3.3	5.3	3.3	6.7
	Lithium (Li) (ppm)	7.3	6.8	6.1	2.7	8.4
	Magnesium (Mg) (%)	0.60	0.46	0.35	0.25	0.62
	Manganese (Mn) (ppm)	587	554	497	683	526

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914704-6	L1914704-7	L1914704-8	L1914704-9	L1914704-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	13-APR-17	13-APR-17	13-APR-17	13-APR-17	13-APR-17
	Sampled Time					
	Client ID	132283	132284	132286	132288	132289
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	7.9	8.0	8.6	8.4
Organic / Inorganic Carbon	Carbon (C) (%)	0.11	0.15	0.28	0.19	0.69
Acid Base Accounting	FIZZ RATING (Unity)	1	1	1	1	2
	MPA (tCaCO3/1Kt)	0.6	0.9	1.3	0.9	10.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	12	18	26	20	55
	NNP (tCaCO3/1Kt)	11	17	25	19	44
	Ratio (NP/MPA) (Unity)	19.20	19.20	20.80	21.33	5.03
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	0.01	0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.02	0.03	0.02	0.34
	Total Sulfur (combustion) (%)	0.02	0.03	0.04	0.03	0.35
Total Metals	Aluminum (Al) (%)	0.83	1.53	1.48	1.12	1.19
	Antimony (Sb) (ppm)	0.22	0.79	0.81	<0.05	<0.05
	Arsenic (As) (ppm)	5.3	7.7	8.0	1.0	1.0
	Barium (Ba) (ppm)	340	340	340	280	290
	Beryllium (Be) (ppm)	0.43	0.62	0.68	0.26	0.37
	Bismuth (Bi) (ppm)	0.05	0.13	0.26	0.03	0.13
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.11	0.28	0.32	0.10	0.42
	Calcium (Ca) (%)	0.62	1.04	1.32	0.87	2.39
	Cerium (Ce) (ppm)	15.95	32.1	33.0	43.1	23.3
	Cesium (Cs) (ppm)	0.61	1.25	1.28	0.37	0.32
	Chromium (Cr) (ppm)	10	36	33	7	5
	Cobalt (Co) (ppm)	6.2	11.7	12.3	7.2	8.4
	Copper (Cu) (ppm)	183.0	62.1	686	1300	3740
	Gallium (Ga) (ppm)	5.34	5.12	5.28	6.02	7.47
	Germanium (Ge) (ppm)	0.05	0.05	0.06	0.07	0.05
	Gold (Au) (ppm)	<0.02	<0.02	<0.02	0.09	0.04
	Hafnium (Hf) (ppm)	0.10	0.27	0.27	0.03	0.03
	Indium (In) (ppm)	0.043	0.028	0.037	0.048	0.075
	Iron (Fe) (%)	2.34	2.83	2.91	2.74	3.24
	Lanthanum (La) (ppm)	7.7	16.2	16.2	22.0	12.7
	Lead (Pb) (ppm)	4.2	7.6	7.8	3.2	4.0
	Lithium (Li) (ppm)	4.7	10.3	10.6	5.6	7.2
	Magnesium (Mg) (%)	0.25	0.70	0.76	0.55	0.65
	Manganese (Mn) (ppm)	389	532	573	628	1120

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914704-11				
	Description	WASTE				
	Sampled Date	13-APR-17				
	Sampled Time					
	Client ID	132290				
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	7.9				
Organic / Inorganic Carbon	Carbon (C) (%)	0.16				
Acid Base Accounting	FIZZ RATING (Unity)	1				
	MPA (tCaCO3/1Kt)	1.3				
	Neutralization Potential (NP) (tCaCO3/1Kt)	14				
	NNP (tCaCO3/1Kt)	13				
	Ratio (NP/MPA) (Unity)	11.20				
	Sulfate Sulfur (carbonate leach) (%)	0.01				
	Sulfate Sulfur (HCl leach) (%)	<0.01				
	Sulfide Sulfur (T minus carbonate leach) (%)	0.03				
	Total Sulfur (combustion) (%)	0.04				
Total Metals	Aluminum (Al) (%)	1.20				
	Antimony (Sb) (ppm)	0.56				
	Arsenic (As) (ppm)	6.2				
	Barium (Ba) (ppm)	310				
	Beryllium (Be) (ppm)	0.48				
	Bismuth (Bi) (ppm)	0.10				
	Boron (B) (ppm)	<10				
	Cadmium (Cd) (ppm)	0.22				
	Calcium (Ca) (%)	0.88				
	Cerium (Ce) (ppm)	27.5				
	Cesium (Cs) (ppm)	0.80				
	Chromium (Cr) (ppm)	26				
	Cobalt (Co) (ppm)	9.8				
	Copper (Cu) (ppm)	101.5				
	Gallium (Ga) (ppm)	4.53				
	Germanium (Ge) (ppm)	0.05				
	Gold (Au) (ppm)	<0.02				
	Hafnium (Hf) (ppm)	0.23				
	Indium (In) (ppm)	0.023				
	Iron (Fe) (%)	2.42				
	Lanthanum (La) (ppm)	14.2				
	Lead (Pb) (ppm)	5.8				
	Lithium (Li) (ppm)	8.6				
	Magnesium (Mg) (%)	0.58				
	Manganese (Mn) (ppm)	521				

	Sample ID	L1914704-1	L1914704-2	L1914704-3	L1914704-4	L1914704-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	28-MAR-17	01-APR-17	13-APR-17	13-APR-17	13-APR-17
	Sampled Time					
	Client ID	132276	133648	132277	132279	132280
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	0.01	<0.01	0.02
	Molybdenum (Mo) (ppm)	1.13	1.40	1.31	1.65	1.68
	Nickel (Ni) (ppm)	10.9	8.7	13.2	2.1	24.3
	Niobium (Nb) (ppm)	0.25	0.36	0.53	0.07	0.78
	Phosphorus (P) (ppm)	860	800	700	750	820
	Potassium (K) (%)	0.27	0.39	0.27	0.27	0.21
	Rhenium (Re) (ppm)	0.001	<0.001	<0.001	<0.001	0.002
	Rubidium (Rb) (ppm)	14.6	19.6	14.0	14.0	12.8
	Scandium (Sc) (ppm)	5.7	5.5	6.7	7.0	5.8
	Selenium (Se) (ppm)	0.6	0.8	0.7	0.7	1.0
	Silver (Ag) (ppm)	0.11	0.21	0.17	0.10	0.15
	Sodium (Na) (%)	0.04	0.05	0.04	0.04	0.04
	Strontium (Sr) (ppm)	62.1	41.1	40.7	57.2	67.5
	Sulfur (S) (%)	0.02	0.01	0.01	<0.01	0.04
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.05	0.04	0.03	0.03
	Thallium (Tl) (ppm)	0.10	0.13	0.11	0.08	0.12
	Thorium (Th) (ppm)	4.5	3.0	3.2	3.7	3.9
	Tin (Sn) (ppm)	0.6	0.6	0.6	0.6	0.5
	Titanium (Ti) (%)	0.057	0.065	0.051	0.029	0.068
	Tungsten (W) (ppm)	0.97	0.53	0.88	0.28	0.80
	Uranium (U) (ppm)	0.44	0.31	0.45	0.30	0.80
	Vanadium (V) (ppm)	56	53	54	50	54
	Yttrium (Y) (ppm)	9.95	9.67	10.30	11.55	10.75
	Zinc (Zn) (ppm)	76	67	70	66	68
	Zirconium (Zr) (ppm)	4.0	3.1	5.3	1.4	8.3
Permanent Gases	Carbon Dioxide (CO2) (%)	0.9	0.5	0.3	1.9	1.0

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914704-6	L1914704-7	L1914704-8	L1914704-9	L1914704-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	13-APR-17	13-APR-17	13-APR-17	13-APR-17	13-APR-17
	Sampled Time					
	Client ID	132283	132284	132286	132288	132289
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.03	0.04	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.98	1.30	1.51	1.94	32.1
	Nickel (Ni) (ppm)	7.1	31.7	32.8	3.1	2.5
	Niobium (Nb) (ppm)	0.27	0.79	0.68	0.20	0.06
	Phosphorus (P) (ppm)	560	870	910	720	810
	Potassium (K) (%)	0.31	0.22	0.25	0.47	0.25
	Rhenium (Re) (ppm)	<0.001	0.001	0.001	<0.001	0.146
	Rubidium (Rb) (ppm)	15.1	13.8	14.7	22.1	12.9
	Scandium (Sc) (ppm)	6.1	6.3	6.5	7.8	4.9
	Selenium (Se) (ppm)	0.4	0.8	1.1	0.9	3.2
	Silver (Ag) (ppm)	0.08	0.12	0.26	0.24	0.63
	Sodium (Na) (%)	0.04	0.04	0.05	0.07	0.04
	Strontium (Sr) (ppm)	43.5	56.8	65.6	43.3	63.3
	Sulfur (S) (%)	0.01	0.02	0.03	0.02	0.39
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.02	0.06	0.03	0.11
	Thallium (Tl) (ppm)	0.09	0.13	0.14	0.14	0.07
	Thorium (Th) (ppm)	1.9	4.5	4.7	6.3	2.6
	Tin (Sn) (ppm)	0.8	0.5	0.6	0.8	1.1
	Titanium (Ti) (%)	0.040	0.073	0.073	0.071	0.026
	Tungsten (W) (ppm)	0.65	1.30	0.50	0.43	0.55
	Uranium (U) (ppm)	0.20	0.84	1.02	0.25	0.47
	Vanadium (V) (ppm)	48	58	58	56	55
	Yttrium (Y) (ppm)	8.54	11.00	11.80	7.69	7.54
	Zinc (Zn) (ppm)	61	74	79	68	88
	Zirconium (Zr) (ppm)	3.5	10.0	9.9	0.9	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	0.4	0.6	1.0	0.7	2.5

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1914704-11				
	Description	WASTE				
	Sampled Date	13-APR-17				
	Sampled Time					
	Client ID	132290				
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02				
	Molybdenum (Mo) (ppm)	1.20				
	Nickel (Ni) (ppm)	21.7				
	Niobium (Nb) (ppm)	1.04				
	Phosphorus (P) (ppm)	790				
	Potassium (K) (%)	0.20				
	Rhenium (Re) (ppm)	<0.001				
	Rubidium (Rb) (ppm)	12.8				
	Scandium (Sc) (ppm)	5.6				
	Selenium (Se) (ppm)	0.7				
	Silver (Ag) (ppm)	0.10				
	Sodium (Na) (%)	0.05				
	Strontium (Sr) (ppm)	58.4				
	Sulfur (S) (%)	0.02				
	Tantalum (Ta) (ppm)	<0.01				
	Tellurium (Te) (ppm)	0.02				
	Thallium (Tl) (ppm)	0.11				
	Thorium (Th) (ppm)	3.8				
	Tin (Sn) (ppm)	0.5				
	Titanium (Ti) (%)	0.075				
	Tungsten (W) (ppm)	0.80				
	Uranium (U) (ppm)	0.74				
	Vanadium (V) (ppm)	53				
	Yttrium (Y) (ppm)	9.83				
	Zinc (Zn) (ppm)	59				
	Zirconium (Zr) (ppm)	8.7				
Permanent Gases	Carbon Dioxide (CO2) (%)	0.6				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

15-16

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17077364

Project: L1914704

P.O. No.: ALSM-CW16-102-APN

This report is for 11 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 21-APR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1914704

CERTIFICATE OF ANALYSIS VA17077364

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-CAL06 S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01
L1914704-1 132276		1.14	0.9	1	22	23	8.1	24.53	0.03	0.02	<0.01	0.01	0.24	0.9	0.11	1.20
L1914704-2 133648		1.12	0.6	1	15	16	8.3	25.60	0.02	0.02	<0.01	<0.01	0.14	0.5	0.21	1.04
L1914704-3 132277		1.12	0.6	1	9	10	8.1	16.00	0.02	0.02	<0.01	<0.01	0.07	0.3	0.17	0.97
L1914704-4 132279		1.12	0.3	2	49	49	8.5	156.80	0.01	0.01	0.02	<0.01	0.52	1.9	0.10	0.77
L1914704-5 132280		1.14	1.6	1	21	23	8.0	14.72	0.05	0.01	<0.01	0.04	0.27	1.0	0.15	1.30
L1914704-6 132283		1.14	0.6	1	11	12	8.5	19.20	0.02	0.01	<0.01	0.01	0.11	0.4	0.08	0.83
L1914704-7 132284		1.12	0.9	1	17	18	7.9	19.20	0.03	0.01	<0.01	0.02	0.15	0.6	0.12	1.53
L1914704-8 132286		1.12	1.3	1	25	26	8.0	20.80	0.04	0.01	<0.01	0.03	0.28	1.0	0.26	1.48
L1914704-9 132288		0.98	0.9	1	19	20	8.6	21.33	0.03	0.01	<0.01	0.02	0.19	0.7	0.24	1.12
L1914704-10 132289		1.06	10.9	2	44	55	8.4	5.03	0.35	0.01	<0.01	0.34	0.69	2.5	0.63	1.19
L1914704-11 132290		1.12	1.3	1	13	14	7.9	11.20	0.04	0.01	<0.01	0.03	0.16	0.6	0.10	1.20

***** See Appendix Page for comments regarding this certificate *****

Project: L1914704

CERTIFICATE OF ANALYSIS VA17077364

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description / **LOR**	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05
L1914704-1 132276	3.2	0.04	<10	240	0.44	0.06	1.14	0.14	34.2	8.8	13	0.80	334	2.78	5.78
L1914704-2 133648	5.0	0.02	<10	300	0.43	0.10	0.80	0.16	25.0	7.9	12	0.67	1310	2.43	5.24
L1914704-3 132277	6.4	0.07	<10	260	0.56	0.12	0.58	0.19	23.5	8.3	16	0.76	747	2.55	5.32
L1914704-4 132279	1.3	<0.02	<10	140	0.46	0.08	2.14	0.06	28.1	6.7	5	0.69	352	2.51	4.16
L1914704-5 132280	6.6	<0.02	<10	310	0.57	0.12	1.20	0.22	29.5	10.4	28	0.93	317	2.57	4.85
L1914704-6 132283	5.3	<0.02	<10	340	0.43	0.05	0.62	0.11	15.95	6.2	10	0.61	183.0	2.34	5.34
L1914704-7 132284	7.7	<0.02	<10	340	0.62	0.13	1.04	0.28	32.1	11.7	36	1.25	62.1	2.83	5.12
L1914704-8 132286	8.0	<0.02	<10	340	0.68	0.26	1.32	0.32	33.0	12.3	33	1.28	686	2.91	5.28
L1914704-9 132288	1.0	0.09	<10	280	0.26	0.03	0.87	0.10	43.1	7.2	7	0.37	1300	2.74	6.02
L1914704-10 132289	1.0	0.04	<10	290	0.37	0.13	2.39	0.42	23.3	8.4	5	0.32	3740	3.24	7.47
L1914704-11 132290	6.2	<0.02	<10	310	0.48	0.10	0.88	0.22	27.5	9.8	26	0.80	101.5	2.42	4.53

CERTIFICATE OF ANALYSIS VA17077364

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1914704-1 132276	0.06	0.12	<0.01	0.035	0.27	17.4	7.3	0.60	587	1.13	0.04	0.25	10.9	860	5.2
L1914704-2 133648	0.06	0.10	<0.01	0.038	0.39	12.5	6.8	0.46	554	1.40	0.05	0.36	8.7	800	3.3
L1914704-3 132277	0.05	0.15	0.01	0.043	0.27	12.1	6.1	0.35	497	1.31	0.04	0.53	13.2	700	5.3
L1914704-4 132279	0.05	0.05	<0.01	0.040	0.27	14.6	2.7	0.25	683	1.65	0.04	0.07	2.1	750	3.3
L1914704-5 132280	0.06	0.21	0.02	0.031	0.21	14.8	8.4	0.62	526	1.68	0.04	0.78	24.3	820	6.7
L1914704-6 132283	0.05	0.10	<0.01	0.043	0.31	7.7	4.7	0.25	389	0.98	0.04	0.27	7.1	560	4.2
L1914704-7 132284	0.05	0.27	0.03	0.028	0.22	16.2	10.3	0.70	532	1.30	0.04	0.79	31.7	870	7.6
L1914704-8 132286	0.06	0.27	0.04	0.037	0.25	16.2	10.6	0.76	573	1.51	0.05	0.68	32.8	910	7.8
L1914704-9 132288	0.07	0.03	<0.01	0.048	0.47	22.0	5.6	0.55	628	1.94	0.07	0.20	3.1	720	3.2
L1914704-10 132289	0.05	0.03	<0.01	0.075	0.25	12.7	7.2	0.65	1120	32.1	0.04	0.06	2.5	810	4.0
L1914704-11 132290	0.05	0.23	0.02	0.023	0.20	14.2	8.6	0.58	521	1.20	0.05	1.04	21.7	790	5.8

CERTIFICATE OF ANALYSIS VA17077364

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Sample Description LOR	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
L1914704-1 132276	14.6	0.001	0.02	0.29	5.7	0.6	0.6	62.1	<0.01	0.02	4.5	0.057	0.10	0.44	56
L1914704-2 133648	19.6	<0.001	0.01	0.25	5.5	0.8	0.6	41.1	<0.01	0.05	3.0	0.065	0.13	0.31	53
L1914704-3 132277	14.0	<0.001	0.01	0.40	6.7	0.7	0.6	40.7	<0.01	0.04	3.2	0.051	0.11	0.45	54
L1914704-4 132279	14.0	<0.001	<0.01	<0.05	7.0	0.7	0.6	57.2	<0.01	0.03	3.7	0.029	0.08	0.30	50
L1914704-5 132280	12.8	0.002	0.04	0.66	5.8	1.0	0.5	67.5	<0.01	0.03	3.9	0.068	0.12	0.80	54
L1914704-6 132283	15.1	<0.001	0.01	0.22	6.1	0.4	0.8	43.5	<0.01	0.02	1.9	0.040	0.09	0.20	48
L1914704-7 132284	13.8	0.001	0.02	0.79	6.3	0.8	0.5	56.8	<0.01	0.02	4.5	0.073	0.13	0.84	58
L1914704-8 132286	14.7	0.001	0.03	0.81	6.5	1.1	0.6	65.6	<0.01	0.06	4.7	0.073	0.14	1.02	58
L1914704-9 132288	22.1	<0.001	0.02	<0.05	7.8	0.9	0.8	43.3	<0.01	0.03	6.3	0.071	0.14	0.25	56
L1914704-10 132289	12.9	0.146	0.39	<0.05	4.9	3.2	1.1	63.3	<0.01	0.11	2.6	0.026	0.07	0.47	55
L1914704-11 132290	12.8	<0.001	0.02	0.56	5.6	0.7	0.5	58.4	<0.01	0.02	3.8	0.075	0.11	0.74	53

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1914704

CERTIFICATE OF ANALYSIS VA17077364

Sample Description / **Method** / **Analyte** / **Units** / **LOR**	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1914704-1 132276	0.97	9.95	76	4.0
L1914704-2 133648	0.53	9.67	67	3.1
L1914704-3 132277	0.88	10.30	70	5.3
L1914704-4 132279	0.28	11.55	66	1.4
L1914704-5 132280	0.80	10.75	68	8.3
L1914704-6 132283	0.65	8.54	61	3.5
L1914704-7 132284	1.30	11.00	74	10.0
L1914704-8 132286	0.50	11.80	79	9.9
L1914704-9 132288	0.43	7.69	68	0.9
L1914704-10 132289	0.55	7.54	88	1.0
L1914704-11 132290	0.80	9.83	59	8.7

***** See Appendix Page for comments regarding this certificate *****

Project: L1914704

CERTIFICATE OF ANALYSIS VA17077364

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

QC CERTIFICATE VA17077364

Project: L1914704

P.O. No.: ALSM-CW16-102-APN

This report is for 11 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 21-APR-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 8-MAY-2017
Account: APN

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description **Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
STANDARDS															
Buffer pH6					6.0										
Buffer pH6					6.0										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CO-ASSAY											0.52	1.9			
Target Range - Lower Bound											0.42	1.5			
Upper Bound											0.64	2.4			
GS313-8							1.24								
Target Range - Lower Bound							1.19								
Upper Bound							1.29								
KZK-1	25.0	2	32	57		2.28									
Target Range - Lower Bound	22.9	<1	30	54		2.18									
Upper Bound	27.1	>4	38	64		2.53									
MA-2c											1.66	6.1			
Target Range - Lower Bound											1.50	5.5			
Upper Bound											1.84	6.8			
NBM-1	9.3	2	38	47		5.05									
Target Range - Lower Bound	8.4	<1	33	42		4.64									
Upper Bound	10.3	>4	42	51		5.37									
OGGeo08													20.8	2.33	123.5
Target Range - Lower Bound													18.15	2.05	107.0
Upper Bound													22.2	2.53	131.0
OREAS 920													0.11	2.43	4.7
Target Range - Lower Bound													0.07	2.18	3.8
Upper Bound													0.12	2.68	4.9
UTS-1								0.87							
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.89						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-2							3.30								
Target Range - Lower Bound							3.11								
Upper Bound							3.35								
UTS-4								1.73							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.73						
Target Range - Lower Bound									1.61						
Upper Bound									1.87						

***** See Appendix Page for comments regarding this certificate *****

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
	LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		0.07	<10	50	0.82	11.80	0.97	19.80	65.0	103.5	84	9.95	8660	5.22	9.29	0.16
Target Range - Lower Bound		0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21
Upper Bound		0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45
OREAS 920		<0.02	<10	80	0.76	0.63	0.34	0.05	76.7	15.3	43	2.10	111.5	3.64	6.97	0.09
Target Range - Lower Bound		<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05
Upper Bound		0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-2																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 8-MAY-2017
Account: APN

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
	Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description	**LOR**	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
									STANDARDS							
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		0.85	0.47	1.545	1.11	31.4	31.4	1.01	398	911	0.32	1.08	9270	820	7460	130.5
Target Range - Lower Bound		0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5
Upper Bound		0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5
OREAS 920		0.56	<0.01	0.031	0.44	38.6	22.1	1.12	523	0.35	0.02	0.34	40.1	730	23.0	25.1
Target Range - Lower Bound		0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2
Upper Bound		0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-2																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description	Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
NBM-1																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		1.465	2.87	22.6	7.5	12.2	13.7	72.1	0.01	0.16	16.8	0.319	1.42	4.92	83	3.31
Target Range - Lower Bound		1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58
Upper Bound		1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60
OREAS 920		<0.001	0.03	0.71	2.9	1.1	1.1	17.8	0.01	0.02	16.0	0.131	0.16	2.06	26	0.52
Target Range - Lower Bound		<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31
Upper Bound		0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-2																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS				
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
GS313-8				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-2c				
Target Range - Lower Bound				
Upper Bound				
NBM-1				
Target Range - Lower Bound				
Upper Bound				
OGGeo08		18.40	7210	26.0
Target Range - Lower Bound		15.35	6500	19.5
Upper Bound		18.85	7950	27.5
OREAS 920		18.80	104	22.8
Target Range - Lower Bound		16.85	93	17.6
Upper Bound		20.7	119	25.0
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-2				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description / **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
BLANKS															
BLANK											<0.05	<0.2			
Target Range - Lower Bound											<0.05	<0.2			
Upper Bound											0.10	0.4			
BLANK													<0.01	<0.01	<0.1
Target Range - Lower Bound													<0.01	<0.01	<0.1
Upper Bound													0.02	0.02	0.2
BLANK					6.3										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										
BLANK								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
BLANK									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						
BLANK							0.02								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								
DUPLICATES															
L1914704-4 132279													0.10	0.77	1.3
DUP													0.10	0.80	1.4
Target Range - Lower Bound													0.09	0.74	1.2
Upper Bound													0.12	0.83	1.5
L1914704-10 132289	10.9	2	44	55	8.4	5.03	0.35	0.01	<0.01	0.34	0.69	2.5			
DUP	10.6	2	44	55	8.4	5.18	0.34	0.01	<0.01	0.33	0.70	2.6			
Target Range - Lower Bound	9.9	<1	41	51	7.9	4.84	0.33	<0.01	<0.01	0.32	0.61	2.2			
Upper Bound	11.6	3	47	59	8.9	5.37	0.36	0.02	0.02	0.35	0.78	2.9			

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
	LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Target Range - Lower Bound		<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound		0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
L1914704-4 132279		<0.02	<10	140	0.46	0.08	2.14	0.06	28.1	6.7	5	0.69	352	2.51	4.16	0.05
DUP		<0.02	<10	140	0.47	0.08	2.13	0.07	28.4	6.8	5	0.71	352	2.56	4.38	0.05
Target Range - Lower Bound		<0.02	<10	120	0.39	0.07	2.02	0.05	26.8	6.3	4	0.62	339	2.40	4.01	<0.05
Upper Bound		0.04	20	160	0.54	0.09	2.25	0.08	29.7	7.2	6	0.79	365	2.67	4.53	0.10
L1914704-10 132289																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Target Range - Lower Bound	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
L1914704-4 132279	0.05	<0.01	0.040	0.27	14.6	2.7	0.25	683	1.65	0.04	0.07	2.1	750	3.3	14.0
DUP	0.05	<0.01	0.045	0.27	14.9	2.5	0.25	683	1.71	0.05	0.07	2.4	750	3.4	14.2
Target Range - Lower Bound	0.03	<0.01	0.035	0.25	13.8	2.4	0.23	644	1.55	0.03	<0.05	1.9	700	3.0	13.3
Upper Bound	0.07	0.02	0.050	0.29	15.7	2.8	0.27	722	1.81	0.06	0.10	2.6	800	3.7	14.9
L1914704-10 132289															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description / Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
L1914704-4 132279	<0.001	<0.01	<0.05	7.0	0.7	0.6	57.2	<0.01	0.03	3.7	0.029	0.08	0.30	50	0.28
DUP	<0.001	<0.01	0.05	7.1	0.8	0.7	58.8	<0.01	0.02	3.7	0.029	0.08	0.30	51	0.26
Target Range - Lower Bound	<0.001	<0.01	<0.05	6.6	0.5	0.4	54.9	<0.01	<0.01	3.3	0.023	0.05	0.24	47	0.20
Upper Bound	0.002	0.02	0.10	7.5	1.0	0.9	61.1	0.02	0.04	4.1	0.035	0.11	0.37	54	0.34
L1914704-10 132289															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17077364

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41
	Analyte	Y	Zn	Zr
	Units	ppm	ppm	ppm
	LOR	0.05	2	0.5
BLANKS				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK		<0.05	<2	<0.5
Target Range - Lower Bound		<0.05	<2	<0.5
Upper Bound		0.10	4	1.0
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
DUPLICATES				
L1914704-4 132279		11.55	66	1.4
DUP		11.70	67	1.5
Target Range - Lower Bound		11.00	61	0.8
Upper Bound		12.25	72	2.1
L1914704-10 132289				
DUP				
Target Range - Lower Bound				
Upper Bound				

Project: L1914704

QC CERTIFICATE OF ANALYSIS VA17077364

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Environmental

www.alsglobal.com

Request Form

Canada Toll Free: 1 800 668 9878

L1914704-COFC

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
-	-	-	-	Composite	R	R	R	R	R	R	
1	132276	28-Mar-17	-	WASTE	X	X	X	X	X	X	
2	133648	01-Apr-17	-	WASTE	X	X	X	X	X	X	
3	132277	13-Apr-17	-	WASTE	X	X	X	X	X	X	
4	132279	13-Apr-17		WASTE	X	X	X	X	X	X	
5	132280	13-Apr-17		WASTE	X	X	X	X	X	X	
6	132283	13-Apr-17		WASTE	X	X	X	X	X	X	
7	132284	13-Apr-17		WASTE	X	X	X	X	X	X	
8	132286	13-Apr-17		WASTE	X	X	X	X	X	X	
9	132288	13-Apr-17		WASTE	X	X	X	X	X	X	
10	132289	13-Apr-17		WASTE	X	X	X	X	X	X	
11	132290	13-Apr-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples¹ (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: 16.0

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Chad Bustin	Date: April 13th 2017	Time: 17:00	Received by: EHF	Date: 18 Apr 2017	Time: 14:42	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

OCTOBER 2015 FRONT

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 28-APR-17
Report Date: 26-MAY-17 21:27 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1919526

Project P.O. #: 220826
Job Reference:
C of C Numbers: 17-16
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1919526-1	L1919526-2	L1919526-3	L1919526-4	L1919526-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	07-APR-17	04-APR-17	02-APR-17	02-APR-17	28-MAR-17
	Sampled Time					
	Client ID	132287	132285	132282	132281	132278
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	8.2	8.8	8.7	8.5
Organic / Inorganic Carbon	Carbon (C) (%)	0.13	0.06	0.25	0.23	0.32
Acid Base Accounting	FIZZ RATING (Unity)	1	1	2	2	2
	MPA (tCaCO3/1Kt)	0.6	0.6	0.6	1.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	18	11	26	27	33
	NNP (tCaCO3/1Kt)	17	10	25	26	33
	Ratio (NP/MPA) (Unity)	28.80	17.60	41.60	21.60	105.60
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.02	0.01	0.04	0.04	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.02	0.02	0.04	0.01
	Total Sulfur (combustion) (%)	0.02	0.02	0.02	0.04	0.01
Total Metals	Aluminum (Al) (%)	1.22	1.38	1.27	1.32	0.95
	Antimony (Sb) (ppm)	0.05	0.30	<0.05	<0.05	0.06
	Arsenic (As) (ppm)	1.5	3.3	2.0	2.2	5.8
	Barium (Ba) (ppm)	260	330	400	200	290
	Beryllium (Be) (ppm)	0.30	0.47	0.23	0.34	0.44
	Bismuth (Bi) (ppm)	0.03	0.05	0.05	0.09	0.13
	Boron (B) (ppm)	<10	<10	<10	<10	10
	Cadmium (Cd) (ppm)	0.10	0.12	0.08	0.08	0.15
	Calcium (Ca) (%)	0.77	0.66	1.09	1.18	1.47
	Cerium (Ce) (ppm)	29.1	28.8	24.5	31.4	22.0
	Cesium (Cs) (ppm)	0.49	0.77	0.55	0.44	0.55
	Chromium (Cr) (ppm)	6	15	7	5	5
	Cobalt (Co) (ppm)	6.7	7.5	7.6	6.4	6.4
	Copper (Cu) (ppm)	488	596	779	1390	927
	Gallium (Ga) (ppm)	5.74	5.68	6.81	6.28	5.43
	Germanium (Ge) (ppm)	0.07	0.07	0.08	0.05	0.07
	Gold (Au) (ppm)	<0.02	<0.02	0.03	0.04	0.02
	Hafnium (Hf) (ppm)	0.05	0.14	0.03	0.04	0.06
	Indium (In) (ppm)	0.024	0.029	0.041	0.042	0.050
	Iron (Fe) (%)	2.60	2.72	3.82	2.77	2.67
	Lanthanum (La) (ppm)	15.2	14.7	12.8	16.2	11.2
	Lead (Pb) (ppm)	2.5	4.2	2.4	2.7	3.4
	Lithium (Li) (ppm)	6.5	8.5	5.6	7.6	5.3
	Magnesium (Mg) (%)	0.58	0.59	0.60	0.67	0.32
	Manganese (Mn) (ppm)	610	553	636	603	664

	Sample ID	L1919526-6	L1919526-7	L1919526-8	L1919526-9	L1919526-10
	Description	WASTE	WASTE	WASTE	TAILS	WASTE
	Sampled Date	14-APR-17	12-APR-17	12-APR-17	22-APR-17	13-APR-17
	Sampled Time					
	Client ID	132292	132291	132293	MARCH TAL 2017	132294
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	7.9	8.6	8.0	8.2
Organic / Inorganic Carbon	Carbon (C) (%)	0.05	0.22	0.26	0.19	0.13
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.9	2.8	2.8	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	10	24	27	21	17
	NNP (tCaCO3/1Kt)	10	23	24	18	16
	Ratio (NP/MPA) (Unity)	32.00	25.60	9.60	7.47	27.20
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.03	0.02	0.01	0.05	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01	0.03	0.09	0.08	0.02
	Total Sulfur (combustion) (%)	0.01	0.03	0.09	0.09	0.02
Total Metals	Aluminum (Al) (%)	1.29	1.77	1.06	1.34	1.48
	Antimony (Sb) (ppm)	0.30	0.68	<0.05	<0.05	0.39
	Arsenic (As) (ppm)	3.7	7.7	1.0	1.6	4.1
	Barium (Ba) (ppm)	360	320	240	220	280
	Beryllium (Be) (ppm)	0.37	0.67	0.23	0.25	0.44
	Bismuth (Bi) (ppm)	0.07	0.16	0.07	0.24	0.06
	Boron (B) (ppm)	10	10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.13	0.36	0.24	0.27	0.16
	Calcium (Ca) (%)	0.54	1.25	1.14	1.02	0.92
	Cerium (Ce) (ppm)	28.3	39.3	23.2	18.75	30.2
	Cesium (Cs) (ppm)	0.70	1.47	0.40	0.46	0.92
	Chromium (Cr) (ppm)	13	31	5	7	18
	Cobalt (Co) (ppm)	7.4	11.7	6.2	7.4	8.9
	Copper (Cu) (ppm)	653	900	3580	2080	110.5
	Gallium (Ga) (ppm)	5.35	6.13	4.97	8.44	5.90
	Germanium (Ge) (ppm)	0.06	0.06	0.06	0.06	0.06
	Gold (Au) (ppm)	<0.02	<0.02	0.04	0.08	<0.02
	Hafnium (Hf) (ppm)	0.12	0.23	0.05	0.04	0.17
	Indium (In) (ppm)	0.030	0.049	0.108	0.093	0.026
	Iron (Fe) (%)	2.62	3.06	2.76	4.50	2.76
	Lanthanum (La) (ppm)	14.9	20.2	12.1	9.4	15.4
	Lead (Pb) (ppm)	3.6	8.4	2.6	2.9	4.9
	Lithium (Li) (ppm)	8.5	11.7	5.0	6.6	9.4
	Magnesium (Mg) (%)	0.55	0.81	0.50	0.68	0.77
	Manganese (Mn) (ppm)	509	616	617	656	615

	Sample ID	L1919526-11	L1919526-12	L1919526-13	L1919526-14	L1919526-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	14-APR-17	15-APR-17	15-APR-17	16-APR-17	17-APR-17
	Sampled Time					
	Client ID	132295	132296	132297	132298	132299
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.8	8.7	8.5	8.5	7.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.10	0.30	0.29	0.07	0.20
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	1	2
	MPA (tCaCO3/1Kt)	0.6	0.3	0.3	0.3	1.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	16	30	31	13	18
	NNP (tCaCO3/1Kt)	15	30	31	13	17
	Ratio (NP/MPA) (Unity)	25.60	96.00	99.20	41.60	14.40
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.03	0.02	0.02	<0.01	0.04
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.01	<0.01	0.01	0.04
	Total Sulfur (combustion) (%)	0.02	0.01	0.01	0.01	0.04
Total Metals	Aluminum (Al) (%)	1.27	1.09	1.11	1.23	1.21
	Antimony (Sb) (ppm)	<0.05	<0.05	0.06	<0.05	0.63
	Arsenic (As) (ppm)	0.6	0.9	4.0	1.4	6.8
	Barium (Ba) (ppm)	320	130	250	310	300
	Beryllium (Be) (ppm)	0.36	0.38	0.37	0.32	0.43
	Bismuth (Bi) (ppm)	0.07	0.02	0.10	0.04	0.10
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.09	0.04	0.10	0.08	0.23
	Calcium (Ca) (%)	0.76	1.43	1.40	0.66	1.01
	Cerium (Ce) (ppm)	25.0	23.6	24.1	27.1	27.5
	Cesium (Cs) (ppm)	0.54	0.41	0.55	0.54	0.83
	Chromium (Cr) (ppm)	6	4	5	5	27
	Cobalt (Co) (ppm)	6.3	5.8	6.7	6.7	8.3
	Copper (Cu) (ppm)	1225	75.8	679	318	93.4
	Gallium (Ga) (ppm)	5.40	5.32	5.56	5.83	4.01
	Germanium (Ge) (ppm)	0.09	0.08	0.07	0.08	0.06
	Gold (Au) (ppm)	0.02	<0.02	0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.09	0.07	0.07	0.07	0.23
	Indium (In) (ppm)	0.042	0.028	0.036	0.029	0.019
	Iron (Fe) (%)	2.60	2.36	2.72	2.70	2.47
	Lanthanum (La) (ppm)	12.4	11.8	12.2	14.2	13.6
	Lead (Pb) (ppm)	1.7	3.3	2.9	2.5	5.5
	Lithium (Li) (ppm)	6.0	5.5	6.3	6.5	8.5
	Magnesium (Mg) (%)	0.65	0.52	0.51	0.56	0.54
	Manganese (Mn) (ppm)	606	576	682	625	542

	Sample ID	L1919526-16
	Description	WASTE
	Sampled Date	18-APR-17
	Sampled Time	
	Client ID	132300
Grouping	**Analyte**	
SOIL		
Physical Tests	pH (Unity)	8.5
Organic / Inorganic Carbon	Carbon (C) (%)	0.34
Acid Base Accounting	FIZZ RATING (Unity)	2
	MPA (tCaCO3/1Kt)	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	35
	NNP (tCaCO3/1Kt)	35
	Ratio (NP/MPA) (Unity)	112.00
	Sulfate Sulfur (carbonate leach) (%)	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01
	Total Sulfur (combustion) (%)	0.01
Total Metals	Aluminum (Al) (%)	1.19
	Antimony (Sb) (ppm)	<0.05
	Arsenic (As) (ppm)	1.0
	Barium (Ba) (ppm)	180
	Beryllium (Be) (ppm)	0.35
	Bismuth (Bi) (ppm)	0.15
	Boron (B) (ppm)	<10
	Cadmium (Cd) (ppm)	0.10
	Calcium (Ca) (%)	1.52
	Cerium (Ce) (ppm)	25.7
	Cesium (Cs) (ppm)	0.46
	Chromium (Cr) (ppm)	5
	Cobalt (Co) (ppm)	7.0
	Copper (Cu) (ppm)	1465
	Gallium (Ga) (ppm)	5.97
	Germanium (Ge) (ppm)	0.06
	Gold (Au) (ppm)	0.03
	Hafnium (Hf) (ppm)	0.06
	Indium (In) (ppm)	0.052
	Iron (Fe) (%)	2.81
	Lanthanum (La) (ppm)	13.0
	Lead (Pb) (ppm)	3.2
	Lithium (Li) (ppm)	6.3
	Magnesium (Mg) (%)	0.58
	Manganese (Mn) (ppm)	753

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1919526-1	L1919526-2	L1919526-3	L1919526-4	L1919526-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	07-APR-17	04-APR-17	02-APR-17	02-APR-17	28-MAR-17
	Sampled Time					
	Client ID	132287	132285	132282	132281	132278
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.97	1.45	1.35	0.90	1.22
	Nickel (Ni) (ppm)	2.7	11.0	2.7	2.4	2.5
	Niobium (Nb) (ppm)	0.16	0.61	0.20	0.09	0.07
	Phosphorus (P) (ppm)	740	830	640	760	710
	Potassium (K) (%)	0.53	0.46	0.73	0.50	0.35
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.002	<0.001
	Rubidium (Rb) (ppm)	24.7	22.4	34.5	22.3	15.8
	Scandium (Sc) (ppm)	4.4	5.2	4.4	3.9	5.5
	Selenium (Se) (ppm)	0.4	0.4	0.5	0.9	0.4
	Silver (Ag) (ppm)	0.06	0.08	0.13	0.30	0.22
	Sodium (Na) (%)	0.05	0.07	0.06	0.07	0.06
	Strontium (Sr) (ppm)	38.2	45.7	41.2	57.9	61.1
	Sulfur (S) (%)	<0.01	<0.01	0.01	0.05	<0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	<0.01	0.03	0.02	0.09	0.05
	Thallium (Tl) (ppm)	0.14	0.16	0.23	0.13	0.09
	Thorium (Th) (ppm)	3.7	3.6	3.0	3.4	2.1
	Tin (Sn) (ppm)	0.7	0.8	1.0	0.7	0.8
	Titanium (Ti) (%)	0.083	0.097	0.128	0.069	0.044
	Tungsten (W) (ppm)	0.20	0.36	0.27	0.20	0.17
	Uranium (U) (ppm)	0.22	0.46	0.21	0.25	0.19
	Vanadium (V) (ppm)	54	58	87	55	55
	Yttrium (Y) (ppm)	8.07	9.70	5.15	7.60	9.52
	Zinc (Zn) (ppm)	74	75	83	75	77
	Zirconium (Zr) (ppm)	1.1	4.4	0.8	0.7	1.2
Permanent Gases	Carbon Dioxide (CO2) (%)	0.5	0.2	0.9	0.8	1.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

		L1919526-6	L1919526-7	L1919526-8	L1919526-9	L1919526-10
	Sample ID	L1919526-6	L1919526-7	L1919526-8	L1919526-9	L1919526-10
	Description	WASTE	WASTE	WASTE	TAILS	WASTE
	Sampled Date	14-APR-17	12-APR-17	12-APR-17	22-APR-17	13-APR-17
	Sampled Time					
	Client ID	132292	132291	132293	MARCH TAL 2017	132294
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02	0.04	0.01	0.01	0.02
	Molybdenum (Mo) (ppm)	1.11	2.72	14.75	1.08	1.47
	Nickel (Ni) (ppm)	11.0	30.3	3.3	3.5	16.1
	Niobium (Nb) (ppm)	0.48	0.40	0.13	0.19	0.73
	Phosphorus (P) (ppm)	740	940	730	810	820
	Potassium (K) (%)	0.47	0.35	0.48	0.57	0.43
	Rhenium (Re) (ppm)	<0.001	0.002	0.007	0.001	0.001
	Rubidium (Rb) (ppm)	21.6	20.0	21.7	30.2	21.3
	Scandium (Sc) (ppm)	5.1	6.4	4.4	4.0	5.3
	Selenium (Se) (ppm)	0.6	0.8	1.4	1.3	0.8
	Silver (Ag) (ppm)	0.12	0.27	0.51	0.72	0.08
	Sodium (Na) (%)	0.06	0.04	0.06	0.06	0.07
	Strontium (Sr) (ppm)	38.3	65.0	54.5	78.9	56.0
	Sulfur (S) (%)	0.01	0.02	0.11	0.11	0.02
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.05	0.08	0.27	0.02
	Thallium (Tl) (ppm)	0.15	0.18	0.13	0.19	0.15
	Thorium (Th) (ppm)	3.2	5.0	2.4	3.6	3.7
	Tin (Sn) (ppm)	0.7	0.9	0.9	1.0	0.6
	Titanium (Ti) (%)	0.087	0.081	0.078	0.109	0.114
	Tungsten (W) (ppm)	0.45	0.25	0.39	0.06	0.43
	Uranium (U) (ppm)	0.31	0.81	0.34	0.30	0.53
	Vanadium (V) (ppm)	54	64	56	76	59
	Yttrium (Y) (ppm)	8.72	12.15	7.57	5.94	9.27
	Zinc (Zn) (ppm)	70	97	77	113	77
	Zirconium (Zr) (ppm)	3.7	8.1	0.9	1.1	5.3
Permanent Gases	Carbon Dioxide (CO2) (%)	0.2	0.8	1.0	0.7	0.5

	Sample ID	L1919526-11	L1919526-12	L1919526-13	L1919526-14	L1919526-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	14-APR-17	15-APR-17	15-APR-17	16-APR-17	17-APR-17
	Sampled Time					
	Client ID	132295	132296	132297	132298	132299
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	0.02
	Molybdenum (Mo) (ppm)	0.81	0.54	1.15	1.05	1.03
	Nickel (Ni) (ppm)	2.8	2.2	2.6	3.0	21.8
	Niobium (Nb) (ppm)	0.20	0.16	0.11	0.16	1.09
	Phosphorus (P) (ppm)	740	650	780	850	830
	Potassium (K) (%)	0.72	0.29	0.34	0.50	0.19
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	<0.001	0.002
	Rubidium (Rb) (ppm)	33.5	13.3	15.7	22.4	11.5
	Scandium (Sc) (ppm)	5.2	4.9	5.3	5.4	4.9
	Selenium (Se) (ppm)	0.7	0.2	0.7	0.5	0.4
	Silver (Ag) (ppm)	0.23	0.05	0.20	0.06	0.10
	Sodium (Na) (%)	0.09	0.06	0.06	0.07	0.05
	Strontium (Sr) (ppm)	45.8	62.7	56.9	38.5	57.5
	Sulfur (S) (%)	0.01	<0.01	<0.01	<0.01	0.04
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.05	0.01	0.03	0.01	0.03
	Thallium (Tl) (ppm)	0.19	0.06	0.08	0.13	0.11
	Thorium (Th) (ppm)	2.9	2.3	2.1	2.9	3.6
	Tin (Sn) (ppm)	0.8	0.6	0.7	0.7	0.5
	Titanium (Ti) (%)	0.132	0.061	0.058	0.080	0.075
	Tungsten (W) (ppm)	0.50	0.25	0.22	0.41	0.71
	Uranium (U) (ppm)	0.27	0.30	0.21	0.21	0.69
	Vanadium (V) (ppm)	56	45	55	56	51
	Yttrium (Y) (ppm)	11.30	8.86	10.35	11.10	9.14
	Zinc (Zn) (ppm)	73	61	73	72	58
	Zirconium (Zr) (ppm)	1.4	1.1	1.2	1.3	7.1
Permanent Gases	Carbon Dioxide (CO2) (%)	0.4	1.1	1.1	0.3	0.7

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1919526-16
	Description	WASTE
	Sampled Date	18-APR-17
	Sampled Time	
	Client ID	132300
Grouping	**Analyte**	
SOIL		
Total Metals	Mercury (Hg) (ppm)	<0.01
	Molybdenum (Mo) (ppm)	0.70
	Nickel (Ni) (ppm)	2.5
	Niobium (Nb) (ppm)	0.07
	Phosphorus (P) (ppm)	830
	Potassium (K) (%)	0.37
	Rhenium (Re) (ppm)	<0.001
	Rubidium (Rb) (ppm)	17.4
	Scandium (Sc) (ppm)	4.9
	Selenium (Se) (ppm)	0.8
	Silver (Ag) (ppm)	0.34
	Sodium (Na) (%)	0.05
	Strontium (Sr) (ppm)	63.0
	Sulfur (S) (%)	<0.01
	Tantalum (Ta) (ppm)	<0.01
	Tellurium (Te) (ppm)	0.10
	Thallium (Tl) (ppm)	0.10
	Thorium (Th) (ppm)	3.3
	Tin (Sn) (ppm)	0.6
	Titanium (Ti) (%)	0.051
	Tungsten (W) (ppm)	0.18
	Uranium (U) (ppm)	0.31
	Vanadium (V) (ppm)	54
	Yttrium (Y) (ppm)	10.50
	Zinc (Zn) (ppm)	83
	Zirconium (Zr) (ppm)	1.2
Permanent Gases	Carbon Dioxide (CO2) (%)	1.2

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS
A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.			
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06
Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.			
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06
A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).			
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A
A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).			
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08
The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-16

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 25-MAY-2017
Account: APN

CERTIFICATE VA17088037

Project: L1919526

P.O. No.: ALSM-CW16-102-APN

This report is for 16 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 4-MAY-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1919526

CERTIFICATE OF ANALYSIS VA17088037

Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41
Analyte	Recvd Wt.	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al
Units	kg	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
Sample Description **LOR**	0.02	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01
L1919526-1 132287	1.14	0.6	1	17	18	8.5	28.80	0.02	<0.01	0.02	0.02	0.13	0.5	0.06	1.22
L1919526-2 132285	1.12	0.6	1	10	11	8.2	17.60	0.02	<0.01	0.01	0.02	0.06	0.2	0.08	1.38
L1919526-3 132282	1.12	0.6	2	25	26	8.8	41.60	0.02	<0.01	0.04	0.02	0.25	0.9	0.13	1.27
L1919526-4 132281	1.10	1.3	2	26	27	8.7	21.60	0.04	<0.01	0.04	0.04	0.23	0.8	0.30	1.32
L1919526-5 132278	1.12	0.3	2	33	33	8.5	105.60	0.01	<0.01	<0.01	0.01	0.32	1.2	0.22	0.95
L1919526-6 132292	1.12	0.3	1	10	10	8.2	32.00	0.01	0.01	0.03	<0.01	0.05	0.2	0.12	1.29
L1919526-7 132291	1.12	0.9	2	23	24	7.9	25.60	0.03	<0.01	0.02	0.03	0.22	0.8	0.27	1.77
L1919526-8 132293	1.10	2.8	2	24	27	8.6	9.60	0.09	<0.01	0.01	0.09	0.26	1.0	0.51	1.06
L1919526-9 MARCH TAL 2017	1.16	2.8	2	18	21	8.0	7.47	0.09	0.01	0.05	0.08	0.19	0.7	0.72	1.34
L1919526-10 132294	1.10	0.6	2	16	17	8.2	27.20	0.02	<0.01	0.02	0.02	0.13	0.5	0.08	1.48
L1919526-11 132295	0.98	0.6	1	15	16	8.8	25.60	0.02	<0.01	0.03	0.02	0.10	0.4	0.23	1.27
L1919526-12 132296	1.12	0.3	2	30	30	8.7	96.00	0.01	<0.01	0.02	0.01	0.30	1.1	0.05	1.09
L1919526-13 132297	1.14	0.3	2	31	31	8.5	99.20	0.01	0.01	0.02	<0.01	0.29	1.1	0.20	1.11
L1919526-14 132298	1.12	0.3	1	13	13	8.5	41.60	0.01	<0.01	<0.01	0.01	0.07	0.3	0.06	1.23
L1919526-15 132299	1.14	1.3	2	17	18	7.8	14.40	0.04	<0.01	0.04	0.04	0.20	0.7	0.10	1.21
L1919526-16 132300	1.12	0.3	2	35	35	8.5	112.00	0.01	<0.01	0.02	0.01	0.34	1.2	0.34	1.19

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17088037

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description LOR	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05
L1919526-1 132287	1.5	<0.02	<10	260	0.30	0.03	0.77	0.10	29.1	6.7	6	0.49	488	2.60	5.74
L1919526-2 132285	3.3	<0.02	<10	330	0.47	0.05	0.66	0.12	28.8	7.5	15	0.77	596	2.72	5.68
L1919526-3 132282	2.0	0.03	<10	400	0.23	0.05	1.09	0.08	24.5	7.6	7	0.55	779	3.82	6.81
L1919526-4 132281	2.2	0.04	<10	200	0.34	0.09	1.18	0.08	31.4	6.4	5	0.44	1390	2.77	6.28
L1919526-5 132278	5.8	0.02	10	290	0.44	0.13	1.47	0.15	22.0	6.4	5	0.55	927	2.67	5.43
L1919526-6 132292	3.7	<0.02	10	360	0.37	0.07	0.54	0.13	28.3	7.4	13	0.70	653	2.62	5.35
L1919526-7 132291	7.7	<0.02	10	320	0.67	0.16	1.25	0.36	39.3	11.7	31	1.47	900	3.06	6.13
L1919526-8 132293	1.0	0.04	<10	240	0.23	0.07	1.14	0.24	23.2	6.2	5	0.40	3580	2.76	4.97
L1919526-9 MARCH TAL 2017	1.6	0.08	<10	220	0.25	0.24	1.02	0.27	18.75	7.4	7	0.46	2080	4.50	8.44
L1919526-10 132294	4.1	<0.02	<10	280	0.44	0.06	0.92	0.16	30.2	8.9	18	0.92	110.5	2.76	5.90
L1919526-11 132295	0.6	0.02	<10	320	0.36	0.07	0.76	0.09	25.0	6.3	6	0.54	1225	2.60	5.40
L1919526-12 132296	0.9	<0.02	<10	130	0.38	0.02	1.43	0.04	23.6	5.8	4	0.41	75.8	2.36	5.32
L1919526-13 132297	4.0	0.02	<10	250	0.37	0.10	1.40	0.10	24.1	6.7	5	0.55	679	2.72	5.56
L1919526-14 132298	1.4	<0.02	<10	310	0.32	0.04	0.66	0.08	27.1	6.7	5	0.54	318	2.70	5.83
L1919526-15 132299	6.8	<0.02	<10	300	0.43	0.10	1.01	0.23	27.5	8.3	27	0.83	93.4	2.47	4.01
L1919526-16 132300	1.0	0.03	<10	180	0.35	0.15	1.52	0.10	25.7	7.0	5	0.46	1465	2.81	5.97

CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1919526-1 132287		0.07	0.05	0.01	0.024	0.53	15.2	6.5	0.58	610	0.97	0.05	0.16	2.7	740	2.5
L1919526-2 132285		0.07	0.14	0.01	0.029	0.46	14.7	8.5	0.59	553	1.45	0.07	0.61	11.0	830	4.2
L1919526-3 132282		0.08	0.03	<0.01	0.041	0.73	12.8	5.6	0.60	636	1.35	0.06	0.20	2.7	640	2.4
L1919526-4 132281		0.05	0.04	<0.01	0.042	0.50	16.2	7.6	0.67	603	0.90	0.07	0.09	2.4	760	2.7
L1919526-5 132278		0.07	0.06	<0.01	0.050	0.35	11.2	5.3	0.32	664	1.22	0.06	0.07	2.5	710	3.4
L1919526-6 132292		0.06	0.12	0.02	0.030	0.47	14.9	8.5	0.55	509	1.11	0.06	0.48	11.0	740	3.6
L1919526-7 132291		0.06	0.23	0.04	0.049	0.35	20.2	11.7	0.81	616	2.72	0.04	0.40	30.3	940	8.4
L1919526-8 132293		0.06	0.05	0.01	0.108	0.48	12.1	5.0	0.50	617	14.75	0.06	0.13	3.3	730	2.6
L1919526-9 MARCH TAL 2017		0.06	0.04	0.01	0.093	0.57	9.4	6.6	0.68	656	1.08	0.06	0.19	3.5	810	2.9
L1919526-10 132294		0.06	0.17	0.02	0.026	0.43	15.4	9.4	0.77	615	1.47	0.07	0.73	16.1	820	4.9
L1919526-11 132295		0.09	0.09	<0.01	0.042	0.72	12.4	6.0	0.65	606	0.81	0.09	0.20	2.8	740	1.7
L1919526-12 132296		0.08	0.07	<0.01	0.028	0.29	11.8	5.5	0.52	576	0.54	0.06	0.16	2.2	650	3.3
L1919526-13 132297		0.07	0.07	<0.01	0.036	0.34	12.2	6.3	0.51	682	1.15	0.06	0.11	2.6	780	2.9
L1919526-14 132298		0.08	0.07	<0.01	0.029	0.50	14.2	6.5	0.56	625	1.05	0.07	0.16	3.0	850	2.5
L1919526-15 132299		0.06	0.23	0.02	0.019	0.19	13.6	8.5	0.54	542	1.03	0.05	1.09	21.8	830	5.5
L1919526-16 132300		0.06	0.06	<0.01	0.052	0.37	13.0	6.3	0.58	753	0.70	0.05	0.07	2.5	830	3.2

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1919526

CERTIFICATE OF ANALYSIS VA17088037

Method Analyte Units LOR **Sample Description**	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1
L1919526-1 132287	24.7	<0.001	<0.01	0.05	4.4	0.4	0.7	38.2	<0.01	<0.01	3.7	0.083	0.14	0.22	54
L1919526-2 132285	22.4	<0.001	<0.01	0.30	5.2	0.4	0.8	45.7	<0.01	0.03	3.6	0.097	0.16	0.46	58
L1919526-3 132282	34.5	<0.001	0.01	<0.05	4.4	0.5	1.0	41.2	<0.01	0.02	3.0	0.128	0.23	0.21	87
L1919526-4 132281	22.3	0.002	0.05	<0.05	3.9	0.9	0.7	57.9	<0.01	0.09	3.4	0.069	0.13	0.25	55
L1919526-5 132278	15.8	<0.001	<0.01	0.06	5.5	0.4	0.8	61.1	<0.01	0.05	2.1	0.044	0.09	0.19	55
L1919526-6 132292	21.6	<0.001	0.01	0.30	5.1	0.6	0.7	38.3	<0.01	0.02	3.2	0.087	0.15	0.31	54
L1919526-7 132291	20.0	0.002	0.02	0.68	6.4	0.8	0.9	65.0	<0.01	0.05	5.0	0.081	0.18	0.81	64
L1919526-8 132293	21.7	0.007	0.11	<0.05	4.4	1.4	0.9	54.5	<0.01	0.08	2.4	0.078	0.13	0.34	56
L1919526-9 MARCH TAL 2017	30.2	0.001	0.11	<0.05	4.0	1.3	1.0	78.9	<0.01	0.27	3.6	0.109	0.19	0.30	76
L1919526-10 132294	21.3	0.001	0.02	0.39	5.3	0.8	0.6	56.0	<0.01	0.02	3.7	0.114	0.15	0.53	59
L1919526-11 132295	33.5	<0.001	0.01	<0.05	5.2	0.7	0.8	45.8	<0.01	0.05	2.9	0.132	0.19	0.27	56
L1919526-12 132296	13.3	<0.001	<0.01	<0.05	4.9	0.2	0.6	62.7	<0.01	0.01	2.3	0.061	0.06	0.30	45
L1919526-13 132297	15.7	<0.001	<0.01	0.06	5.3	0.7	0.7	56.9	<0.01	0.03	2.1	0.058	0.08	0.21	55
L1919526-14 132298	22.4	<0.001	<0.01	<0.05	5.4	0.5	0.7	38.5	<0.01	0.01	2.9	0.080	0.13	0.21	56
L1919526-15 132299	11.5	0.002	0.04	0.63	4.9	0.4	0.5	57.5	<0.01	0.03	3.6	0.075	0.11	0.69	51
L1919526-16 132300	17.4	<0.001	<0.01	<0.05	4.9	0.8	0.6	63.0	<0.01	0.10	3.3	0.051	0.10	0.31	54

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1919526-1 132287		0.20	8.07	74	1.1
L1919526-2 132285		0.36	9.70	75	4.4
L1919526-3 132282		0.27	5.15	83	0.8
L1919526-4 132281		0.20	7.60	75	0.7
L1919526-5 132278		0.17	9.52	77	1.2
L1919526-6 132292		0.45	8.72	70	3.7
L1919526-7 132291		0.25	12.15	97	8.1
L1919526-8 132293		0.39	7.57	77	0.9
L1919526-9 MARCH TAL 2017		0.06	5.94	113	1.1
L1919526-10 132294		0.43	9.27	77	5.3
L1919526-11 132295		0.50	11.30	73	1.4
L1919526-12 132296		0.25	8.86	61	1.1
L1919526-13 132297		0.22	10.35	73	1.2
L1919526-14 132298		0.41	11.10	72	1.3
L1919526-15 132299		0.71	9.14	58	7.1
L1919526-16 132300		0.18	10.50	83	1.2

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 25-MAY-2017
Account: APN

Project: L1919526

CERTIFICATE OF ANALYSIS VA17088037

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	LOG-22	ME-MS41	OA-ELE07
OA-VOL08m	PUL-31	PUL-QC	S-CAL06
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 4 (A - E)
Plus Appendix Pages
Finalized Date: 25-MAY-2017
Account: APN

QC CERTIFICATE VA17088037

Project: L1919526

P.O. No.: ALSM-CW16-102-APN

This report is for 16 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 4-MAY-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 25-MAY-2017
Account: APN

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
STANDARDS															
Buffer pH6					6.0										
Buffer pH6					6.0										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CO-ASSAY										0.48	1.8				
Target Range - Lower Bound										0.42	1.5				
Upper Bound										0.64	2.4				
DS-1							2.67								
Target Range - Lower Bound							2.51								
Upper Bound							2.71								
GS310-10							0.26								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								
KZK-1	25.0	2	32	57		2.28									
KZK-1	25.0	2	31	56		2.24									
Target Range - Lower Bound	22.9	<1	30	54		2.18									
Upper Bound	27.1	>4	38	64		2.53									
MA-2c										1.55	5.7				
Target Range - Lower Bound										1.50	5.5				
Upper Bound										1.84	6.8				
MRGeo08												4.48	2.76	34.4	<0.02
Target Range - Lower Bound												4.00	2.44	29.6	<0.02
Upper Bound												4.92	3.00	36.4	0.04
OREAS 905												0.54	0.90	36.8	0.41
Target Range - Lower Bound												0.45	0.73	28.4	0.33
Upper Bound												0.58	0.91	35.0	0.45
UTS-1								0.88							
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.91						
UTS-1									0.92						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-4								1.74							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.78						

QC CERTIFICATE OF ANALYSIS VA17088037

STANDARDS

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		10	450	0.76	0.64	1.13	2.31	75.8	18.5	92	10.55	651	3.59	9.35	0.15	0.81
Target Range - Lower Bound		<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07	0.64
Upper Bound		20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29	0.83
OREAS 905		<10	260	1.01	5.55	0.35	0.37	82.4	14.8	20	1.31	1640	3.53	6.69	0.11	1.18
Target Range - Lower Bound		<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05	1.08
Upper Bound		20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22	1.36
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																

QC CERTIFICATE OF ANALYSIS VA17088037

STANDARDS

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
Sample Description															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.06	0.159	1.30	37.7	32.0	1.17	419	14.95	0.35	0.83	723	1040	1095	142.5	0.009
Target Range - Lower Bound	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0	0.006
Upper Bound	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0	0.010
OREAS 905	0.01	0.614	0.34	41.0	5.2	0.16	350	3.28	0.09	0.31	10.7	250	16.0	21.0	<0.001
Target Range - Lower Bound	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3	<0.001
Upper Bound	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3	0.002
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.31	3.41	7.6	1.1	3.6	82.4	0.01	0.02	21.4	0.388	0.78	5.35	101	2.91	20.6
Target Range - Lower Bound	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44	17.50
Upper Bound	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42	21.5
OREAS 905	0.07	1.10	2.0	2.6	1.4	13.6	<0.01	0.06	8.9	0.022	0.11	2.25	6	0.62	7.74
Target Range - Lower Bound	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44	6.32
Upper Bound	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76	7.84
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 25-MAY-2017
Account: APN

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

STANDARDS

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
Buffer pH6			
Buffer pH6			
Target Range - Lower Bound			
Upper Bound			
CO-ASSAY			
Target Range - Lower Bound			
Upper Bound			
DS-1			
Target Range - Lower Bound			
Upper Bound			
GS310-10			
Target Range - Lower Bound			
Upper Bound			
KZK-1			
KZK-1			
Target Range - Lower Bound			
Upper Bound			
MA-2c			
Target Range - Lower Bound			
Upper Bound			
MRGeo08		791	22.5
Target Range - Lower Bound		708	18.1
Upper Bound		870	25.7
OREAS 905		68	48.3
Target Range - Lower Bound		58	39.9
Upper Bound		76	55.1
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
UTS-4			

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method Analyte Units LOR	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02
STANDARDS																
UTS-4										1.76						
Target Range - Lower Bound										1.61						
Upper Bound										1.87						
BLANKS																
BLANK											<0.05	<0.2				
Target Range - Lower Bound											<0.05	<0.2				
Upper Bound											0.10	0.4				
BLANK													<0.01	<0.01	<0.1	<0.02
Target Range - Lower Bound													<0.01	<0.01	<0.1	<0.02
Upper Bound													0.02	0.02	0.2	0.04
BLANK						6.1										
Target Range - Lower Bound						5.5										
Upper Bound						6.9										
BLANK									<0.01							
Target Range - Lower Bound									<0.01							
Upper Bound									0.02							
BLANK										<0.01						
BLANK										<0.01						
Target Range - Lower Bound										<0.01						
Upper Bound										0.02						
BLANK								0.01								
Target Range - Lower Bound								<0.01								
Upper Bound								0.02								
DUPLICATES																
ORIGINAL													1.95	0.38	504	0.40
DUP													1.98	0.36	492	0.40
Target Range - Lower Bound													1.86	0.34	473	0.36
Upper Bound													2.07	0.40	523	0.44

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Target Range - Lower Bound	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Upper Bound	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	<10	60	0.20	0.25	0.10	<0.01	48.7	0.4	4	4.35	4.5	0.98	1.44	0.05	0.08
DUP	<10	60	0.16	0.24	0.10	0.01	50.4	0.4	5	4.36	4.0	0.94	1.35	<0.05	0.07
Target Range - Lower Bound	<10	50	0.12	0.22	0.09	<0.01	47.1	0.3	3	4.09	3.9	0.90	1.28	<0.05	0.05
Upper Bound	20	70	0.24	0.27	0.12	0.02	52.0	0.5	6	4.62	4.6	1.02	1.51	0.10	0.10

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description **Method** **Analyte** **Units** **LOR**	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Target Range - Lower Bound	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Upper Bound	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2	0.002
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.45	0.013	0.33	25.9	1.0	0.03	48	3.02	0.01	0.13	0.8	140	15.5	16.0	<0.001
DUP	0.45	0.013	0.32	26.9	1.0	0.03	46	3.09	0.01	0.13	0.7	140	15.5	15.4	<0.001
Target Range - Lower Bound	0.41	0.007	0.30	24.9	0.9	0.02	40	2.85	<0.01	0.07	0.5	120	14.5	14.8	<0.001
Upper Bound	0.49	0.019	0.35	27.9	1.2	0.04	54	3.26	0.02	0.19	1.0	160	16.5	16.6	0.002

Sample Description	Method Analyte Units LOR	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05
STANDARDS																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Target Range - Lower Bound		<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Upper Bound		0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL		0.25	5.08	0.6	<0.2	2.5	20.1	<0.01	0.04	8.6	<0.005	0.37	1.07	2	0.20	3.56
DUP		0.24	5.29	0.5	0.2	2.5	20.1	<0.01	0.04	8.2	<0.005	0.37	1.06	2	0.19	3.44
Target Range - Lower Bound		0.22	4.75	0.4	<0.2	2.2	18.9	<0.01	0.03	7.8	<0.005	0.32	0.96	<1	0.13	3.28
Upper Bound		0.27	5.62	0.7	0.4	2.8	21.3	0.02	0.05	9.0	0.010	0.42	1.17	3	0.26	3.73

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 25-MAY-2017
Account: APN

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
BLANKS			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK		<2	<0.5
Target Range - Lower Bound		<2	<0.5
Upper Bound		4	1.0
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
DUPLICATES			
ORIGINAL		6	2.0
DUP		6	1.9
Target Range - Lower Bound		4	1.3
Upper Bound		8	2.6

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
DUPLICATES																
L1919526-3 132282										0.04						
DUP										0.04						
Target Range - Lower Bound										0.03						
Upper Bound										0.05						
L1919526-7 132291									<0.01							
DUP									<0.01							
Target Range - Lower Bound									<0.01							
Upper Bound									0.02							
L1919526-9 MARCH TAL 2017						8.0		0.09								
DUP						8.0		0.09								
Target Range - Lower Bound						7.5		0.08								
Upper Bound						8.5		0.10								
L1919526-10 132294		0.6	2	16	17		27.20				0.13	0.5				
DUP		0.6	2	16	17		27.20				0.12	0.4				
Target Range - Lower Bound		<0.3	<1	14	15		25.83				0.07	<0.2				
Upper Bound		0.9	3	18	19		28.57				0.18	0.7				
L1919526-14 132298										<0.01						
DUP										<0.01						
Target Range - Lower Bound										<0.01						
Upper Bound										0.02						

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 25-MAY-2017
Account: APN

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	**Method Analyte Units LOR**	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
								DUPLICATES								
L1919526-3 132282																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-7 132291																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-9 MARCH TAL 2017																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-10 132294																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-14 132298																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
	Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
									DUPLICATES							
L1919526-3 132282																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-7 132291																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-9 MARCH TAL 2017																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-10 132294																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-14 132298																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
		DUPLICATES														
L1919526-3 132282																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-7 132291																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-9 MARCH TAL 2017																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-10 132294																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1919526-14 132298																
DUP																
Target Range - Lower Bound																
Upper Bound																

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
DUPLICATES			
L1919526-3 132282			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1919526-7 132291			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1919526-9 MARCH TAL 2017			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1919526-10 132294			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1919526-14 132298			
DUP			
Target Range - Lower Bound			
Upper Bound			

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1919526

QC CERTIFICATE OF ANALYSIS VA17088037

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	LOG-22	ME-MS41	OA-ELE07
OA-VOL08m	PUL-31	PUL-QC	S-CAL06
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1919526-COFC

COC Number: 17-10

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
		1:		~~Composite~~	R	R	R	R	R	R	
1	132287	07-Apr-17		WASTE	X	X	X	X	X	X	
2	132285	04-Apr-17		WASTE	X	X	X	X	X	X	
3	132282	02-Apr-17		WASTE	X	X	X	X	X	X	
4	132281	02-Apr-17		WASTE	X	X	X	X	X	X	
5	132278	28-Mar-17		WASTE	X	X	X	X	X	X	
6	132292	14-Apr-17		WASTE	X	X	X	X	X	X	
7	132291	12-APR-17		WASTE	X	X	X	X	X	X	
8	132293	12-APR-17		WASTE	X	X	X	X	X	X	
9	MARCH TAL 2017	22-APR-17		TAILS	X	X	X	X	X	X	
10	132294	13-APR-17		WASTE	X	X	X	X	X	X	
11	132295	14-APR-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Kala Joe	Date: April 24, 2017	Time:	Received by: VD	Date: April 28/17	Time: 15:45	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

JR May 2 15:00 12, 12, 12, 12, 1, 10, 10, 2

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1919526-COFC

COC Number: 15[redacted]

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

...irm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals - Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
12	132296	15-APR-17		WASTE	X	X	X	X	X	X	
13	132297	15-APR-17		WASTE	X	X	X	X	X	X	
14	132298	16APR17		WASTE	X	X	X	X	X	X	
15	132299	17-APR-17		WASTE	X	X	X	X	X	X	
16	132300	18-APR-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: Kara Joe Date: April 26, 2017 Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: VD Date: Apr 28/17 Time: 15:45

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1 If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 23-MAY-17
Report Date: 23-JUN-17 18:02 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #:	L1929673
Project P.O. #:	220826
Job Reference:	
C of C Numbers:	17-17
Legal Site Desc:	

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1929673-1	L1929673-2	L1929673-3	L1929673-4	L1929673-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	19-APR-17	19-APR-17	20-APR-17	21-APR-17	21-APR-17
	Sampled Time					
	Client ID	135351	135352	135353	135354	135355
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.1	8.8	8.5	8.2	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	0.22	0.36	0.24	0.06	0.05
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	1	1
	MPA (tCaCO3/1Kt)	0.6	0.3	0.6	0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	23	35	27	12	10
	NNP (tCaCO3/1Kt)	22	35	26	12	10
	Ratio (NP/MPA) (Unity)	36.80	112.00	43.20	38.40	32.00
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	0.02	<0.01	<0.01	0.02	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.01	0.02	0.01	<0.01
	Total Sulfur (combustion) (%)	0.02	0.01	0.02	0.01	0.01
Total Metals	Aluminum (Al) (%)	1.08	0.70	1.05	0.95	0.89
	Antimony (Sb) (ppm)	0.52	0.10	<0.05	0.17	<0.05
	Arsenic (As) (ppm)	6.2	6.8	1.2	3.2	3.9
	Barium (Ba) (ppm)	300	260	220	260	190
	Beryllium (Be) (ppm)	0.44	0.36	0.27	0.30	0.24
	Bismuth (Bi) (ppm)	0.32	0.02	0.03	0.07	0.24
	Boron (B) (ppm)	<10	10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.27	0.11	0.08	0.13	0.24
	Calcium (Ca) (%)	1.01	1.46	1.10	0.51	0.31
	Cerium (Ce) (ppm)	26.6	14.50	28.5	22.4	26.3
	Cesium (Cs) (ppm)	0.75	0.45	0.48	0.48	0.77
	Chromium (Cr) (ppm)	24	4	5	11	6
	Cobalt (Co) (ppm)	7.9	4.0	6.0	5.7	6.1
	Copper (Cu) (ppm)	1730	331	593	577	4470
	Gallium (Ga) (ppm)	4.10	4.79	5.32	4.45	4.41
	Germanium (Ge) (ppm)	0.10	0.08	0.11	0.09	0.11
	Gold (Au) (ppm)	0.03	<0.02	<0.02	<0.02	0.08
	Hafnium (Hf) (ppm)	0.22	0.05	0.04	0.10	0.04
	Indium (In) (ppm)	0.045	0.045	0.027	0.025	0.045
	Iron (Fe) (%)	2.46	1.90	2.44	2.08	2.11
	Lanthanum (La) (ppm)	13.5	6.7	14.8	11.3	14.1
	Lead (Pb) (ppm)	5.0	3.8	2.4	3.4	3.4
	Lithium (Li) (ppm)	7.0	4.1	5.6	6.5	4.0
	Magnesium (Mg) (%)	0.46	0.16	0.63	0.39	0.42
	Manganese (Mn) (ppm)	541	452	624	512	550

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929673-6	L1929673-7	L1929673-8	L1929673-9	L1929673-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	23-APR-17	02-MAY-17	26-APR-17	26-APR-17	28-APR-17
	Sampled Time					
	Client ID	135356	135359	135361	135362	135363
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.6	7.8	8.8	8.4	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	0.33	0.30	0.23	0.43	0.33
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	0.3	0.3	2.2	2.2
	Neutralization Potential (NP) (tCaCO3/1Kt)	31	13	29	44	34
	NNP (tCaCO3/1Kt)	30	13	29	42	32
	Ratio (NP/MPA) (Unity)	49.60	41.60	92.80	20.11	15.54
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	<0.01	0.01	<0.01	0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	<0.01	0.01	0.06	0.07
	Total Sulfur (combustion) (%)	0.02	0.01	0.01	0.07	0.07
Total Metals	Aluminum (Al) (%)	0.61	0.75	1.19	0.74	1.09
	Antimony (Sb) (ppm)	0.12	0.17	<0.05	0.14	<0.05
	Arsenic (As) (ppm)	7.3	10.0	1.3	2.7	0.8
	Barium (Ba) (ppm)	510	420	330	250	210
	Beryllium (Be) (ppm)	0.47	0.42	0.32	0.36	0.30
	Bismuth (Bi) (ppm)	0.03	10.10	0.09	1.12	0.21
	Boron (B) (ppm)	10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.14	0.81	0.05	0.21	0.17
	Calcium (Ca) (%)	1.30	0.23	1.16	1.64	1.33
	Cerium (Ce) (ppm)	19.95	14.70	22.6	25.4	25.9
	Cesium (Cs) (ppm)	0.52	0.51	0.43	0.50	0.47
	Chromium (Cr) (ppm)	4	7	6	4	5
	Cobalt (Co) (ppm)	5.6	7.1	6.2	7.8	5.7
	Copper (Cu) (ppm)	407	>10000	1250	4650	1360
	Gallium (Ga) (ppm)	4.95	3.58	5.87	4.15	5.51
	Germanium (Ge) (ppm)	0.09	0.11	0.11	0.10	0.08
	Gold (Au) (ppm)	<0.02	1.13	0.02	0.13	0.03
	Hafnium (Hf) (ppm)	0.06	0.09	0.06	0.04	0.05
	Indium (In) (ppm)	0.050	0.226	0.030	0.045	0.049
	Iron (Fe) (%)	2.30	3.75	2.55	2.72	2.45
	Lanthanum (La) (ppm)	9.3	7.7	11.4	13.9	13.6
	Lead (Pb) (ppm)	4.7	6.6	2.4	4.6	2.8
	Lithium (Li) (ppm)	3.3	3.1	6.3	3.3	5.5
	Magnesium (Mg) (%)	0.16	0.17	0.67	0.28	0.55
	Manganese (Mn) (ppm)	534	326	604	725	616

	Sample ID	L1929673-11	L1929673-12	L1929673-13	L1929673-14	L1929673-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	29-APR-17	29-APR-17	30-APR-17	30-APR-17	30-APR-17
	Sampled Time					
	Client ID	135364	135365	135366	135367	135368
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.3	8.7	8.7	8.7	8.5
Organic / Inorganic Carbon	Carbon (C) (%)	0.13	0.43	0.32	0.39	0.54
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.3	1.3	7.8	10.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	16	14	35	31	51
	NNP (tCaCO3/1Kt)	16	14	34	23	40
	Ratio (NP/MPA) (Unity)	51.20	44.80	28.00	3.97	4.66
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.01	0.02	0.02	0.01
	Sulfate Sulfur (HCl leach) (%)	0.02	0.01	0.02	0.02	0.03
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01	<0.01	0.02	0.23	0.34
	Total Sulfur (combustion) (%)	0.01	0.01	0.04	0.25	0.35
Total Metals	Aluminum (Al) (%)	1.14	0.71	1.51	1.21	1.30
	Antimony (Sb) (ppm)	0.24	0.09	0.05	<0.05	<0.05
	Arsenic (As) (ppm)	5.0	9.5	1.4	0.4	0.7
	Barium (Ba) (ppm)	270	250	280	300	290
	Beryllium (Be) (ppm)	0.37	0.41	0.44	0.21	0.26
	Bismuth (Bi) (ppm)	0.41	0.05	0.11	0.06	0.08
	Boron (B) (ppm)	<10	10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.19	0.15	0.07	0.10	0.37
	Calcium (Ca) (%)	0.69	1.68	1.40	1.22	1.90
	Cerium (Ce) (ppm)	24.5	22.8	27.6	19.10	25.0
	Cesium (Cs) (ppm)	0.71	0.57	0.43	0.52	0.48
	Chromium (Cr) (ppm)	17	5	6	5	5
	Cobalt (Co) (ppm)	6.9	5.3	6.1	5.9	6.5
	Copper (Cu) (ppm)	2860	636	717	1620	3050
	Gallium (Ga) (ppm)	5.02	5.13	7.52	5.49	7.20
	Germanium (Ge) (ppm)	0.09	0.10	0.10	0.09	0.11
	Gold (Au) (ppm)	0.11	0.02	0.05	0.02	0.05
	Hafnium (Hf) (ppm)	0.17	0.04	0.03	0.03	0.03
	Indium (In) (ppm)	0.072	0.057	0.034	0.082	0.101
	Iron (Fe) (%)	2.48	2.26	2.64	2.60	3.06
	Lanthanum (La) (ppm)	12.2	10.8	14.9	9.3	12.9
	Lead (Pb) (ppm)	4.8	4.0	4.0	2.5	3.5
	Lithium (Li) (ppm)	7.0	4.0	8.8	5.1	6.5
	Magnesium (Mg) (%)	0.46	0.19	0.78	0.67	0.65
	Manganese (Mn) (ppm)	384	540	626	417	642

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929673-16				
	Description	WASTE				
	Sampled Date	05-MAY-17				
	Sampled Time					
	Client ID	140902				
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2				
Organic / Inorganic Carbon	Carbon (C) (%)	0.26				
Acid Base Accounting	FIZZ RATING (Unity)	2				
	MPA (tCaCO3/1Kt)	0.6				
	Neutralization Potential (NP) (tCaCO3/1Kt)	29				
	NNP (tCaCO3/1Kt)	28				
	Ratio (NP/MPA) (Unity)	46.40				
	Sulfate Sulfur (carbonate leach) (%)	0.02				
	Sulfate Sulfur (HCl leach) (%)	0.04				
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01				
	Total Sulfur (combustion) (%)	0.02				
Total Metals	Aluminum (Al) (%)	1.06				
	Antimony (Sb) (ppm)	0.49				
	Arsenic (As) (ppm)	6.1				
	Barium (Ba) (ppm)	260				
	Beryllium (Be) (ppm)	0.40				
	Bismuth (Bi) (ppm)	0.10				
	Boron (B) (ppm)	<10				
	Cadmium (Cd) (ppm)	0.24				
	Calcium (Ca) (%)	1.25				
	Cerium (Ce) (ppm)	25.5				
	Cesium (Cs) (ppm)	0.78				
	Chromium (Cr) (ppm)	26				
	Cobalt (Co) (ppm)	7.9				
	Copper (Cu) (ppm)	141.5				
	Gallium (Ga) (ppm)	3.91				
	Germanium (Ge) (ppm)	0.09				
	Gold (Au) (ppm)	<0.02				
	Hafnium (Hf) (ppm)	0.24				
	Indium (In) (ppm)	0.023				
	Iron (Fe) (%)	2.18				
	Lanthanum (La) (ppm)	13.1				
	Lead (Pb) (ppm)	5.7				
	Lithium (Li) (ppm)	7.7				
	Magnesium (Mg) (%)	0.51				
	Manganese (Mn) (ppm)	445				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929673-1	L1929673-2	L1929673-3	L1929673-4	L1929673-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	19-APR-17	19-APR-17	20-APR-17	21-APR-17	21-APR-17
	Sampled Time					
	Client ID	135351	135352	135353	135354	135355
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.04	<0.01	0.01	0.01	0.01
	Molybdenum (Mo) (ppm)	1.09	0.44	1.15	1.17	2.90
	Nickel (Ni) (ppm)	19.3	1.6	2.3	8.3	3.1
	Niobium (Nb) (ppm)	0.73	0.06	0.11	0.30	0.23
	Phosphorus (P) (ppm)	860	460	760	640	790
	Potassium (K) (%)	0.22	0.31	0.49	0.25	0.61
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	<0.001	<0.001
	Rubidium (Rb) (ppm)	12.4	9.3	22.7	11.4	34.5
	Scandium (Sc) (ppm)	5.2	5.3	4.5	4.3	4.9
	Selenium (Se) (ppm)	0.9	0.2	0.5	0.4	1.2
	Silver (Ag) (ppm)	0.67	0.05	0.07	0.09	0.45
	Sodium (Na) (%)	0.05	0.07	0.03	0.04	0.04
	Strontium (Sr) (ppm)	54.7	67.7	51.2	32.7	22.6
	Sulfur (S) (%)	0.01	<0.01	0.01	<0.01	<0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.15	0.02	0.03	0.03	0.08
	Thallium (Tl) (ppm)	0.12	0.06	0.15	0.09	0.30
	Thorium (Th) (ppm)	3.4	1.7	3.5	2.8	4.0
	Tin (Sn) (ppm)	0.5	0.7	0.5	0.5	0.5
	Titanium (Ti) (%)	0.065	0.019	0.077	0.043	0.093
	Tungsten (W) (ppm)	0.43	0.08	0.42	0.53	0.53
	Uranium (U) (ppm)	0.51	0.12	0.22	0.26	0.24
	Vanadium (V) (ppm)	51	39	50	42	53
	Yttrium (Y) (ppm)	8.98	8.00	7.49	7.51	8.25
	Zinc (Zn) (ppm)	64	54	67	56	69
	Zirconium (Zr) (ppm)	6.9	1.1	0.7	3.1	1.3
Permanent Gases	Carbon Dioxide (CO2) (%)	0.8	1.3	0.9	0.2	0.2

	Sample ID	L1929673-6	L1929673-7	L1929673-8	L1929673-9	L1929673-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	23-APR-17	02-MAY-17	26-APR-17	26-APR-17	28-APR-17
	Sampled Time					
	Client ID	135356	135359	135361	135362	135363
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.22	0.01	0.01	0.01
	Molybdenum (Mo) (ppm)	0.69	2.17	0.72	1.34	1.15
	Nickel (Ni) (ppm)	2.9	6.2	2.4	2.3	2.1
	Niobium (Nb) (ppm)	<0.05	0.24	0.11	0.06	0.10
	Phosphorus (P) (ppm)	630	600	760	800	700
	Potassium (K) (%)	0.28	0.22	0.53	0.31	0.44
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	<0.001	0.002
	Rubidium (Rb) (ppm)	10.1	12.4	23.4	14.4	21.3
	Scandium (Sc) (ppm)	7.6	5.3	4.3	5.1	4.3
	Selenium (Se) (ppm)	0.5	11.4	0.6	3.5	0.7
	Silver (Ag) (ppm)	0.10	13.85	0.14	2.37	0.43
	Sodium (Na) (%)	0.04	0.03	0.08	0.03	0.05
	Strontium (Sr) (ppm)	47.1	55.8	64.9	60.9	63.8
	Sulfur (S) (%)	0.01	0.01	0.01	0.07	0.07
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	2.77	0.11	0.41	0.08
	Thallium (Tl) (ppm)	0.05	0.11	0.15	0.09	0.17
	Thorium (Th) (ppm)	2.5	2.9	2.2	2.8	4.1
	Tin (Sn) (ppm)	0.8	0.7	0.5	0.5	0.5
	Titanium (Ti) (%)	0.017	0.032	0.104	0.037	0.058
	Tungsten (W) (ppm)	0.13	0.30	0.42	0.14	0.29
	Uranium (U) (ppm)	0.15	0.72	0.23	0.26	0.32
	Vanadium (V) (ppm)	51	64	60	55	50
	Yttrium (Y) (ppm)	9.22	9.10	8.38	9.25	7.77
	Zinc (Zn) (ppm)	68	121	66	66	64
	Zirconium (Zr) (ppm)	1.5	3.2	1.1	1.0	1.1
Permanent Gases	Carbon Dioxide (CO2) (%)	1.2	1.1	0.9	1.6	1.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929673-11	L1929673-12	L1929673-13	L1929673-14	L1929673-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	29-APR-17	29-APR-17	30-APR-17	30-APR-17	30-APR-17
	Sampled Time					
	Client ID	135364	135365	135366	135367	135368
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.03	0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	1.17	0.72	1.09	6.93	9.27
	Nickel (Ni) (ppm)	11.0	2.3	2.6	2.1	2.1
	Niobium (Nb) (ppm)	0.95	0.07	0.15	0.19	0.17
	Phosphorus (P) (ppm)	700	640	740	840	840
	Potassium (K) (%)	0.42	0.33	0.54	0.69	0.57
	Rhenium (Re) (ppm)	<0.001	<0.001	0.001	0.031	0.025
	Rubidium (Rb) (ppm)	24.5	15.0	24.7	32.6	27.8
	Scandium (Sc) (ppm)	5.7	7.3	4.8	4.6	5.4
	Selenium (Se) (ppm)	1.2	0.4	1.1	1.7	2.6
	Silver (Ag) (ppm)	0.63	0.12	0.35	0.33	0.67
	Sodium (Na) (%)	0.05	0.05	0.07	0.07	0.06
	Strontium (Sr) (ppm)	43.9	64.6	70.6	63.2	96.3
	Sulfur (S) (%)	<0.01	<0.01	0.04	0.29	0.35
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.17	0.02	0.04	0.07	0.13
	Thallium (Tl) (ppm)	0.20	0.08	0.15	0.24	0.21
	Thorium (Th) (ppm)	4.2	2.7	3.1	1.6	1.9
	Tin (Sn) (ppm)	0.6	0.8	0.6	1.1	1.1
	Titanium (Ti) (%)	0.093	0.032	0.077	0.115	0.089
	Tungsten (W) (ppm)	0.60	0.21	0.41	0.44	0.29
	Uranium (U) (ppm)	0.48	0.18	0.20	0.26	0.68
	Vanadium (V) (ppm)	57	54	57	58	64
	Yttrium (Y) (ppm)	8.37	8.54	6.53	6.32	8.10
	Zinc (Zn) (ppm)	58	67	79	65	82
	Zirconium (Zr) (ppm)	5.8	1.1	0.8	0.8	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	0.5	1.6	1.2	1.4	2.0

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1929673-16				
	Description	WASTE				
	Sampled Date	05-MAY-17				
	Sampled Time					
	Client ID	140902				
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.04				
	Molybdenum (Mo) (ppm)	0.92				
	Nickel (Ni) (ppm)	20.6				
	Niobium (Nb) (ppm)	0.73				
	Phosphorus (P) (ppm)	790				
	Potassium (K) (%)	0.18				
	Rhenium (Re) (ppm)	0.001				
	Rubidium (Rb) (ppm)	10.5				
	Scandium (Sc) (ppm)	5.0				
	Selenium (Se) (ppm)	0.7				
	Silver (Ag) (ppm)	0.09				
	Sodium (Na) (%)	0.04				
	Strontium (Sr) (ppm)	63.9				
	Sulfur (S) (%)	0.01				
	Tantalum (Ta) (ppm)	<0.01				
	Tellurium (Te) (ppm)	0.02				
	Thallium (Tl) (ppm)	0.12				
	Thorium (Th) (ppm)	3.5				
	Tin (Sn) (ppm)	0.4				
	Titanium (Ti) (%)	0.066				
	Tungsten (W) (ppm)	0.31				
	Uranium (U) (ppm)	0.72				
	Vanadium (V) (ppm)	49				
	Yttrium (Y) (ppm)	8.54				
	Zinc (Zn) (ppm)	55				
	Zirconium (Zr) (ppm)	7.5				
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-17

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17104646

Project: L1929673
P.O. No.: ALSM-CW16-102-APN
This report is for 16 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 26-MAY-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1929673

CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41
	Analyte	Recvd Wt.	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al
	Units	kg	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
	LOR	0.02	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01
L1929673-1 135351		1.16	0.6	2	22	23	8.1	36.80	0.02	<0.01	0.02	0.02	0.22	0.8	0.67	1.08
L1929673-2 135352		1.08	0.3	2	35	35	8.8	112.00	0.01	<0.01	<0.01	0.01	0.36	1.3	0.05	0.70
L1929673-3 135353		1.16	0.6	2	26	27	8.5	43.20	0.02	<0.01	<0.01	0.02	0.24	0.9	0.07	1.05
L1929673-4 135354		1.16	0.3	1	12	12	8.2	38.40	0.01	<0.01	0.02	0.01	0.06	0.2	0.09	0.95
L1929673-5 135355		1.06	0.3	1	10	10	8.6	32.00	0.01	0.01	<0.01	<0.01	0.05	0.2	0.45	0.89
L1929673-6 135356		1.14	0.6	2	30	31	8.6	49.60	0.02	<0.01	0.01	0.02	0.33	1.2	0.10	0.61
L1929673-7 135359		2.00	0.3	2	13	13	7.8	41.60	0.01	0.01	<0.01	<0.01	0.30	1.1	13.85	0.75
L1929673-8 135361		1.12	0.3	2	29	29	8.8	92.80	0.01	<0.01	0.01	0.01	0.23	0.9	0.14	1.19
L1929673-9 135362		1.04	2.2	2	42	44	8.4	20.11	0.07	0.01	<0.01	0.06	0.43	1.6	2.37	0.74
L1929673-10 135363		1.16	2.2	2	32	34	8.6	15.54	0.07	<0.01	0.01	0.07	0.33	1.2	0.43	1.09
L1929673-11 135364		1.38	0.3	2	16	16	8.3	51.20	0.01	0.02	0.02	<0.01	0.13	0.5	0.63	1.14
L1929673-12 135365		1.04	0.3	2	14	14	8.7	44.80	0.01	0.01	0.01	<0.01	0.43	1.6	0.12	0.71
L1929673-13 135366		1.16	1.3	2	34	35	8.7	28.00	0.04	0.02	0.02	0.02	0.32	1.2	0.35	1.51
L1929673-14 135367		0.92	7.8	2	23	31	8.7	3.97	0.25	0.02	0.02	0.23	0.39	1.4	0.33	1.21
L1929673-15 135368		1.08	10.9	2	40	51	8.5	4.66	0.35	0.01	0.03	0.34	0.54	2.0	0.67	1.30
L1929673-16 140902		1.08	0.6	2	28	29	8.2	46.40	0.02	0.02	0.04	<0.01	0.26	1.0	0.09	1.06

CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
L1929673-1 135351		6.2	0.03	<10	300	0.44	0.32	1.01	0.27	26.6	7.9	24	0.75	1730	2.46	4.10
L1929673-2 135352		6.8	<0.02	10	260	0.36	0.02	1.46	0.11	14.50	4.0	4	0.45	331	1.90	4.79
L1929673-3 135353		1.2	<0.02	<10	220	0.27	0.03	1.10	0.08	28.5	6.0	5	0.48	593	2.44	5.32
L1929673-4 135354		3.2	<0.02	<10	260	0.30	0.07	0.51	0.13	22.4	5.7	11	0.48	577	2.08	4.45
L1929673-5 135355		3.9	0.08	<10	190	0.24	0.24	0.31	0.24	26.3	6.1	6	0.77	4470	2.11	4.41
L1929673-6 135356		7.3	<0.02	10	510	0.47	0.03	1.30	0.14	19.95	5.6	4	0.52	407	2.30	4.95
L1929673-7 135359		10.0	1.13	<10	420	0.42	10.10	0.23	0.81	14.70	7.1	7	0.51	>10000	3.75	3.58
L1929673-8 135361		1.3	0.02	<10	330	0.32	0.09	1.16	0.05	22.6	6.2	6	0.43	1250	2.55	5.87
L1929673-9 135362		2.7	0.13	<10	250	0.36	1.12	1.64	0.21	25.4	7.8	4	0.50	4650	2.72	4.15
L1929673-10 135363		0.8	0.03	<10	210	0.30	0.21	1.33	0.17	25.9	5.7	5	0.47	1360	2.45	5.51
L1929673-11 135364		5.0	0.11	<10	270	0.37	0.41	0.69	0.19	24.5	6.9	17	0.71	2860	2.48	5.02
L1929673-12 135365		9.5	0.02	10	250	0.41	0.05	1.68	0.15	22.8	5.3	5	0.57	636	2.26	5.13
L1929673-13 135366		1.4	0.05	<10	280	0.44	0.11	1.40	0.07	27.6	6.1	6	0.43	717	2.64	7.52
L1929673-14 135367		0.4	0.02	<10	300	0.21	0.06	1.22	0.10	19.10	5.9	5	0.52	1620	2.60	5.49
L1929673-15 135368		0.7	0.05	<10	290	0.26	0.08	1.90	0.37	25.0	6.5	5	0.48	3050	3.06	7.20
L1929673-16 140902		6.1	<0.02	<10	260	0.40	0.10	1.25	0.24	25.5	7.9	26	0.78	141.5	2.18	3.91

Project: L1929673

CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1929673-1 135351		0.10	0.22	0.04	0.045	0.22	13.5	7.0	0.46	541	1.09	0.05	0.73	19.3	860	5.0
L1929673-2 135352		0.08	0.05	<0.01	0.045	0.31	6.7	4.1	0.16	452	0.44	0.07	0.06	1.6	460	3.8
L1929673-3 135353		0.11	0.04	0.01	0.027	0.49	14.8	5.6	0.63	624	1.15	0.03	0.11	2.3	760	2.4
L1929673-4 135354		0.09	0.10	0.01	0.025	0.25	11.3	6.5	0.39	512	1.17	0.04	0.30	8.3	640	3.4
L1929673-5 135355		0.11	0.04	0.01	0.045	0.61	14.1	4.0	0.42	550	2.90	0.04	0.23	3.1	790	3.4
L1929673-6 135356		0.09	0.06	0.01	0.050	0.28	9.3	3.3	0.16	534	0.69	0.04	<0.05	2.9	630	4.7
L1929673-7 135359		0.11	0.09	0.22	0.226	0.22	7.7	3.1	0.17	326	2.17	0.03	0.24	6.2	600	6.6
L1929673-8 135361		0.11	0.06	0.01	0.030	0.53	11.4	6.3	0.67	604	0.72	0.08	0.11	2.4	760	2.4
L1929673-9 135362		0.10	0.04	0.01	0.045	0.31	13.9	3.3	0.28	725	1.34	0.03	0.06	2.3	800	4.6
L1929673-10 135363		0.08	0.05	0.01	0.049	0.44	13.6	5.5	0.55	616	1.15	0.05	0.10	2.1	700	2.8
L1929673-11 135364		0.09	0.17	0.03	0.072	0.42	12.2	7.0	0.46	384	1.17	0.05	0.95	11.0	700	4.8
L1929673-12 135365		0.10	0.04	0.01	0.057	0.33	10.8	4.0	0.19	540	0.72	0.05	0.07	2.3	640	4.0
L1929673-13 135366		0.10	0.03	<0.01	0.034	0.54	14.9	8.8	0.78	626	1.09	0.07	0.15	2.6	740	4.0
L1929673-14 135367		0.09	0.03	<0.01	0.082	0.69	9.3	5.1	0.67	417	6.93	0.07	0.19	2.1	840	2.5
L1929673-15 135368		0.11	0.03	<0.01	0.101	0.57	12.9	6.5	0.65	642	9.27	0.06	0.17	2.1	840	3.5
L1929673-16 140902		0.09	0.24	0.04	0.023	0.18	13.1	7.7	0.51	445	0.92	0.04	0.73	20.6	790	5.7

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
	Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
	LOR	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
L1929673-1 135351		12.4	<0.001	0.01	0.52	5.2	0.9	0.5	54.7	<0.01	0.15	3.4	0.065	0.12	0.51	51
L1929673-2 135352		9.3	<0.001	<0.01	0.10	5.3	0.2	0.7	67.7	<0.01	0.02	1.7	0.019	0.06	0.12	39
L1929673-3 135353		22.7	<0.001	0.01	<0.05	4.5	0.5	0.5	51.2	<0.01	0.03	3.5	0.077	0.15	0.22	50
L1929673-4 135354		11.4	<0.001	<0.01	0.17	4.3	0.4	0.5	32.7	<0.01	0.03	2.8	0.043	0.09	0.26	42
L1929673-5 135355		34.5	<0.001	<0.01	<0.05	4.9	1.2	0.5	22.6	<0.01	0.08	4.0	0.093	0.30	0.24	53
L1929673-6 135356		10.1	<0.001	0.01	0.12	7.6	0.5	0.8	47.1	<0.01	0.01	2.5	0.017	0.05	0.15	51
L1929673-7 135359		12.4	<0.001	0.01	0.17	5.3	11.4	0.7	55.8	<0.01	2.77	2.9	0.032	0.11	0.72	64
L1929673-8 135361		23.4	<0.001	0.01	<0.05	4.3	0.6	0.5	64.9	<0.01	0.11	2.2	0.104	0.15	0.23	60
L1929673-9 135362		14.4	<0.001	0.07	0.14	5.1	3.5	0.5	60.9	<0.01	0.41	2.8	0.037	0.09	0.26	55
L1929673-10 135363		21.3	0.002	0.07	<0.05	4.3	0.7	0.5	63.8	<0.01	0.08	4.1	0.058	0.17	0.32	50
L1929673-11 135364		24.5	<0.001	<0.01	0.24	5.7	1.2	0.6	43.9	<0.01	0.17	4.2	0.093	0.20	0.48	57
L1929673-12 135365		15.0	<0.001	<0.01	0.09	7.3	0.4	0.8	64.6	<0.01	0.02	2.7	0.032	0.08	0.18	54
L1929673-13 135366		24.7	0.001	0.04	0.05	4.8	1.1	0.6	70.6	<0.01	0.04	3.1	0.077	0.15	0.20	57
L1929673-14 135367		32.6	0.031	0.29	<0.05	4.6	1.7	1.1	63.2	<0.01	0.07	1.6	0.115	0.24	0.26	58
L1929673-15 135368		27.8	0.025	0.35	<0.05	5.4	2.6	1.1	96.3	<0.01	0.13	1.9	0.089	0.21	0.68	64
L1929673-16 140902		10.5	0.001	0.01	0.49	5.0	0.7	0.4	63.9	<0.01	0.02	3.5	0.066	0.12	0.72	49

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1929673

CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
L1929673-1 135351		0.43	8.98	64	6.9	
L1929673-2 135352		0.08	8.00	54	1.1	
L1929673-3 135353		0.42	7.49	67	0.7	
L1929673-4 135354		0.53	7.51	56	3.1	
L1929673-5 135355		0.53	8.25	69	1.3	
L1929673-6 135356		0.13	9.22	68	1.5	
L1929673-7 135359		0.30	9.10	121	3.2	3.54
L1929673-8 135361		0.42	8.38	66	1.1	
L1929673-9 135362		0.14	9.25	66	1.0	
L1929673-10 135363		0.29	7.77	64	1.1	
L1929673-11 135364		0.60	8.37	58	5.8	
L1929673-12 135365		0.21	8.54	67	1.1	
L1929673-13 135366		0.41	6.53	79	0.8	
L1929673-14 135367		0.44	6.32	65	0.8	
L1929673-15 135368		0.29	8.10	82	0.9	
L1929673-16 140902		0.31	8.54	55	7.5	

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1929673

CERTIFICATE OF ANALYSIS VA17104646

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	Cu-OG46	LOG-22	ME-MS41
ME-OG46	OA-ELE07	OA-VOL08m	PUL-31
PUL-QC	S-CAL06	S-GRA06	S-GRA06a
S-IR08	SPL-21	WEI-21	

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 22-JUN-2017
Account: APN

QC CERTIFICATE VA17104646

Project: L1929673

P.O. No.: ALSM-CW16-102-APN

This report is for 16 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 26-MAY-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE
SOFTWARE DEVELOPMENT GROUP
SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

STANDARDS

Sample Description / Method / Analyte / Units / LOR	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02
Buffer pH6					6.0										
Buffer pH6					6.0										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CCU-1e															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY										0.50	1.9				
Target Range - Lower Bound										0.42	1.5				
Upper Bound										0.64	2.4				
DS-1							2.63								
Target Range - Lower Bound							2.51								
Upper Bound							2.71								
GBM903-13															
Target Range - Lower Bound															
Upper Bound															
GS310-10							0.27								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								
KZK-1	25.0	2	31	56		2.24									
KZK-1	25.0	2	32	57		2.28									
Target Range - Lower Bound	22.9	<1	30	54		2.18									
Upper Bound	27.1	>4	38	64		2.53									
MA-2c										1.61	5.9				
Target Range - Lower Bound										1.50	5.5				
Upper Bound										1.84	6.8				
MA-3a										2.40	8.8				
Target Range - Lower Bound										2.31	8.4				
Upper Bound										2.77	10.2				
OGGeo08												19.40	2.25	125.0	0.07
Target Range - Lower Bound												18.15	2.05	107.0	0.03
Upper Bound												22.2	2.53	131.0	0.11

QC CERTIFICATE OF ANALYSIS VA17104646

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02
Sample Description															
							STANDARDS								
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CCU-1e															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GBM903-13															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	<10	70	0.75	10.55	0.90	19.70	60.1	94.4	84	9.35	8430	5.08	8.27	0.18	0.79
Target Range - Lower Bound	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21	0.72
Upper Bound	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45	0.92

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description																
	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
	Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CCU-1e																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GBM903-13																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		0.48	1.410	1.11	29.5	30.4	0.96	389	889	0.29	0.82	9000	830	7350	120.5	1.365
Target Range - Lower Bound		0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5	1.295
Upper Bound		0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5	1.585

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CCU-1e															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GBM903-13															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	2.78	19.05	6.1	12.1	12.9	64.3	0.01	0.13	16.1	0.309	1.52	4.81	82	2.96	16.20
Target Range - Lower Bound	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58	15.35
Upper Bound	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60	18.85

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
STANDARDS				
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CCU-1e				22.5
Target Range - Lower Bound				22.1
Upper Bound				23.7
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
DS-1				
Target Range - Lower Bound				
Upper Bound				
GBM903-13				2.84
Target Range - Lower Bound				2.79
Upper Bound				3.00
GS310-10				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-2c				
Target Range - Lower Bound				
Upper Bound				
MA-3a				
Target Range - Lower Bound				
Upper Bound				
OGGeo08		7090	22.7	
Target Range - Lower Bound		6500	19.5	
Upper Bound		7950	27.5	

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 22-JUN-2017
Account: APN

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description **Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
STANDARDS															
OREAS 621															
Target Range - Lower Bound															
Upper Bound															
OREAS 920												0.09	2.31	4.9	<0.02
Target Range - Lower Bound												0.07	2.18	3.8	<0.02
Upper Bound												0.12	2.68	4.9	0.04
SY-4										0.90	3.3				
Target Range - Lower Bound										0.84	3.0				
Upper Bound										1.08	4.0				
UTS-1								0.85							
UTS-1								0.86							
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.84						
UTS-1									0.90						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-4								1.74							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.75						
UTS-4									1.76						
Target Range - Lower Bound									1.61						
Upper Bound									1.87						
BLANKS															
BLANK										<0.05	<0.2				
BLANK										<0.05	<0.2				
Target Range - Lower Bound										<0.05	<0.2				
Upper Bound										0.10	0.4				

***** See Appendix Page for comments regarding this certificate *****

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
								STANDARDS								
OREAS 621																
Target Range - Lower Bound																
Upper Bound																
OREAS 920		<10	80	0.65	0.59	0.31	0.06	70.2	13.4	44	1.94	111.5	3.42	6.34	0.12	0.57
Target Range - Lower Bound		<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05	0.53
Upper Bound		20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22	0.69
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
								BLANKS								
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17104646

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
Sample Description															
STANDARDS															
OREAS 621															
Target Range - Lower Bound															
Upper Bound															
OREAS 920	0.01	0.029	0.40	35.3	20.4	1.03	495	0.46	0.01	0.33	38.1	710	22.0	23.3	<0.001
Target Range - Lower Bound	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2	<0.001
Upper Bound	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4	0.002
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
STANDARDS															
OREAS 621															
Target Range - Lower Bound															
Upper Bound															
OREAS 920	0.03	0.63	2.7	0.9	1.1	17.1	0.01	0.02	14.9	0.110	0.16	1.99	24	0.41	17.30
Target Range - Lower Bound	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31	16.85
Upper Bound	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61	20.7
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
STANDARDS				
OREAS 621				0.361
Target Range - Lower Bound				
Upper Bound				
OREAS 920		100	21.4	
Target Range - Lower Bound		93	17.6	
Upper Bound		119	25.0	
SY-4				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
BLANKS				
BLANK				
BLANK				
Target Range - Lower Bound				
Upper Bound				

QC CERTIFICATE OF ANALYSIS VA17104646

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK												<0.01	<0.01	0.1	<0.02
Target Range - Lower Bound												<0.01	<0.01	<0.1	<0.02
Upper Bound												0.02	0.02	0.2	0.04
BLANK					6.0										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										
BLANK								<0.01							
BLANK								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
BLANK									<0.01						
BLANK									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						
BLANK							0.01								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL												2.67	1.63	27.6	0.39
DUP												2.76	1.74	29.0	0.93
Target Range - Lower Bound												2.57	1.59	26.8	0.61
Upper Bound												2.86	1.78	29.8	0.71

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	0.05	<0.02
Target Range - Lower Bound		<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Upper Bound		20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10	0.04
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		10	60	0.30	0.90	0.81	2.20	8.81	9.9	29	3.57	2400	4.26	4.55	0.09	0.03
DUP		10	70	0.33	0.99	0.85	2.35	9.56	10.5	31	3.83	2480	4.51	4.85	0.08	0.03
Target Range - Lower Bound		<10	50	0.25	0.89	0.78	2.15	8.71	9.6	28	3.47	2350	4.16	4.42	<0.05	<0.02
Upper Bound		20	80	0.38	1.00	0.88	2.40	9.66	10.8	33	3.94	2530	4.61	4.99	0.10	0.04

QC CERTIFICATE OF ANALYSIS VA17104646

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Target Range - Lower Bound	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Upper Bound	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2	0.002
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	0.06	0.134	0.28	4.4	16.1	0.54	722	217	0.04	0.23	19.4	720	74.8	13.4	0.195
DUP	0.05	0.135	0.30	4.8	17.2	0.57	757	227	0.05	0.23	21.1	760	79.5	14.6	0.224
Target Range - Lower Bound	0.04	0.123	0.27	4.2	15.7	0.52	698	211	0.03	0.17	19.0	690	73.1	13.2	0.198
Upper Bound	0.07	0.146	0.31	5.0	17.6	0.59	781	233	0.06	0.29	21.5	790	81.2	14.8	0.221

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Target Range - Lower Bound	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Upper Bound	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	2.11	1.60	2.5	4.0	0.6	53.3	<0.01	0.66	3.0	0.040	0.30	0.58	31	1.46	4.48
DUP	2.22	1.63	2.6	4.5	0.6	57.2	<0.01	0.75	3.2	0.043	0.28	0.61	33	1.49	4.73
Target Range - Lower Bound	2.05	1.44	2.3	3.8	0.4	52.3	<0.01	0.66	2.7	0.034	0.25	0.52	29	1.31	4.32
Upper Bound	2.28	1.79	2.8	4.7	0.8	58.2	0.02	0.75	3.5	0.049	0.33	0.67	35	1.64	4.89

QC CERTIFICATE OF ANALYSIS VA17104646

Method	ME-MS41	ME-MS41	Cu-OG46
Analyte	Zn	Zr	Cu
Units	ppm	ppm	%
Sample Description LOR	2	0.5	0.001
BLANKS			
BLANK			<0.001
Target Range - Lower Bound			<0.001
Upper Bound			0.002
BLANK	<2	<0.5	
Target Range - Lower Bound	<2	<0.5	
Upper Bound	4	1.0	
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
DUPLICATES			
ORIGINAL			0.163
DUP			0.165
Target Range - Lower Bound			0.159
Upper Bound			0.169
ORIGINAL	423	0.8	
DUP	444	0.9	
Target Range - Lower Bound	410	<0.5	
Upper Bound	457	1.0	

***** See Appendix Page for comments regarding this certificate *****

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

DUPLICATES

Sample Description / Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
ORIGINAL								0.02							
DUP								0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
L1929673-3 135353								<0.01							
DUP								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
L1929673-10 135363	2.2	2	32	34	8.6	15.54	0.07		0.01	0.33	1.2				
DUP	1.9	2	32	34	8.6	18.13	0.06		0.03	0.32	1.2				
Target Range - Lower Bound	1.6	<1	29	31	8.1	15.98	0.05		<0.01	0.26	0.9				
Upper Bound	2.5	3	35	37	9.1	17.69	0.08		0.03	0.39	1.5				
L1929673-12 135365										0.43	1.6				
DUP										0.44	1.6				
Target Range - Lower Bound										0.36	1.3				
Upper Bound										0.51	1.9				
I1932378-1 C4									<0.01						
DUP									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
		DUPLICATES														
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-3 135353																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-10 135363																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-12 135365																
DUP																
Target Range - Lower Bound																
Upper Bound																
I1932378-1 C4																
DUP																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 22-JUN-2017
Account: APN

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001
								DUPLICATES								
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-3 135353																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-10 135363																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-12 135365																
DUP																
Target Range - Lower Bound																
Upper Bound																
I1932378-1 C4																
DUP																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1929673

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-3 135353																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-10 135363																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1929673-12 135365																
DUP																
Target Range - Lower Bound																
Upper Bound																
I1932378-1 C4																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17104646

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
		DUPLICATES		
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1929673-3 135353				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1929673-10 135363				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1929673-12 135365				
DUP				
Target Range - Lower Bound				
Upper Bound				
I1932378-1 C4				
DUP				
Target Range - Lower Bound				
Upper Bound				

QC CERTIFICATE OF ANALYSIS VA17104646

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
ME-OG46
PUL-QC
S-IR08
Cu-OG46
OA-ELE07
S-CAL06
SPL-21
LOG-22
OA-VOL08m
S-GRA06
WEI-21
ME-MS41
PUL-31
S-GRA06a

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1929673-COFC

COC Number: 17-17

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Di

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	~~[illegible]~~	~~19APR~~		Composite	R	R	R	R	R	R	
1	135351	19-APR-17		WASTE	X	X	X	X	X	X	
2	135352	19-APR-17		WASTE	X	X	X	X	X	X	
3	135353	20-APR-17		WASTE	X	X	X	X	X	X	
4	135354	21-APR-17		WASTE	X	X	X	X	X	X	
5	135355	21-APR-17		WASTE	X	X	X	X	X	X	
6	135356	23-APR-17		WASTE	X	X	X	X	X	X	
7	135359	2-may-17		WASTE	X	X	X	X	X	X	
8	135361	26/04/17		WASTE	X	X	X	X	X	X	
9	135362	26/04/17		|	X	X	X	X	X	X	
10	135363	28/04/17		|	X	X	X	X	X	X	
11	135364	29/04/17		|	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 13.6
FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: VD	Date: May 23/17	Time: 9:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form.

CEF May 24/17 12:40 92/162

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

1 L1929673-COFC

COC Number: 17-17

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / D

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Il E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
12	135365	29/04/17		Composite	X	X	X	X	X	X	
13	135366	30/04/17		waste	X	X	X	X	X	X	
14	135367	30/04/17		waste	X	X	X	X	X	X	
15	135368	30/04/17		waste	X	X	X	X	X	X	
16	140902	05/05/17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 13.6

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: VD	Date: May 23/17	Time: 9:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

CEF May 24/17 92/162 12:40

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 26-MAY-17
Report Date: 05-JUL-17 17:30 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1932915
Project P.O. #: 226298
Job Reference:
C of C Numbers: 17-18
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1932915-1	L1932915-2	L1932915-3	L1932915-4	L1932915-5
	Sample ID	L1932915-1	L1932915-2	L1932915-3	L1932915-4	L1932915-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	24-APR-17	24-APR-17	02-MAY-17	02-MAY-17	03-MAY-17
	Sampled Time					
	Client ID	135357	135358	135369	135370	135372
SOIL						
Physical Tests	pH (Unity)	8.7	8.5	7.9	8.6	8.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.27	0.41	0.27	0.30	0.23
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	27.2	0.9	0.9	0.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	28	37	28	32	26
	NNP (tCaCO3/1Kt)	27	10	27	31	25
	Ratio (NP/MPA) (Unity)	44.80	1.36	29.87	34.13	27.73
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.02	0.01	0.02	0.03
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.86	0.03	0.03	0.03
	Total Sulfur (combustion) (%)	0.02	0.87	0.03	0.03	0.03
Total Metals	Aluminum (Al) (%)	1.11	1.14	1.19	1.27	1.38
	Antimony (Sb) (ppm)	<0.05	0.05	0.52	<0.05	0.72
	Arsenic (As) (ppm)	1.2	4.9	6.8	0.8	8.1
	Barium (Ba) (ppm)	250	190	280	230	320
	Beryllium (Be) (ppm)	0.35	0.23	0.45	0.30	0.52
	Bismuth (Bi) (ppm)	0.04	0.25	0.10	0.04	0.13
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.05	0.66	0.28	0.07	0.30
	Calcium (Ca) (%)	1.22	1.45	1.34	1.26	1.19
	Cerium (Ce) (ppm)	23.3	23.7	30.2	30.7	32.1
	Cesium (Cs) (ppm)	0.32	0.72	0.78	0.44	1.12
	Chromium (Cr) (ppm)	5	5	28	5	33
	Cobalt (Co) (ppm)	5.5	5.7	9.7	7.5	11.5
	Copper (Cu) (ppm)	214	5320	206	535	95.1
	Gallium (Ga) (ppm)	6.17	6.70	4.42	6.85	5.06
	Germanium (Ge) (ppm)	0.09	0.10	0.08	0.07	0.06
	Gold (Au) (ppm)	<0.02	0.13	<0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.04	0.04	0.26	0.05	0.29
	Indium (In) (ppm)	0.019	0.156	0.025	0.028	0.027
	Iron (Fe) (%)	2.30	3.29	2.47	2.61	2.81
	Lanthanum (La) (ppm)	12.5	12.4	15.6	16.5	16.0
	Lead (Pb) (ppm)	3.2	4.0	6.7	2.6	7.4
	Lithium (Li) (ppm)	7.2	4.9	8.7	6.8	9.5
	Magnesium (Mg) (%)	0.60	0.61	0.60	0.74	0.72
	Manganese (Mn) (ppm)	515	535	604	618	603

	Sample ID	L1932915-6	L1932915-7	L1932915-8	L1932915-9	L1932915-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-MAY-17	05-MAY-17	05-MAY-17	06-MAY-17	05-MAY-17
	Sampled Time					
	Client ID	135373	135374	135375	140903	140901
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.8	8.3	8.2	8.7	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.26	0.21	<0.05	0.23	0.25
Acid Base Accounting	FIZZ RATING (Unity)	2	1	1	2	2
	MPA (tCaCO3/1Kt)	1.3	0.6	0.3	0.6	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	30	23	6	27	31
	NNP (tCaCO3/1Kt)	29	22	6	26	31
	Ratio (NP/MPA) (Unity)	24.00	36.80	19.20	43.20	99.20
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.02	0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.03	<0.01	0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.04	<0.01	<0.01	0.01	0.01
	Total Sulfur (combustion) (%)	0.04	0.02	0.01	0.02	0.01
Total Metals	Aluminum (Al) (%)	1.22	0.84	0.79	1.12	0.57
	Antimony (Sb) (ppm)	<0.05	0.28	0.09	<0.05	0.05
	Arsenic (As) (ppm)	1.0	4.2	5.6	1.5	10.6
	Barium (Ba) (ppm)	200	230	160	180	230
	Beryllium (Be) (ppm)	0.34	0.30	0.36	0.31	0.40
	Bismuth (Bi) (ppm)	0.11	0.30	0.24	0.10	0.04
	Boron (B) (ppm)	<10	<10	<10	<10	10
	Cadmium (Cd) (ppm)	0.09	0.18	0.37	0.05	0.27
	Calcium (Ca) (%)	1.29	0.87	0.27	1.20	1.26
	Cerium (Ce) (ppm)	21.4	20.1	23.6	23.0	25.1
	Cesium (Cs) (ppm)	0.36	0.54	0.58	0.41	0.47
	Chromium (Cr) (ppm)	5	14	8	5	6
	Cobalt (Co) (ppm)	6.8	6.4	6.9	7.6	6.3
	Copper (Cu) (ppm)	668	2600	3260	699	495
	Gallium (Ga) (ppm)	6.40	3.88	4.71	5.96	4.56
	Germanium (Ge) (ppm)	0.07	0.06	0.06	0.07	0.07
	Gold (Au) (ppm)	<0.02	0.10	0.10	0.02	<0.02
	Hafnium (Hf) (ppm)	0.06	0.15	0.09	0.06	0.05
	Indium (In) (ppm)	0.029	0.080	0.048	0.020	0.057
	Iron (Fe) (%)	2.50	2.39	2.59	2.28	2.47
	Lanthanum (La) (ppm)	11.4	10.6	11.1	12.5	12.6
	Lead (Pb) (ppm)	2.4	3.6	3.3	2.5	3.5
	Lithium (Li) (ppm)	6.3	4.5	3.6	6.2	2.5
	Magnesium (Mg) (%)	0.75	0.39	0.23	0.67	0.14
	Manganese (Mn) (ppm)	637	423	494	556	732

Grouping	Analyte					
	Sample ID	L1932915-11	L1932915-12	L1932915-13	L1932915-14	L1932915-15
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	08-MAY-17	08-MAY-17	26-MAY-17	12-MAY-17	14-MAY-17
	Sampled Time					
	Client ID	140904	140905	135360	140909	140913
SOIL						
Physical Tests	pH (Unity)	8.3	8.5	8.1	8.8	8.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.27	0.08	0.19	0.14	0.35
Acid Base Accounting	FIZZ RATING (Unity)	2	1	1	1	2
	MPA (tCaCO3/1Kt)	0.9	0.3	0.9	6.6	4.4
	Neutralization Potential (NP) (tCaCO3/1Kt)	28	11	21	22	33
	NNP (tCaCO3/1Kt)	27	11	20	15	29
	Ratio (NP/MPA) (Unity)	29.87	35.20	22.40	3.35	7.54
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	0.01	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.03	0.01	0.03	0.20	0.13
	Total Sulfur (combustion) (%)	0.03	0.01	0.03	0.21	0.14
Total Metals	Aluminum (Al) (%)	0.85	0.64	0.95	1.26	1.15
	Antimony (Sb) (ppm)	0.45	0.14	0.50	<0.05	<0.05
	Arsenic (As) (ppm)	4.8	4.6	5.8	0.4	0.7
	Barium (Ba) (ppm)	280	230	300	330	250
	Beryllium (Be) (ppm)	0.34	0.39	0.38	0.21	0.25
	Bismuth (Bi) (ppm)	0.21	0.96	0.23	0.20	0.07
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.18	0.18	0.21	0.26	0.21
	Calcium (Ca) (%)	1.19	0.39	0.92	0.74	1.29
	Cerium (Ce) (ppm)	21.2	15.15	22.3	24.1	24.8
	Cesium (Cs) (ppm)	0.62	0.61	0.72	0.36	0.48
	Chromium (Cr) (ppm)	21	8	20	6	5
	Cobalt (Co) (ppm)	7.4	5.8	7.9	6.9	6.7
	Copper (Cu) (ppm)	694	4370	367	3050	1455
	Gallium (Ga) (ppm)	3.44	4.91	4.21	6.35	6.43
	Germanium (Ge) (ppm)	0.05	0.06	0.05	0.06	0.07
	Gold (Au) (ppm)	0.05	0.18	0.02	0.06	0.03
	Hafnium (Hf) (ppm)	0.20	0.06	0.18	0.06	0.05
	Indium (In) (ppm)	0.037	0.067	0.034	0.060	0.053
	Iron (Fe) (%)	2.07	2.88	2.36	2.54	2.79
	Lanthanum (La) (ppm)	10.7	7.7	11.3	12.7	12.7
	Lead (Pb) (ppm)	4.3	3.3	4.7	2.0	2.3
	Lithium (Li) (ppm)	5.5	3.4	6.2	6.1	5.2
	Magnesium (Mg) (%)	0.43	0.18	0.43	0.74	0.68
	Manganese (Mn) (ppm)	410	473	478	543	605

	Sample ID	L1932915-16	L1932915-17	L1932915-18	L1932915-19	L1932915-20
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-MAY-17	02-MAY-17	10-MAY-17	11-MAY-17	12-MAY-17
	Sampled Time					
	Client ID	140906	135371	140907	140908	140910
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	8.7	8.6	8.4	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.07	0.50	0.27	0.16	0.36
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	1	2
	MPA (tCaCO3/1Kt)	0.3	0.3	0.6	0.9	3.1
	Neutralization Potential (NP) (tCaCO3/1Kt)	14	44	27	22	36
	NNP (tCaCO3/1Kt)	14	44	26	21	33
	Ratio (NP/MPA) (Unity)	44.80	140.80	43.20	23.47	11.52
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.02	0.01	<0.01	0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.01	0.02	0.03	0.10
	Total Sulfur (combustion) (%)	0.01	0.01	0.02	0.03	0.10
Total Metals	Aluminum (Al) (%)	0.90	0.48	0.51	0.95	0.98
	Antimony (Sb) (ppm)	0.05	0.06	0.17	0.07	<0.05
	Arsenic (As) (ppm)	1.4	11.2	5.8	1.8	0.9
	Barium (Ba) (ppm)	210	240	460	170	190
	Beryllium (Be) (ppm)	0.33	0.40	0.43	0.30	0.30
	Bismuth (Bi) (ppm)	0.05	0.02	0.05	0.10	0.28
	Boron (B) (ppm)	<10	10	10	<10	<10
	Cadmium (Cd) (ppm)	0.10	0.09	0.13	0.18	0.09
	Calcium (Ca) (%)	0.59	1.83	1.15	0.92	1.33
	Cerium (Ce) (ppm)	22.5	24.2	18.15	26.3	34.4
	Cesium (Cs) (ppm)	0.46	0.42	0.33	0.44	0.46
	Chromium (Cr) (ppm)	5	4	6	7	6
	Cobalt (Co) (ppm)	5.5	4.5	5.5	5.6	7.4
	Copper (Cu) (ppm)	1105	191.0	573	916	2710
	Gallium (Ga) (ppm)	5.07	4.02	3.50	5.07	5.82
	Germanium (Ge) (ppm)	0.06	0.05	<0.05	0.06	0.08
	Gold (Au) (ppm)	<0.02	<0.02	0.03	0.03	0.06
	Hafnium (Hf) (ppm)	0.06	0.04	0.07	0.07	0.06
	Indium (In) (ppm)	0.033	0.039	0.066	0.038	0.048
	Iron (Fe) (%)	2.19	2.02	1.99	2.34	2.87
	Lanthanum (La) (ppm)	11.1	12.5	9.6	14.1	18.6
	Lead (Pb) (ppm)	2.9	3.6	9.1	4.5	3.1
	Lithium (Li) (ppm)	4.8	2.1	1.6	4.4	4.7
	Magnesium (Mg) (%)	0.40	0.11	0.07	0.43	0.58
	Manganese (Mn) (ppm)	559	486	412	642	625

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1932915-21	L1932915-22	L1932915-23		
	Description	Waste	Waste	Waste		
	Sampled Date	18-MAY-17	15-MAY-17	16-MAY-17		
	Sampled Time					
	Client ID	140918	140914	140916		
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	8.3	8.7		
Organic / Inorganic Carbon	Carbon (C) (%)	0.26	0.05	0.31		
Acid Base Accounting	FIZZ RATING (Unity)	2	1	2		
	MPA (tCaCO3/1Kt)	0.6	0.6	0.6		
	Neutralization Potential (NP) (tCaCO3/1Kt)	25	10	32		
	NNP (tCaCO3/1Kt)	24	9	31		
	Ratio (NP/MPA) (Unity)	40.00	16.00	51.20		
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01		
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.01		
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.02	0.02		
	Total Sulfur (combustion) (%)	0.02	0.02	0.02		
Total Metals	Aluminum (Al) (%)	0.50	0.91	0.70		
	Antimony (Sb) (ppm)	0.11	0.07	0.06		
	Arsenic (As) (ppm)	6.3	2.1	6.1		
	Barium (Ba) (ppm)	280	170	190		
	Beryllium (Be) (ppm)	0.44	0.28	0.35		
	Bismuth (Bi) (ppm)	0.21	0.42	0.05		
	Boron (B) (ppm)	10	<10	<10		
	Cadmium (Cd) (ppm)	0.16	0.29	0.05		
	Calcium (Ca) (%)	0.98	0.27	1.29		
	Cerium (Ce) (ppm)	18.85	20.5	27.5		
	Cesium (Cs) (ppm)	0.45	0.51	0.59		
	Chromium (Cr) (ppm)	5	5	4		
	Cobalt (Co) (ppm)	5.7	8.1	5.5		
	Copper (Cu) (ppm)	2770	7840	879		
	Gallium (Ga) (ppm)	4.10	5.30	4.52		
	Germanium (Ge) (ppm)	0.05	0.08	0.06		
	Gold (Au) (ppm)	0.07	0.22	<0.02		
	Hafnium (Hf) (ppm)	0.05	0.10	0.03		
	Indium (In) (ppm)	0.080	0.203	0.035		
	Iron (Fe) (%)	2.41	3.80	2.14		
	Lanthanum (La) (ppm)	9.5	10.3	13.9		
	Lead (Pb) (ppm)	4.1	6.1	2.8		
	Lithium (Li) (ppm)	2.2	3.8	3.6		
	Magnesium (Mg) (%)	0.10	0.34	0.29		
	Manganese (Mn) (ppm)	653	419	476		

	Sample ID	L1932915-1	L1932915-2	L1932915-3	L1932915-4	L1932915-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	24-APR-17	24-APR-17	02-MAY-17	02-MAY-17	03-MAY-17
	Sampled Time					
	Client ID	135357	135358	135369	135370	135372
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.02	0.05	<0.01	0.05
	Molybdenum (Mo) (ppm)	0.81	1.13	1.08	0.95	1.16
	Nickel (Ni) (ppm)	2.7	2.3	23.9	3.2	28.9
	Niobium (Nb) (ppm)	0.06	0.33	0.87	0.10	0.91
	Phosphorus (P) (ppm)	590	650	880	810	900
	Potassium (K) (%)	0.35	0.72	0.18	0.43	0.20
	Rhenium (Re) (ppm)	0.002	0.005	0.003	0.001	0.001
	Rubidium (Rb) (ppm)	16.5	39.4	11.7	19.5	13.2
	Scandium (Sc) (ppm)	3.4	5.6	5.4	4.8	6.1
	Selenium (Se) (ppm)	0.4	4.7	0.8	0.6	1.0
	Silver (Ag) (ppm)	0.08	0.93	0.10	0.12	0.12
	Sodium (Na) (%)	0.06	0.06	0.05	0.06	0.04
	Strontium (Sr) (ppm)	62.1	56.7	61.9	84.5	66.5
	Sulfur (S) (%)	0.01	0.95	0.02	0.03	0.03
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.15	0.01	0.02	0.03
	Thallium (Tl) (ppm)	0.10	0.35	0.12	0.11	0.13
	Thorium (Th) (ppm)	2.2	4.1	3.9	3.6	4.7
	Tin (Sn) (ppm)	0.5	1.5	0.5	0.6	0.5
	Titanium (Ti) (%)	0.053	0.121	0.074	0.065	0.079
	Tungsten (W) (ppm)	0.25	1.53	0.28	0.78	0.34
	Uranium (U) (ppm)	0.21	0.33	0.73	0.24	0.87
	Vanadium (V) (ppm)	44	61	52	51	59
	Yttrium (Y) (ppm)	5.76	8.34	10.25	7.36	10.70
	Zinc (Zn) (ppm)	62	69	61	74	73
	Zirconium (Zr) (ppm)	0.8	0.9	7.6	1.3	10.6
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	1.5	1.0	1.1	0.9

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1932915-6	L1932915-7	L1932915-8	L1932915-9	L1932915-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-MAY-17	05-MAY-17	05-MAY-17	06-MAY-17	05-MAY-17
	Sampled Time					
	Client ID	135373	135374	135375	140903	140901
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.03	0.02	<0.01	0.01
	Molybdenum (Mo) (ppm)	0.80	1.22	1.35	0.58	1.19
	Nickel (Ni) (ppm)	2.6	11.4	8.3	2.5	2.6
	Niobium (Nb) (ppm)	0.14	0.83	0.38	0.18	0.08
	Phosphorus (P) (ppm)	720	750	710	720	620
	Potassium (K) (%)	0.38	0.25	0.32	0.35	0.25
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.001	<0.001
	Rubidium (Rb) (ppm)	16.2	14.8	18.6	15.6	13.3
	Scandium (Sc) (ppm)	3.8	4.3	5.6	4.1	9.4
	Selenium (Se) (ppm)	1.0	1.8	1.2	0.8	0.5
	Silver (Ag) (ppm)	0.24	0.70	0.47	0.19	0.10
	Sodium (Na) (%)	0.08	0.04	0.05	0.08	0.06
	Strontium (Sr) (ppm)	70.2	46.4	30.3	78.6	57.9
	Sulfur (S) (%)	0.05	0.02	0.01	0.02	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.16	0.11	0.04	0.01
	Thallium (Tl) (ppm)	0.08	0.13	0.12	0.09	0.07
	Thorium (Th) (ppm)	2.1	3.2	3.8	2.7	2.6
	Tin (Sn) (ppm)	0.4	0.6	0.6	0.4	0.8
	Titanium (Ti) (%)	0.078	0.070	0.046	0.078	0.030
	Tungsten (W) (ppm)	0.82	1.05	0.46	3.79	0.46
	Uranium (U) (ppm)	0.34	0.45	0.27	0.23	0.19
	Vanadium (V) (ppm)	51	49	55	50	54
	Yttrium (Y) (ppm)	6.91	7.50	7.27	7.74	9.12
	Zinc (Zn) (ppm)	69	57	73	60	80
	Zirconium (Zr) (ppm)	1.2	5.2	2.6	1.1	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	0.9	0.8	0.2	0.8	0.9

	Sample ID	L1932915-11	L1932915-12	L1932915-13	L1932915-14	L1932915-15
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	08-MAY-17	08-MAY-17	26-MAY-17	12-MAY-17	14-MAY-17
	Sampled Time					
	Client ID	140904	140905	135360	140909	140913
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.03	0.03	0.04	0.01	0.01
	Molybdenum (Mo) (ppm)	1.12	1.30	1.30	12.75	2.96
	Nickel (Ni) (ppm)	17.8	5.6	18.0	2.8	2.4
	Niobium (Nb) (ppm)	0.58	0.20	0.86	0.13	0.21
	Phosphorus (P) (ppm)	680	530	710	740	720
	Potassium (K) (%)	0.17	0.30	0.21	0.58	0.53
	Rhenium (Re) (ppm)	0.001	<0.001	0.001	0.034	0.011
	Rubidium (Rb) (ppm)	9.6	15.9	12.4	25.6	24.3
	Scandium (Sc) (ppm)	4.3	4.3	4.7	3.7	4.8
	Selenium (Se) (ppm)	1.0	1.5	0.8	2.3	1.5
	Silver (Ag) (ppm)	0.29	1.26	0.18	1.02	0.31
	Sodium (Na) (%)	0.04	0.05	0.04	0.08	0.06
	Strontium (Sr) (ppm)	58.3	33.7	52.4	44.9	71.5
	Sulfur (S) (%)	0.02	0.01	0.03	0.18	0.16
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.07	0.29	0.06	0.13	0.06
	Thallium (Tl) (ppm)	0.09	0.10	0.10	0.15	0.14
	Thorium (Th) (ppm)	2.8	1.7	3.0	3.1	2.9
	Tin (Sn) (ppm)	0.4	0.6	0.5	0.6	0.7
	Titanium (Ti) (%)	0.062	0.036	0.065	0.096	0.086
	Tungsten (W) (ppm)	0.62	0.57	0.78	0.59	0.46
	Uranium (U) (ppm)	0.53	0.27	0.52	0.21	0.37
	Vanadium (V) (ppm)	44	49	49	54	56
	Yttrium (Y) (ppm)	7.55	6.84	8.38	6.38	8.47
	Zinc (Zn) (ppm)	48	71	56	84	71
	Zirconium (Zr) (ppm)	7.2	2.1	6.4	1.9	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	0.3	0.7	0.5	1.3

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1932915-16	L1932915-17	L1932915-18	L1932915-19	L1932915-20
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-MAY-17	02-MAY-17	10-MAY-17	11-MAY-17	12-MAY-17
	Sampled Time					
	Client ID	140906	135371	140907	140908	140910
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	0.01	0.01	0.01
	Molybdenum (Mo) (ppm)	1.39	0.67	1.31	4.21	5.46
	Nickel (Ni) (ppm)	3.2	3.6	6.5	4.6	2.6
	Niobium (Nb) (ppm)	0.15	0.05	<0.05	0.23	0.15
	Phosphorus (P) (ppm)	700	580	640	700	830
	Potassium (K) (%)	0.28	0.20	0.18	0.40	0.45
	Rhenium (Re) (ppm)	<0.001	<0.001	0.001	0.001	0.010
	Rubidium (Rb) (ppm)	12.8	8.5	7.1	20.6	21.7
	Scandium (Sc) (ppm)	4.6	7.4	5.6	5.0	7.0
	Selenium (Se) (ppm)	0.6	0.4	0.4	0.9	2.1
	Silver (Ag) (ppm)	0.06	0.06	0.24	0.17	0.45
	Sodium (Na) (%)	0.06	0.05	0.04	0.06	0.06
	Strontium (Sr) (ppm)	40.8	53.6	55.8	41.5	80.9
	Sulfur (S) (%)	0.01	0.01	0.02	0.03	0.12
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	<0.01	0.04	0.03	0.10
	Thallium (Tl) (ppm)	0.07	0.04	0.04	0.14	0.12
	Thorium (Th) (ppm)	2.6	2.6	2.9	4.5	4.1
	Tin (Sn) (ppm)	0.5	0.6	1.1	0.6	0.7
	Titanium (Ti) (%)	0.039	0.014	0.011	0.067	0.068
	Tungsten (W) (ppm)	0.46	0.79	0.25	0.47	0.84
	Uranium (U) (ppm)	0.21	0.18	0.17	0.30	0.22
	Vanadium (V) (ppm)	45	44	50	48	64
	Yttrium (Y) (ppm)	10.20	7.30	8.39	8.89	10.45
	Zinc (Zn) (ppm)	63	57	55	86	73
	Zirconium (Zr) (ppm)	1.3	1.2	2.3	2.0	1.5
Permanent Gases	Carbon Dioxide (CO2) (%)	0.3	1.8	1.0	0.6	1.3

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1932915-21	L1932915-22	L1932915-23		
	Description	Waste	Waste	Waste		
	Sampled Date	18-MAY-17	15-MAY-17	16-MAY-17		
	Sampled Time					
	Client ID	140918	140914	140916		
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.02	0.01		
	Molybdenum (Mo) (ppm)	1.25	11.35	0.67		
	Nickel (Ni) (ppm)	3.5	4.2	2.0		
	Niobium (Nb) (ppm)	0.06	0.63	0.13		
	Phosphorus (P) (ppm)	590	760	720		
	Potassium (K) (%)	0.20	0.47	0.25		
	Rhenium (Re) (ppm)	<0.001	0.002	<0.001		
	Rubidium (Rb) (ppm)	10.0	26.2	13.0		
	Scandium (Sc) (ppm)	5.3	6.1	5.0		
	Selenium (Se) (ppm)	0.8	3.8	0.6		
	Silver (Ag) (ppm)	0.40	1.74	0.23		
	Sodium (Na) (%)	0.04	0.04	0.05		
	Strontium (Sr) (ppm)	41.7	22.2	57.9		
	Sulfur (S) (%)	0.02	0.02	0.02		
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01		
	Tellurium (Te) (ppm)	0.09	0.50	0.02		
	Thallium (Tl) (ppm)	0.05	0.24	0.06		
	Thorium (Th) (ppm)	2.4	5.3	2.8		
	Tin (Sn) (ppm)	0.7	1.1	0.7		
	Titanium (Ti) (%)	0.018	0.085	0.033		
	Tungsten (W) (ppm)	0.19	0.42	0.33		
	Uranium (U) (ppm)	0.25	0.56	0.21		
	Vanadium (V) (ppm)	50	69	46		
	Yttrium (Y) (ppm)	7.20	8.61	8.31		
	Zinc (Zn) (ppm)	72	126	61		
	Zirconium (Zr) (ppm)	1.5	3.5	0.9		
Permanent Gases	Carbon Dioxide (CO2) (%)	0.9	0.2	1.1		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-18

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 4-JUL-2017
Account: APN

CERTIFICATE VA17109714

Project: L1932915

P.O. No.: ALSM-CW16-102-APN

This report is for 23 Other samples submitted to our lab in Vancouver, BC, Canada on 31-MAY-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1932915

CERTIFICATE OF ANALYSIS VA17109714

	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41
	Analyte	Recvd Wt.	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al
	Units	kg	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
Sample Description	LOR	0.02	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01
L1932915-1 135357		0.88	0.6	2	27	28	8.7	44.80	0.02	<0.01	0.01	0.02	0.27	1.0	0.08	1.11
L1932915-2 135358		0.90	27.2	2	10	37	8.5	1.36	0.87	0.01	0.02	0.86	0.41	1.5	0.93	1.14
L1932915-3 135369		1.12	0.9	2	27	28	7.9	29.87	0.03	<0.01	0.01	0.03	0.27	1.0	0.10	1.19
L1932915-4 135370		1.12	0.9	2	31	32	8.6	34.13	0.03	<0.01	0.02	0.03	0.30	1.1	0.12	1.27
L1932915-5 135372		1.08	0.9	2	25	26	8.0	27.73	0.03	<0.01	0.03	0.03	0.23	0.9	0.12	1.38
L1932915-6 135373		1.16	1.3	2	29	30	8.8	24.00	0.04	<0.01	0.01	0.04	0.26	0.9	0.24	1.22
L1932915-7 135374		0.90	0.6	1	22	23	8.3	36.80	0.02	0.02	0.03	<0.01	0.21	0.8	0.70	0.84
L1932915-8 135375		0.94	0.3	1	6	6	8.2	19.20	0.01	0.01	<0.01	<0.01	<0.05	0.2	0.47	0.79
L1932915-9 140903		1.14	0.6	2	26	27	8.7	43.20	0.02	0.01	0.01	0.01	0.23	0.8	0.19	1.12
L1932915-10 140901		1.14	0.3	2	31	31	8.7	99.20	0.01	<0.01	<0.01	0.01	0.25	0.9	0.10	0.57
L1932915-11 140904		1.10	0.9	2	27	28	8.3	29.87	0.03	<0.01	<0.01	0.03	0.27	1.0	0.29	0.85
L1932915-12 140905		0.90	0.3	1	11	11	8.5	35.20	0.01	<0.01	<0.01	0.01	0.08	0.3	1.26	0.64
L1932915-13 135360		1.14	0.9	1	20	21	8.1	22.40	0.03	<0.01	<0.01	0.03	0.19	0.7	0.18	0.95
L1932915-14 140909		1.14	6.6	1	15	22	8.8	3.35	0.21	0.01	0.01	0.20	0.14	0.5	1.02	1.26
L1932915-15 140913		1.12	4.4	2	29	33	8.8	7.54	0.14	0.01	0.02	0.13	0.35	1.3	0.31	1.15
L1932915-16 140906		1.16	0.3	1	14	14	8.5	44.80	0.01	<0.01	0.02	0.01	0.07	0.3	0.06	0.90
L1932915-17 135371		1.06	0.3	2	44	44	8.7	140.80	0.01	<0.01	0.01	0.01	0.50	1.8	0.06	0.48
L1932915-18 140907		1.18	0.6	2	26	27	8.6	43.20	0.02	<0.01	<0.01	0.02	0.27	1.0	0.24	0.51
L1932915-19 140908		1.38	0.9	1	21	22	8.4	23.47	0.03	<0.01	0.01	0.03	0.16	0.6	0.17	0.95
L1932915-20 140910		1.16	3.1	2	33	36	8.7	11.52	0.10	<0.01	<0.01	0.10	0.36	1.3	0.45	0.98
L1932915-21 140918		1.16	0.6	2	24	25	8.5	40.00	0.02	<0.01	<0.01	0.02	0.26	0.9	0.40	0.50
L1932915-22 140914		1.16	0.6	1	9	10	8.3	16.00	0.02	<0.01	<0.01	0.02	0.05	0.2	1.74	0.91
L1932915-23 140916		1.14	0.6	2	31	32	8.7	51.20	0.02	<0.01	0.01	0.02	0.31	1.1	0.23	0.70

***** See Appendix Page for comments regarding this certificate *****

Project: L1932915

CERTIFICATE OF ANALYSIS VA17109714

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
L1932915-1 135357		1.2	<0.02	<10	250	0.35	0.04	1.22	0.05	23.3	5.5	5	0.32	214	2.30	6.17
L1932915-2 135358		4.9	0.13	<10	190	0.23	0.25	1.45	0.66	23.7	5.7	5	0.72	5320	3.29	6.70
L1932915-3 135369		6.8	<0.02	<10	280	0.45	0.10	1.34	0.28	30.2	9.7	28	0.78	206	2.47	4.42
L1932915-4 135370		0.8	<0.02	<10	230	0.30	0.04	1.26	0.07	30.7	7.5	5	0.44	535	2.61	6.85
L1932915-5 135372		8.1	<0.02	<10	320	0.52	0.13	1.19	0.30	32.1	11.5	33	1.12	95.1	2.81	5.06
L1932915-6 135373		1.0	<0.02	<10	200	0.34	0.11	1.29	0.09	21.4	6.8	5	0.36	668	2.50	6.40
L1932915-7 135374		4.2	0.10	<10	230	0.30	0.30	0.87	0.18	20.1	6.4	14	0.54	2600	2.39	3.88
L1932915-8 135375		5.6	0.10	<10	160	0.36	0.24	0.27	0.37	23.6	6.9	8	0.58	3260	2.59	4.71
L1932915-9 140903		1.5	0.02	<10	180	0.31	0.10	1.20	0.05	23.0	7.6	5	0.41	699	2.28	5.96
L1932915-10 140901		10.6	<0.02	10	230	0.40	0.04	1.26	0.27	25.1	6.3	6	0.47	495	2.47	4.56
L1932915-11 140904		4.8	0.05	<10	280	0.34	0.21	1.19	0.18	21.2	7.4	21	0.62	694	2.07	3.44
L1932915-12 140905		4.6	0.18	<10	230	0.39	0.96	0.39	0.18	15.15	5.8	8	0.61	4370	2.88	4.91
L1932915-13 135360		5.8	0.02	<10	300	0.38	0.23	0.92	0.21	22.3	7.9	20	0.72	367	2.36	4.21
L1932915-14 140909		0.4	0.06	<10	330	0.21	0.20	0.74	0.26	24.1	6.9	6	0.36	3050	2.54	6.35
L1932915-15 140913		0.7	0.03	<10	250	0.25	0.07	1.29	0.21	24.8	6.7	5	0.48	1455	2.79	6.43
L1932915-16 140906		1.4	<0.02	<10	210	0.33	0.05	0.59	0.10	22.5	5.5	5	0.46	1105	2.19	5.07
L1932915-17 135371		11.2	<0.02	10	240	0.40	0.02	1.83	0.09	24.2	4.5	4	0.42	191.0	2.02	4.02
L1932915-18 140907		5.8	0.03	10	460	0.43	0.05	1.15	0.13	18.15	5.5	6	0.33	573	1.99	3.50
L1932915-19 140908		1.8	0.03	<10	170	0.30	0.10	0.92	0.18	26.3	5.6	7	0.44	916	2.34	5.07
L1932915-20 140910		0.9	0.06	<10	190	0.30	0.28	1.33	0.09	34.4	7.4	6	0.46	2710	2.87	5.82
L1932915-21 140918		6.3	0.07	10	280	0.44	0.21	0.98	0.16	18.85	5.7	5	0.45	2770	2.41	4.10
L1932915-22 140914		2.1	0.22	<10	170	0.28	0.42	0.27	0.29	20.5	8.1	5	0.51	7840	3.80	5.30
L1932915-23 140916		6.1	<0.02	<10	190	0.35	0.05	1.29	0.05	27.5	5.5	4	0.59	879	2.14	4.52

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1932915

CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1932915-1 135357		0.09	0.04	<0.01	0.019	0.35	12.5	7.2	0.60	515	0.81	0.06	0.06	2.7	590	3.2
L1932915-2 135358		0.10	0.04	0.02	0.156	0.72	12.4	4.9	0.61	535	1.13	0.06	0.33	2.3	650	4.0
L1932915-3 135369		0.08	0.26	0.05	0.025	0.18	15.6	8.7	0.60	604	1.08	0.05	0.87	23.9	880	6.7
L1932915-4 135370		0.07	0.05	<0.01	0.028	0.43	16.5	6.8	0.74	618	0.95	0.06	0.10	3.2	810	2.6
L1932915-5 135372		0.06	0.29	0.05	0.027	0.20	16.0	9.5	0.72	603	1.16	0.04	0.91	28.9	900	7.4
L1932915-6 135373		0.07	0.06	<0.01	0.029	0.38	11.4	6.3	0.75	637	0.80	0.08	0.14	2.6	720	2.4
L1932915-7 135374		0.06	0.15	0.03	0.080	0.25	10.6	4.5	0.39	423	1.22	0.04	0.83	11.4	750	3.6
L1932915-8 135375		0.06	0.09	0.02	0.048	0.32	11.1	3.6	0.23	494	1.35	0.05	0.38	8.3	710	3.3
L1932915-9 140903		0.07	0.06	<0.01	0.020	0.35	12.5	6.2	0.67	556	0.58	0.08	0.18	2.5	720	2.5
L1932915-10 140901		0.07	0.05	0.01	0.057	0.25	12.6	2.5	0.14	732	1.19	0.06	0.08	2.6	620	3.5
L1932915-11 140904		0.05	0.20	0.03	0.037	0.17	10.7	5.5	0.43	410	1.12	0.04	0.58	17.8	680	4.3
L1932915-12 140905		0.06	0.06	0.03	0.067	0.30	7.7	3.4	0.18	473	1.30	0.05	0.20	5.6	530	3.3
L1932915-13 135360		0.05	0.18	0.04	0.034	0.21	11.3	6.2	0.43	478	1.30	0.04	0.86	18.0	710	4.7
L1932915-14 140909		0.06	0.06	0.01	0.060	0.58	12.7	6.1	0.74	543	12.75	0.08	0.13	2.8	740	2.0
L1932915-15 140913		0.07	0.05	0.01	0.053	0.53	12.7	5.2	0.68	605	2.96	0.06	0.21	2.4	720	2.3
L1932915-16 140906		0.06	0.06	0.01	0.033	0.28	11.1	4.8	0.40	559	1.39	0.06	0.15	3.2	700	2.9
L1932915-17 135371		0.05	0.04	0.01	0.039	0.20	12.5	2.1	0.11	486	0.67	0.05	0.05	3.6	580	3.6
L1932915-18 140907		<0.05	0.07	0.01	0.066	0.18	9.6	1.6	0.07	412	1.31	0.04	<0.05	6.5	640	9.1
L1932915-19 140908		0.06	0.07	0.01	0.038	0.40	14.1	4.4	0.43	642	4.21	0.06	0.23	4.6	700	4.5
L1932915-20 140910		0.08	0.06	0.01	0.048	0.45	18.6	4.7	0.58	625	5.46	0.06	0.15	2.6	830	3.1
L1932915-21 140918		0.05	0.05	0.01	0.080	0.20	9.5	2.2	0.10	653	1.25	0.04	0.06	3.5	590	4.1
L1932915-22 140914		0.08	0.10	0.02	0.203	0.47	10.3	3.8	0.34	419	11.35	0.04	0.63	4.2	760	6.1
L1932915-23 140916		0.06	0.03	0.01	0.035	0.25	13.9	3.6	0.29	476	0.67	0.05	0.13	2.0	720	2.8

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1932915

CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
	Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
	LOR	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
L1932915-1 135357		16.5	0.002	0.01	<0.05	3.4	0.4	0.5	62.1	<0.01	0.01	2.2	0.053	0.10	0.21	44
L1932915-2 135358		39.4	0.005	0.95	0.05	5.6	4.7	1.5	56.7	<0.01	0.15	4.1	0.121	0.35	0.33	61
L1932915-3 135369		11.7	0.003	0.02	0.52	5.4	0.8	0.5	61.9	<0.01	0.01	3.9	0.074	0.12	0.73	52
L1932915-4 135370		19.5	0.001	0.03	<0.05	4.8	0.6	0.6	84.5	<0.01	0.02	3.6	0.065	0.11	0.24	51
L1932915-5 135372		13.2	0.001	0.03	0.72	6.1	1.0	0.5	66.5	<0.01	0.03	4.7	0.079	0.13	0.87	59
L1932915-6 135373		16.2	<0.001	0.05	<0.05	3.8	1.0	0.4	70.2	<0.01	0.03	2.1	0.078	0.08	0.34	51
L1932915-7 135374		14.8	<0.001	0.02	0.28	4.3	1.8	0.6	46.4	<0.01	0.16	3.2	0.070	0.13	0.45	49
L1932915-8 135375		18.6	<0.001	0.01	0.09	5.6	1.2	0.6	30.3	<0.01	0.11	3.8	0.046	0.12	0.27	55
L1932915-9 140903		15.6	0.001	0.02	<0.05	4.1	0.8	0.4	78.6	<0.01	0.04	2.7	0.078	0.09	0.23	50
L1932915-10 140901		13.3	<0.001	0.01	0.05	9.4	0.5	0.8	57.9	<0.01	0.01	2.6	0.030	0.07	0.19	54
L1932915-11 140904		9.6	0.001	0.02	0.45	4.3	1.0	0.4	58.3	<0.01	0.07	2.8	0.062	0.09	0.53	44
L1932915-12 140905		15.9	<0.001	0.01	0.14	4.3	1.5	0.6	33.7	<0.01	0.29	1.7	0.036	0.10	0.27	49
L1932915-13 135360		12.4	0.001	0.03	0.50	4.7	0.8	0.5	52.4	<0.01	0.06	3.0	0.065	0.10	0.52	49
L1932915-14 140909		25.6	0.034	0.18	<0.05	3.7	2.3	0.6	44.9	<0.01	0.13	3.1	0.096	0.15	0.21	54
L1932915-15 140913		24.3	0.011	0.16	<0.05	4.8	1.5	0.7	71.5	<0.01	0.06	2.9	0.086	0.14	0.37	56
L1932915-16 140906		12.8	<0.001	0.01	0.05	4.6	0.6	0.5	40.8	<0.01	0.02	2.6	0.039	0.07	0.21	45
L1932915-17 135371		8.5	<0.001	0.01	0.06	7.4	0.4	0.6	53.6	<0.01	<0.01	2.6	0.014	0.04	0.18	44
L1932915-18 140907		7.1	0.001	0.02	0.17	5.6	0.4	1.1	55.8	<0.01	0.04	2.9	0.011	0.04	0.17	50
L1932915-19 140908		20.6	0.001	0.03	0.07	5.0	0.9	0.6	41.5	<0.01	0.03	4.5	0.067	0.14	0.30	48
L1932915-20 140910		21.7	0.010	0.12	<0.05	7.0	2.1	0.7	80.9	<0.01	0.10	4.1	0.068	0.12	0.22	64
L1932915-21 140918		10.0	<0.001	0.02	0.11	5.3	0.8	0.7	41.7	<0.01	0.09	2.4	0.018	0.05	0.25	50
L1932915-22 140914		26.2	0.002	0.02	0.07	6.1	3.8	1.1	22.2	<0.01	0.50	5.3	0.085	0.24	0.56	69
L1932915-23 140916		13.0	<0.001	0.02	0.06	5.0	0.6	0.7	57.9	<0.01	0.02	2.8	0.033	0.06	0.21	46

Project: L1932915

CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1932915-1 135357		0.25	5.76	62	0.8
L1932915-2 135358		1.53	8.34	69	0.9
L1932915-3 135369		0.28	10.25	61	7.6
L1932915-4 135370		0.78	7.36	74	1.3
L1932915-5 135372		0.34	10.70	73	10.6
L1932915-6 135373		0.82	6.91	69	1.2
L1932915-7 135374		1.05	7.50	57	5.2
L1932915-8 135375		0.46	7.27	73	2.6
L1932915-9 140903		3.79	7.74	60	1.1
L1932915-10 140901		0.46	9.12	80	1.0
L1932915-11 140904		0.62	7.55	48	7.2
L1932915-12 140905		0.57	6.84	71	2.1
L1932915-13 135360		0.78	8.38	56	6.4
L1932915-14 140909		0.59	6.38	84	1.9
L1932915-15 140913		0.46	8.47	71	0.9
L1932915-16 140906		0.46	10.20	63	1.3
L1932915-17 135371		0.79	7.30	57	1.2
L1932915-18 140907		0.25	8.39	55	2.3
L1932915-19 140908		0.47	8.89	86	2.0
L1932915-20 140910		0.84	10.45	73	1.5
L1932915-21 140918		0.19	7.20	72	1.5
L1932915-22 140914		0.42	8.61	126	3.5
L1932915-23 140916		0.33	8.31	61	0.9

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 4-JUL-2017
Account: APN

Project: L1932915

CERTIFICATE OF ANALYSIS VA17109714

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-VOL08m
S-GRA06
WEI-21
LOG-22
PUL-31
S-GRA06a
ME-MS41
PUL-QC
S-IR08
OA-ELE07
S-CAL06
SPL-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 5 (A - E)
Plus Appendix Pages
Finalized Date: 4-JUL-2017
Account: APN

QC CERTIFICATE VA17109714

Project: L1932915

P.O. No.: ALSM-CW16-102-APN

This report is for 23 Other samples submitted to our lab in Vancouver, BC, Canada on 31-MAY-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17109714

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
STANDARDS															
Buffer pH6					6.0										
Buffer pH6					6.0										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
GS310-10							0.26								
GS310-10							0.27								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								
KZK-1	25.0	2	32	57		2.28									
KZK-1	25.0	2	31	56		2.24									
Target Range - Lower Bound	22.9	<1	30	54		2.18									
Upper Bound	27.1	>4	38	64		2.53									
MA-1b							1.18								
MA-1b							1.16								
Target Range - Lower Bound							1.12								
Upper Bound							1.22								
MA-3a											2.36	8.6			
Target Range - Lower Bound											2.31	8.4			
Upper Bound											2.77	10.2			
MRGeo08													4.32	2.60	31.7
Target Range - Lower Bound													4.00	2.44	29.6
Upper Bound													4.92	3.00	36.4
OGGeo08													18.80	2.09	113.5
Target Range - Lower Bound													18.15	2.05	107.0
Upper Bound													22.2	2.53	131.0
OREAS 905													0.55	0.76	32.0
Target Range - Lower Bound													0.45	0.73	28.4
Upper Bound													0.58	0.91	35.0
OREAS 920													0.13	2.30	4.7
Target Range - Lower Bound													0.07	2.18	3.8
Upper Bound													0.12	2.68	4.9
SY-4											0.89	3.3			
Target Range - Lower Bound											0.84	3.0			
Upper Bound											1.08	4.0			

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	<0.02	<10	440	0.78	0.62	1.08	2.25	75.3	18.3	90	10.90	600	3.53	9.61	0.18
Target Range - Lower Bound	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07
Upper Bound	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29
OGGeo08	0.07	<10	120	0.73	10.35	0.85	18.15	60.0	92.1	78	8.98	8030	4.87	8.37	0.16
Target Range - Lower Bound	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21
Upper Bound	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45
OREAS 905	0.42	<10	240	0.94	5.33	0.34	0.34	79.3	13.9	17	1.11	1550	3.37	6.16	0.12
Target Range - Lower Bound	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05
Upper Bound	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22
OREAS 920	<0.02	<10	80	0.61	0.62	0.31	0.05	73.7	14.2	40	2.01	109.5	3.47	6.97	0.10
Target Range - Lower Bound	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05
Upper Bound	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22
SY-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.76	0.06	0.152	1.26	37.3	33.7	1.14	404	14.00	0.33	0.96	691	1020	1050	144.5
Target Range - Lower Bound	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0
Upper Bound	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0
OGGeo08	0.75	0.47	1.420	1.03	29.1	31.6	0.92	374	852	0.28	1.23	8470	770	6890	113.0
Target Range - Lower Bound	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5
Upper Bound	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5
OREAS 905	1.17	0.01	0.592	0.30	39.6	4.4	0.15	346	3.00	0.09	0.21	8.6	240	16.0	18.3
Target Range - Lower Bound	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3
Upper Bound	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3
OREAS 920	0.56	0.01	0.031	0.41	36.7	19.0	1.04	489	0.34	0.02	0.36	38.1	680	20.1	23.7
Target Range - Lower Bound	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2
Upper Bound	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4
SY-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
	LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05

STANDARDS

Sample Description	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.007	0.30	2.87	7.0	1.6	3.1	79.3	0.01	0.02	21.0	0.391	0.77	5.20	100	2.51
Target Range - Lower Bound	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44
Upper Bound	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42
OGGeo08	1.365	2.67	21.5	6.3	10.9	12.6	62.0	0.01	0.15	16.2	0.302	1.28	4.87	77	3.23
Target Range - Lower Bound	1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58
Upper Bound	1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60
OREAS 905	0.001	0.06	0.95	1.8	2.8	1.2	12.4	<0.01	0.07	7.8	0.020	0.10	2.06	6	0.46
Target Range - Lower Bound	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44
Upper Bound	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76
OREAS 920	<0.001	0.04	0.65	2.9	0.9	1.1	17.7	0.01	0.02	14.9	0.121	0.14	1.93	24	0.49
Target Range - Lower Bound	<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31
Upper Bound	0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61
SY-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS				
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
GS310-10				
GS310-10				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-1b				
MA-1b				
Target Range - Lower Bound				
Upper Bound				
MA-3a				
Target Range - Lower Bound				
Upper Bound				
MRGeo08		18.80	746	21.8
Target Range - Lower Bound		17.50	708	18.1
Upper Bound		21.5	870	25.7
OGGeo08		15.45	6830	22.3
Target Range - Lower Bound		15.35	6500	19.5
Upper Bound		18.85	7950	27.5
OREAS 905		7.00	63	42.7
Target Range - Lower Bound		6.32	58	39.9
Upper Bound		7.84	76	55.1
OREAS 920		17.20	100	22.3
Target Range - Lower Bound		16.85	93	17.6
Upper Bound		20.7	119	25.0
SY-4				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
STANDARDS															
UTS-1								0.89							
UTS-1								0.86							
UTS-1								0.85							
Target Range - Lower Bound								0.83							
Upper Bound								0.93							
UTS-1									0.88						
UTS-1									0.84						
UTS-1									0.93						
UTS-1									0.91						
UTS-1									0.90						
Target Range - Lower Bound									0.81						
Upper Bound									0.95						
UTS-4								1.66							
UTS-4								1.75							
Target Range - Lower Bound								1.64							
Upper Bound								1.84							
UTS-4									1.78						
Target Range - Lower Bound									1.61						
Upper Bound									1.87						
BLANKS															
BLANK											<0.05	<0.2			
Target Range - Lower Bound											<0.05	<0.2			
Upper Bound											0.10	0.4			
BLANK													<0.01	<0.01	<0.1
BLANK													<0.01	<0.01	0.1
Target Range - Lower Bound													<0.01	<0.01	<0.1
Upper Bound													0.02	0.02	0.2
BLANK					6.0										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 4-JUL-2017
Account: APN

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description **LOR**	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Target Range - Lower Bound	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method Analyte Units LOR	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
									STANDARDS							
UTS-1																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
UTS-1																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
									BLANKS							
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
BLANK		<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Target Range - Lower Bound		<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound		0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
BLANK	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS			
UTS-1			
UTS-1			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
UTS-1			
UTS-1			
UTS-1			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
BLANKS			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK	<0.05	<2	<0.5
BLANK	<0.05	<2	<0.5
Target Range - Lower Bound	<0.05	<2	<0.5
Upper Bound	0.10	4	1.0
BLANK			
Target Range - Lower Bound			
Upper Bound			

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	**Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
BLANKS																
BLANK									<0.01							
BLANK									<0.01							
BLANK									<0.01							
Target Range - Lower Bound									<0.01							
Upper Bound									0.02							
BLANK										<0.01						
BLANK										<0.01						
BLANK										<0.01						
Target Range - Lower Bound										<0.01						
Upper Bound										0.02						
BLANK								<0.01								
BLANK								<0.01								
Target Range - Lower Bound								<0.01								
Upper Bound								0.02								
DUPLICATES																
ORIGINAL														0.02	0.40	1.4
DUP														0.02	0.41	1.3
Target Range - Lower Bound														<0.01	0.37	1.2
Upper Bound														0.03	0.44	1.5
L1932915-2 135358									0.01	0.02						
DUP									<0.01	0.01						
Target Range - Lower Bound									<0.01	<0.01						
Upper Bound									0.02	0.02						
L1932915-4 135370						8.6										
DUP						8.6										
Target Range - Lower Bound						8.1										
Upper Bound						9.1										
L1932915-7 135374										0.03						
DUP										0.04						
Target Range - Lower Bound										0.02						
Upper Bound										0.04						

***** See Appendix Page for comments regarding this certificate *****

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method Analyte Units LOR	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
BLANKS																
BLANK																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL		<0.02	<10	60	0.29	0.04	0.19	0.02	10.80	2.0	4	2.11	4.4	0.36	1.24	0.08
DUP		<0.02	<10	60	0.29	0.04	0.19	0.02	11.10	2.1	4	2.12	4.8	0.37	1.28	0.08
Target Range - Lower Bound		<0.02	<10	50	0.23	0.03	0.17	<0.01	10.40	1.8	3	1.96	4.2	0.34	1.15	<0.05
Upper Bound		0.04	20	70	0.35	0.05	0.21	0.03	11.50	2.3	5	2.27	5.0	0.39	1.37	0.10
L1932915-2 135358																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-4 135370																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-7 135374																
DUP																
Target Range - Lower Bound																
Upper Bound																

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method Analyte Units LOR	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
BLANKS																
BLANK																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL		0.15	0.05	0.008	0.15	5.1	1.9	0.08	59	0.24	0.13	0.05	1.8	90	3.6	7.5
DUP		0.16	0.05	0.008	0.15	5.1	1.9	0.08	62	0.24	0.14	0.05	1.8	80	3.7	7.8
Target Range - Lower Bound		0.13	0.04	<0.005	0.13	4.6	1.7	0.07	52	0.18	0.12	<0.05	1.5	70	3.3	7.2
Upper Bound		0.18	0.06	0.010	0.17	5.6	2.1	0.09	69	0.30	0.15	0.10	2.1	100	4.0	8.1
L1932915-2 135358																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-4 135370																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-7 135374																
DUP																
Target Range - Lower Bound																
Upper Bound																

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description	**LOR**	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
BLANKS																
BLANK																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL		0.001	<0.01	0.37	0.9	0.2	0.2	21.5	<0.01	<0.01	1.8	0.014	0.06	0.98	17	0.09
DUP		0.001	<0.01	0.37	0.9	<0.2	0.2	22.1	<0.01	<0.01	2.0	0.014	0.06	1.02	17	0.09
Target Range - Lower Bound		<0.001	<0.01	0.29	0.8	<0.2	<0.2	20.5	<0.01	<0.01	1.6	0.008	0.04	0.90	15	<0.05
Upper Bound		0.002	0.02	0.45	1.0	0.4	0.4	23.1	0.02	0.02	2.2	0.020	0.08	1.10	19	0.10
L1932915-2 135358																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-4 135370																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-7 135374																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
BLANKS			
BLANK			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
DUPLICATES			
ORIGINAL	2.50	13	4.3
DUP	2.52	14	4.2
Target Range - Lower Bound	2.33	11	3.4
Upper Bound	2.69	16	5.1
L1932915-2 135358			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1932915-4 135370			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1932915-7 135374			
DUP			
Target Range - Lower Bound			
Upper Bound			

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 4-JUL-2017
Account: APN

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al	As
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1
							DUPLICATES									
L1932915-10 140901		0.3	2	31	31		99.20	0.01	<0.01		0.01					
DUP		0.3	2	31	31		99.20	0.01	<0.01		0.01					
Target Range - Lower Bound		<0.3	<1	28	28		94.23	<0.01	<0.01		<0.01					
Upper Bound		0.6	3	34	34		104.17	0.02	0.02		0.02					
L1932915-13 135360														0.18	0.95	5.8
DUP														0.18	0.93	5.8
Target Range - Lower Bound														0.16	0.88	5.4
Upper Bound														0.20	1.00	6.2
ORIGINAL									0.64							
DUP									0.64							
Target Range - Lower Bound									0.61							
Upper Bound									0.67							
ORIGINAL												1.39	5.1			
DUP												1.43	5.2			
Target Range - Lower Bound												1.29	4.7			
Upper Bound												1.53	5.6			
ORIGINAL								0.24								
DUP								0.25								
Target Range - Lower Bound								0.23								
Upper Bound								0.26								

***** See Appendix Page for comments regarding this certificate *****

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / **Method** / **Analyte** / **Units** / **LOR**	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
DUPLICATES															
L1932915-10 140901															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1932915-13 135360	0.02	<10	300	0.38	0.23	0.92	0.21	22.3	7.9	20	0.72	367	2.36	4.21	0.05
DUP	0.03	<10	300	0.40	0.23	0.90	0.21	22.8	7.8	20	0.72	400	2.32	4.25	0.05
Target Range - Lower Bound	<0.02	<10	270	0.32	0.21	0.85	0.19	21.4	7.4	18	0.63	370	2.21	3.97	<0.05
Upper Bound	0.04	20	330	0.46	0.25	0.97	0.23	23.7	8.3	22	0.81	397	2.47	4.49	0.10
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
								DUPLICATES								
L1932915-10 140901																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1932915-13 135360		0.18	0.04	0.034	0.21	11.3	6.2	0.43	478	1.30	0.04	0.86	18.0	710	4.7	12.4
DUP		0.19	0.03	0.034	0.20	11.5	7.0	0.42	467	1.28	0.04	0.85	17.9	700	4.7	12.1
Target Range - Lower Bound		0.16	0.02	0.027	0.18	10.6	6.2	0.39	444	1.18	0.03	0.76	16.9	660	4.3	11.5
Upper Bound		0.21	0.05	0.041	0.23	12.2	7.0	0.46	501	1.40	0.05	0.95	19.0	750	5.1	13.0
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
DUPLICATES															
L1932915-10 140901															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1932915-13 135360	0.001	0.03	0.50	4.7	0.8	0.5	52.4	<0.01	0.06	3.0	0.065	0.10	0.52	49	0.78
DUP	0.001	0.03	0.50	4.7	0.6	0.5	50.7	<0.01	0.06	3.1	0.064	0.10	0.58	47	0.93
Target Range - Lower Bound	<0.001	0.02	0.41	4.4	0.5	0.3	48.8	<0.01	0.05	2.7	0.056	0.07	0.47	45	0.74
Upper Bound	0.002	0.04	0.59	5.0	0.9	0.7	54.3	0.02	0.07	3.4	0.073	0.13	0.63	51	0.97
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17109714

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41
	Analyte	Y	Zn	Zr
	Units	ppm	ppm	ppm
	LOR	0.05	2	0.5
		DUPLICATES		
L1932915-10 140901				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1932915-13 135360		8.38	56	6.4
DUP		8.20	55	6.3
Target Range - Lower Bound		7.83	51	5.4
Upper Bound		8.75	60	7.3
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 4-JUL-2017
Account: APN

Project: L1932915

QC CERTIFICATE OF ANALYSIS VA17109714

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	LOG-22	ME-MS41	OA-ELE07
OA-VOL08m	PUL-31	PUL-QC	S-CAL06
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1932915-COFC

COC Number: 17-18

Page of

Report To Contact and company name below will appear on the final report
Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659
Company address below will appear on the final report
Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To
Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Report Format / Di
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

E&P TATs with your AM - surcharges will apply
Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐
EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐
Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm
For tests that can not be performed according to the service level selected, you will be contacted.

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

Oil and Gas Required Fields (client use)
AFE/Cost Center
PO#
Major/Minor Code
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)
ALS Contact:
Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)								Number of Containers
1	135357	24-APR-17		Waste	X	X	R X	R X	R X	R X								
2	135358	24-APR-17			X	X	X	X	X	X								
3	135369	2-may-17			X	X	X	X	X	X								
4	135370	2-may-17			X	X	X	X	X	X								
5	135372	3-may-17			X	X	X	X	X	X								
6	135373	4-may-17			X	X	X	X	X	X								
7	135374	5-may-17			X	X	X	X	X	X								
8	135375	5-may-17			X	X	X	X	X	X								
9	140903	6-may-17			X	X	X	X	X	X								
10	140901	5-may-17			X	X	X	X	X	X								
11	140904	8-may-17			X	X	X	X	X	X								
12	140905	8-may-17		waste	X	X	X	X	X	X								

Drinking Water (DW) Samples [1] (client use)
Are samples taken from a Regulated DW System? ☐ YES ☑ NO
Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐
INITIAL COOLER TEMPERATURES °C
FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: JOEY	Date: may 24/17	Time:	Received by: VD	Date: May 26/17	Time: 16:00	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1932915-COFC

COC Number: 17-18

Page of

Report To	Contact and company name below will appear on the final report	**Report Format**	
Company:	Minto Explorations Ltd.	Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)	
Contact:	Minto Environment - Coordinator	Quality Control (QC) Report with Report ☑ YES ☐ NO	
Phone:	1-604-759-4659	☑ Compare Results to Criteria on Report - provide details below if box checked	
	Company address below will appear on the final report	Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Street:	2100-510 West Georgia St.	Email 1 or Fax	minto_environment@mintomine.com
City/Province:	Vancouver, British Columbia	Email 2	
Postal Code:	V6B 0M3	Email 3	
Invoice To	Same as Report To ☐ YES ☑ NO	**Invoice Distribution**	
	Copy of Invoice with Report ☐ YES ☑ NO	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Company:	Minto Explorations Ltd.	Email 1 or Fax	ap@mintomine.com
Contact:	Ruth Cayetano	Email 2	

m all E&P TATs with your AM - surcharges will apply

Regular [R] ☐ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information		**Oil and Gas Required Fields (client use)**	
ALS Account # / Quote #:		AFE/Cost Center:	PO#
Job #:		Major/Minor Code:	Routing Code:
PO / AFE:	TBD	Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals - Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
13	135360	26-APR-17		waste	X	X	X	X	X	X	
14	140909	12-may-17			X	X	X	X	X	X	
15	140913	14-may-17			X	X	X	X	X	X	
16	140906	9-may-17			X	X	X	X	X	X	
17	135371	02-may-17			X	X	X	X	X	X	
18	140907	10-may-17			X	X	X	X	X	X	
19	140908	11-may-17			X	X	X	X	X	X	
20	140910	12-may-17			X	X	X	X	X	X	
21	140918	18-may-17			X	X	X	X	X	X	
22	140914	15-may-17			X	X	X	X	X	X	
23	140916	16-may-17		waste	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice Packs	☐	Ice Cubes	☐	Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☐						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 21-JUN-17
Report Date: 20-JUL-17 14:00 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1946295
Project P.O. #: TRD
Job Reference:
C of C Numbers: 17-19
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946295-1	L1946295-2	L1946295-3	L1946295-4	L1946295-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	13-MAY-17	14-MAY-17	15-MAY-17	17-MAY-17	21-MAY-17
	Sampled Time					
	Client ID	140911	140912	140915	140917	140919
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.0	8.4	8.3	8.4	8.2
Organic / Inorganic Carbon	Carbon (C) (%)	0.10	0.52	0.27	0.30	0.22
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	2	2
	MPA (tCaCO3/1Kt)	0.3	15.9	0.6	1.6	0.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	41	27	30	22
	NNP (tCaCO3/1Kt)	8	25	26	28	21
	Ratio (NP/MPA) (Unity)	25.60	2.57	43.20	19.20	23.47
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.02	0.02	0.03	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.51	0.02	0.05	0.03
	Total Sulfur (combustion) (%)	0.01	0.51	0.02	0.05	0.03
Total Metals	Aluminum (Al) (%)	1.01	0.96	0.65	0.89	0.89
	Antimony (Sb) (ppm)	<0.05	<0.05	0.07	<0.05	0.41
	Arsenic (As) (ppm)	2.7	0.8	5.1	0.7	5.9
	Barium (Ba) (ppm)	150	510	190	130	260
	Beryllium (Be) (ppm)	0.32	0.24	0.40	0.33	0.45
	Bismuth (Bi) (ppm)	0.31	0.32	0.21	0.07	0.26
	Boron (B) (ppm)	<10	<10	10	<10	10
	Cadmium (Cd) (ppm)	0.12	0.32	0.38	0.17	0.21
	Calcium (Ca) (%)	0.26	1.50	1.12	1.24	0.96
	Cerium (Ce) (ppm)	26.3	20.2	26.8	24.2	22.9
	Cesium (Cs) (ppm)	0.67	0.59	0.63	0.44	0.77
	Chromium (Cr) (ppm)	4	4	4	4	18
	Cobalt (Co) (ppm)	6.0	7.6	6.6	5.6	8.2
	Copper (Cu) (ppm)	8790	7190	4540	1125	1655
	Gallium (Ga) (ppm)	5.49	5.62	4.16	5.06	4.23
	Germanium (Ge) (ppm)	0.14	0.13	0.12	0.11	0.11
	Gold (Au) (ppm)	0.18	0.18	0.05	0.04	0.04
	Hafnium (Hf) (ppm)	0.13	0.03	0.05	0.05	0.17
	Indium (In) (ppm)	0.086	0.166	0.053	0.036	0.044
	Iron (Fe) (%)	2.56	3.41	2.49	2.41	2.61
	Lanthanum (La) (ppm)	14.5	10.6	13.9	13.2	11.8
	Lead (Pb) (ppm)	2.9	2.8	3.1	12.4	4.7
	Lithium (Li) (ppm)	4.8	4.2	3.5	4.9	6.2
	Magnesium (Mg) (%)	0.45	0.68	0.25	0.50	0.42
	Manganese (Mn) (ppm)	329	602	610	629	472

	Sample ID	L1946295-6	L1946295-7	L1946295-8	L1946295-9	L1946295-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	22-MAY-17	05-APR-17	10-APR-17	08-MAY-17	29-MAY-17
	Sampled Time					
	Client ID	140920	APR TAL COMP. 2017	APR TAL U/F 2017	MAY TAL U/F 2017	MAY TAL U/F 2017
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.9	8.0	8.0	8.0	7.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.11	0.23	0.19	0.18	0.21
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	1.9	2.8	2.8	5.0
	Neutralization Potential (NP) (tCaCO3/1Kt)	19	25	23	19	19
	NNP (tCaCO3/1Kt)	18	23	20	16	14
	Ratio (NP/MPA) (Unity)	30.40	13.33	8.18	6.76	3.80
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	0.03
	Sulfate Sulfur (HCl leach) (%)	0.02	0.03	0.02	0.03	0.07
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	0.06	0.09	0.09	0.13
	Total Sulfur (combustion) (%)	0.02	0.06	0.09	0.09	0.16
Total Metals	Aluminum (Al) (%)	1.10	1.44	1.18	1.11	1.06
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	0.6	1.4	1.1	1.1	1.1
	Barium (Ba) (ppm)	280	240	200	210	220
	Beryllium (Be) (ppm)	0.24	0.33	0.26	0.23	0.23
	Bismuth (Bi) (ppm)	0.05	0.54	0.22	0.59	0.29
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.04	0.22	0.23	0.28	0.38
	Calcium (Ca) (%)	0.83	1.23	1.04	0.84	0.90
	Cerium (Ce) (ppm)	19.70	23.0	19.95	17.30	19.75
	Cesium (Cs) (ppm)	0.43	0.50	0.45	0.44	0.46
	Chromium (Cr) (ppm)	4	6	5	6	5
	Cobalt (Co) (ppm)	6.1	7.4	7.7	7.9	8.2
	Copper (Cu) (ppm)	401	2080	1830	2850	2910
	Gallium (Ga) (ppm)	5.22	8.20	7.55	8.02	7.08
	Germanium (Ge) (ppm)	0.13	0.14	0.13	0.13	0.14
	Gold (Au) (ppm)	<0.02	0.20	0.11	0.18	0.15
	Hafnium (Hf) (ppm)	0.06	0.05	0.04	0.04	0.04
	Indium (In) (ppm)	0.022	0.111	0.080	0.095	0.080
	Iron (Fe) (%)	2.34	3.37	4.00	4.26	3.97
	Lanthanum (La) (ppm)	10.4	11.8	10.4	9.1	10.5
	Lead (Pb) (ppm)	1.5	2.4	2.2	2.7	2.4
	Lithium (Li) (ppm)	5.3	7.4	5.7	5.4	5.1
	Magnesium (Mg) (%)	0.67	0.75	0.66	0.61	0.59
	Manganese (Mn) (ppm)	616	566	590	617	602

	Sample ID	L1946295-11	L1946295-12	L1946295-13	L1946295-14	L1946295-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	18-MAY-17	24-MAY-17	24-MAY-17	24-MAY-17	25-MAY-17
	Sampled Time					
	Client ID	140921	140924	140923	140922	140925
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	8.8	8.6	8.6	8.3
Organic / Inorganic Carbon	Carbon (C) (%)	0.29	0.34	0.38	0.39	0.31
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	1.3	13.8	4.4	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	27	32	34	32	31
	NNP (tCaCO3/1Kt)	26	31	20	28	30
	Ratio (NP/MPA) (Unity)	43.20	25.60	2.47	7.31	49.60
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.02	0.02	0.01	0.02
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.04	0.44	0.14	0.02
	Total Sulfur (combustion) (%)	0.02	0.04	0.44	0.14	0.02
Total Metals	Aluminum (Al) (%)	0.77	1.15	1.37	1.05	0.97
	Antimony (Sb) (ppm)	0.39	<0.05	<0.05	<0.05	0.43
	Arsenic (As) (ppm)	5.6	0.5	0.4	0.7	5.3
	Barium (Ba) (ppm)	240	250	310	240	260
	Beryllium (Be) (ppm)	0.33	0.32	0.25	0.29	0.38
	Bismuth (Bi) (ppm)	0.08	0.03	0.11	0.04	0.12
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.15	0.05	0.19	0.09	0.18
	Calcium (Ca) (%)	1.30	1.35	1.36	1.33	1.44
	Cerium (Ce) (ppm)	20.1	22.0	25.3	25.5	24.1
	Cesium (Cs) (ppm)	0.57	0.36	0.61	0.39	0.70
	Chromium (Cr) (ppm)	19	6	6	7	23
	Cobalt (Co) (ppm)	6.9	6.7	7.1	6.8	8.1
	Copper (Cu) (ppm)	361	283	4100	1170	604
	Gallium (Ga) (ppm)	3.01	6.00	6.88	5.35	3.79
	Germanium (Ge) (ppm)	0.10	0.12	0.14	0.11	0.11
	Gold (Au) (ppm)	<0.02	<0.02	0.05	0.02	0.02
	Hafnium (Hf) (ppm)	0.22	0.04	0.04	0.05	0.25
	Indium (In) (ppm)	0.023	0.024	0.136	0.062	0.025
	Iron (Fe) (%)	1.93	2.50	2.99	2.58	2.23
	Lanthanum (La) (ppm)	10.4	11.8	13.1	13.5	12.4
	Lead (Pb) (ppm)	3.7	2.6	2.7	2.4	4.3
	Lithium (Li) (ppm)	5.3	6.6	5.7	5.0	6.8
	Magnesium (Mg) (%)	0.39	0.69	0.80	0.67	0.51
	Manganese (Mn) (ppm)	336	561	561	571	412

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946295-16				
	Description	WASTE				
	Sampled Date	25-MAY-17				
	Sampled Time					
	Client ID	142501				
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.1				
Organic / Inorganic Carbon	Carbon (C) (%)	0.06				
Acid Base Accounting	FIZZ RATING (Unity)	1				
	MPA (tCaCO3/1Kt)	0.3				
	Neutralization Potential (NP) (tCaCO3/1Kt)	8				
	NNP (tCaCO3/1Kt)	8				
	Ratio (NP/MPA) (Unity)	25.60				
	Sulfate Sulfur (carbonate leach) (%)	<0.01				
	Sulfate Sulfur (HCl leach) (%)	0.01				
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01				
	Total Sulfur (combustion) (%)	0.01				
Total Metals	Aluminum (Al) (%)	1.03				
	Antimony (Sb) (ppm)	0.06				
	Arsenic (As) (ppm)	3.6				
	Barium (Ba) (ppm)	190				
	Beryllium (Be) (ppm)	0.32				
	Bismuth (Bi) (ppm)	0.32				
	Boron (B) (ppm)	<10				
	Cadmium (Cd) (ppm)	0.11				
	Calcium (Ca) (%)	0.29				
	Cerium (Ce) (ppm)	27.4				
	Cesium (Cs) (ppm)	0.63				
	Chromium (Cr) (ppm)	8				
	Cobalt (Co) (ppm)	6.5				
	Copper (Cu) (ppm)	7350				
	Gallium (Ga) (ppm)	5.29				
	Germanium (Ge) (ppm)	0.14				
	Gold (Au) (ppm)	0.10				
	Hafnium (Hf) (ppm)	0.10				
	Indium (In) (ppm)	0.086				
	Iron (Fe) (%)	2.65				
	Lanthanum (La) (ppm)	13.3				
	Lead (Pb) (ppm)	3.5				
	Lithium (Li) (ppm)	5.0				
	Magnesium (Mg) (%)	0.47				
	Manganese (Mn) (ppm)	426				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946295-1	L1946295-2	L1946295-3	L1946295-4	L1946295-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	13-MAY-17	14-MAY-17	15-MAY-17	17-MAY-17	21-MAY-17
	Sampled Time					
	Client ID	140911	140912	140915	140917	140919
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02	0.01	0.02	0.01	0.04
	Molybdenum (Mo) (ppm)	1.37	2.65	0.99	2.57	1.76
	Nickel (Ni) (ppm)	2.5	2.0	2.4	2.0	15.4
	Niobium (Nb) (ppm)	1.16	0.26	0.13	0.15	0.42
	Phosphorus (P) (ppm)	790	800	660	700	720
	Potassium (K) (%)	0.60	0.55	0.28	0.30	0.25
	Rhenium (Re) (ppm)	<0.001	0.010	<0.001	0.001	0.001
	Rubidium (Rb) (ppm)	38.5	29.3	18.3	16.6	16.2
	Scandium (Sc) (ppm)	6.7	4.4	6.2	4.7	5.6
	Selenium (Se) (ppm)	1.5	5.5	1.3	0.8	0.9
	Silver (Ag) (ppm)	0.72	1.59	0.49	0.29	0.38
	Sodium (Na) (%)	0.03	0.04	0.04	0.04	0.04
	Strontium (Sr) (ppm)	16.0	75.7	39.2	55.0	48.6
	Sulfur (S) (%)	0.01	0.55	0.02	0.04	0.03
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.18	0.23	0.12	0.04	0.09
	Thallium (Tl) (ppm)	0.24	0.16	0.08	0.10	0.10
	Thorium (Th) (ppm)	6.3	2.3	2.8	4.6	2.8
	Tin (Sn) (ppm)	0.7	1.0	0.6	0.6	0.5
	Titanium (Ti) (%)	0.114	0.094	0.040	0.043	0.054
	Tungsten (W) (ppm)	0.50	0.41	0.32	0.34	0.58
	Uranium (U) (ppm)	0.31	0.27	0.23	0.28	0.48
	Vanadium (V) (ppm)	57	63	50	46	50
	Yttrium (Y) (ppm)	10.90	7.32	8.93	8.42	9.69
	Zinc (Zn) (ppm)	69	86	81	106	69
	Zirconium (Zr) (ppm)	3.5	0.9	1.1	1.1	5.2
Permanent Gases	Carbon Dioxide (CO2) (%)	0.4	1.9	1.0	1.1	0.8

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946295-6	L1946295-7	L1946295-8	L1946295-9	L1946295-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	22-MAY-17	05-APR-17	10-APR-17	08-MAY-17	29-MAY-17
	Sampled Time					
	Client ID	140920	APR TAL COMP. 2017	APR TAL U/F 2017	MAY TAL U/F 2017	MAY TAL U/F 2017
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.02	0.01	0.02	0.01
	Molybdenum (Mo) (ppm)	0.51	1.02	2.07	1.83	3.00
	Nickel (Ni) (ppm)	2.0	2.7	2.2	2.4	2.2
	Niobium (Nb) (ppm)	0.18	0.29	0.25	0.28	0.27
	Phosphorus (P) (ppm)	650	1000	840	740	740
	Potassium (K) (%)	0.69	0.62	0.57	0.55	0.57
	Rhenium (Re) (ppm)	<0.001	0.001	0.003	0.002	0.003
	Rubidium (Rb) (ppm)	32.3	36.8	30.9	30.6	30.9
	Scandium (Sc) (ppm)	3.7	4.8	3.9	3.8	3.8
	Selenium (Se) (ppm)	0.5	1.6	1.4	2.3	2.1
	Silver (Ag) (ppm)	0.12	0.94	0.60	1.09	0.89
	Sodium (Na) (%)	0.08	0.06	0.04	0.05	0.05
	Strontium (Sr) (ppm)	46.7	111.0	81.4	83.2	72.7
	Sulfur (S) (%)	0.01	0.07	0.09	0.11	0.17
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.36	0.21	0.34	0.27
	Thallium (Tl) (ppm)	0.16	0.19	0.17	0.18	0.16
	Thorium (Th) (ppm)	2.1	5.2	3.8	3.8	2.9
	Tin (Sn) (ppm)	0.5	0.9	0.8	0.8	0.8
	Titanium (Ti) (%)	0.128	0.111	0.105	0.102	0.108
	Tungsten (W) (ppm)	0.60	0.06	0.06	0.07	0.08
	Uranium (U) (ppm)	0.27	0.40	0.32	0.33	0.35
	Vanadium (V) (ppm)	51	67	68	69	71
	Yttrium (Y) (ppm)	8.49	8.77	6.95	6.26	7.00
	Zinc (Zn) (ppm)	67	101	94	98	102
	Zirconium (Zr) (ppm)	0.8	1.1	0.9	1.0	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	0.4	0.9	0.7	0.7	0.8

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946295-11	L1946295-12	L1946295-13	L1946295-14	L1946295-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	18-MAY-17	24-MAY-17	24-MAY-17	24-MAY-17	25-MAY-17
	Sampled Time					
	Client ID	140921	140924	140923	140922	140925
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.03	0.01	0.01	<0.01	0.05
	Molybdenum (Mo) (ppm)	0.88	0.53	3.15	1.91	0.86
	Nickel (Ni) (ppm)	14.1	2.6	2.4	3.0	16.3
	Niobium (Nb) (ppm)	0.50	0.17	0.36	0.15	0.69
	Phosphorus (P) (ppm)	660	630	1120	750	780
	Potassium (K) (%)	0.14	0.49	0.87	0.48	0.20
	Rhenium (Re) (ppm)	0.001	0.001	0.012	0.007	0.001
	Rubidium (Rb) (ppm)	9.3	24.2	44.3	22.8	13.5
	Scandium (Sc) (ppm)	4.3	3.4	6.2	7.8	5.3
	Selenium (Se) (ppm)	0.7	0.5	3.6	1.1	0.5
	Silver (Ag) (ppm)	0.16	0.10	0.83	0.24	0.20
	Sodium (Na) (%)	0.05	0.06	0.06	0.06	0.05
	Strontium (Sr) (ppm)	60.9	69.2	47.8	69.1	66.5
	Sulfur (S) (%)	0.02	0.04	0.49	0.17	0.02
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.02	0.15	0.04	0.04
	Thallium (Tl) (ppm)	0.08	0.11	0.24	0.12	0.10
	Thorium (Th) (ppm)	2.5	2.0	2.0	2.7	2.9
	Tin (Sn) (ppm)	0.4	0.5	1.3	0.7	0.4
	Titanium (Ti) (%)	0.063	0.086	0.150	0.073	0.078
	Tungsten (W) (ppm)	0.68	0.63	0.51	0.76	0.31
	Uranium (U) (ppm)	0.45	0.40	0.34	0.31	0.51
	Vanadium (V) (ppm)	41	50	72	55	48
	Yttrium (Y) (ppm)	8.17	6.72	9.15	8.89	9.30
	Zinc (Zn) (ppm)	40	67	85	66	52
	Zirconium (Zr) (ppm)	7.3	0.7	0.9	0.8	8.5
Permanent Gases	Carbon Dioxide (CO2) (%)	1.1	1.3	1.4	1.4	1.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946295-16
	Description	WASTE
	Sampled Date	25-MAY-17
	Sampled Time	
	Client ID	142501
Grouping	**Analyte**	
SOIL		
Total Metals	Mercury (Hg) (ppm)	0.01
	Molybdenum (Mo) (ppm)	1.78
	Nickel (Ni) (ppm)	3.6
	Niobium (Nb) (ppm)	1.01
	Phosphorus (P) (ppm)	840
	Potassium (K) (%)	0.55
	Rhenium (Re) (ppm)	<0.001
	Rubidium (Rb) (ppm)	36.8
	Scandium (Sc) (ppm)	6.6
	Selenium (Se) (ppm)	1.4
	Silver (Ag) (ppm)	0.56
	Sodium (Na) (%)	0.04
	Strontium (Sr) (ppm)	20.5
	Sulfur (S) (%)	0.01
	Tantalum (Ta) (ppm)	<0.01
	Tellurium (Te) (ppm)	0.15
	Thallium (Tl) (ppm)	0.25
	Thorium (Th) (ppm)	5.6
	Tin (Sn) (ppm)	0.7
	Titanium (Ti) (%)	0.108
	Tungsten (W) (ppm)	0.54
	Uranium (U) (ppm)	0.32
	Vanadium (V) (ppm)	61
	Yttrium (Y) (ppm)	10.70
	Zinc (Zn) (ppm)	73
	Zirconium (Zr) (ppm)	3.0
Permanent Gases	Carbon Dioxide (CO2) (%)	0.2

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-19

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

L1946295-COFC

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

COC Number: 17-19

Page 1 of 2

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St
City/Province:	Vancouver British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: minto_environment@mintomine.com

Email 2:

Email 3:

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: ap@mintomine.com

Email 2:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE:

TRD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#:

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP determination by % sulphide sulphur	Modified NP (MEND 1991)								Number of Containers
		~~[illegible]~~		Composite	R	R	R	R	R	R								
	140911	13-MAY-17		WASTE	X	X	X	X	X	X								
	140912	14-MAY-17		WASTE	X	X	X	X	X	X								
	140915	15-MAY-17		WASTE	X	X	X	X	X	X								
	140917	17-MAY-17		WASTE	X	X	X	X	X	X								
	140919	21-MAY-17		WASTE	X	X	X	X	X	X								
	140920	22-MAY-17		WASTE	X	X	X	X	X	X								
	APR TAL COMP. 2017	05-APR-17		TAILS	X	X	X	X	X	X								
	APR TAL U/F. 2017	10-APR-17		TAILS	X	X	X	X	X	X								
	MAY TAL U/F. 2017	08-MAY-17		TAILS	X	X	X	X	X	X								
	MAY TAL VF 2017	29-MAY-17		TAILS	X	X	X	X	X	X								
	140921	18-MAY-17		WASTE	X	X	X	X	X	X								

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 18.0

FINAL COOLER TEMPERATURES °C: 20

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: KALA JOE	Date: Jun 17, 2017	Time:	Received by: EHF	Date: 20 Jun 2017	Time: 16:20	Received by: JC	Date: 6/21/17	Time: 2pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

ALS

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1946295-COFC

COC Number: 17-19

Page 2 of 2

Report To	Contact and company name below will appear on the final report	
Company	Minto Explorations Ltd	
Contact	Minto Environment - Coordinator	
Phone	1-604-759-4659	
	Company address below will appear on the final report	
Street	2100-510 West Georgia St	
City/Province	Vancouver British Columbia	
Postal Code	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company	Minto Explorations Ltd	
Contact	Ruth Cayetano	

Report Format / Distribution

Select Report Format ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh mm

For tests that can not be performed according to the service level selected, you will be contacted

Project Information

ALS Account # / Quote #

Job #

PO / AFE TBD

LSD

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center

PO#

Major/Minor Code

Routing Code

Requisitioner

Location

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP determination by % sulphide sulphur	Modified NP (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	140924	24-MAY-17		WASTE	X	X	X	X	X	X	
	140923	24-MAY-17		WASTE	X	X	X	X	X	X	
	140922	24-MAY-17		WASTE	X	X	X	X	X	X	
	140925	25-MAY-17		WASTE	X	X	X	X	X	X	
	142501	25-MAY-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 18.0

FINAL COOLER TEMPERATURES °C: 20

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by	Date	Time	Received by: EHF	Date: 20Jun2017	Time: 16:20	Received by: JC	Date 6/21/17	Time 2pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 21-JUN-17
Report Date: 04-AUG-17 17:10 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1946299
Project P.O. #: PO#226298
Job Reference:
C of C Numbers: 17-20
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

Grouping	Analyte	L1946299-1	L1946299-2	L1946299-3	L1946299-4	L1946299-5
	Sample ID	L1946299-1	L1946299-2	L1946299-3	L1946299-4	L1946299-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	26-MAY-17	27-MAY-17	29-MAY-17	29-MAY-17	29-MAY-17
	Sampled Time					
	Client ID	142503	142502	142505	142507	142504
SOIL						
Physical Tests	pH (Unity)	8.6	8.4	8.4	8.5	8.2
Organic / Inorganic Carbon	Carbon (C) (%)	0.24	0.38	0.21	0.65	<0.05
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	1
	MPA (tCaCO3/1Kt)	1.6	<0.3	0.6	4.7	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	28	36	24	48	8
	NNP (tCaCO3/1Kt)	26	36	23	43	8
	Ratio (NP/MPA) (Unity)	17.92	230.40	38.40	10.24	25.60
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	<0.01	<0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.01	0.02	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.05	<0.01	0.02	0.15	<0.01
	Total Sulfur (combustion) (%)	0.05	<0.01	0.02	0.15	0.01
Total Metals	Aluminum (Al) (%)	1.15	0.76	0.92	1.30	0.96
	Antimony (Sb) (ppm)	0.05	0.05	0.34	<0.05	0.10
	Arsenic (As) (ppm)	0.7	7.4	5.3	0.2	4.7
	Barium (Ba) (ppm)	210	150	250	280	280
	Beryllium (Be) (ppm)	0.32	0.42	0.38	0.34	0.36
	Bismuth (Bi) (ppm)	0.23	0.11	0.08	0.08	0.11
	Boron (B) (ppm)	<10	<10	<10	<10	10
	Cadmium (Cd) (ppm)	0.14	0.19	0.21	0.14	0.36
	Calcium (Ca) (%)	1.07	1.39	1.04	1.79	0.40
	Cerium (Ce) (ppm)	20.6	26.4	26.4	21.7	23.8
	Cesium (Cs) (ppm)	0.37	0.56	0.58	0.42	0.52
	Chromium (Cr) (ppm)	6	5	17	6	8
	Cobalt (Co) (ppm)	6.4	6.0	6.9	7.9	6.8
	Copper (Cu) (ppm)	1470	482	392	1210	1240
	Gallium (Ga) (ppm)	6.40	4.87	4.09	8.25	5.56
	Germanium (Ge) (ppm)	0.08	0.06	0.06	0.07	0.07
	Gold (Au) (ppm)	<0.02	<0.02	<0.02	0.02	0.02
	Hafnium (Hf) (ppm)	0.05	0.05	0.18	0.04	0.09
	Indium (In) (ppm)	0.036	0.035	0.024	0.067	0.035
	Iron (Fe) (%)	2.38	2.18	2.01	3.91	2.47
	Lanthanum (La) (ppm)	11.1	14.0	13.9	11.0	14.8
	Lead (Pb) (ppm)	4.7	4.1	4.1	3.0	3.6
	Lithium (Li) (ppm)	7.2	5.1	6.8	7.3	5.1
	Magnesium (Mg) (%)	0.62	0.31	0.41	0.72	0.30
	Manganese (Mn) (ppm)	607	573	413	678	541

	Sample ID	L1946299-6	L1946299-7	L1946299-8	L1946299-9	L1946299-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	29-MAY-17	31-MAY-17	29-MAY-17	30-MAY-17	02-JUN-17
	Sampled Time					
	Client ID	142508	142509	142506	142510	142513
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	8.8	8.7	8.5	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	0.36	0.24	0.42	0.21	0.47
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.9	0.6	2.2	0.3	2.5
	Neutralization Potential (NP) (tCaCO3/1Kt)	36	29	35	24	40
	NNP (tCaCO3/1Kt)	35	28	33	24	38
	Ratio (NP/MPA) (Unity)	38.40	46.40	16.00	76.80	16.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.02	0.01	0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.02	<0.01	0.06	<0.01	0.07
	Total Sulfur (combustion) (%)	0.03	0.02	0.07	0.01	0.08
Total Metals	Aluminum (Al) (%)	0.78	1.25	1.13	0.74	1.18
	Antimony (Sb) (ppm)	0.09	<0.05	<0.05	0.08	<0.05
	Arsenic (As) (ppm)	3.8	0.8	0.5	6.4	0.6
	Barium (Ba) (ppm)	230	210	250	310	120
	Beryllium (Be) (ppm)	0.47	0.38	0.29	0.51	0.37
	Bismuth (Bi) (ppm)	0.12	0.03	0.08	0.04	0.06
	Boron (B) (ppm)	<10	<10	<10	10	<10
	Cadmium (Cd) (ppm)	0.17	0.05	0.10	0.20	0.13
	Calcium (Ca) (%)	1.41	1.20	1.31	0.96	1.37
	Cerium (Ce) (ppm)	29.8	28.0	27.3	31.4	23.5
	Cesium (Cs) (ppm)	0.55	0.32	0.39	0.70	0.44
	Chromium (Cr) (ppm)	4	6	6	5	6
	Cobalt (Co) (ppm)	7.1	6.7	6.6	7.5	6.7
	Copper (Cu) (ppm)	1900	199.0	956	589	995
	Gallium (Ga) (ppm)	4.83	6.63	5.94	4.88	6.97
	Germanium (Ge) (ppm)	0.06	0.08	0.07	0.07	0.07
	Gold (Au) (ppm)	0.05	<0.02	<0.02	<0.02	0.02
	Hafnium (Hf) (ppm)	0.05	0.06	0.05	0.05	0.05
	Indium (In) (ppm)	0.085	0.031	0.043	0.045	0.041
	Iron (Fe) (%)	2.53	2.32	2.41	2.51	2.60
	Lanthanum (La) (ppm)	15.0	14.7	14.8	16.7	12.2
	Lead (Pb) (ppm)	4.2	3.1	3.3	4.7	4.4
	Lithium (Li) (ppm)	3.4	7.7	5.7	3.5	7.2
	Magnesium (Mg) (%)	0.26	0.66	0.58	0.17	0.72
	Manganese (Mn) (ppm)	590	561	534	1010	610

	Sample ID	L1946299-11	L1946299-12	L1946299-13	L1946299-14	L1946299-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	02-JUN-17	02-JUN-17	04-JUN-17	06-JUN-17	06-JUN-17
	Sampled Time					
	Client ID	142511	142512	142514	142517	142516
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	8.2	8.7	8.9	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	0.08	0.37	0.22	0.34
Acid Base Accounting	FIZZ RATING (Unity)	1	1	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.3	3.1	3.8	1.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	10	7	36	25	30
	NNP (tCaCO3/1Kt)	10	7	33	21	28
	Ratio (NP/MPA) (Unity)	32.00	22.40	11.52	6.67	16.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.01	<0.01	<0.01	0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01	<0.01	0.10	0.12	0.06
	Total Sulfur (combustion) (%)	0.01	0.01	0.10	0.12	0.06
Total Metals	Aluminum (Al) (%)	1.21	1.08	1.08	1.04	1.10
	Antimony (Sb) (ppm)	0.06	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	2.2	2.0	0.6	0.1	0.2
	Barium (Ba) (ppm)	330	170	180	160	260
	Beryllium (Be) (ppm)	0.36	0.30	0.37	0.29	0.31
	Bismuth (Bi) (ppm)	0.08	0.71	0.21	0.48	0.21
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.30	0.42	0.09	0.15	0.19
	Calcium (Ca) (%)	0.41	0.23	1.36	0.97	1.07
	Cerium (Ce) (ppm)	33.1	21.1	23.4	19.25	27.8
	Cesium (Cs) (ppm)	0.44	0.54	0.30	0.30	0.49
	Chromium (Cr) (ppm)	7	6	5	5	5
	Cobalt (Co) (ppm)	7.7	6.1	6.1	5.1	6.3
	Copper (Cu) (ppm)	3310	>10000	1060	2100	979
	Gallium (Ga) (ppm)	6.62	5.84	6.33	6.16	5.74
	Germanium (Ge) (ppm)	0.08	0.06	0.07	0.05	0.06
	Gold (Au) (ppm)	0.03	0.15	0.02	0.08	0.03
	Hafnium (Hf) (ppm)	0.11	0.11	0.04	0.04	0.05
	Indium (In) (ppm)	0.070	0.175	0.041	0.043	0.033
	Iron (Fe) (%)	2.74	2.59	2.40	2.15	2.31
	Lanthanum (La) (ppm)	18.0	10.6	12.7	10.5	15.3
	Lead (Pb) (ppm)	3.3	4.9	3.4	4.2	2.7
	Lithium (Li) (ppm)	6.2	4.7	6.5	6.2	5.7
	Magnesium (Mg) (%)	0.44	0.37	0.61	0.48	0.65
	Manganese (Mn) (ppm)	487	394	502	549	573

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946299-16				
	Description	WASTE				
	Sampled Date	06-JUN-17				
	Sampled Time					
	Client ID	142515				
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.3				
Organic / Inorganic Carbon	Carbon (C) (%)	0.14				
Acid Base Accounting	FIZZ RATING (Unity)	1				
	MPA (tCaCO3/1Kt)	0.3				
	Neutralization Potential (NP) (tCaCO3/1Kt)	18				
	NNP (tCaCO3/1Kt)	18				
	Ratio (NP/MPA) (Unity)	57.60				
	Sulfate Sulfur (carbonate leach) (%)	0.02				
	Sulfate Sulfur (HCl leach) (%)	<0.01				
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01				
	Total Sulfur (combustion) (%)	0.01				
Total Metals	Aluminum (Al) (%)	1.11				
	Antimony (Sb) (ppm)	0.21				
	Arsenic (As) (ppm)	3.6				
	Barium (Ba) (ppm)	240				
	Beryllium (Be) (ppm)	0.30				
	Bismuth (Bi) (ppm)	0.13				
	Boron (B) (ppm)	<10				
	Cadmium (Cd) (ppm)	0.17				
	Calcium (Ca) (%)	0.76				
	Cerium (Ce) (ppm)	36.1				
	Cesium (Cs) (ppm)	0.59				
	Chromium (Cr) (ppm)	12				
	Cobalt (Co) (ppm)	7.0				
	Copper (Cu) (ppm)	2610				
	Gallium (Ga) (ppm)	5.33				
	Germanium (Ge) (ppm)	0.07				
	Gold (Au) (ppm)	0.04				
	Hafnium (Hf) (ppm)	0.15				
	Indium (In) (ppm)	0.084				
	Iron (Fe) (%)	2.25				
	Lanthanum (La) (ppm)	19.6				
	Lead (Pb) (ppm)	4.6				
	Lithium (Li) (ppm)	6.7				
	Magnesium (Mg) (%)	0.46				
	Manganese (Mn) (ppm)	508				

	Sample ID	L1946299-1	L1946299-2	L1946299-3	L1946299-4	L1946299-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	26-MAY-17	27-MAY-17	29-MAY-17	29-MAY-17	29-MAY-17
	Sampled Time					
	Client ID	142503	142502	142505	142507	142504
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	0.02	<0.01	0.01
	Molybdenum (Mo) (ppm)	1.11	0.66	1.33	1.00	1.17
	Nickel (Ni) (ppm)	4.8	4.2	13.5	2.8	5.0
	Niobium (Nb) (ppm)	0.16	0.05	0.27	0.16	0.13
	Phosphorus (P) (ppm)	620	550	690	800	670
	Potassium (K) (%)	0.42	0.20	0.21	0.53	0.36
	Rhenium (Re) (ppm)	0.002	<0.001	0.001	0.003	<0.001
	Rubidium (Rb) (ppm)	21.8	12.3	12.4	28.2	24.6
	Scandium (Sc) (ppm)	3.5	5.0	5.0	5.3	5.3
	Selenium (Se) (ppm)	1.4	0.5	0.6	1.2	0.8
	Silver (Ag) (ppm)	0.59	0.11	0.10	0.32	0.35
	Sodium (Na) (%)	0.07	0.05	0.05	0.06	0.05
	Strontium (Sr) (ppm)	53.9	56.1	51.2	75.1	35.2
	Sulfur (S) (%)	0.07	0.01	0.03	0.17	0.02
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.10	0.05	0.02	0.05	0.05
	Thallium (Tl) (ppm)	0.11	0.06	0.08	0.15	0.11
	Thorium (Th) (ppm)	2.0	2.5	3.1	1.6	2.5
	Tin (Sn) (ppm)	0.5	0.6	0.5	1.0	0.7
	Titanium (Ti) (%)	0.082	0.024	0.065	0.097	0.060
	Tungsten (W) (ppm)	0.64	0.20	0.55	0.65	0.33
	Uranium (U) (ppm)	0.24	0.20	0.43	0.23	0.26
	Vanadium (V) (ppm)	46	41	43	78	54
	Yttrium (Y) (ppm)	7.42	7.73	8.29	7.97	9.63
	Zinc (Zn) (ppm)	77	68	53	76	86
	Zirconium (Zr) (ppm)	1.0	1.0	5.5	1.1	2.3
Permanent Gases	Carbon Dioxide (CO2) (%)	0.9	1.4	0.8	2.4	0.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1946299-6 WASTE 29-MAY-17 142508	L1946299-7 WASTE 31-MAY-17 142509	L1946299-8 WASTE 29-MAY-17 142506	L1946299-9 WASTE 30-MAY-17 142510	L1946299-10 WASTE 02-JUN-17 142513
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	0.01	0.01	<0.01
	Molybdenum (Mo) (ppm)	1.13	0.51	1.16	0.98	2.14
	Nickel (Ni) (ppm)	2.3	4.4	2.3	4.2	2.8
	Niobium (Nb) (ppm)	0.11	0.11	0.15	0.05	0.12
	Phosphorus (P) (ppm)	860	690	700	600	680
	Potassium (K) (%)	0.28	0.34	0.46	0.28	0.29
	Rhenium (Re) (ppm)	0.001	0.001	0.002	<0.001	0.003
	Rubidium (Rb) (ppm)	15.9	16.3	24.5	21.9	17.8
	Scandium (Sc) (ppm)	5.4	4.6	5.1	6.9	5.0
	Selenium (Se) (ppm)	1.1	0.5	0.9	0.5	0.8
	Silver (Ag) (ppm)	0.41	0.07	0.33	0.33	0.30
	Sodium (Na) (%)	0.05	0.09	0.07	0.05	0.06
	Strontium (Sr) (ppm)	59.5	73.0	79.1	34.2	117.5
	Sulfur (S) (%)	0.04	0.04	0.09	0.02	0.10
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.07	0.01	0.07	0.02	0.04
	Thallium (Tl) (ppm)	0.08	0.08	0.12	0.08	0.12
	Thorium (Th) (ppm)	3.7	2.7	3.2	3.5	3.6
	Tin (Sn) (ppm)	1.1	0.6	0.8	0.7	0.8
	Titanium (Ti) (%)	0.041	0.069	0.078	0.034	0.044
	Tungsten (W) (ppm)	0.18	0.98	0.28	0.15	0.38
	Uranium (U) (ppm)	0.32	0.42	0.32	0.23	0.31
	Vanadium (V) (ppm)	62	47	51	53	48
	Yttrium (Y) (ppm)	12.45	7.91	7.90	7.72	8.82
	Zinc (Zn) (ppm)	70	65	69	81	79
	Zirconium (Zr) (ppm)	1.4	1.1	1.1	1.7	1.3
Permanent Gases	Carbon Dioxide (CO2) (%)	1.3	0.9	1.6	0.8	1.7

	Sample ID	L1946299-11	L1946299-12	L1946299-13	L1946299-14	L1946299-15
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	02-JUN-17	02-JUN-17	04-JUN-17	06-JUN-17	06-JUN-17
	Sampled Time					
	Client ID	142511	142512	142514	142517	142516
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02	0.02	<0.01	0.01	<0.01
	Molybdenum (Mo) (ppm)	1.27	6.31	1.96	2.79	0.82
	Nickel (Ni) (ppm)	5.1	2.6	2.4	1.9	2.4
	Niobium (Nb) (ppm)	0.21	0.69	0.09	0.13	0.16
	Phosphorus (P) (ppm)	820	660	620	520	630
	Potassium (K) (%)	0.49	0.51	0.27	0.37	0.54
	Rhenium (Re) (ppm)	<0.001	0.001	0.002	0.005	0.001
	Rubidium (Rb) (ppm)	31.4	34.9	13.7	20.3	29.1
	Scandium (Sc) (ppm)	6.6	6.2	3.9	2.9	4.6
	Selenium (Se) (ppm)	0.7	2.6	1.2	2.1	1.2
	Silver (Ag) (ppm)	0.59	3.22	0.40	0.96	0.38
	Sodium (Na) (%)	0.05	0.04	0.06	0.07	0.08
	Strontium (Sr) (ppm)	36.1	25.9	77.8	43.8	83.0
	Sulfur (S) (%)	0.02	0.02	0.12	0.15	0.08
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.18	0.06	0.20	0.04
	Thallium (Tl) (ppm)	0.15	0.27	0.06	0.10	0.15
	Thorium (Th) (ppm)	3.5	6.7	2.5	2.2	3.1
	Tin (Sn) (ppm)	0.9	1.1	0.6	0.5	0.7
	Titanium (Ti) (%)	0.090	0.099	0.042	0.058	0.096
	Tungsten (W) (ppm)	0.47	0.19	0.22	0.34	0.48
	Uranium (U) (ppm)	0.27	0.48	0.41	0.41	0.27
	Vanadium (V) (ppm)	62	58	46	38	48
	Yttrium (Y) (ppm)	9.79	8.96	6.32	4.66	8.22
	Zinc (Zn) (ppm)	89	87	60	56	65
	Zirconium (Zr) (ppm)	3.0	3.7	0.9	1.0	1.1
Permanent Gases	Carbon Dioxide (CO2) (%)	0.2	0.3	1.4	0.8	1.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1946299-16
	Description	WASTE
	Sampled Date	06-JUN-17
	Sampled Time	
	Client ID	142515
Grouping	**Analyte**	
SOIL		
Total Metals	Mercury (Hg) (ppm)	0.01
	Molybdenum (Mo) (ppm)	3.01
	Nickel (Ni) (ppm)	8.5
	Niobium (Nb) (ppm)	0.57
	Phosphorus (P) (ppm)	780
	Potassium (K) (%)	0.34
	Rhenium (Re) (ppm)	0.004
	Rubidium (Rb) (ppm)	22.1
	Scandium (Sc) (ppm)	5.3
	Selenium (Se) (ppm)	1.2
	Silver (Ag) (ppm)	0.26
	Sodium (Na) (%)	0.05
	Strontium (Sr) (ppm)	43.7
	Sulfur (S) (%)	0.02
	Tantalum (Ta) (ppm)	<0.01
	Tellurium (Te) (ppm)	0.05
	Thallium (Tl) (ppm)	0.14
	Thorium (Th) (ppm)	3.7
	Tin (Sn) (ppm)	0.9
	Titanium (Ti) (%)	0.080
	Tungsten (W) (ppm)	0.30
	Uranium (U) (ppm)	0.41
	Vanadium (V) (ppm)	54
	Yttrium (Y) (ppm)	10.15
	Zinc (Zn) (ppm)	59
	Zirconium (Zr) (ppm)	4.8
Permanent Gases	Carbon Dioxide (CO2) (%)	0.5

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-20

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17127938

Project: L1946299

This report is for 16 Other samples submitted to our lab in Vancouver, BC, Canada on 22-JUN-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-CAL06 S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01
L1946299-1 142503		0.92	1.6	2	26	28	8.6	17.92	0.05	<0.01	<0.01	0.05	0.24	0.9	0.59	1.15
L1946299-2 142502		1.10	<0.3	2	36	36	8.4	230.40	<0.01	0.01	0.01	<0.01	0.38	1.4	0.11	0.76
L1946299-3 142505		1.08	0.6	2	23	24	8.4	38.40	0.02	<0.01	0.02	0.02	0.21	0.8	0.10	0.92
L1946299-4 142507		0.92	4.7	2	43	48	8.5	10.24	0.15	<0.01	<0.01	0.15	0.65	2.4	0.32	1.30
L1946299-5 142504		1.08	0.3	1	8	8	8.2	25.60	0.01	0.01	<0.01	<0.01	<0.05	0.2	0.35	0.96
L1946299-6 142508		1.10	0.9	2	35	36	8.5	38.40	0.03	0.01	0.01	0.02	0.36	1.3	0.41	0.78
L1946299-7 142509		1.08	0.6	2	28	29	8.8	46.40	0.02	0.02	0.01	<0.01	0.24	0.9	0.07	1.25
L1946299-8 142506		1.12	2.2	2	33	35	8.7	16.00	0.07	0.01	<0.01	0.06	0.42	1.6	0.33	1.13
L1946299-9 142510		1.10	0.3	2	24	24	8.5	76.80	0.01	0.01	<0.01	<0.01	0.21	0.8	0.33	0.74
L1946299-10 142513		1.06	2.5	2	38	40	8.6	16.00	0.08	0.01	<0.01	0.07	0.47	1.7	0.30	1.18
L1946299-11 142511		1.08	0.3	1	10	10	8.2	32.00	0.01	0.01	0.01	<0.01	<0.05	0.2	0.59	1.21
L1946299-12 142512		0.80	0.3	1	7	7	8.2	22.40	0.01	0.01	0.01	<0.01	0.08	0.3	3.22	1.08
L1946299-13 142514		1.06	3.1	2	33	36	8.7	11.52	0.10	<0.01	<0.01	0.10	0.37	1.4	0.40	1.08
L1946299-14 142517		1.06	3.8	2	21	25	8.9	6.67	0.12	<0.01	<0.01	0.12	0.22	0.8	0.96	1.04
L1946299-15 142516		1.12	1.9	2	28	30	8.9	16.00	0.06	<0.01	0.01	0.06	0.34	1.2	0.38	1.10
L1946299-16 142515		1.06	0.3	1	18	18	8.3	57.60	0.01	0.02	<0.01	<0.01	0.14	0.5	0.26	1.11

Project: L1946299

CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
L1946299-1 142503		0.7	<0.02	<10	210	0.32	0.23	1.07	0.14	20.6	6.4	6	0.37	1470	2.38	6.40
L1946299-2 142502		7.4	<0.02	<10	150	0.42	0.11	1.39	0.19	26.4	6.0	5	0.56	482	2.18	4.87
L1946299-3 142505		5.3	<0.02	<10	250	0.38	0.08	1.04	0.21	26.4	6.9	17	0.58	392	2.01	4.09
L1946299-4 142507		0.2	0.02	<10	280	0.34	0.08	1.79	0.14	21.7	7.9	6	0.42	1210	3.91	8.25
L1946299-5 142504		4.7	0.02	10	280	0.36	0.11	0.40	0.36	23.8	6.8	8	0.52	1240	2.47	5.56
L1946299-6 142508		3.8	0.05	<10	230	0.47	0.12	1.41	0.17	29.8	7.1	4	0.55	1900	2.53	4.83
L1946299-7 142509		0.8	<0.02	<10	210	0.38	0.03	1.20	0.05	28.0	6.7	6	0.32	199.0	2.32	6.63
L1946299-8 142506		0.5	<0.02	<10	250	0.29	0.08	1.31	0.10	27.3	6.6	6	0.39	956	2.41	5.94
L1946299-9 142510		6.4	<0.02	10	310	0.51	0.04	0.96	0.20	31.4	7.5	5	0.70	589	2.51	4.88
L1946299-10 142513		0.6	0.02	<10	120	0.37	0.06	1.37	0.13	23.5	6.7	6	0.44	995	2.60	6.97
L1946299-11 142511		2.2	0.03	<10	330	0.36	0.08	0.41	0.30	33.1	7.7	7	0.44	3310	2.74	6.62
L1946299-12 142512		2.0	0.15	<10	170	0.30	0.71	0.23	0.42	21.1	6.1	6	0.54	>10000	2.59	5.84
L1946299-13 142514		0.6	0.02	<10	180	0.37	0.21	1.36	0.09	23.4	6.1	5	0.30	1060	2.40	6.33
L1946299-14 142517		0.1	0.08	<10	160	0.29	0.48	0.97	0.15	19.25	5.1	5	0.30	2100	2.15	6.16
L1946299-15 142516		0.2	0.03	<10	260	0.31	0.21	1.07	0.19	27.8	6.3	5	0.49	979	2.31	5.74
L1946299-16 142515		3.6	0.04	<10	240	0.30	0.13	0.76	0.17	36.1	7.0	12	0.59	2610	2.25	5.33

Project: L1946299

CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1946299-1 142503		0.08	0.05	<0.01	0.036	0.42	11.1	7.2	0.62	607	1.11	0.07	0.16	4.8	620	4.7
L1946299-2 142502		0.06	0.05	0.01	0.035	0.20	14.0	5.1	0.31	573	0.66	0.05	0.05	4.2	550	4.1
L1946299-3 142505		0.06	0.18	0.02	0.024	0.21	13.9	6.8	0.41	413	1.33	0.05	0.27	13.5	690	4.1
L1946299-4 142507		0.07	0.04	<0.01	0.067	0.53	11.0	7.3	0.72	678	1.00	0.06	0.16	2.8	800	3.0
L1946299-5 142504		0.07	0.09	0.01	0.035	0.36	14.8	5.1	0.30	541	1.17	0.05	0.13	5.0	670	3.6
L1946299-6 142508		0.06	0.05	0.01	0.085	0.28	15.0	3.4	0.26	590	1.13	0.05	0.11	2.3	860	4.2
L1946299-7 142509		0.08	0.06	<0.01	0.031	0.34	14.7	7.7	0.66	561	0.51	0.09	0.11	4.4	690	3.1
L1946299-8 142506		0.07	0.05	0.01	0.043	0.46	14.8	5.7	0.58	534	1.16	0.07	0.15	2.3	700	3.3
L1946299-9 142510		0.07	0.05	0.01	0.045	0.28	16.7	3.5	0.17	1010	0.98	0.05	0.05	4.2	600	4.7
L1946299-10 142513		0.07	0.05	<0.01	0.041	0.29	12.2	7.2	0.72	610	2.14	0.06	0.12	2.8	680	4.4
L1946299-11 142511		0.08	0.11	0.02	0.070	0.49	18.0	6.2	0.44	487	1.27	0.05	0.21	5.1	820	3.3
L1946299-12 142512		0.06	0.11	0.02	0.175	0.51	10.6	4.7	0.37	394	6.31	0.04	0.69	2.6	660	4.9
L1946299-13 142514		0.07	0.04	<0.01	0.041	0.27	12.7	6.5	0.61	502	1.96	0.06	0.09	2.4	620	3.4
L1946299-14 142517		0.05	0.04	0.01	0.043	0.37	10.5	6.2	0.48	549	2.79	0.07	0.13	1.9	520	4.2
L1946299-15 142516		0.06	0.05	<0.01	0.033	0.54	15.3	5.7	0.65	573	0.82	0.08	0.16	2.4	630	2.7
L1946299-16 142515		0.07	0.15	0.01	0.084	0.34	19.6	6.7	0.46	508	3.01	0.05	0.57	8.5	780	4.6

Project: L1946299

CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1
L1946299-1 142503		21.8	0.002	0.07	0.05	3.5	1.4	0.5	53.9	<0.01	0.10	2.0	0.082	0.11	0.24	46
L1946299-2 142502		12.3	<0.001	0.01	0.05	5.0	0.5	0.6	56.1	<0.01	0.05	2.5	0.024	0.06	0.20	41
L1946299-3 142505		12.4	0.001	0.03	0.34	5.0	0.6	0.5	51.2	<0.01	0.02	3.1	0.065	0.08	0.43	43
L1946299-4 142507		28.2	0.003	0.17	<0.05	5.3	1.2	1.0	75.1	<0.01	0.05	1.6	0.097	0.15	0.23	78
L1946299-5 142504		24.6	<0.001	0.02	0.10	5.3	0.8	0.7	35.2	<0.01	0.05	2.5	0.060	0.11	0.26	54
L1946299-6 142508		15.9	0.001	0.04	0.09	5.4	1.1	1.1	59.5	<0.01	0.07	3.7	0.041	0.08	0.32	62
L1946299-7 142509		16.3	0.001	0.04	<0.05	4.6	0.5	0.6	73.0	<0.01	0.01	2.7	0.069	0.08	0.42	47
L1946299-8 142506		24.5	0.002	0.09	<0.05	5.1	0.9	0.8	79.1	<0.01	0.07	3.2	0.078	0.12	0.32	51
L1946299-9 142510		21.9	<0.001	0.02	0.08	6.9	0.5	0.7	34.2	<0.01	0.02	3.5	0.034	0.08	0.23	53
L1946299-10 142513		17.8	0.003	0.10	<0.05	5.0	0.8	0.8	117.5	<0.01	0.04	3.6	0.044	0.12	0.31	48
L1946299-11 142511		31.4	<0.001	0.02	0.06	6.6	0.7	0.9	36.1	<0.01	0.03	3.5	0.090	0.15	0.27	62
L1946299-12 142512		34.9	0.001	0.02	<0.05	6.2	2.6	1.1	25.9	<0.01	0.18	6.7	0.099	0.27	0.48	58
L1946299-13 142514		13.7	0.002	0.12	<0.05	3.9	1.2	0.6	77.8	<0.01	0.06	2.5	0.042	0.06	0.41	46
L1946299-14 142517		20.3	0.005	0.15	<0.05	2.9	2.1	0.5	43.8	<0.01	0.20	2.2	0.058	0.10	0.41	38
L1946299-15 142516		29.1	0.001	0.08	<0.05	4.6	1.2	0.7	83.0	<0.01	0.04	3.1	0.096	0.15	0.27	48
L1946299-16 142515		22.1	0.004	0.02	0.21	5.3	1.2	0.9	43.7	<0.01	0.05	3.7	0.080	0.14	0.41	54

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 16-JUL-2017
Account: APN

Project: L1946299

CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
L1946299-1 142503		0.64	7.42	77	1.0	
L1946299-2 142502		0.20	7.73	68	1.0	
L1946299-3 142505		0.55	8.29	53	5.5	
L1946299-4 142507		0.65	7.97	76	1.1	
L1946299-5 142504		0.33	9.63	86	2.3	
L1946299-6 142508		0.18	12.45	70	1.4	
L1946299-7 142509		0.98	7.91	65	1.1	
L1946299-8 142506		0.28	7.90	69	1.1	
L1946299-9 142510		0.15	7.72	81	1.7	
L1946299-10 142513		0.38	8.82	79	1.3	
L1946299-11 142511		0.47	9.79	89	3.0	
L1946299-12 142512		0.19	8.96	87	3.7	1.260
L1946299-13 142514		0.22	6.32	60	0.9	
L1946299-14 142517		0.34	4.66	56	1.0	
L1946299-15 142516		0.48	8.22	65	1.1	
L1946299-16 142515		0.30	10.15	59	4.8	

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1946299

CERTIFICATE OF ANALYSIS VA17127938

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	Cu-OG46	LOG-22	ME-MS41
ME-OG46	OA-ELE07	OA-VOL08m	PUL-31
PUL-QC	S-CAL06	S-GRA06	S-GRA06a
S-IR08	SPL-21	WEI-21	

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 4 (A - E)
Plus Appendix Pages
Finalized Date: 16-JUL-2017
Account: APN

QC CERTIFICATE VA17127938

Project: L1946299

This report is for 16 Other samples submitted to our lab in Vancouver, BC, Canada on 22-JUN-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17127938

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
STANDARDS															
Buffer pH6					6.0										
Buffer pH6					6.1										
Target Range - Lower Bound					5.3										
Upper Bound					6.7										
CCU-1e															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY										0.50	1.8				
Target Range - Lower Bound										0.42	1.5				
Upper Bound										0.64	2.4				
DS-1							2.58								
Target Range - Lower Bound							2.51								
Upper Bound							2.71								
GBM903-13															
Target Range - Lower Bound															
Upper Bound															
GMO-12															
Target Range - Lower Bound															
Upper Bound															
GS313-8							1.20								
Target Range - Lower Bound							1.19								
Upper Bound							1.29								
KZK-1	25.0	2	32	57		2.28									
KZK-1	25.0	2	32	57		2.28									
Target Range - Lower Bound	22.9	<1	30	54		2.18									
Upper Bound	27.1	>4	38	64		2.53									
MRGeo08												4.57	2.51	31.0	<0.02
Target Range - Lower Bound												4.00	2.44	29.6	<0.02
Upper Bound												4.92	3.00	36.4	0.04
OREAS 604															
OREAS 604															
Target Range - Lower Bound															
Upper Bound															
OREAS 621															
Target Range - Lower Bound															
Upper Bound															
OREAS 905												0.53	0.76	30.2	0.38

QC CERTIFICATE OF ANALYSIS VA17127938

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Sample Description	**LOR**	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CCU-1e																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GBM903-13																
Target Range - Lower Bound																
Upper Bound																
GMO-12																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		<10	430	0.80	0.66	1.01	2.32	78.3	19.3	87	11.30	605	3.29	10.00	0.14	0.73
Target Range - Lower Bound		<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07	0.64
Upper Bound		20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29	0.83
OREAS 604																
OREAS 604																
Target Range - Lower Bound																
Upper Bound																
OREAS 621																
Target Range - Lower Bound																
Upper Bound																
OREAS 905		<10	240	0.95	5.47	0.32	0.36	81.1	14.0	17	1.19	1500	3.13	6.34	0.09	1.18

QC CERTIFICATE OF ANALYSIS VA17127938

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CCU-1e															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GBM903-13															
Target Range - Lower Bound															
Upper Bound															
GMO-12															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.06	0.167	1.18	39.0	31.7	1.07	395	15.40	0.31	0.81	682	940	989	151.0	0.008
Target Range - Lower Bound	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0	0.006
Upper Bound	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0	0.010
OREAS 604															
OREAS 604															
Target Range - Lower Bound															
Upper Bound															
OREAS 621															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	0.01	0.622	0.29	41.3	4.8	0.14	326	3.13	0.08	0.31	8.8	220	15.6	18.2	<0.001

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CCU-1e															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GBM903-13															
Target Range - Lower Bound															
Upper Bound															
GMO-12															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.30	3.64	7.3	1.5	3.6	75.2	0.01	0.02	22.8	0.383	0.75	5.55	93	3.34	20.8
Target Range - Lower Bound	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44	17.50
Upper Bound	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42	21.5
OREAS 604															
OREAS 604															
Target Range - Lower Bound															
Upper Bound															
OREAS 621															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	0.07	1.13	1.7	2.2	1.3	11.2	<0.01	0.07	8.2	0.020	0.10	2.18	5	0.63	6.90

QC CERTIFICATE OF ANALYSIS VA17127938

STANDARDS

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CCU-1e				23.0
Target Range - Lower Bound				22.1
Upper Bound				23.7
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
DS-1				
Target Range - Lower Bound				
Upper Bound				
GBM903-13				2.93
Target Range - Lower Bound				2.79
Upper Bound				3.00
GMO-12				0.017
Target Range - Lower Bound				
Upper Bound				
GS313-8				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MRGeo08		745	23.5	
Target Range - Lower Bound		708	18.1	
Upper Bound		870	25.7	
OREAS 604				2.19
OREAS 604				2.16
Target Range - Lower Bound				
Upper Bound				
OREAS 621				0.358
Target Range - Lower Bound				
Upper Bound				
OREAS 905		61	49.2	

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1946299

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description																
	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
STANDARDS																
Target Range - Lower Bound													0.45	0.73	28.4	0.33
Upper Bound													0.58	0.91	35.0	0.45
UTS-1									0.89							
Target Range - Lower Bound									0.83							
Upper Bound									0.93							
UTS-1										0.92						
Target Range - Lower Bound										0.81						
Upper Bound										0.95						
UTS-4									1.76							
Target Range - Lower Bound									1.64							
Upper Bound									1.84							
UTS-4										1.72						
Target Range - Lower Bound										1.61						
Upper Bound										1.87						
BLANKS																
BLANK											<0.05	<0.2				
Target Range - Lower Bound											<0.05	<0.2				
Upper Bound											0.10	0.4				
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK													<0.01	<0.01	0.3	<0.02
Target Range - Lower Bound													<0.01	<0.01	<0.1	<0.02
Upper Bound													0.02	0.02	0.2	0.04
BLANK						6.0										
Target Range - Lower Bound						5.5										
Upper Bound						6.9										
BLANK									<0.01							
Target Range - Lower Bound									<0.01							
Upper Bound									0.02							
BLANK										<0.01						
Target Range - Lower Bound										<0.01						
Upper Bound										0.02						
BLANK								<0.01								
Target Range - Lower Bound								<0.01								
Upper Bound								0.02								

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description — Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02
STANDARDS															
Target Range - Lower Bound	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05	1.08
Upper Bound	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22	1.36
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	10	<0.05	0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Target Range - Lower Bound	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Upper Bound	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001
STANDARDS																
Target Range - Lower Bound		<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3	<0.001
Upper Bound		0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3	0.002
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Target Range - Lower Bound		<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Upper Bound		0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2	0.002
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17127938

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
STANDARDS															
Target Range - Lower Bound	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44	6.32
Upper Bound	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76	7.84
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Target Range - Lower Bound	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Upper Bound	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1946299

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
STANDARDS				
Target Range - Lower Bound		58	39.9	
Upper Bound		76	55.1	
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
BLANKS				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				<0.001
Target Range - Lower Bound				<0.001
Upper Bound				0.002
BLANK		<2	<0.5	
Target Range - Lower Bound		<2	<0.5	
Upper Bound		4	1.0	
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17127938

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description / **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
							DUPLICATES								
L1946299-8 142506								0.01							
DUP								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
L1946299-10 142513	2.5	2	38	40	8.6	16.00			<0.01	0.47	1.7	0.30	1.18	0.6	0.02
DUP	2.5	2	37	39	8.6	15.60			<0.01	0.48	1.8	0.29	1.20	0.5	0.03
Target Range - Lower Bound	2.1	<1	35	37	8.1	15.00			<0.01	0.40	1.5	0.27	1.12	0.4	<0.02
Upper Bound	2.9	3	40	42	9.1	16.60			0.02	0.55	2.0	0.32	1.26	0.7	0.04
ORIGINAL							0.05								
DUP							0.05								
Target Range - Lower Bound							0.04								
Upper Bound							0.06								

***** See Appendix Page for comments regarding this certificate *****

Project: L1946299

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
DUPLICATES																
L1946299-8 142506																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1946299-10 142513		<10	120	0.37	0.06	1.37	0.13	23.5	6.7	6	0.44	995	2.60	6.97	0.07	0.05
DUP		<10	120	0.42	0.06	1.39	0.12	23.6	6.5	5	0.45	998	2.62	6.78	0.07	0.06
Target Range - Lower Bound		<10	100	0.33	0.05	1.30	0.11	22.4	6.2	4	0.37	961	2.47	6.48	<0.05	0.03
Upper Bound		20	140	0.46	0.07	1.46	0.14	24.7	7.0	7	0.52	1030	2.75	7.27	0.10	0.08
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
DUPLICATES															
L1946299-8 142506															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1946299-10 142513	<0.01	0.041	0.29	12.2	7.2	0.72	610	2.14	0.06	0.12	2.8	680	4.4	17.8	0.003
DUP	<0.01	0.037	0.29	12.3	7.0	0.72	614	2.37	0.06	0.11	2.7	690	4.4	18.1	0.003
Target Range - Lower Bound	<0.01	0.032	0.27	11.4	6.6	0.67	576	2.09	0.05	0.06	2.4	640	4.0	17.0	0.002
Upper Bound	0.02	0.046	0.31	13.1	7.6	0.77	648	2.42	0.07	0.17	3.1	730	4.8	18.9	0.004
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17127938

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
							DUPLICATES								
L1946299-8 142506															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1946299-10 142513	0.10	<0.05	5.0	0.8	0.8	117.5	<0.01	0.04	3.6	0.044	0.12	0.31	48	0.38	8.82
DUP	0.10	<0.05	4.9	0.9	0.8	118.0	<0.01	0.05	3.6	0.044	0.13	0.33	49	0.40	8.80
Target Range - Lower Bound	0.09	<0.05	4.6	0.6	0.6	111.5	<0.01	0.03	3.2	0.037	0.10	0.25	45	0.31	8.32
Upper Bound	0.12	0.10	5.3	1.1	1.0	124.0	0.02	0.06	4.0	0.051	0.15	0.39	52	0.47	9.30
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1946299

QC CERTIFICATE OF ANALYSIS VA17127938

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
DUPLICATES				
L1946299-8 142506				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1946299-10 142513		79	1.3	
DUP		79	1.3	
Target Range - Lower Bound		73	0.7	
Upper Bound		85	1.9	
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 16-JUL-2017
Account: APN

Project: L1946299

QC CERTIFICATE OF ANALYSIS VA17127938

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	Cu-OG46	LOG-22	ME-MS41
ME-OG46	OA-ELE07	OA-VOL08m	PUL-31
PUL-QC	S-CAL06	S-GRA06	S-GRA06a
S-IR08	SPL-21	WEI-21	

ALS

Chain of Custody (COC) / Analytical Request Form

L1946299-COFC

COC Number 17-20

Page 2 of

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

Report To	Contact and company name below will appear on the final report
Company	Minto Explorations Ltd
Contact	Minto Environment - Coordinator
Phone	1-604-759-4659
	Company address below will appear on the final report
Street	2100-510 West Georgia St
City/Province	Vancouver British Columbia
Postal Code	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company	Minto Explorations Ltd
Contact	Ruth Cayetano

Report Format / Distribution

Select Report Format ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine com

Email 2

Select Service Level Below Please confirm all E&P TATs with your AM surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm business days no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #

Job #

PO / AFE TRD

LSD

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center

PO#

Major/Minor Code

Routing Code

Requisitioner

Location

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals Aqua regia digestion (ICP)	Paste pH	Inorganic Carbonate	Total Carbon/Sulphur (LECO)	AP determination by % sulphide sulphur	Modified NP (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	142512	9-Jun-17		WASTE	X	X	X	X	X	X	
	142514	4-June-17		WASTE	X	X	X	X	X	X	
	142517	6-Jun-17		WASTE	X	X	X	X	X	X	
	142516	6-June-17		WASTE	X	X	X	X	X	X	
	142515	6-Jun-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☐ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 18.0

FINAL COOLER TEMPERATURES °C: 20

SHIPMENT RELEASE (client use)

Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF Date: 20 June 2017 Time: 16:26

FINAL SHIPMENT RECEPTION (lab use only)

Received by: JC Date: 6/21/17 Time: 2pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form

ALS

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1946299-COFC

COC Number: 17-20

Page 1 of

Report To	Contact and company name below will appear on the final report	
Company	Minto Explorations Ltd	
Contact	Minto Environment - Coordinator	
Phone	1-604-759-4659	
	Company address below will appear on the final report	
Street	2100-510 West Georgia St.	
City/Province	Vancouver, British Columbia	
Postal Code	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company	Minto Explorations Ltd	
Contact	Ruth Cayetano	

Report Format / Distribution

Select Report Format ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #

Job #

PO / AFE TBD

LSD

Oil and Gas Required Fields (client use)

AFE/Cost Center

PO#

Major/Minor Code

Routing Code

Requisitioner

Location

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (LECO)	AP determination by % sulphide sulphur	Modified NP (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	142503	26-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142502	29-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142505	29-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142507	29-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142504	29-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142508	29-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142509	31-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142506	29-MAY-17		WASTE	✓	✓	✓	✓	✓	✓	
	142510	30-June-17		WASTE	✓	✓	✓	✓	✓	✓	
	142513	2-June-17		WASTE	✓	✓	✓	✓	✓	✓	
	142511	2-Jun-17		WASTE	✓	✓	✓	✓	✓	✓	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C	
18.0			20	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by	Date	Time	Received by	Date	Time	Received by	Date	Time
Kara Joe	June 17, 2017		EHF	20 June 2017	16:20	JC	~~6/14~~ 6/21/17	

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	14-JUL-17
Report Date:	08-AUG-17 18:20 (MT)
Version:	FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #:	L1958661
Project P.O. #:	PO#226298
Job Reference:	
C of C Numbers:	17 21
Legal Site Desc:	

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1958661-1	L1958661-2	L1958661-3	L1958661-4	L1958661-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	19-JUN-17	16-JUN-17	18-JUN-17	11-JUN-17	08-JUN-17
	Sampled Time					
	Client ID	787-49 MM 142654	787-52 MM 142652	781-44 MM 142653	787-48 MM 142521	793-32A MM 142519
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.4	8.3	8.5	8.3	8.2
Organic / Inorganic Carbon	Carbon (C) (%)	0.34	0.05	0.41	0.12	<0.05
Acid Base Accounting	FIZZ RATING (Unity)	1	1	2	2	1
	MPA (tCaCO3/1Kt)	0.3	0.3	1.6	0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	32	9	34	18	7
	NNP (tCaCO3/1Kt)	32	9	32	18	7
	Ratio (NP/MPA) (Unity)	102.40	28.80	21.76	57.60	22.40
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.03	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01	0.01	0.05	<0.01	0.01
	Total Sulfur (combustion) (%)	0.01	0.01	0.05	0.01	0.01
Total Metals	Aluminum (Al) (%)	0.72	1.07	1.22	1.10	0.86
	Antimony (Sb) (ppm)	0.06	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	3.2	1.0	1.1	2.9	1.3
	Barium (Ba) (ppm)	180	280	260	250	180
	Beryllium (Be) (ppm)	0.41	0.25	0.43	0.36	0.34
	Bismuth (Bi) (ppm)	0.09	0.15	0.19	0.18	0.15
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.12	0.31	0.08	0.38	0.27
	Calcium (Ca) (%)	1.28	0.30	1.29	0.69	0.27
	Cerium (Ce) (ppm)	24.7	26.8	34.7	26.6	28.0
	Cesium (Cs) (ppm)	0.55	0.46	0.48	0.37	0.35
	Chromium (Cr) (ppm)	4	4	5	8	6
	Cobalt (Co) (ppm)	5.8	6.8	6.9	7.0	5.6
	Copper (Cu) (ppm)	705	2650	751	1460	2030
	Gallium (Ga) (ppm)	4.36	5.24	6.64	5.75	4.46
	Germanium (Ge) (ppm)	0.10	0.11	0.13	0.12	0.11
	Gold (Au) (ppm)	<0.02	0.05	0.04	0.05	0.05
	Hafnium (Hf) (ppm)	0.04	0.06	0.05	0.09	0.05
	Indium (In) (ppm)	0.044	0.048	0.033	0.042	0.045
	Iron (Fe) (%)	2.26	2.37	2.56	2.39	2.20
	Lanthanum (La) (ppm)	12.6	14.5	18.3	13.7	15.6
	Lead (Pb) (ppm)	4.7	2.8	3.2	2.9	3.5
	Lithium (Li) (ppm)	4.6	5.9	7.5	8.9	4.5
	Magnesium (Mg) (%)	0.27	0.48	0.74	0.61	0.32
	Manganese (Mn) (ppm)	648	570	599	578	493

	Sample ID	L1958661-6	L1958661-7	L1958661-8	L1958661-9	L1958661-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-JUN-17	15-JUN-17	14-JUN-17	12-JUN-17	14-JUN-17
	Sampled Time					
	Client ID	793-32B MM 142520	787-53 MM 142651	787-54 MM 142525	787-51 MM 142523	787-47 MM 142524
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	8.3	8.5	8.5	8.5
Organic / Inorganic Carbon	Carbon (C) (%)	0.05	<0.05	0.25	0.10	0.38
Acid Base Accounting	FIZZ RATING (Unity)	1	1	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.9	5.9	<0.3	5.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	7	8	23	15	33
	NNP (tCaCO3/1Kt)	7	7	17	15	27
	Ratio (NP/MPA) (Unity)	22.40	8.53	3.87	96.00	5.87
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01	0.02	0.19	<0.01	0.18
	Total Sulfur (combustion) (%)	0.01	0.03	0.19	<0.01	0.18
Total Metals	Aluminum (Al) (%)	0.78	0.76	1.11	0.97	0.53
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	0.07
	Arsenic (As) (ppm)	1.0	1.8	0.6	0.8	3.0
	Barium (Ba) (ppm)	160	120	210	170	90
	Beryllium (Be) (ppm)	0.32	0.25	0.27	0.38	0.34
	Bismuth (Bi) (ppm)	0.18	0.24	0.64	0.03	0.17
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.38	0.46	0.46	0.42	0.09
	Calcium (Ca) (%)	0.30	0.27	0.73	0.61	1.22
	Cerium (Ce) (ppm)	24.7	24.8	26.9	22.5	42.3
	Cesium (Cs) (ppm)	0.35	0.41	0.58	0.32	0.28
	Chromium (Cr) (ppm)	5	5	6	5	3
	Cobalt (Co) (ppm)	5.5	5.7	7.6	5.3	7.2
	Copper (Cu) (ppm)	2170	3940	7450	1195	2830
	Gallium (Ga) (ppm)	4.20	4.00	5.88	5.19	3.31
	Germanium (Ge) (ppm)	0.10	0.10	0.12	0.10	0.12
	Gold (Au) (ppm)	0.05	0.08	0.16	<0.02	0.04
	Hafnium (Hf) (ppm)	0.05	0.04	0.05	0.04	0.04
	Indium (In) (ppm)	0.052	0.074	0.120	0.025	0.072
	Iron (Fe) (%)	1.91	2.15	2.93	2.00	2.17
	Lanthanum (La) (ppm)	12.4	13.2	14.3	12.1	21.8
	Lead (Pb) (ppm)	3.1	4.8	3.6	2.9	4.9
	Lithium (Li) (ppm)	4.1	3.3	5.1	6.9	2.6
	Magnesium (Mg) (%)	0.29	0.31	0.69	0.47	0.26
	Manganese (Mn) (ppm)	529	625	636	559	498

	Sample ID	L1958661-11	L1958661-12	L1958661-13	L1958661-14	L1958661-15
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	11-JUN-17	21-JUN-17	20-JUN-17	24-JUN-17	24-JUN-17
	Sampled Time					
	Client ID	787-50 MM 142522	781-38 MM 142656	781-44 MM 142655	781-45 MM 142657	781-45 MM 142658
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	8.5	8.5	8.7	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	0.33	0.23	0.29	0.19
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	2	2
	MPA (tCaCO3/1Kt)	<0.3	0.9	1.3	1.3	19.1
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	29	25	28	23
	NNP (tCaCO3/1Kt)	8	28	24	27	4
	Ratio (NP/MPA) (Unity)	51.20	30.93	20.00	22.40	1.21
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	0.01	<0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	<0.01	0.02	0.03	0.04	0.60
	Total Sulfur (combustion) (%)	<0.01	0.03	0.04	0.04	0.61
Total Metals	Aluminum (Al) (%)	1.06	1.11	1.11	1.21	1.43
	Antimony (Sb) (ppm)	0.05	0.06	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	3.2	1.0	0.7	0.7	0.6
	Barium (Ba) (ppm)	270	190	260	150	170
	Beryllium (Be) (ppm)	0.40	0.32	0.35	0.36	0.21
	Bismuth (Bi) (ppm)	0.13	0.08	0.12	0.06	2.86
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.24	0.10	0.10	0.04	0.17
	Calcium (Ca) (%)	0.39	1.15	1.01	1.27	0.89
	Cerium (Ce) (ppm)	28.6	28.5	28.1	19.95	17.75
	Cesium (Cs) (ppm)	0.38	0.48	0.41	0.29	0.66
	Chromium (Cr) (ppm)	5	5	6	5	7
	Cobalt (Co) (ppm)	6.3	6.0	7.1	5.9	6.5
	Copper (Cu) (ppm)	1455	739	836	426	>10000
	Gallium (Ga) (ppm)	5.51	5.74	5.61	6.05	8.85
	Germanium (Ge) (ppm)	0.12	0.12	0.12	0.11	0.14
	Gold (Au) (ppm)	0.03	0.02	<0.02	<0.02	0.24
	Hafnium (Hf) (ppm)	0.05	0.04	0.06	0.05	0.06
	Indium (In) (ppm)	0.044	0.035	0.036	0.026	0.136
	Iron (Fe) (%)	2.53	2.35	2.36	2.33	4.35
	Lanthanum (La) (ppm)	14.5	14.7	14.8	10.6	9.2
	Lead (Pb) (ppm)	3.1	3.3	2.7	3.3	4.3
	Lithium (Li) (ppm)	8.6	7.3	6.1	7.5	7.2
	Magnesium (Mg) (%)	0.42	0.69	0.64	0.73	0.83
	Manganese (Mn) (ppm)	663	604	607	567	670

	Sample ID	L1958661-16	L1958661-17
	Description	Waste	Waste
	Sampled Date	25-JUN-17	
	Sampled Time		
	Client ID	781-46 MM 142659	787-46 MM 142518
Grouping	**Analyte**		
SOIL			
Physical Tests	pH (Unity)	8.5	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.38	0.19
Acid Base Accounting	FIZZ RATING (Unity)	2	2
	MPA (tCaCO3/1Kt)	6.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	32	21
	NNP (tCaCO3/1Kt)	26	21
	Ratio (NP/MPA) (Unity)	5.12	67.20
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.19	0.01
	Total Sulfur (combustion) (%)	0.20	0.01
Total Metals	Aluminum (Al) (%)	1.35	1.09
	Antimony (Sb) (ppm)	<0.05	0.05
	Arsenic (As) (ppm)	1.2	1.3
	Barium (Ba) (ppm)	200	200
	Beryllium (Be) (ppm)	0.44	0.34
	Bismuth (Bi) (ppm)	0.66	0.02
	Boron (B) (ppm)	<10	<10
	Cadmium (Cd) (ppm)	0.69	0.07
	Calcium (Ca) (%)	1.41	0.90
	Cerium (Ce) (ppm)	23.0	28.0
	Cesium (Cs) (ppm)	0.69	0.44
	Chromium (Cr) (ppm)	5	5
	Cobalt (Co) (ppm)	6.6	5.7
	Copper (Cu) (ppm)	2780	191.0
	Gallium (Ga) (ppm)	7.55	5.74
	Germanium (Ge) (ppm)	0.13	0.12
	Gold (Au) (ppm)	0.09	<0.02
	Hafnium (Hf) (ppm)	0.05	0.04
	Indium (In) (ppm)	0.060	0.026
	Iron (Fe) (%)	3.18	2.10
	Lanthanum (La) (ppm)	11.3	14.2
	Lead (Pb) (ppm)	4.0	2.9
	Lithium (Li) (ppm)	7.5	7.4
	Magnesium (Mg) (%)	0.76	0.63
	Manganese (Mn) (ppm)	880	570

	Sample ID	L1958661-1	L1958661-2	L1958661-3	L1958661-4	L1958661-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	19-JUN-17	16-JUN-17	18-JUN-17	11-JUN-17	08-JUN-17
	Sampled Time					
	Client ID	787-49 MM 142654	787-52 MM 142652	781-44 MM 142653	787-48 MM 142521	793-32A MM 142519
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	<0.01	0.01	0.01
	Molybdenum (Mo) (ppm)	1.02	3.55	0.32	0.98	1.89
	Nickel (Ni) (ppm)	2.6	2.4	2.7	11.2	2.6
	Niobium (Nb) (ppm)	<0.05	0.16	0.09	0.09	0.14
	Phosphorus (P) (ppm)	600	750	720	740	670
	Potassium (K) (%)	0.20	0.55	0.37	0.39	0.28
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.001	<0.001
	Rubidium (Rb) (ppm)	12.7	29.1	18.4	21.3	16.2
	Scandium (Sc) (ppm)	6.0	4.8	4.6	5.4	5.0
	Selenium (Se) (ppm)	0.8	0.9	0.9	0.8	0.7
	Silver (Ag) (ppm)	0.19	0.31	0.28	0.44	0.30
	Sodium (Na) (%)	0.04	0.05	0.06	0.06	0.05
	Strontium (Sr) (ppm)	51.2	25.1	93.6	45.5	22.7
	Sulfur (S) (%)	0.01	0.01	0.06	0.02	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.11	0.06	0.05	0.09
	Thallium (Tl) (ppm)	0.06	0.18	0.10	0.11	0.10
	Thorium (Th) (ppm)	2.6	3.7	3.7	2.6	4.0
	Tin (Sn) (ppm)	0.6	0.6	0.6	0.6	0.6
	Titanium (Ti) (%)	0.018	0.092	0.053	0.068	0.039
	Tungsten (W) (ppm)	0.15	0.31	0.33	0.20	0.24
	Uranium (U) (ppm)	0.23	0.21	0.39	0.22	0.22
	Vanadium (V) (ppm)	44	54	50	51	43
	Yttrium (Y) (ppm)	8.86	7.84	8.54	8.86	8.52
	Zinc (Zn) (ppm)	75	78	74	77	71
	Zirconium (Zr) (ppm)	1.0	1.5	1.0	2.3	1.4
Permanent Gases	Carbon Dioxide (CO2) (%)	1.2	0.2	1.5	0.4	<0.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1958661-6	L1958661-7	L1958661-8	L1958661-9	L1958661-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-JUN-17	15-JUN-17	14-JUN-17	12-JUN-17	14-JUN-17
	Sampled Time					
	Client ID	793-32B MM 142520	787-53 MM 142651	787-54 MM 142525	787-51 MM 142523	787-47 MM 142524
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	2.81	3.36	4.93	1.07	7.79
	Nickel (Ni) (ppm)	2.3	2.1	2.6	2.2	2.3
	Niobium (Nb) (ppm)	0.07	0.17	0.17	0.06	0.07
	Phosphorus (P) (ppm)	610	760	920	550	870
	Potassium (K) (%)	0.21	0.39	0.70	0.21	0.15
	Rhenium (Re) (ppm)	<0.001	<0.001	0.003	<0.001	0.009
	Rubidium (Rb) (ppm)	11.7	22.9	38.6	11.1	8.3
	Scandium (Sc) (ppm)	5.4	4.7	5.5	4.2	4.3
	Selenium (Se) (ppm)	1.0	2.1	4.7	0.5	2.1
	Silver (Ag) (ppm)	0.43	0.67	1.88	0.06	0.36
	Sodium (Na) (%)	0.05	0.05	0.04	0.06	0.04
	Strontium (Sr) (ppm)	27.2	22.5	55.8	38.4	59.9
	Sulfur (S) (%)	0.02	0.04	0.22	0.01	0.22
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.09	0.14	0.27	0.02	0.05
	Thallium (Tl) (ppm)	0.07	0.19	0.30	0.05	0.05
	Thorium (Th) (ppm)	3.3	5.5	4.9	2.1	5.9
	Tin (Sn) (ppm)	0.6	0.6	0.8	0.5	0.9
	Titanium (Ti) (%)	0.023	0.054	0.111	0.027	0.012
	Tungsten (W) (ppm)	0.19	0.38	0.55	0.30	0.32
	Uranium (U) (ppm)	0.21	0.30	0.29	0.14	0.48
	Vanadium (V) (ppm)	36	47	69	36	40
	Yttrium (Y) (ppm)	8.64	8.60	9.15	7.51	12.50
	Zinc (Zn) (ppm)	65	74	103	74	48
	Zirconium (Zr) (ppm)	1.0	1.1	1.2	0.7	1.7
Permanent Gases	Carbon Dioxide (CO2) (%)	0.2	0.2	0.9	0.4	1.4

	Sample ID	L1958661-11	L1958661-12	L1958661-13	L1958661-14	L1958661-15
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	11-JUN-17	21-JUN-17	20-JUN-17	24-JUN-17	24-JUN-17
	Sampled Time					
	Client ID	787-50 MM 142522	781-38 MM 142656	781-44 MM 142655	781-45 MM 142657	781-45 MM 142658
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	<0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	0.90	0.60	1.31	0.80	2.16
	Nickel (Ni) (ppm)	2.9	2.8	3.4	2.3	6.2
	Niobium (Nb) (ppm)	0.07	0.16	0.17	0.14	0.32
	Phosphorus (P) (ppm)	720	690	690	690	970
	Potassium (K) (%)	0.38	0.36	0.47	0.31	0.81
	Rhenium (Re) (ppm)	<0.001	0.001	0.001	0.002	0.005
	Rubidium (Rb) (ppm)	19.3	17.8	22.9	14.7	40.0
	Scandium (Sc) (ppm)	6.0	5.4	4.6	3.4	4.9
	Selenium (Se) (ppm)	0.5	0.9	0.9	0.5	8.5
	Silver (Ag) (ppm)	0.21	0.19	0.28	0.15	2.71
	Sodium (Na) (%)	0.06	0.07	0.07	0.08	0.05
	Strontium (Sr) (ppm)	36.4	88.4	72.8	61.7	36.6
	Sulfur (S) (%)	0.01	0.05	0.06	0.06	0.67
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.04	0.04	0.04	0.03	0.52
	Thallium (Tl) (ppm)	0.10	0.10	0.12	0.08	0.33
	Thorium (Th) (ppm)	2.8	3.2	2.9	2.0	5.0
	Tin (Sn) (ppm)	0.6	0.7	0.6	0.5	0.7
	Titanium (Ti) (%)	0.051	0.059	0.085	0.074	0.144
	Tungsten (W) (ppm)	0.24	0.47	0.59	0.53	4.93
	Uranium (U) (ppm)	0.21	0.26	0.33	0.38	0.25
	Vanadium (V) (ppm)	50	48	50	48	70
	Yttrium (Y) (ppm)	9.74	9.27	10.15	6.12	8.08
	Zinc (Zn) (ppm)	83	68	70	67	72
	Zirconium (Zr) (ppm)	1.1	0.8	1.0	1.0	1.3
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	1.2	0.8	1.1	0.7

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1958661-16	L1958661-17			
	Description	Waste	Waste			
	Sampled Date	25-JUN-17				
	Sampled Time					
	Client ID	781-46 MM 142659	787-46 MM 142518			
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01			
	Molybdenum (Mo) (ppm)	2.23	0.63			
	Nickel (Ni) (ppm)	2.4	2.8			
	Niobium (Nb) (ppm)	0.31	0.18			
	Phosphorus (P) (ppm)	770	590			
	Potassium (K) (%)	0.57	0.38			
	Rhenium (Re) (ppm)	0.007	0.001			
	Rubidium (Rb) (ppm)	29.2	18.7			
	Scandium (Sc) (ppm)	4.8	4.0			
	Selenium (Se) (ppm)	2.6	0.7			
	Silver (Ag) (ppm)	0.96	0.05			
	Sodium (Na) (%)	0.07	0.09			
	Strontium (Sr) (ppm)	80.3	76.9			
	Sulfur (S) (%)	0.23	0.01			
	Tantalum (Ta) (ppm)	<0.01	<0.01			
	Tellurium (Te) (ppm)	0.16	0.01			
	Thallium (Tl) (ppm)	0.20	0.11			
	Thorium (Th) (ppm)	3.2	3.0			
	Tin (Sn) (ppm)	0.7	0.6			
	Titanium (Ti) (%)	0.103	0.069			
	Tungsten (W) (ppm)	0.73	0.35			
	Uranium (U) (ppm)	0.56	0.26			
	Vanadium (V) (ppm)	57	43			
	Yttrium (Y) (ppm)	10.75	9.75			
	Zinc (Zn) (ppm)	89	61			
	Zirconium (Zr) (ppm)	1.0	0.9			
Permanent Gases	Carbon Dioxide (CO2) (%)	1.4	0.7			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06

Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17 21

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 5-AUG-2017
Account: APN

CERTIFICATE VA17152306

Project: L1958661

P.O. No.: ALSM-CW16-102-APN

This report is for 17 Other samples submitted to our lab in Vancouver, BC, Canada on 18-JUL-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1958661

CERTIFICATE OF ANALYSIS VA17152306

Method	WEI-21	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Recvd Wt.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs
Units	kg	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.02	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05
L1958661-1 787-49 MM 142654	1.06	0.19	0.72	3.2	<0.02	<10	180	0.41	0.09	1.28	0.12	24.7	5.8	4	0.55
L1958661-2 787-52 MM 142652	1.10	0.31	1.07	1.0	0.05	<10	280	0.25	0.15	0.30	0.31	26.8	6.8	4	0.46
L1958661-3 781-44 MM 142653	1.08	0.28	1.22	1.1	0.04	<10	260	0.43	0.19	1.29	0.08	34.7	6.9	5	0.48
L1958661-4 787-48 MM 142521	1.10	0.44	1.10	2.9	0.05	<10	250	0.36	0.18	0.69	0.38	26.6	7.0	8	0.37
L1958661-5 793-32A MM 142519	1.12	0.30	0.86	1.3	0.05	<10	180	0.34	0.15	0.27	0.27	28.0	5.6	6	0.35
L1958661-6 793-32B MM 142520	1.08	0.43	0.78	1.0	0.05	<10	160	0.32	0.18	0.30	0.38	24.7	5.5	5	0.35
L1958661-7 787-53 MM 142651	1.08	0.67	0.76	1.8	0.08	<10	120	0.25	0.24	0.27	0.46	24.8	5.7	5	0.41
L1958661-8 787-54 MM 142525	1.10	1.88	1.11	0.6	0.16	<10	210	0.27	0.64	0.73	0.46	26.9	7.6	6	0.58
L1958661-9 787-51 MM 142543	1.06	0.06	0.97	0.8	<0.02	<10	170	0.38	0.03	0.61	0.42	22.5	5.3	5	0.32
L1958661-10 787-47 MM 142524	1.14	0.36	0.53	3.0	0.04	<10	90	0.34	0.17	1.22	0.09	42.3	7.2	3	0.28
L1958661-11 787-50 MM 142522	1.06	0.21	1.06	3.2	0.03	<10	270	0.40	0.13	0.39	0.24	28.6	6.3	5	0.38
L1958661-12 781-38 MM 142656	1.12	0.19	1.11	1.0	0.02	<10	190	0.32	0.08	1.15	0.10	28.5	6.0	5	0.48
L1958661-13 781-44 MM 142655	1.06	0.28	1.11	0.7	<0.02	<10	260	0.35	0.12	1.01	0.10	28.1	7.1	6	0.41
L1958661-14 781-45 MM 142657	1.08	0.15	1.21	0.7	<0.02	<10	150	0.36	0.06	1.27	0.04	19.95	5.9	5	0.29
L1958661-15 781-45 MM 142658	1.12	2.71	1.43	0.6	0.24	<10	170	0.21	2.86	0.89	0.17	17.75	6.5	7	0.66
L1958661-16 781-46 MM 142659	1.08	0.96	1.35	1.2	0.09	<10	200	0.44	0.66	1.41	0.69	23.0	6.6	5	0.69
L1958661-17 781-46 MM 142518	1.08	0.05	1.09	1.3	<0.02	<10	200	0.34	0.02	0.90	0.07	28.0	5.7	5	0.44

***** See Appendix Page for comments regarding this certificate *****

Project: L1958661

CERTIFICATE OF ANALYSIS VA17152306

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
Sample Description / **LOR**	0.2	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05
L1958661-1 787-49 MM 142654	705	2.26	4.36	0.10	0.04	0.01	0.044	0.20	12.6	4.6	0.27	648	1.02	0.04	<0.05
L1958661-2 787-52 MM 142652	2650	2.37	5.24	0.11	0.06	0.01	0.048	0.55	14.5	5.9	0.48	570	3.55	0.05	0.16
L1958661-3 781-44 MM 142653	751	2.56	6.64	0.13	0.05	<0.01	0.033	0.37	18.3	7.5	0.74	599	0.32	0.06	0.09
L1958661-4 787-48 MM 142521	1460	2.39	5.75	0.12	0.09	0.01	0.042	0.39	13.7	8.9	0.61	578	0.98	0.06	0.09
L1958661-5 793-32A MM 142519	2030	2.20	4.46	0.11	0.05	0.01	0.045	0.28	15.6	4.5	0.32	493	1.89	0.05	0.14
L1958661-6 793-32B MM 142520	2170	1.91	4.20	0.10	0.05	0.01	0.052	0.21	12.4	4.1	0.29	529	2.81	0.05	0.07
L1958661-7 787-53 MM 142651	3940	2.15	4.00	0.10	0.04	<0.01	0.074	0.39	13.2	3.3	0.31	625	3.36	0.05	0.17
L1958661-8 787-54 MM 142525	7450	2.93	5.88	0.12	0.05	<0.01	0.120	0.70	14.3	5.1	0.69	636	4.93	0.04	0.17
L1958661-9 787-51 MM 142543	1195	2.00	5.19	0.10	0.04	<0.01	0.025	0.21	12.1	6.9	0.47	559	1.07	0.06	0.06
L1958661-10 787-47 MM 142524	2830	2.17	3.31	0.12	0.04	<0.01	0.072	0.15	21.8	2.6	0.26	498	7.79	0.04	0.07
L1958661-11 787-50 MM 142522	1455	2.53	5.51	0.12	0.05	0.01	0.044	0.38	14.5	8.6	0.42	663	0.90	0.06	0.07
L1958661-12 781-38 MM 142656	739	2.35	5.74	0.12	0.04	<0.01	0.035	0.36	14.7	7.3	0.69	604	0.60	0.07	0.16
L1958661-13 781-44 MM 142655	836	2.36	5.61	0.12	0.06	<0.01	0.036	0.47	14.8	6.1	0.64	607	1.31	0.07	0.17
L1958661-14 781-45 MM 142657	426	2.33	6.05	0.11	0.05	<0.01	0.026	0.31	10.6	7.5	0.73	567	0.80	0.08	0.14
L1958661-15 781-45 MM 142658	>10000	4.35	8.85	0.14	0.06	0.01	0.136	0.81	9.2	7.2	0.83	670	2.16	0.05	0.32
L1958661-16 781-46 MM 142659	2780	3.18	7.55	0.13	0.05	<0.01	0.060	0.57	11.3	7.5	0.76	880	2.23	0.07	0.31
L1958661-17 781-46 MM 142518	191.0	2.10	5.74	0.12	0.04	<0.01	0.026	0.38	14.2	7.4	0.63	570	0.63	0.09	0.18

CERTIFICATE OF ANALYSIS VA17152306

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description / **LOR**	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
L1958661-1 787-49 MM 142654	2.6	600	4.7	12.7	<0.001	0.01	0.06	6.0	0.8	0.6	51.2	<0.01	0.02	2.6	0.018
L1958661-2 787-52 MM 142652	2.4	750	2.8	29.1	<0.001	0.01	<0.05	4.8	0.9	0.6	25.1	<0.01	0.11	3.7	0.092
L1958661-3 781-44 MM 142653	2.7	720	3.2	18.4	<0.001	0.06	<0.05	4.6	0.9	0.6	93.6	<0.01	0.06	3.7	0.053
L1958661-4 787-48 MM 142521	11.2	740	2.9	21.3	0.001	0.02	<0.05	5.4	0.8	0.6	45.5	<0.01	0.05	2.6	0.068
L1958661-5 793-32A MM 142519	2.6	670	3.5	16.2	<0.001	0.01	<0.05	5.0	0.7	0.6	22.7	<0.01	0.09	4.0	0.039
L1958661-6 793-32B MM 142520	2.3	610	3.1	11.7	<0.001	0.02	<0.05	5.4	1.0	0.6	27.2	<0.01	0.09	3.3	0.023
L1958661-7 787-53 MM 142651	2.1	760	4.8	22.9	<0.001	0.04	<0.05	4.7	2.1	0.6	22.5	<0.01	0.14	5.5	0.054
L1958661-8 787-54 MM 142525	2.6	920	3.6	38.6	0.003	0.22	<0.05	5.5	4.7	0.8	55.8	<0.01	0.27	4.9	0.111
L1958661-9 787-51 MM 142543	2.2	550	2.9	11.1	<0.001	0.01	<0.05	4.2	0.5	0.5	38.4	<0.01	0.02	2.1	0.027
L1958661-10 787-47 MM 142524	2.3	870	4.9	8.3	0.009	0.22	0.07	4.3	2.1	0.9	59.9	<0.01	0.05	5.9	0.012
L1958661-11 787-50 MM 142522	2.9	720	3.1	19.3	<0.001	0.01	0.05	6.0	0.5	0.6	36.4	<0.01	0.04	2.8	0.051
L1958661-12 781-38 MM 142656	2.8	690	3.3	17.8	0.001	0.05	0.06	5.4	0.9	0.7	88.4	<0.01	0.04	3.2	0.059
L1958661-13 781-44 MM 142655	3.4	690	2.7	22.9	0.001	0.06	<0.05	4.6	0.9	0.6	72.8	<0.01	0.04	2.9	0.085
L1958661-14 781-45 MM 142657	2.3	690	3.3	14.7	0.002	0.06	<0.05	3.4	0.5	0.5	61.7	<0.01	0.03	2.0	0.074
L1958661-15 781-45 MM 142658	6.2	970	4.3	40.0	0.005	0.67	<0.05	4.9	8.5	0.7	36.6	<0.01	0.52	5.0	0.144
L1958661-16 781-46 MM 142659	2.4	770	4.0	29.2	0.007	0.23	<0.05	4.8	2.6	0.7	80.3	<0.01	0.16	3.2	0.103
L1958661-17 781-46 MM 142518	2.8	590	2.9	18.7	0.001	0.01	0.05	4.0	0.7	0.6	76.9	<0.01	0.01	3.0	0.069

CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method Analyte Units LOR	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-ELE07 pH Unity 0.1	OA-VOL08m Ratio (N Unity 0.01	S-IR08 S % 0.01
L1958661-1 787-49 MM 142654		0.06	0.23	44	0.15	8.86	75	1.0		0.3	1	32	32	8.4	102.40	0.01
L1958661-2 787-52 MM 142652		0.18	0.21	54	0.31	7.84	78	1.5		0.3	1	9	9	8.3	28.80	0.01
L1958661-3 781-44 MM 142653		0.10	0.39	50	0.33	8.54	74	1.0		1.6	2	32	34	8.5	21.76	0.05
L1958661-4 787-48 MM 142521		0.11	0.22	51	0.20	8.86	77	2.3		0.3	2	18	18	8.3	57.60	0.01
L1958661-5 793-32A MM 142519		0.10	0.22	43	0.24	8.52	71	1.4		0.3	1	7	7	8.2	22.40	0.01
L1958661-6 793-32B MM 142520		0.07	0.21	36	0.19	8.64	65	1.0		0.3	1	7	7	8.2	22.40	0.01
L1958661-7 787-53 MM 142651		0.19	0.30	47	0.38	8.60	74	1.1		0.9	1	7	8	8.3	8.53	0.03
L1958661-8 787-54 MM 142525		0.30	0.29	69	0.55	9.15	103	1.2		5.9	2	17	23	8.5	3.87	0.19
L1958661-9 787-51 MM 142543		0.05	0.14	36	0.30	7.51	74	0.7		<0.3	2	15	15	8.5	96.00	<0.01
L1958661-10 787-47 MM 142524		0.05	0.48	40	0.32	12.50	48	1.7		5.6	2	27	33	8.5	5.87	0.18
L1958661-11 787-50 MM 142522		0.10	0.21	50	0.24	9.74	83	1.1		<0.3	1	8	8	8.2	51.20	<0.01
L1958661-12 781-38 MM 142656		0.10	0.26	48	0.47	9.27	68	0.8		0.9	2	28	29	8.5	30.93	0.03
L1958661-13 781-44 MM 142655		0.12	0.33	50	0.59	10.15	70	1.0		1.3	2	24	25	8.5	20.00	0.04
L1958661-14 781-45 MM 142657		0.08	0.38	48	0.53	6.12	67	1.0		1.3	2	27	28	8.7	22.40	0.04
L1958661-15 781-45 MM 142658		0.33	0.25	70	4.93	8.08	72	1.3	1.125	19.1	2	4	23	8.6	1.21	0.61
L1958661-16 781-46 MM 142659		0.20	0.56	57	0.73	10.75	89	1.0		6.3	2	26	32	8.5	5.12	0.20
L1958661-17 781-46 MM 142518		0.11	0.26	43	0.35	9.75	61	0.9		0.3	2	21	21	8.7	67.20	0.01

CERTIFICATE OF ANALYSIS VA17152306

Sample Description	**Method** **Analyte** **Units** **LOR**	S-GRA06 S % 0.01	S-GRA06a S % 0.01	S-CAL06 S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
L1958661-1 787-49 MM 142654		0.01	0.03	<0.01	0.34	1.2
L1958661-2 787-52 MM 142652		<0.01	<0.01	0.01	0.05	0.2
L1958661-3 781-44 MM 142653		<0.01	<0.01	0.05	0.41	1.5
L1958661-4 787-48 MM 142521		0.01	<0.01	<0.01	0.12	0.4
L1958661-5 793-32A MM 142519		<0.01	<0.01	0.01	<0.05	<0.2
L1958661-6 793-32B MM 142520		0.01	<0.01	<0.01	0.05	0.2
L1958661-7 787-53 MM 142651		0.01	<0.01	0.02	<0.05	0.2
L1958661-8 787-54 MM 142525		<0.01	<0.01	0.19	0.25	0.9
L1958661-9 787-51 MM 142543		<0.01	<0.01	<0.01	0.10	0.4
L1958661-10 787-47 MM 142524		<0.01	<0.01	0.18	0.38	1.4
L1958661-11 787-50 MM 142522		<0.01	<0.01	<0.01	<0.05	<0.2
L1958661-12 781-38 MM 142656		0.01	<0.01	0.02	0.33	1.2
L1958661-13 781-44 MM 142655		0.01	<0.01	0.03	0.23	0.8
L1958661-14 781-45 MM 142657		<0.01	<0.01	0.04	0.29	1.1
L1958661-15 781-45 MM 142658		0.01	<0.01	0.60	0.19	0.7
L1958661-16 781-46 MM 142659		0.01	<0.01	0.19	0.38	1.4
L1958661-17 781-46 MM 142518		<0.01	<0.01	0.01	0.19	0.7

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 5-AUG-2017
Account: APN

Project: L1958661

CERTIFICATE OF ANALYSIS VA17152306

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
ME-OG46
PUL-QC
S-IR08
Cu-OG46
OA-ELE07
S-CAL06
SPL-21
LOG-22
OA-VOL08m
S-GRA06
WEI-21
ME-MS41
PUL-31
S-GRA06a

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

QC CERTIFICATE VA17152306

Project: L1958661

P.O. No.: ALSM-CW16-102-APN

This report is for 17 Other samples submitted to our lab in Vancouver, BC, Canada on 18-JUL-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-AUG-2017
Account: APN

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description **Method** **Analyte** **Units** **LOR**	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	4.10	2.56	33.0	<0.02	<10	430	0.82	0.63	1.03	2.24	72.3	18.8	88	10.50	597
Target Range - Lower Bound	4.00	2.44	29.6	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587
Upper Bound	4.92	3.00	36.4	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description **Method** **Analyte** **Units** **LOR**	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2
							STANDARDS								
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	3.44	9.16	0.18	0.64	0.06	0.151	1.22	36.0	32.2	1.10	402	13.95	0.32	0.92	665
Target Range - Lower Bound	3.22	8.73	0.07	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622
Upper Bound	3.96	10.80	0.29	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-AUG-2017
Account: APN

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		990	1050	141.0	0.008	0.30	3.17	7.0	1.3	3.2	77.0	0.01	0.02	20.8	0.367	0.76
Target Range - Lower Bound		900	959	132.0	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64
Upper Bound		1130	1175	162.0	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92

ALS Minerals

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-AUG-2017
Account: APN

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	Cu-OG46	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06
	Analyte	U	V	W	Y	Zn	Zr	Cu	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S
	Units	ppm	ppm	ppm	ppm	ppm	ppm	%	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%
	LOR	0.05	1	0.05	0.05	2	0.5	0.001	0.3	1	1	1	0.1	0.01	0.01	0.01
STANDARDS																
Buffer pH6													6.1			
Buffer pH6													6.1			
Target Range - Lower Bound													5.3			
Upper Bound													6.7			
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1															2.55	
Target Range - Lower Bound															2.51	
Upper Bound															2.71	
GS310-10															0.28	
Target Range - Lower Bound															0.25	
Upper Bound															0.29	
GS313-8															1.25	
Target Range - Lower Bound															1.19	
Upper Bound															1.29	
KZK-1									25.0	2	33	58		2.32		
KZK-1									25.0	2	33	58		2.32		
Target Range - Lower Bound									22.9	<1	30	54		2.18		
Upper Bound									27.1	>4	38	64		2.53		
MA-1b															1.15	
Target Range - Lower Bound															1.12	
Upper Bound															1.22	
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		5.14	98	2.64	19.05	754	21.4									
Target Range - Lower Bound		4.93	90	2.44	17.50	708	18.1									
Upper Bound		6.13	112	3.42	21.5	870	25.7									

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description / Method	S-GRA06a	C-GAS05	C-GAS05
Analyte	S	C	CO2
Units	%	%	%
LOR	0.01	0.05	0.2
STANDARDS			
Buffer pH6			
Buffer pH6			
Target Range - Lower Bound			
Upper Bound			
CO-ASSAY		0.48	1.8
Target Range - Lower Bound		0.42	1.5
Upper Bound		0.64	2.4
DS-1			
Target Range - Lower Bound			
Upper Bound			
GS310-10			
Target Range - Lower Bound			
Upper Bound			
GS313-8			
Target Range - Lower Bound			
Upper Bound			
KZK-1			
KZK-1			
Target Range - Lower Bound			
Upper Bound			
MA-1b			
Target Range - Lower Bound			
Upper Bound			
MA-2c		1.63	6.0
Target Range - Lower Bound		1.50	5.5
Upper Bound		1.84	6.8
MA-3a		2.34	8.6
Target Range - Lower Bound		2.31	8.4
Upper Bound		2.77	10.2
MRGeo08			
Target Range - Lower Bound			
Upper Bound			

***** See Appendix Page for comments regarding this certificate *****

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS															
OGGeo08															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	0.49	0.82	33.4	0.37	<10	250	0.96	5.53	0.32	0.36	82.4	14.0	17	1.29	1490
Target Range - Lower Bound	0.45	0.73	28.4	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450
Upper Bound	0.58	0.91	35.0	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670
OREAS 932															
Target Range - Lower Bound															
Upper Bound															
OREAS-133b															
Target Range - Lower Bound															
Upper Bound															
OREAS-134b															
Target Range - Lower Bound															
Upper Bound															
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method Analyte Units LOR	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2
									STANDARDS							
OGGeo08																
Target Range - Lower Bound																
Upper Bound																
OREAS 905		3.38	6.23	0.14	1.17	0.01	0.586	0.31	40.7	5.0	0.15	343	2.98	0.09	0.39	8.9
Target Range - Lower Bound		3.14	5.74	<0.05	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8
Upper Bound		3.86	7.12	0.22	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0
OREAS 932																
Target Range - Lower Bound																
Upper Bound																
OREAS-133b																
Target Range - Lower Bound																
Upper Bound																
OREAS-134b																
Target Range - Lower Bound																
Upper Bound																
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
STANDARDS															
OGGeo08															
Target Range - Lower Bound															
Upper Bound															
OREAS 905	240	16.8	19.3	<0.001	0.07	1.07	1.7	2.8	1.3	12.8	<0.01	0.07	9.3	0.021	0.11
Target Range - Lower Bound		15.2	17.3	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06
Upper Bound		19.0	21.3	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16
OREAS 932															
Target Range - Lower Bound															
Upper Bound															
OREAS-133b															
Target Range - Lower Bound															
Upper Bound															
OREAS-134b															
Target Range - Lower Bound															
Upper Bound															
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	Cu-OG46	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06
	Analyte	U	V	W	Y	Zn	Zr	Cu	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S
	Units	ppm	ppm	ppm	ppm	ppm	ppm	%	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%
	LOR	0.05	1	0.05	0.05	2	0.5	0.001	0.3	1	1	1	0.1	0.01	0.01	0.01
								STANDARDS								
OGGeo08								0.836								
Target Range - Lower Bound								0.809								
Upper Bound								0.869								
OREAS 905		2.27	6	0.59	7.40	65	48.6									
Target Range - Lower Bound		2.08	4	0.44	6.32	58	39.9									
Upper Bound		2.66	8	0.76	7.84	76	55.1									
OREAS 932								6.14								
Target Range - Lower Bound								5.90								
Upper Bound								6.32								
OREAS-133b								0.033								
Target Range - Lower Bound								0.031								
Upper Bound								0.035								
OREAS-134b								0.138								
Target Range - Lower Bound								0.131								
Upper Bound								0.142								
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																0.88
Target Range - Lower Bound																0.83
Upper Bound																0.93
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																1.76
Target Range - Lower Bound																1.64
Upper Bound																1.84
UTS-4																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method Analyte Units LOR	S-GRA06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
STANDARDS				
OGGeo08				
Target Range - Lower Bound				
Upper Bound				
OREAS 905				
Target Range - Lower Bound				
Upper Bound				
OREAS 932				
Target Range - Lower Bound				
Upper Bound				
OREAS-133b				
Target Range - Lower Bound				
Upper Bound				
OREAS-134b				
Target Range - Lower Bound				
Upper Bound				
SY-4			0.85	3.1
Target Range - Lower Bound			0.84	3.0
Upper Bound			1.08	4.0
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1		0.89		
Target Range - Lower Bound		0.81		
Upper Bound		0.95		
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4		1.73		
Target Range - Lower Bound		1.61		
Upper Bound		1.87		

QC CERTIFICATE OF ANALYSIS VA17152306

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
Sample Description															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound	0.02	0.02	0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	0.11	2.30	12.3	<0.02	<10	440	1.07	0.09	0.47	0.38	31.2	34.1	55	1.39	24.1
DUP	0.11	2.41	12.3	<0.02	<10	450	1.02	0.09	0.48	0.35	30.5	33.7	57	1.37	24.9
Target Range - Lower Bound	0.09	2.23	11.6	<0.02	<10	400	0.94	0.08	0.44	0.34	29.3	32.1	52	1.26	23.4
Upper Bound	0.13	2.48	13.0	0.04	20	490	1.15	0.10	0.51	0.39	32.4	35.7	60	1.50	25.6

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.05	0.08	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound	0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	5.40	13.80	0.15	0.04	0.06	0.054	0.13	12.8	35.1	1.45	4470	0.68	0.01	1.10	29.9
DUP	5.63	14.00	0.16	0.04	0.05	0.052	0.13	12.6	32.6	1.49	4550	0.70	0.01	1.05	30.2
Target Range - Lower Bound	5.23	13.15	0.10	<0.02	0.04	0.045	0.11	11.9	32.1	1.39	4280	0.61	<0.01	0.97	28.3
Upper Bound	5.80	14.65	0.21	0.06	0.07	0.061	0.15	13.5	35.6	1.55	4740	0.77	0.02	1.18	31.8

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
BLANKS																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound		20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		1030	14.2	12.7	<0.001	0.02	0.78	12.9	0.9	1.4	59.1	<0.01	0.01	0.9	0.194	0.19
DUP		1050	12.4	12.7	<0.001	0.02	0.78	13.1	1.1	1.4	57.8	<0.01	<0.01	0.8	0.210	0.18
Target Range - Lower Bound		980	12.4	12.0	<0.001	<0.01	0.67	12.3	0.8	1.1	55.3	<0.01	<0.01	0.6	0.187	0.15
Upper Bound		1100	14.2	13.4	0.002	0.03	0.89	13.8	1.3	1.7	61.6	0.02	0.02	1.1	0.217	0.22

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	Cu-OG46	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06
Analyte	U	V	W	Y	Zn	Zr	Cu	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%
Sample Description LOR	0.05	1	0.05	0.05	2	0.5	0.001	0.3	1	1	1	0.1	0.01	0.01	0.01

BLANKS

Sample Description	U	V	W	Y	Zn	Zr	Cu	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S (S-IR08)	S (S-GRA06)
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK							<0.001								
Target Range - Lower Bound							<0.001								
Upper Bound							0.002								
BLANK	<0.05	<1	<0.05	<0.05	<2	<0.5									
Target Range - Lower Bound	<0.05	<1	<0.05	<0.05	<2	<0.5									
Upper Bound	0.10	2	0.10	0.10	4	1.0									
BLANK												5.9			
Target Range - Lower Bound												5.5			
Upper Bound												6.9			
BLANK															<0.01
Target Range - Lower Bound															<0.01
Upper Bound															0.02
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK														<0.01	
BLANK														0.01	
Target Range - Lower Bound														<0.01	
Upper Bound														0.02	

DUPLICATES

Sample Description	U	V	W	Y	Zn	Zr	Cu	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S (S-IR08)	S (S-GRA06)
ORIGINAL							1.370								
DUP							1.405								
Target Range - Lower Bound							1.350								
Upper Bound							1.425								
ORIGINAL	0.33	143	0.13	16.95	400	1.0									
DUP	0.32	148	0.10	17.25	411	1.0									
Target Range - Lower Bound	0.26	137	0.06	16.20	383	<0.5									
Upper Bound	0.39	154	0.17	18.00	428	1.6									

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method Analyte Units LOR	S-GRA06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
BLANKS				
BLANK			<0.05	<0.2
BLANK			<0.05	<0.2
Target Range - Lower Bound			<0.05	<0.2
Upper Bound			0.10	0.4
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK		<0.01		
Target Range - Lower Bound		<0.01		
Upper Bound		0.02		
BLANK				
BLANK				
Target Range - Lower Bound				
Upper Bound				
DUPLICATES				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
DUPLICATES																
L1958661-10 787-47 MM 142524																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958661-16 781-46 MM 142659																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958661-17 781-46 MM 142518																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-7 142666																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-8 142667																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-9 142668																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
									DUPLICATES							
L1958661-10 787-47 MM 142524																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958661-16 781-46 MM 142659																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958661-17 781-46 MM 142518																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-7 142666																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-8 142667																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-9 142668																
DUP																
Target Range - Lower Bound																
Upper Bound																

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
									DUPLICATES							
L1958661-10 787-47 MM 142524																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958661-16 781-46 MM 142659																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958661-17 781-46 MM 142518																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-7 142666																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-8 142667																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-9 142668																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17152306

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	Cu-OG46	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06
Analyte	U	V	W	Y	Zn	Zr	Cu	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%
LOR	0.05	1	0.05	0.05	2	0.5	0.001	0.3	1	1	1	0.1	0.01	0.01	0.01
DUPLICATES															
L1958661-10 787-47 MM 142524														0.18	
DUP														0.20	
Target Range - Lower Bound														0.18	
Upper Bound														0.20	
L1958661-16 781-46 MM 142659														0.20	
DUP														0.19	
Target Range - Lower Bound														0.18	
Upper Bound														0.21	
L1958661-17 781-46 MM 142518															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1958669-7 142666												8.5			
DUP												8.5			
Target Range - Lower Bound												8.0			
Upper Bound												9.0			
L1958669-8 142667								0.6	2	22	23		36.80		
DUP								0.6	2	22	23		36.80		
Target Range - Lower Bound								<0.3	<1	20	21		34.95		
Upper Bound								0.9	3	24	25		38.65		
L1958669-9 142668															<0.01
DUP															<0.01
Target Range - Lower Bound															<0.01
Upper Bound															0.02

QC CERTIFICATE OF ANALYSIS VA17152306

Method **Analyte** **Units** **Sample Description** **LOR**	S-GRA06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2
DUPLICATES			
L1958661-10 787-47 MM 142524			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1958661-16 781-46 MM 142659			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1958661-17 781-46 MM 142518		0.19	0.7
DUP		0.19	0.7
Target Range - Lower Bound		0.13	0.5
Upper Bound		0.25	0.9
L1958669-7 142666			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1958669-8 142667			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1958669-9 142668	<0.01	<0.05	<0.2
DUP	0.02	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.05	<0.2
Upper Bound	0.02	0.10	0.4

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 5-AUG-2017
Account: APN

Project: L1958661

QC CERTIFICATE OF ANALYSIS VA17152306

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	Cu-OG46	LOG-22	ME-MS41
ME-OG46	OA-ELE07	OA-VOL08m	PUL-31
PUL-QC	S-CAL06	S-GRA06	S-GRA06a
S-IR08	SPL-21	WEI-21	

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1958661-COFC

COC Number: 17-21

Page 2 of 2

Report To	Contact and company name below will appear on the final report
Company	Minto Explorations Ltd
Contact	Minto Environment - Coordinator
Phone	1-604-759-4659
	Company address below will appear on the final report
Street	2100-510 West Georgia St
City/Province	Vancouver British Columbia
Postal Code	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company	Minto Explorations Ltd
Contact	Ruth Cayetano

Project Information

ALS Account # / Quote #

Job #

PO / AFE TBD

LSD

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center | PO#

Major/Minor Code | Routing Code

Requisitioner

Location

ALS Contact: | Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals - Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon /Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	787-50 mm 142522	11/06/17		waste	X	X	X	X	X	X	
	781-38 mm 142656	21/06/17		WASTE	X	X	X	X	X	X	
	781-41 mm 142655	20/06/17		WASTE	X	X	X	X	X	X	
	781-45 mm 142657	24/06/17		WASTE	X	X	X	X	X	X	
	781-45 mm 142658	24/06/17		WASTE	X	X	X	X	X	X	
	781-46 mm 142659	25/06/17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1958661-COFC

COC Number: 17-21

Page 1 of 2

Report To	Contact and company name below will appear on the final report
Company	Minto Explorations Ltd
Contact	Minto Environment - Coordinator
Phone	1-604-759-4659
	Company address below will appear on the final report
Street	2100-510 West Georgia St.
City/Province	Vancouver, British Columbia
Postal Code	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company	Minto Explorations Ltd
Contact	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #

Job #

PO / AFE TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center	PO#
Major/Minor Code	Routing Code
Requisitioner	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date dd-mmm-yy	Time hh:mm	Sample Type	Total Metals Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	787-49 mm 142654	19/06/17		WASTE	X	X	X	X	X	X	
	787-52 mm 142652	16/06/17		WASTE	X	X	X	X	X	X	
	781-44 mm 142653	18/06/17		WASTE	X	X	X	X	X	X	
	787-48 mm 142521	11/06/17		WASTE	X	X	X	X	X	X	
	793-32A mm 142519	08/06/17		WASTE	X	X	X	X	X	X	
	793-32B mm 142520	09/06/17		WASTE	X	X	X	X	X	X	
	787-53 mm 142651	15/06/17		WASTE	X	X	X	X	X	X	
	787-54 mm 142525	14/06/17		WASTE	X	X	X	X	X	X	
	787-51 mm 142543	12/06/17		WASTE	X	X	X	X	X	X	
	787-47 mm 142524	14/06/17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C
16.0	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by	Date	Time:	Received by EHF	Date 14 July 2017	Time 09:52	Received by	Date	Time

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100 - 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 14-JUL-17
Report Date: 08-AUG-17 18:22 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1958669
Project P.O. #: PO#226298
Job Reference:
C of C Numbers: 17 22
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1958669-1	L1958669-2	L1958669-3	L1958669-4	L1958669-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time					
	Client ID	142660	142661	142662	142663	142664
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.7	8.5	8.4	8.6	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	0.27	0.69	0.20	0.20	0.05
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	1
	MPA (tCaCO3/1Kt)	4.4	0.3	0.3	0.6	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	25	64	26	25	8
	NNP (tCaCO3/1Kt)	21	64	26	24	7
	Ratio (NP/MPA) (Unity)	5.71	204.80	83.20	40.00	12.80
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.14	<0.01	<0.01	0.02	0.02
	Total Sulfur (combustion) (%)	0.14	0.01	0.01	0.02	0.02
Total Metals	Aluminum (Al) (%)	1.02	1.14	1.24	1.33	1.09
	Antimony (Sb) (ppm)	<0.05	0.14	0.10	<0.05	<0.05
	Arsenic (As) (ppm)	0.7	6.0	1.6	0.7	0.6
	Barium (Ba) (ppm)	150	80	180	220	290
	Beryllium (Be) (ppm)	0.21	0.63	0.40	0.36	0.23
	Bismuth (Bi) (ppm)	0.18	0.02	0.04	0.02	0.14
	Boron (B) (ppm)	<10	10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.06	0.04	0.12	0.25	0.31
	Calcium (Ca) (%)	0.80	2.40	1.12	1.07	0.26
	Cerium (Ce) (ppm)	20.8	28.9	23.1	27.5	18.55
	Cesium (Cs) (ppm)	0.47	0.46	0.37	0.44	0.30
	Chromium (Cr) (ppm)	5	14	7	6	5
	Cobalt (Co) (ppm)	4.8	7.6	6.5	6.4	6.2
	Copper (Cu) (ppm)	1550	129.5	404	631	3890
	Gallium (Ga) (ppm)	5.18	6.25	6.39	6.51	5.71
	Germanium (Ge) (ppm)	0.09	0.09	0.11	0.11	0.09
	Gold (Au) (ppm)	0.02	<0.02	0.03	<0.02	0.07
	Hafnium (Hf) (ppm)	0.02	0.07	0.09	0.05	0.05
	Indium (In) (ppm)	0.042	0.040	0.029	0.027	0.058
	Iron (Fe) (%)	2.17	2.39	2.37	2.44	2.34
	Lanthanum (La) (ppm)	10.5	15.0	11.6	14.6	9.5
	Lead (Pb) (ppm)	3.1	6.2	3.2	3.2	3.2
	Lithium (Li) (ppm)	6.7	9.2	9.2	8.7	6.7
	Magnesium (Mg) (%)	0.63	0.85	0.71	0.74	0.52
	Manganese (Mn) (ppm)	373	649	600	630	560

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1958669-6	L1958669-7	L1958669-8	L1958669-9	L1958669-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time					
	Client ID	142665	142666	142667	142668	142669
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.4	8.5	8.8	8.3	8.3
Organic / Inorganic Carbon	Carbon (C) (%)	0.30	<0.05	0.20	<0.05	0.29
Acid Base Accounting	FIZZ RATING (Unity)	2	1	2	1	2
	MPA (tCaCO3/1Kt)	0.3	0.3	0.6	0.3	8.4
	Neutralization Potential (NP) (tCaCO3/1Kt)	31	9	23	9	34
	NNP (tCaCO3/1Kt)	31	9	22	9	26
	Ratio (NP/MPA) (Unity)	99.20	28.80	36.80	28.80	4.03
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.01	0.02	0.01	0.26
	Total Sulfur (combustion) (%)	0.01	0.01	0.02	0.01	0.27
Total Metals	Aluminum (Al) (%)	0.93	1.20	1.13	1.32	1.27
	Antimony (Sb) (ppm)	0.09	<0.05	0.08	<0.05	0.05
	Arsenic (As) (ppm)	4.8	2.8	1.1	0.7	1.5
	Barium (Ba) (ppm)	170	310	210	340	90
	Beryllium (Be) (ppm)	0.43	0.28	0.32	0.30	0.42
	Bismuth (Bi) (ppm)	0.03	0.36	0.07	0.03	1.51
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.15	0.14	0.07	0.38	0.27
	Calcium (Ca) (%)	1.22	0.41	1.11	0.46	1.40
	Cerium (Ce) (ppm)	27.5	27.1	21.9	28.5	14.60
	Cesium (Cs) (ppm)	0.52	0.42	0.41	0.51	0.22
	Chromium (Cr) (ppm)	4	6	7	5	4
	Cobalt (Co) (ppm)	5.9	6.1	5.9	7.6	6.4
	Copper (Cu) (ppm)	357	1875	356	382	5490
	Gallium (Ga) (ppm)	5.09	6.07	5.75	6.15	8.34
	Germanium (Ge) (ppm)	0.10	0.12	0.08	0.08	0.06
	Gold (Au) (ppm)	<0.02	0.04	0.03	<0.02	0.15
	Hafnium (Hf) (ppm)	0.04	0.06	0.09	0.11	0.04
	Indium (In) (ppm)	0.045	0.042	0.033	0.031	0.042
	Iron (Fe) (%)	2.35	2.77	2.36	2.60	3.10
	Lanthanum (La) (ppm)	14.1	13.9	10.9	15.1	7.2
	Lead (Pb) (ppm)	3.8	3.3	2.6	1.8	5.9
	Lithium (Li) (ppm)	7.1	7.6	5.7	5.9	9.0
	Magnesium (Mg) (%)	0.39	0.57	0.68	0.61	0.71
	Manganese (Mn) (ppm)	646	649	630	757	605

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1958669-11	L1958669-12			
	Description	Waste	Waste			
	Sampled Date	04-JUL-17	04-JUL-17			
	Sampled Time					
	Client ID	142670	142671			
SOIL						
Physical Tests	pH (Unity)	8.8	8.7			
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	0.35			
Acid Base Accounting	FIZZ RATING (Unity)	1	2			
	MPA (tCaCO3/1Kt)	0.3	1.3			
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	29			
	NNP (tCaCO3/1Kt)	8	28			
	Ratio (NP/MPA) (Unity)	25.60	23.20			
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01			
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01			
	Sulfide Sulfur (T minus carbonate leach) (%)	0.01	0.04			
	Total Sulfur (combustion) (%)	0.01	0.04			
Total Metals	Aluminum (Al) (%)	1.37	1.05			
	Antimony (Sb) (ppm)	<0.05	<0.05			
	Arsenic (As) (ppm)	0.8	1.2			
	Barium (Ba) (ppm)	450	150			
	Beryllium (Be) (ppm)	0.25	0.36			
	Bismuth (Bi) (ppm)	0.10	0.06			
	Boron (B) (ppm)	<10	<10			
	Cadmium (Cd) (ppm)	0.07	0.06			
	Calcium (Ca) (%)	0.27	1.28			
	Cerium (Ce) (ppm)	25.6	21.0			
	Cesium (Cs) (ppm)	0.48	0.32			
	Chromium (Cr) (ppm)	6	5			
	Cobalt (Co) (ppm)	6.7	5.5			
	Copper (Cu) (ppm)	1920	425			
	Gallium (Ga) (ppm)	6.62	5.62			
	Germanium (Ge) (ppm)	0.06	0.05			
	Gold (Au) (ppm)	0.02	<0.02			
	Hafnium (Hf) (ppm)	0.04	0.05			
	Indium (In) (ppm)	0.034	0.026			
	Iron (Fe) (%)	2.38	2.21			
	Lanthanum (La) (ppm)	13.8	10.2			
	Lead (Pb) (ppm)	2.1	3.5			
	Lithium (Li) (ppm)	6.5	6.0			
	Magnesium (Mg) (%)	0.63	0.64			
	Manganese (Mn) (ppm)	581	534			

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte					
	Sample ID	L1958669-1	L1958669-2	L1958669-3	L1958669-4	L1958669-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time					
	Client ID	142660	142661	142662	142663	142664
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.97	0.34	0.76	0.84	1.64
	Nickel (Ni) (ppm)	2.5	19.9	7.8	2.9	4.9
	Niobium (Nb) (ppm)	0.16	<0.05	0.09	0.10	0.10
	Phosphorus (P) (ppm)	680	700	700	700	630
	Potassium (K) (%)	0.45	0.17	0.35	0.40	0.46
	Rhenium (Re) (ppm)	0.003	0.001	<0.001	0.001	0.001
	Rubidium (Rb) (ppm)	21.1	7.8	14.7	16.2	19.6
	Scandium (Sc) (ppm)	4.7	5.2	4.7	4.2	3.0
	Selenium (Se) (ppm)	1.5	0.6	0.7	0.7	1.2
	Silver (Ag) (ppm)	0.30	0.03	0.11	0.07	0.63
	Sodium (Na) (%)	0.07	0.05	0.08	0.10	0.08
	Strontium (Sr) (ppm)	82.9	116.0	71.2	77.7	31.1
	Sulfur (S) (%)	0.14	0.01	<0.01	<0.01	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.05	<0.01	0.01	0.01	0.08
	Thallium (Tl) (ppm)	0.17	0.03	0.08	0.08	0.12
	Thorium (Th) (ppm)	2.8	2.5	2.1	2.8	2.9
	Tin (Sn) (ppm)	0.8	0.5	0.6	0.5	0.5
	Titanium (Ti) (%)	0.062	<0.005	0.055	0.068	0.077
	Tungsten (W) (ppm)	0.41	0.10	0.26	0.53	0.35
	Uranium (U) (ppm)	0.37	0.41	0.21	0.23	0.25
	Vanadium (V) (ppm)	46	40	49	51	46
	Yttrium (Y) (ppm)	6.47	9.48	8.62	7.98	4.79
	Zinc (Zn) (ppm)	43	72	69	78	72
	Zirconium (Zr) (ppm)	0.8	1.6	1.8	0.9	1.6
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	2.5	0.7	0.7	0.2

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1958669-6	L1958669-7	L1958669-8	L1958669-9	L1958669-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17	04-JUL-17
	Sampled Time					
	Client ID	142665	142666	142667	142668	142669
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	<0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	1.53	1.13	0.81	1.60	0.60
	Nickel (Ni) (ppm)	2.4	2.7	4.0	2.1	1.9
	Niobium (Nb) (ppm)	<0.05	0.15	0.16	0.07	<0.05
	Phosphorus (P) (ppm)	630	790	860	860	660
	Potassium (K) (%)	0.22	0.59	0.42	0.59	0.15
	Rhenium (Re) (ppm)	0.001	<0.001	<0.001	<0.001	0.001
	Rubidium (Rb) (ppm)	12.1	26.2	17.7	25.8	6.4
	Scandium (Sc) (ppm)	6.2	4.0	5.2	6.1	3.5
	Selenium (Se) (ppm)	0.7	1.0	0.5	0.6	5.4
	Silver (Ag) (ppm)	0.09	0.45	0.17	0.07	2.89
	Sodium (Na) (%)	0.06	0.09	0.14	0.09	0.06
	Strontium (Sr) (ppm)	56.0	39.5	77.7	42.5	83.6
	Sulfur (S) (%)	<0.01	<0.01	0.02	0.01	0.28
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.06	0.04	0.01	0.52
	Thallium (Tl) (ppm)	0.05	0.16	0.09	0.14	0.04
	Thorium (Th) (ppm)	3.0	2.9	1.9	2.5	1.5
	Tin (Sn) (ppm)	0.6	0.6	0.7	0.7	0.6
	Titanium (Ti) (%)	0.020	0.104	0.093	0.090	0.015
	Tungsten (W) (ppm)	0.20	0.40	1.67	0.30	0.10
	Uranium (U) (ppm)	0.28	0.21	0.28	0.23	0.40
	Vanadium (V) (ppm)	49	57	51	57	51
	Yttrium (Y) (ppm)	9.05	6.85	11.85	13.40	6.01
	Zinc (Zn) (ppm)	73	85	69	79	79
	Zirconium (Zr) (ppm)	1.1	1.0	1.3	2.2	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	1.1	<0.2	0.7	<0.2	1.1

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1958669-11	L1958669-12			
	Description	Waste	Waste			
	Sampled Date	04-JUL-17	04-JUL-17			
	Sampled Time					
	Client ID	142670	142671			
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01			
	Molybdenum (Mo) (ppm)	0.87	0.53			
	Nickel (Ni) (ppm)	3.0	2.3			
	Niobium (Nb) (ppm)	0.16	0.07			
	Phosphorus (P) (ppm)	730	610			
	Potassium (K) (%)	0.95	0.26			
	Rhenium (Re) (ppm)	<0.001	<0.001			
	Rubidium (Rb) (ppm)	45.0	10.5			
	Scandium (Sc) (ppm)	4.1	4.2			
	Selenium (Se) (ppm)	0.3	0.5			
	Silver (Ag) (ppm)	0.35	0.15			
	Sodium (Na) (%)	0.09	0.09			
	Strontium (Sr) (ppm)	27.7	101.0			
	Sulfur (S) (%)	0.01	0.05			
	Tantalum (Ta) (ppm)	<0.01	<0.01			
	Tellurium (Te) (ppm)	0.10	0.04			
	Thallium (Tl) (ppm)	0.25	0.06			
	Thorium (Th) (ppm)	2.3	1.9			
	Tin (Sn) (ppm)	0.6	0.5			
	Titanium (Ti) (%)	0.177	0.040			
	Tungsten (W) (ppm)	0.53	0.30			
	Uranium (U) (ppm)	0.15	0.45			
	Vanadium (V) (ppm)	60	43			
	Yttrium (Y) (ppm)	5.35	8.72			
	Zinc (Zn) (ppm)	86	59			
	Zirconium (Zr) (ppm)	1.0	0.8			
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	1.3			

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS
A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.			
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06-AX	Soil	Sulfide Sulfur Calc from Carbonate Leach	ALS Minerals S-CAL06
Sulfide Sulfur (as S) is calculated by subtracting the Carbonate Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.			
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06
A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).			
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A
A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).			
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08
The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.			

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17 22

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-AUG-2017
Account: APN

CERTIFICATE VA17152307

Project: L1958669

P.O. No.: ALSM-CW16-102-APN

This report is for 12 Other samples submitted to our lab in Vancouver, BC, Canada on 18-JUL-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1958669

CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	S-CAL06	C-GAS05	C-GAS05	ME-MS41	ME-MS41
	Analyte	Recvd Wt.	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	S	C	CO2	Ag	Al
	Units	kg	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%
	LOR	0.02	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01
L1958669-1 142660		1.32	4.4	2	21	25	8.7	5.71	0.14	<0.01	<0.01	0.14	0.27	1.0	0.30	1.02
L1958669-2 142661		1.24	0.3	2	64	64	8.5	204.80	0.01	0.01	<0.01	<0.01	0.69	2.5	0.03	1.14
L1958669-3 142662		1.06	0.3	2	26	26	8.4	83.20	0.01	0.01	<0.01	<0.01	0.20	0.7	0.11	1.24
L1958669-4 142663		1.06	0.6	2	24	25	8.6	40.00	0.02	<0.01	<0.01	0.02	0.20	0.7	0.07	1.33
L1958669-5 142664		1.10	0.6	1	7	8	8.6	12.80	0.02	<0.01	<0.01	0.02	0.05	0.2	0.63	1.09
L1958669-6 142665		1.08	0.3	2	31	31	8.4	99.20	0.01	<0.01	<0.01	0.01	0.30	1.1	0.09	0.93
L1958669-7 142666		1.06	0.3	1	9	9	8.5	28.80	0.01	<0.01	<0.01	0.01	<0.05	<0.2	0.45	1.20
L1958669-8 142667		1.00	0.6	2	22	23	8.8	36.80	0.02	<0.01	<0.01	0.02	0.20	0.7	0.17	1.13
L1958669-9 142668		1.12	0.3	1	9	9	8.3	28.80	0.01	<0.01	<0.01	0.01	<0.05	<0.2	0.07	1.32
L1958669-10 142669		1.32	8.4	2	26	34	8.3	4.03	0.27	0.01	<0.01	0.26	0.29	1.1	2.89	1.27
L1958669-11 142670		1.08	0.3	1	8	8	8.8	25.60	0.01	<0.01	<0.01	0.01	<0.05	<0.2	0.35	1.37
L1958669-12 142671		1.04	1.3	2	28	29	8.7	23.20	0.04	<0.01	<0.01	0.04	0.35	1.3	0.15	1.05

***** See Appendix Page for comments regarding this certificate *****

Project: L1958669

CERTIFICATE OF ANALYSIS VA17152307

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
L1958669-1 142660		0.7	0.02	<10	150	0.21	0.18	0.80	0.06	20.8	4.8	5	0.47	1550	2.17	5.18
L1958669-2 142661		6.0	<0.02	10	80	0.63	0.02	2.40	0.04	28.9	7.6	14	0.46	129.5	2.39	6.25
L1958669-3 142662		1.6	0.03	<10	180	0.40	0.04	1.12	0.12	23.1	6.5	7	0.37	404	2.37	6.39
L1958669-4 142663		0.7	<0.02	<10	220	0.36	0.02	1.07	0.25	27.5	6.4	6	0.44	631	2.44	6.51
L1958669-5 142664		0.6	0.07	<10	290	0.23	0.14	0.26	0.31	18.55	6.2	5	0.30	3890	2.34	5.71
L1958669-6 142665		4.8	<0.02	<10	170	0.43	0.03	1.22	0.15	27.5	5.9	4	0.52	357	2.35	5.09
L1958669-7 142666		2.8	0.04	<10	310	0.28	0.36	0.41	0.14	27.1	6.1	6	0.42	1875	2.77	6.07
L1958669-8 142667		1.1	0.03	<10	210	0.32	0.07	1.11	0.07	21.9	5.9	7	0.41	356	2.36	5.75
L1958669-9 142668		0.7	<0.02	<10	340	0.30	0.03	0.46	0.38	28.5	7.6	5	0.51	382	2.60	6.15
L1958669-10 142669		1.5	0.15	<10	90	0.42	1.51	1.40	0.27	14.60	6.4	4	0.22	5490	3.10	8.34
L1958669-11 142670		0.8	0.02	<10	450	0.25	0.10	0.27	0.07	25.6	6.7	6	0.48	1920	2.38	6.62
L1958669-12 142671		1.2	<0.02	<10	150	0.36	0.06	1.28	0.06	21.0	5.5	5	0.32	425	2.21	5.62

Project: L1958669

CERTIFICATE OF ANALYSIS VA17152307

Sample Description / Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
L1958669-1 142660	0.09	0.02	<0.01	0.042	0.45	10.5	6.7	0.63	373	0.97	0.07	0.16	2.5	680	3.1
L1958669-2 142661	0.09	0.07	<0.01	0.040	0.17	15.0	9.2	0.85	649	0.34	0.05	<0.05	19.9	700	6.2
L1958669-3 142662	0.11	0.09	<0.01	0.029	0.35	11.6	9.2	0.71	600	0.76	0.08	0.09	7.8	700	3.2
L1958669-4 142663	0.11	0.05	<0.01	0.027	0.40	14.6	8.7	0.74	630	0.84	0.10	0.10	2.9	700	3.2
L1958669-5 142664	0.09	0.05	<0.01	0.058	0.46	9.5	6.7	0.52	560	1.64	0.08	0.10	4.9	630	3.2
L1958669-6 142665	0.10	0.04	<0.01	0.045	0.22	14.1	7.1	0.39	646	1.53	0.06	<0.05	2.4	630	3.8
L1958669-7 142666	0.12	0.06	0.01	0.042	0.59	13.9	7.6	0.57	649	1.13	0.09	0.15	2.7	790	3.3
L1958669-8 142667	0.08	0.09	<0.01	0.033	0.42	10.9	5.7	0.68	630	0.81	0.14	0.16	4.0	860	2.6
L1958669-9 142668	0.08	0.11	<0.01	0.031	0.59	15.1	5.9	0.61	757	1.60	0.09	0.07	2.1	860	1.8
L1958669-10 142669	0.06	0.04	0.01	0.042	0.15	7.2	9.0	0.71	605	0.60	0.06	<0.05	1.9	660	5.9
L1958669-11 142670	0.06	0.04	<0.01	0.034	0.95	13.8	6.5	0.63	581	0.87	0.09	0.16	3.0	730	2.1
L1958669-12 142671	0.05	0.05	<0.01	0.026	0.26	10.2	6.0	0.64	534	0.53	0.09	0.07	2.3	610	3.5

Project: L1958669

CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1
L1958669-1 142660		21.1	0.003	0.14	<0.05	4.7	1.5	0.8	82.9	<0.01	0.05	2.8	0.062	0.17	0.37	46
L1958669-2 142661		7.8	0.001	0.01	0.14	5.2	0.6	0.5	116.0	<0.01	<0.01	2.5	<0.005	0.03	0.41	40
L1958669-3 142662		14.7	<0.001	<0.01	0.10	4.7	0.7	0.6	71.2	<0.01	0.01	2.1	0.055	0.08	0.21	49
L1958669-4 142663		16.2	0.001	<0.01	<0.05	4.2	0.7	0.5	77.7	<0.01	0.01	2.8	0.068	0.08	0.23	51
L1958669-5 142664		19.6	0.001	0.01	<0.05	3.0	1.2	0.5	31.1	<0.01	0.08	2.9	0.077	0.12	0.25	46
L1958669-6 142665		12.1	0.001	<0.01	0.09	6.2	0.7	0.6	56.0	<0.01	0.01	3.0	0.020	0.05	0.28	49
L1958669-7 142666		26.2	<0.001	<0.01	<0.05	4.0	1.0	0.6	39.5	<0.01	0.06	2.9	0.104	0.16	0.21	57
L1958669-8 142667		17.7	<0.001	0.02	0.08	5.2	0.5	0.7	77.7	<0.01	0.04	1.9	0.093	0.09	0.28	51
L1958669-9 142668		25.8	<0.001	0.01	<0.05	6.1	0.6	0.7	42.5	<0.01	0.01	2.5	0.090	0.14	0.23	57
L1958669-10 142669		6.4	0.001	0.28	0.05	3.5	5.4	0.6	83.6	<0.01	0.52	1.5	0.015	0.04	0.40	51
L1958669-11 142670		45.0	<0.001	0.01	<0.05	4.1	0.3	0.6	27.7	<0.01	0.10	2.3	0.177	0.25	0.15	60
L1958669-12 142671		10.5	<0.001	0.05	<0.05	4.2	0.5	0.5	101.0	<0.01	0.04	1.9	0.040	0.06	0.45	43

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1958669

CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1958669-1 142660		0.41	6.47	43	0.8
L1958669-2 142661		0.10	9.48	72	1.6
L1958669-3 142662		0.26	8.62	69	1.8
L1958669-4 142663		0.53	7.98	78	0.9
L1958669-5 142664		0.35	4.79	72	1.6
L1958669-6 142665		0.20	9.05	73	1.1
L1958669-7 142666		0.40	6.85	85	1.0
L1958669-8 142667		1.67	11.85	69	1.3
L1958669-9 142668		0.30	13.40	79	2.2
L1958669-10 142669		0.10	6.01	79	1.0
L1958669-11 142670		0.53	5.35	86	1.0
L1958669-12 142671		0.30	8.72	59	0.8

CERTIFICATE OF ANALYSIS VA17152307

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

QC CERTIFICATE VA17152307

Project: L1958669

P.O. No.: ALSM-CW16-102-APN

This report is for 12 Other samples submitted to our lab in Vancouver, BC, Canada on 18-JUL-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
S-CAL06	Sulfide Sulfur (calculated)	LECO

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-AUG-2017
Account: APN

Project: L1958669

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
	Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
	LOR	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
							STANDARDS									
Buffer pH6						6.1										
Buffer pH6						6.1										
Target Range - Lower Bound						5.3										
Upper Bound						6.7										
GS310-10								0.27								
Target Range - Lower Bound								0.25								
Upper Bound								0.29								
KZK-1		25.0	2	33	58		2.32									
KZK-1		25.0	2	33	58		2.32									
Target Range - Lower Bound		22.9	<1	30	54		2.18									
Upper Bound		27.1	>4	38	64		2.53									
MA-1b								1.16								
Target Range - Lower Bound								1.12								
Upper Bound								1.22								
MA-3a											2.34	8.6				
Target Range - Lower Bound											2.31	8.4				
Upper Bound											2.77	10.2				
OGGeo08													20.0	2.16	117.0	0.07
OGGeo08													19.30	2.30	121.5	0.07
Target Range - Lower Bound													18.15	2.05	107.0	0.03
Upper Bound													22.2	2.53	131.0	0.11
OREAS 920													0.09	2.36	4.8	<0.02
OREAS 920													0.10	2.46	5.1	<0.02
Target Range - Lower Bound													0.07	2.18	3.8	<0.02
Upper Bound													0.12	2.68	4.9	0.04
SY-4											0.85	3.1				
Target Range - Lower Bound											0.84	3.0				
Upper Bound											1.08	4.0				
UTS-1									0.88							
Target Range - Lower Bound									0.83							
Upper Bound									0.93							
UTS-1										0.89						
Target Range - Lower Bound										0.81						
Upper Bound										0.95						
UTS-4									1.76							
Target Range - Lower Bound									1.64							
Upper Bound									1.84							
UTS-4										1.73						
Target Range - Lower Bound										1.61						
Upper Bound										1.87						

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		<10	80	0.66	10.55	0.88	19.20	59.0	95.8	81	9.43	8300	4.97	8.26	0.12	0.75
OGGeo08		<10	100	0.75	9.67	0.91	18.60	60.6	96.9	86	9.05	8830	5.19	8.26	0.21	0.78
Target Range - Lower Bound		<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21	0.72
Upper Bound		30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45	0.92
OREAS 920		<10	80	0.70	0.51	0.31	0.06	72.8	14.0	43	1.94	107.0	3.55	6.71	0.08	0.55
OREAS 920		<10	80	0.74	0.63	0.33	0.05	75.5	14.5	44	2.09	115.5	3.67	6.78	0.15	0.60
Target Range - Lower Bound		<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05	0.53
Upper Bound		20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22	0.69
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001
								STANDARDS								
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		0.46	1.400	1.08	27.9	29.8	0.92	388	884	0.29	0.94	8960	800	6990	116.5	1.375
OGGeo08		0.45	1.380	1.12	29.2	31.0	0.97	403	905	0.30	0.98	9180	850	7350	116.0	1.365
Target Range - Lower Bound		0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5	1.295
Upper Bound		0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5	1.585
OREAS 920		0.01	0.029	0.41	35.5	21.8	1.06	519	0.33	0.03	0.33	38.2	720	20.2	23.6	<0.001
OREAS 920		<0.01	0.029	0.45	37.1	22.2	1.09	530	0.36	0.02	0.34	39.2	760	20.7	23.9	<0.001
Target Range - Lower Bound		<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2	<0.001
Upper Bound		0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4	0.002
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17152307

STANDARDS

Sample Description	Method Analyte Units LOR	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		2.75	18.30	6.2	10.6	12.9	61.8	0.01	0.14	16.5	0.310	1.25	4.69	79	2.85	16.10
OGGeo08		2.88	18.35	6.2	11.4	12.5	68.0	<0.01	0.15	15.8	0.319	1.33	4.53	83	3.09	15.60
Target Range - Lower Bound		2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58	15.35
Upper Bound		3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60	18.85
OREAS 920		0.03	0.56	2.9	0.7	1.1	16.9	0.01	0.01	15.5	0.126	0.13	2.03	25	0.42	17.30
OREAS 920		0.03	0.56	2.8	1.2	1.1	17.7	0.01	0.01	14.9	0.132	0.14	2.04	26	0.48	17.15
Target Range - Lower Bound		<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31	16.85
Upper Bound		0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61	20.7
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS			
Buffer pH6			
Buffer pH6			
Target Range - Lower Bound			
Upper Bound			
GS310-10			
Target Range - Lower Bound			
Upper Bound			
KZK-1			
KZK-1			
Target Range - Lower Bound			
Upper Bound			
MA-1b			
Target Range - Lower Bound			
Upper Bound			
MA-3a			
Target Range - Lower Bound			
Upper Bound			
OGGeo08		6740	22.3
OGGeo08		7150	22.5
Target Range - Lower Bound		6500	19.5
Upper Bound		7950	27.5
OREAS 920		106	20.9
OREAS 920		108	22.3
Target Range - Lower Bound		93	17.6
Upper Bound		119	25.0
SY-4			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-1			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1958669

QC CERTIFICATE OF ANALYSIS VA17152307

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
BLANKS															
BLANK										<0.05	<0.2				
Target Range - Lower Bound										<0.05	<0.2				
Upper Bound										0.10	0.4				
BLANK												<0.01	<0.01	<0.1	<0.02
BLANK												<0.01	<0.01	0.1	<0.02
Target Range - Lower Bound												<0.01	<0.01	<0.1	<0.02
Upper Bound												0.02	0.02	0.2	0.04
BLANK					5.9										
Target Range - Lower Bound					5.5										
Upper Bound					6.9										
BLANK								<0.01							
Target Range - Lower Bound								<0.01							
Upper Bound								0.02							
BLANK									<0.01						
Target Range - Lower Bound									<0.01						
Upper Bound									0.02						
BLANK							0.01								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								
DUPLICATES															
ORIGINAL												0.05	0.72	8.2	<0.02
DUP												0.05	0.75	8.1	<0.02
Target Range - Lower Bound												0.04	0.69	7.6	<0.02
Upper Bound												0.06	0.78	8.7	0.04
ORIGINAL												0.45	0.73	0.2	0.09
DUP												0.89	0.74	0.4	0.06
Target Range - Lower Bound												0.63	0.69	0.2	0.05
Upper Bound												0.71	0.78	0.4	0.10
L1958669-7 142666					8.5										
DUP					8.5										
Target Range - Lower Bound					8.0										
Upper Bound					9.0										

QC CERTIFICATE OF ANALYSIS VA17152307

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Sample Description / **LOR**	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
BLANK	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	0.05	<0.02
Target Range - Lower Bound	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02
Upper Bound	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	<10	90	0.78	0.06	17.70	0.09	50.7	4.3	7	9.38	9.7	1.24	2.44	0.05	0.18
DUP	<10	90	0.84	0.06	17.75	0.10	50.9	4.3	8	9.69	9.6	1.26	2.51	0.05	0.18
Target Range - Lower Bound	<10	70	0.72	0.05	16.85	0.08	48.2	4.0	6	9.01	9.1	1.18	2.30	<0.05	0.15
Upper Bound	20	110	0.90	0.07	18.60	0.11	53.4	4.6	9	10.05	10.2	1.32	2.65	0.10	0.21
ORIGINAL	<10	50	0.10	0.92	2.34	0.03	11.15	3.9	20	0.38	36.5	1.74	3.88	0.06	0.05
DUP	<10	60	0.09	1.05	2.36	0.03	11.45	4.0	20	0.40	38.3	1.77	3.94	0.06	0.06
Target Range - Lower Bound	<10	40	<0.05	0.93	2.22	0.02	10.70	3.7	18	0.32	35.9	1.66	3.66	<0.05	0.03
Upper Bound	20	70	0.10	1.04	2.48	0.04	11.90	4.2	22	0.46	38.9	1.85	4.16	0.10	0.08
L1958669-7 142666															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
BLANK	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Target Range - Lower Bound	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001
Upper Bound	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2	0.002
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.03	0.018	0.33	25.2	7.0	0.45	555	1.07	0.02	0.07	3.5	380	7.5	23.6	0.001
DUP	0.03	0.019	0.34	25.5	7.1	0.45	553	1.12	0.02	0.07	3.5	380	8.0	24.6	0.001
Target Range - Lower Bound	0.02	0.013	0.31	23.9	6.6	0.42	521	0.99	<0.01	<0.05	3.1	350	7.2	22.8	<0.001
Upper Bound	0.04	0.024	0.36	26.8	7.5	0.48	587	1.20	0.03	0.10	3.9	410	8.3	25.4	0.002
ORIGINAL	<0.01	0.038	0.17	5.4	11.5	0.50	236	0.38	0.04	0.06	26.5	300	1.8	5.7	<0.001
DUP	<0.01	0.039	0.17	5.5	10.2	0.50	242	0.41	0.04	0.06	27.0	300	1.9	5.8	<0.001
Target Range - Lower Bound	<0.01	0.032	0.15	5.0	10.2	0.47	222	0.33	0.03	<0.05	25.2	280	1.6	5.4	<0.001
Upper Bound	0.02	0.045	0.19	5.9	11.5	0.54	256	0.46	0.05	0.10	28.3	330	2.1	6.1	0.002
L1958669-7 142666															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17152307

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
BLANK	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Target Range - Lower Bound	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05
Upper Bound	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.15	0.41	4.3	0.4	0.3	134.0	<0.01	<0.01	8.9	0.027	0.17	1.01	22	0.16	8.94
DUP	0.15	0.43	4.2	0.2	0.4	134.5	<0.01	0.01	9.1	0.027	0.17	1.02	22	0.16	8.58
Target Range - Lower Bound	0.13	0.34	3.9	<0.2	<0.2	127.5	<0.01	<0.01	8.4	0.021	0.14	0.91	20	0.10	8.27
Upper Bound	0.17	0.50	4.6	0.4	0.4	141.0	0.02	0.02	9.7	0.033	0.20	1.12	24	0.22	9.25
ORIGINAL	0.15	0.08	1.0	0.3	<0.2	48.1	<0.01	0.47	0.3	0.081	0.03	<0.05	14	0.26	1.82
DUP	0.15	0.09	1.0	0.2	<0.2	48.6	<0.01	0.75	0.3	0.082	0.03	<0.05	14	0.27	1.87
Target Range - Lower Bound	0.13	<0.05	0.9	<0.2	<0.2	45.7	<0.01	0.57	<0.2	0.072	<0.02	<0.05	12	0.20	1.70
Upper Bound	0.17	0.10	1.2	0.4	0.4	51.0	0.02	0.65	0.4	0.091	0.04	0.10	16	0.33	1.99
L1958669-7 142666															
DUP															
Target Range - Lower Bound															
Upper Bound															

Project: L1958669

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
BLANKS			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK		<2	<0.5
BLANK		<2	<0.5
Target Range - Lower Bound		<2	<0.5
Upper Bound		4	1.0
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
DUPLICATES			
ORIGINAL		22	5.0
DUP		22	5.0
Target Range - Lower Bound		19	4.1
Upper Bound		25	5.9
ORIGINAL		27	1.8
DUP		28	1.8
Target Range - Lower Bound		24	1.2
Upper Bound		31	2.4
L1958669-7 142666			
DUP			
Target Range - Lower Bound			
Upper Bound			

Project: L1958669

QC CERTIFICATE OF ANALYSIS VA17152307

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	OA-VOL08m	S-IR08	S-GRA06	S-GRA06a	C-GAS05	C-GAS05	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	MPA	FIZZ RAT	NNP	NP	pH	Ratio (N	S	S	S	C	CO2	Ag	Al	As	Au
Units	tCaCO3/1Kt	Unity	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm	ppm
Sample Description **LOR**	0.3	1	1	1	0.1	0.01	0.01	0.01	0.01	0.05	0.2	0.01	0.01	0.1	0.02
	DUPLICATES														
L1958669-8 142667	0.6	2	22	23		36.80									
DUP	0.6	2	22	23		36.80									
Target Range - Lower Bound	<0.3	<1	20	21		34.95									
Upper Bound	0.9	3	24	25		38.65									
L1958669-9 142668								<0.01	<0.01	<0.05	<0.2				
DUP								<0.01	0.02	<0.05	<0.2				
Target Range - Lower Bound								<0.01	<0.01	<0.05	<0.2				
Upper Bound								0.02	0.02	0.10	0.4				
L1958669-10 142669							0.27								
DUP							0.27								
Target Range - Lower Bound							0.25								
Upper Bound							0.29								

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-AUG-2017
Account: APN

Project: L1958669

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02
								DUPLICATES								
L1958669-8 142667																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-9 142668																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-10 142669																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re
	Units	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description	**LOR**	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001
									DUPLICATES							
L1958669-8 142667																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-9 142668																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-10 142669																
DUP																
Target Range - Lower Bound																
Upper Bound																

ALS Minerals

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1958669

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05
DUPLICATES																
L1958669-8 142667																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-9 142668																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1958669-10 142669																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17152307

Sample Description	Method Analyte Units LOR	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
DUPLICATES			
L1958669-8 142667			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1958669-9 142668			
DUP			
Target Range - Lower Bound			
Upper Bound			
L1958669-10 142669			
DUP			
Target Range - Lower Bound			
Upper Bound			

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17152307

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1958669-COFC

COC Number: 17-22

Page 2 of 2

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
Company address below will appear on the final report		
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #

PO / AFE: TBD

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	142670	04-JUL-17		WASTE	X	X	X	X	X	X	
	142671	04-JUL-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

October 2015 Front

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1958669-COFC

COC Number: 17 22

Page 1 of 2

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD
ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:
ALS Contact: Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	~~14~~	~~04-Jul-17~~		Composite	R	R	R	R	R	R	
	142660	04-JUL-17		WASTE	X	X	X	X	X	X	
	142661	04-JUL-17		WASTE	X	X	X	X	X	X	
	142662	04-JUL-17		WASTE	X	X	X	X	X	X	
	142663	04-JUL-17		WASTE	X	X	X	X	X	X	
	142664	04-JUL-17		WASTE	X	X	X	X	X	X	
	142665	04-JUL-17		WASTE	X	X	X	X	X	X	
	142666	04-JUL-17		WASTE	X	X	X	X	X	X	
	142667	04-JUL-17		WASTE	X	X	X	X	X	X	
	142668	04-JUL-17		WASTE	X	X	X	X	X	X	
	142669	04-JUL-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: 16.0
FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)
Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: ~~14~~ E/HF Date: 14 July 2017 Time: 09:52

FINAL SHIPMENT RECEPTION (lab use only)
Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 02-AUG-17
Report Date: 18-SEP-17 19:13 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1968927
Project P.O. #: 226298
Job Reference:
C of C Numbers: 17-23
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1968927-1	L1968927-2	L1968927-3	L1968927-4	L1968927-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	10-JUL-17	10-JUL-17	11-JUL-17	11-JUL-17	13-JUL-17
	Sampled Time					
	Client ID	142672 775-43	142673 775-43	142674 775-45A	142675 775-45A	129726 775-45B
SOIL						
Physical Tests	pH (Unity)	9.1	9.0	9.1	8.7	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.27	0.23	0.22	0.56	0.25
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.9	1.6	0.6	0.3	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	28	24	24	53	27
	NNP (tCaCO3/1Kt)	27	22	23	53	26
	Ratio (NP/MPA) (Unity)	29.87	15.36	38.40	169.60	43.20
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	<0.01	0.02	0.02	0.02
	Sulfide Sulfur (T minus HCl leach) (%)	0.02	0.05	<0.01	<0.01	<0.01
	Total Sulfur (combustion) (%)	0.03	0.05	0.02	0.01	0.02
Total Metals	Aluminum (Al) (%)	1.02	1.17	1.21	1.10	1.10
	Antimony (Sb) (ppm)	<0.05	0.07	<0.05	0.12	0.06
	Arsenic (As) (ppm)	0.9	0.7	0.8	1.5	1.4
	Barium (Ba) (ppm)	210	230	200	60	240
	Beryllium (Be) (ppm)	0.31	0.32	0.34	0.48	0.31
	Bismuth (Bi) (ppm)	0.07	0.19	0.03	0.02	0.05
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.05	0.06	0.04	0.05	0.13
	Calcium (Ca) (%)	1.21	0.96	1.16	2.09	1.10
	Cerium (Ce) (ppm)	18.55	23.9	21.5	25.1	26.2
	Cesium (Cs) (ppm)	0.41	0.52	0.50	0.47	0.48
	Chromium (Cr) (ppm)	5	292	5	4	5
	Cobalt (Co) (ppm)	5.0	7.3	5.7	5.6	6.3
	Copper (Cu) (ppm)	324	770	145.0	46.2	702
	Gallium (Ga) (ppm)	4.99	6.13	6.28	6.33	5.97
	Germanium (Ge) (ppm)	0.06	0.08	0.06	0.05	0.06
	Gold (Au) (ppm)	<0.02	0.02	<0.02	<0.02	0.02
	Hafnium (Hf) (ppm)	0.06	0.05	0.05	0.04	0.06
	Indium (In) (ppm)	0.026	0.034	0.028	0.036	0.034
	Iron (Fe) (%)	2.05	2.54	2.27	2.15	2.30
	Lanthanum (La) (ppm)	9.1	12.8	11.1	12.8	14.2
	Lead (Pb) (ppm)	2.5	2.7	3.2	5.2	2.9
	Lithium (Li) (ppm)	5.4	6.4	7.1	7.9	7.3
	Magnesium (Mg) (%)	0.60	0.68	0.70	0.68	0.63
	Manganese (Mn) (ppm)	560	584	581	629	662

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968927-6	L1968927-7	L1968927-8	L1968927-9	L1968927-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	18-JUL-17	18-JUL-17	15-JUL-17	15-JUL-17	20-JUL-17
	Sampled Time					
	Client ID	129730 775-45C	129731 775-45C	129729 775-44	142628 775-44	129732 775-46
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.9	9.1	9.2	9.1	8.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.56	0.59	0.43	0.13	0.68
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	15.3	7.5	2.5	15.6	16.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	39	35	37	16	39
	NNP (tCaCO3/1Kt)	24	28	35	0	23
	Ratio (NP/MPA) (Unity)	2.55	4.67	14.80	1.02	2.40
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	0.01	0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.03	<0.01	0.01	0.03
	Sulfide Sulfur (T minus HCl leach) (%)	0.48	0.21	0.08	0.49	0.49
	Total Sulfur (combustion) (%)	0.49	0.24	0.08	0.50	0.52
Total Metals	Aluminum (Al) (%)	0.80	0.53	1.10	1.17	0.62
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	1.3	1.3	0.8	0.7	0.8
	Barium (Ba) (ppm)	100	80	210	290	80
	Beryllium (Be) (ppm)	0.27	0.36	0.37	0.23	0.31
	Bismuth (Bi) (ppm)	0.67	0.09	0.19	0.25	0.35
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.32	0.16	0.06	0.13	0.17
	Calcium (Ca) (%)	1.19	1.02	1.52	0.68	1.13
	Cerium (Ce) (ppm)	36.6	12.65	24.4	38.3	36.9
	Cesium (Cs) (ppm)	0.55	0.42	0.39	0.44	0.32
	Chromium (Cr) (ppm)	3	4	5	5	5
	Cobalt (Co) (ppm)	4.4	5.7	5.3	6.4	4.9
	Copper (Cu) (ppm)	5410	2240	1090	3400	3960
	Gallium (Ga) (ppm)	4.82	2.85	5.89	6.06	3.82
	Germanium (Ge) (ppm)	0.09	0.05	0.07	0.08	0.07
	Gold (Au) (ppm)	0.07	0.03	0.03	0.02	0.06
	Hafnium (Hf) (ppm)	0.06	0.04	0.04	0.04	0.03
	Indium (In) (ppm)	0.137	0.065	0.041	0.124	0.105
	Iron (Fe) (%)	2.45	2.34	2.33	2.46	2.35
	Lanthanum (La) (ppm)	18.0	6.0	12.7	20.9	18.3
	Lead (Pb) (ppm)	3.6	3.0	3.1	2.3	3.7
	Lithium (Li) (ppm)	4.5	2.6	7.0	7.1	3.4
	Magnesium (Mg) (%)	0.78	0.54	0.67	0.69	0.64
	Manganese (Mn) (ppm)	386	473	609	325	400

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968927-1	L1968927-2	L1968927-3	L1968927-4	L1968927-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	10-JUL-17	10-JUL-17	11-JUL-17	11-JUL-17	13-JUL-17
	Sampled Time					
	Client ID	142672 775-43	142673 775-43	142674 775-45A	142675 775-45A	129726 775-45B
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.46	1.65	0.51	0.40	1.80
	Nickel (Ni) (ppm)	2.5	81.9	2.5	2.1	3.5
	Niobium (Nb) (ppm)	0.12	0.17	0.12	<0.05	0.09
	Phosphorus (P) (ppm)	580	660	690	650	670
	Potassium (K) (%)	0.44	0.61	0.36	0.12	0.39
	Rhenium (Re) (ppm)	0.001	0.001	0.001	<0.001	0.001
	Rubidium (Rb) (ppm)	19.5	29.7	16.7	6.2	18.6
	Scandium (Sc) (ppm)	3.7	3.5	3.6	5.0	5.3
	Selenium (Se) (ppm)	0.5	0.7	0.2	0.2	0.4
	Silver (Ag) (ppm)	0.10	0.36	0.05	0.02	0.11
	Sodium (Na) (%)	0.08	0.07	0.10	0.04	0.06
	Strontium (Sr) (ppm)	88.3	68.5	66.0	116.0	73.5
	Sulfur (S) (%)	0.01	0.03	<0.01	<0.01	<0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.07	0.01	<0.01	0.01
	Thallium (Tl) (ppm)	0.12	0.17	0.09	0.03	0.10
	Thorium (Th) (ppm)	1.8	2.6	2.3	2.5	2.8
	Tin (Sn) (ppm)	0.5	0.6	0.5	0.5	0.6
	Titanium (Ti) (%)	0.078	0.105	0.079	0.006	0.058
	Tungsten (W) (ppm)	0.66	0.64	1.01	0.23	0.63
	Uranium (U) (ppm)	0.66	0.24	0.31	0.37	0.25
	Vanadium (V) (ppm)	44	53	45	38	48
	Yttrium (Y) (ppm)	9.40	7.61	7.03	11.35	9.06
	Zinc (Zn) (ppm)	58	65	69	67	67
	Zirconium (Zr) (ppm)	0.8	0.8	0.8	0.7	1.1
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	0.9	0.8	2.0	0.9
Miscellaneous	Carbon (C) (%)	0.36	0.34	0.30	0.67	0.31

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968927-6	L1968927-7	L1968927-8	L1968927-9	L1968927-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	18-JUL-17	18-JUL-17	15-JUL-17	15-JUL-17	20-JUL-17
	Sampled Time					
	Client ID	129730 775-45C	129731 775-45C	129729 775-44	142628 775-44	129732 775-46
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	0.01	0.01	0.01
	Molybdenum (Mo) (ppm)	4.59	3.94	1.04	43.4	4.19
	Nickel (Ni) (ppm)	2.6	2.5	2.2	2.2	2.5
	Niobium (Nb) (ppm)	0.37	0.12	0.15	0.28	0.26
	Phosphorus (P) (ppm)	960	650	610	880	850
	Potassium (K) (%)	0.52	0.24	0.42	0.73	0.28
	Rhenium (Re) (ppm)	0.018	0.006	0.002	0.152	0.009
	Rubidium (Rb) (ppm)	28.3	13.0	19.8	36.1	15.0
	Scandium (Sc) (ppm)	6.7	3.2	4.1	4.3	4.9
	Selenium (Se) (ppm)	4.8	2.2	1.1	2.5	3.9
	Silver (Ag) (ppm)	0.99	0.50	0.36	0.69	0.81
	Sodium (Na) (%)	0.05	0.05	0.07	0.08	0.05
	Strontium (Sr) (ppm)	105.0	112.0	116.5	42.5	133.0
	Sulfur (S) (%)	0.51	0.24	0.07	0.55	0.53
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.16	0.05	0.05	0.10	0.13
	Thallium (Tl) (ppm)	0.24	0.07	0.12	0.25	0.13
	Thorium (Th) (ppm)	5.1	1.4	3.1	4.6	4.1
	Tin (Sn) (ppm)	1.2	0.7	0.6	2.1	1.3
	Titanium (Ti) (%)	0.089	0.032	0.066	0.128	0.036
	Tungsten (W) (ppm)	0.62	0.62	0.31	0.85	0.71
	Uranium (U) (ppm)	0.36	0.29	0.41	0.35	0.89
	Vanadium (V) (ppm)	62	45	45	68	49
	Yttrium (Y) (ppm)	12.65	5.18	7.51	7.67	11.85
	Zinc (Zn) (ppm)	54	75	65	50	46
	Zirconium (Zr) (ppm)	2.0	1.4	0.9	1.1	1.3
Permanent Gases	Carbon Dioxide (CO2) (%)	2.1	2.2	1.6	0.5	2.5
Miscellaneous	Carbon (C) (%)	0.69	0.74	0.52	0.19	0.81

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-23

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 2-SEP-2017
Account: APN

CERTIFICATE VA17165021

Project: L1968927

P.O. No.: ALSM-CW16-102-APN

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 6-AUG-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

CERTIFICATE OF ANALYSIS VA17165021

Sample Description / Method	WEI-21	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Recvd Wt.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs
Units	kg	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.02	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05
L1968927-1-142672 775-43	1.04	0.10	1.02	0.9	<0.02	<10	210	0.31	0.07	1.21	0.05	18.55	5.0	5	0.41
L1968927-2-142673 775-43	1.06	0.36	1.17	0.7	0.02	<10	230	0.32	0.19	0.96	0.06	23.9	7.3	292	0.52
L1968927-3-142674 775-45A	1.06	0.05	1.21	0.8	<0.02	<10	200	0.34	0.03	1.16	0.04	21.5	5.7	5	0.50
L1968927-4-142675 775-45A	0.98	0.02	1.10	1.5	<0.02	<10	60	0.48	0.02	2.09	0.05	25.1	5.6	4	0.47
L1968927-5-129726 775-45B	1.06	0.11	1.10	1.4	0.02	<10	240	0.31	0.05	1.10	0.13	26.2	6.3	5	0.48
L1968927-6-129730 775-45C	1.08	0.99	0.80	1.3	0.07	<10	100	0.27	0.67	1.19	0.32	36.6	4.4	3	0.55
L1968927-7-129731 775-45C	1.06	0.50	0.53	1.3	0.03	<10	80	0.36	0.09	1.02	0.16	12.65	5.7	4	0.42
L1968927-8-129729 775-44	1.12	0.36	1.10	0.8	0.03	<10	210	0.37	0.19	1.52	0.06	24.4	5.3	5	0.39
L1968927-9-142628 775-44	1.06	0.69	1.17	0.7	0.02	<10	290	0.23	0.25	0.68	0.13	38.3	6.4	5	0.44
L1968927-10-129732 775-46	1.10	0.81	0.62	0.8	0.06	<10	80	0.31	0.35	1.13	0.17	36.9	4.9	5	0.32

Project: L1968927

CERTIFICATE OF ANALYSIS VA17165021

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05
L1968927-1-142672 775-43	324	2.05	4.99	0.06	0.06	<0.01	0.026	0.44	9.1	5.4	0.60	560	0.46	0.08	0.12
L1968927-2-142673 775-43	770	2.54	6.13	0.08	0.05	<0.01	0.034	0.61	12.8	6.4	0.68	584	1.65	0.07	0.17
L1968927-3-142674 775-45A	145.0	2.27	6.28	0.06	0.05	<0.01	0.028	0.36	11.1	7.1	0.70	581	0.51	0.10	0.12
L1968927-4-142675 775-45A	46.2	2.15	6.33	0.05	0.04	<0.01	0.036	0.12	12.8	7.9	0.68	629	0.40	0.04	<0.05
L1968927-5-129726 775-45B	702	2.30	5.97	0.06	0.06	<0.01	0.034	0.39	14.2	7.3	0.63	662	1.80	0.06	0.09
L1968927-6-129730 775-45C	5410	2.45	4.82	0.09	0.06	<0.01	0.137	0.52	18.0	4.5	0.78	386	4.59	0.05	0.37
L1968927-7-129731 775-45C	2240	2.34	2.85	0.05	0.04	0.01	0.065	0.24	6.0	2.6	0.54	473	3.94	0.05	0.12
L1968927-8-129729 775-44	1090	2.33	5.89	0.07	0.04	0.01	0.041	0.42	12.7	7.0	0.67	609	1.04	0.07	0.15
L1968927-9-142628 775-44	3400	2.46	6.06	0.08	0.04	0.01	0.124	0.73	20.9	7.1	0.69	325	43.4	0.08	0.28
L1968927-10-129732 775-46	3960	2.35	3.82	0.07	0.03	0.01	0.105	0.28	18.3	3.4	0.64	400	4.19	0.05	0.26

Project: L1968927

CERTIFICATE OF ANALYSIS VA17165021

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description / **LOR**	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
L1968927-1-142672 775-43	2.5	580	2.5	19.5	0.001	0.01	<0.05	3.7	0.5	0.5	88.3	<0.01	0.01	1.8	0.078
L1968927-2-142673 775-43	81.9	660	2.7	29.7	0.001	0.03	0.07	3.5	0.7	0.6	68.5	<0.01	0.07	2.6	0.105
L1968927-3-142674 775-45A	2.5	690	3.2	16.7	0.001	<0.01	<0.05	3.6	0.2	0.5	66.0	<0.01	0.01	2.3	0.079
L1968927-4-142675 775-45A	2.1	650	5.2	6.2	<0.001	<0.01	0.12	5.0	0.2	0.5	116.0	<0.01	<0.01	2.5	0.006
L1968927-5-129726 775-45B	3.5	670	2.9	18.6	0.001	<0.01	0.06	5.3	0.4	0.6	73.5	<0.01	0.01	2.8	0.058
L1968927-6-129730 775-45C	2.6	960	3.6	28.3	0.018	0.51	<0.05	6.7	4.8	1.2	105.0	<0.01	0.16	5.1	0.089
L1968927-7-129731 775-45C	2.5	650	3.0	13.0	0.006	0.24	<0.05	3.2	2.2	0.7	112.0	<0.01	0.05	1.4	0.032
L1968927-8-129729 775-44	2.2	610	3.1	19.8	0.002	0.07	<0.05	4.1	1.1	0.6	116.5	<0.01	0.05	3.1	0.066
L1968927-9-142628 775-44	2.2	880	2.3	36.1	0.152	0.55	<0.05	4.3	2.5	2.1	42.5	<0.01	0.10	4.6	0.128
L1968927-10-129732 775-46	2.5	850	3.7	15.0	0.009	0.53	<0.05	4.9	3.9	1.3	133.0	<0.01	0.13	4.1	0.036

Project: L1968927

CERTIFICATE OF ANALYSIS VA17165021

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a
Analyte	Tl	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%
Sample Description **LOR**	0.02	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.01
L1968927-1-142672 775-43	0.12	0.66	44	0.66	9.40	58	0.8	2	0.9	27	28	29.87	9.1	0.03	0.02
L1968927-2-142673 775-43	0.17	0.24	53	0.64	7.61	65	0.8	2	1.6	22	24	15.36	9.0	0.05	0.05
L1968927-3-142674 775-45A	0.09	0.31	45	1.01	7.03	69	0.8	2	0.6	23	24	38.40	9.1	0.02	<0.01
L1968927-4-142675 775-45A	0.03	0.37	38	0.23	11.35	67	0.7	2	0.3	53	53	169.60	8.7	0.01	<0.01
L1968927-5-129726 775-45B	0.10	0.25	48	0.63	9.06	67	1.1	2	0.6	26	27	43.20	8.7	0.02	<0.01
L1968927-6-129730 775-45C	0.24	0.36	62	0.62	12.65	54	2.0	2	15.3	24	39	2.55	8.9	0.49	0.48
L1968927-7-129731 775-45C	0.07	0.29	45	0.62	5.18	75	1.4	2	7.5	28	35	4.67	9.1	0.24	0.21
L1968927-8-129729 775-44	0.12	0.41	45	0.31	7.51	65	0.9	2	2.5	35	37	14.80	9.2	0.08	0.08
L1968927-9-142628 775-44	0.25	0.35	68	0.85	7.67	50	1.1	2	15.6	0	16	1.02	9.1	0.50	0.49
L1968927-10-129732 775-46	0.13	0.89	49	0.71	11.85	46	1.3	2	16.3	23	39	2.40	8.8	0.52	0.49

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 2-SEP-2017
Account: APN

Project: L1968927

CERTIFICATE OF ANALYSIS VA17165021

Method	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06
Analyte	C	CO2	S	C	S
Units	%	%	%	%	%
Sample Description / **LOR**	0.05	0.2	0.01	0.01	0.01
L1968927-1-142672 775-43	0.27	1.0	0.01	0.36	<0.01
L1968927-2-142673 775-43	0.23	0.9	<0.01	0.34	0.01
L1968927-3-142674 775-45A	0.22	0.8	0.02	0.30	0.01
L1968927-4-142675 775-45A	0.56	2.0	0.02	0.67	<0.01
L1968927-5-129726 775-45B	0.25	0.9	0.02	0.31	<0.01
L1968927-6-129730 775-45C	0.56	2.1	0.01	0.69	0.01
L1968927-7-129731 775-45C	0.59	2.2	0.03	0.74	0.01
L1968927-8-129729 775-44	0.43	1.6	<0.01	0.52	0.01
L1968927-9-142628 775-44	0.13	0.5	0.01	0.19	0.01
L1968927-10-129732 775-46	0.68	2.5	0.03	0.81	0.01

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 2-SEP-2017
Account: APN

Project: L1968927

CERTIFICATE OF ANALYSIS VA17165021

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-ELE07
S-GRA06
WEI-21
C-IR07
OA-VOL08m
S-GRA06a
LOG-22
PUL-31
S-IR08
ME-MS41
S-CAL06a
SPL-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 4 (A - E)
Plus Appendix Pages
Finalized Date: 2-SEP-2017
Account: APN

QC CERTIFICATE VA17165021

Project: L1968927

P.O. No.: ALSM-CW16-102-APN

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 6-AUG-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description — Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
	STANDARDS														
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	4.13	2.50	31.3	<0.02	<10	420	0.70	0.62	1.00	2.14	76.0	18.0	87	11.05	601
Target Range - Lower Bound	4.00	2.44	29.6	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587
Upper Bound	4.92	3.00	36.4	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675
OGGeo08	18.45	2.16	119.0	0.06	<10	120	0.75	8.92	0.86	18.05	57.7	90.1	80	9.32	8240
Target Range - Lower Bound	18.15	2.05	107.0	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800
Upper Bound	22.2	2.53	131.0	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980
OREAS 905	0.46	0.74	29.7	0.37	<10	230	0.93	5.30	0.32	0.30	74.4	12.8	16	1.16	1515
Target Range - Lower Bound	0.45	0.73	28.4	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450
Upper Bound	0.58	0.91	35.0	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670
OREAS 920	0.09	2.41	4.9	<0.02	<10	80	0.83	0.65	0.32	0.06	70.8	13.5	43	1.93	113.0
Target Range - Lower Bound	0.07	2.18	3.8	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0
Upper Bound	0.12	2.68	4.9	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		3.45	9.46	0.13	0.71	0.05	0.153	1.20	37.3	30.3	1.08	394	14.40	0.31	1.05	671
Target Range - Lower Bound		3.22	8.73	0.07	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622
Upper Bound		3.96	10.80	0.29	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760
OGGeo08		5.03	8.55	0.22	0.80	0.43	1.410	1.04	27.7	28.9	0.93	383	868	0.28	1.69	8740
Target Range - Lower Bound		4.51	8.05	0.21	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760
Upper Bound		5.53	9.95	0.45	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480
OREAS 905		3.38	5.60	0.08	1.09	0.01	0.523	0.29	37.4	4.9	0.14	332	2.77	0.08	0.29	8.2
Target Range - Lower Bound		3.14	5.74	<0.05	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8
Upper Bound		3.86	7.12	0.22	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0
OREAS 920		3.65	6.68	0.10	0.55	0.01	0.034	0.41	35.0	23.2	1.07	519	0.34	0.02	0.34	37.7
Target Range - Lower Bound		3.26	6.12	<0.05	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4
Upper Bound		4.00	7.60	0.22	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4

QC CERTIFICATE OF ANALYSIS VA17165021

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		960	1005	136.5	0.007	0.27	3.18	7.1	1.3	3.3	73.5	0.02	0.02	20.1	0.353	0.76
Target Range - Lower Bound		900	959	132.0	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64
Upper Bound		1130	1175	162.0	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92
OGGeo08		770	6990	119.0	1.305	2.68	18.20	6.6	10.6	12.7	64.0	0.05	0.12	16.1	0.300	1.23
Target Range - Lower Bound		700	6520	109.5	1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14
Upper Bound		880	7970	134.5	1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58
OREAS 905		240	15.6	16.4	<0.001	0.05	0.97	1.7	2.3	1.2	11.1	<0.01	0.06	7.9	0.018	0.10
Target Range - Lower Bound			15.2	17.3	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06
Upper Bound			19.0	21.3	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16
OREAS 920		710	19.8	23.5	<0.001	0.02	0.59	2.6	0.8	1.0	16.6	0.01	0.01	15.4	0.122	0.14
Target Range - Lower Bound			19.2	22.2	<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07
Upper Bound			23.9	27.4	0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05
Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2
Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
LOR	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2
								STANDARDS							
Buffer pH6												6.1			
Buffer pH6												6.0			
Target Range - Lower Bound												5.3			
Upper Bound												6.7			
CO-ASSAY														0.50	1.8
Target Range - Lower Bound														0.42	1.5
Upper Bound														0.64	2.4
DS-1													2.68		
Target Range - Lower Bound													2.51		
Upper Bound													2.71		
GS313-8													1.26		
Target Range - Lower Bound													1.19		
Upper Bound													1.29		
KZK-1							2	25.0	31	56	2.24				
KZK-1							2	25.0	30	55	2.20				
Target Range - Lower Bound							<1	22.9	30	54	2.18				
Upper Bound							>4	27.1	38	64	2.53				
MA-2c														1.54	5.6
Target Range - Lower Bound														1.50	5.5
Upper Bound														1.84	6.8
MRGeo08	5.43	96	2.92	19.45	725	21.4									
Target Range - Lower Bound	4.93	90	2.44	17.50	708	18.1									
Upper Bound	6.13	112	3.42	21.5	870	25.7									
OGGeo08	4.55	78	2.80	15.75	6870	24.4									
Target Range - Lower Bound	4.45	70	2.58	15.35	6500	19.5									
Upper Bound	5.55	88	3.60	18.85	7950	27.5									
OREAS 905	2.18	6	0.60	6.34	60	40.3									
Target Range - Lower Bound	2.08	4	0.44	6.32	58	39.9									
Upper Bound	2.66	8	0.76	7.84	76	55.1									
OREAS 920	2.05	25	0.41	17.20	102	22.0									
Target Range - Lower Bound	1.89	23	0.31	16.85	93	17.6									
Upper Bound	2.42	30	0.61	20.7	119	25.0									

***** See Appendix Page for comments regarding this certificate *****

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description	Method Analyte Units LOR	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01
			STANDARDS	
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
DS-1			3.13	
Target Range - Lower Bound			3.01	
Upper Bound			3.25	
GS313-8			0.95	
Target Range - Lower Bound			0.90	
Upper Bound			0.98	
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-2c				
Target Range - Lower Bound				
Upper Bound				
MRGeo08				
Target Range - Lower Bound				
Upper Bound				
OGGeo08				
Target Range - Lower Bound				
Upper Bound				
OREAS 905				
Target Range - Lower Bound				
Upper Bound				
OREAS 920				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17165021

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description	**LOR**	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
		STANDARDS														
UTS-1																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
		BLANKS														
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
BLANK		<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Target Range - Lower Bound		<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound		0.02	0.02	0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	0.06	<0.05	<0.02	<0.01	0.005	<0.01	<0.2	0.2	<0.01	<5	<0.05	<0.01	<0.05	<0.2
BLANK	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound	0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
								STANDARDS								
UTS-1																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
								BLANKS								
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<10	<0.2	<0.1	<0.001	<0.01	<0.05	0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
BLANK		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound		20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17165021

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05
Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2
Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
Sample Description LOR	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK														<0.05	<0.2
Target Range - Lower Bound														<0.05	<0.2
Upper Bound														0.10	0.4
BLANK	<0.05	<1	<0.05	<0.05	<2	<0.5									
BLANK	<0.05	<1	<0.05	<0.05	<2	<0.5									
Target Range - Lower Bound	<0.05	<1	<0.05	<0.05	<2	<0.5									
Upper Bound	0.10	2	0.10	0.10	4	1.0									
BLANK												6.3			
Target Range - Lower Bound												5.5			
Upper Bound												6.9			
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK													<0.01		
Target Range - Lower Bound													<0.01		
Upper Bound													0.02		

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 2-SEP-2017
Account: APN

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description	Method Analyte Units LOR	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01
STANDARDS				
UTS-1				0.93
UTS-1				0.87
UTS-1				0.88
Target Range - Lower Bound				0.83
Upper Bound				0.93
UTS-1		0.90		
UTS-1		0.91		
UTS-1		0.90		
Target Range - Lower Bound		0.81		
Upper Bound		0.95		
UTS-4				1.79
Target Range - Lower Bound				1.64
Upper Bound				1.84
UTS-4		1.73		
Target Range - Lower Bound		1.61		
Upper Bound		1.87		
BLANKS				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				<0.01
BLANK				<0.01
Target Range - Lower Bound				<0.01
Upper Bound				0.02
BLANK		<0.01		
BLANK		<0.01		
Target Range - Lower Bound		<0.01		
Upper Bound		0.02		
BLANK			<0.01	
Target Range - Lower Bound			<0.01	
Upper Bound			0.02	

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
		DUPLICATES														
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		0.04	1.52	9.9	<0.02	<10	140	1.12	0.04	0.21	0.06	16.30	11.9	14	0.31	6.6
DUP		0.05	1.52	10.3	<0.02	<10	140	1.09	0.04	0.21	0.06	17.70	12.9	14	0.33	7.8
Target Range - Lower Bound		0.03	1.43	9.5	<0.02	<10	120	1.00	0.03	0.19	0.05	16.15	11.7	12	0.25	6.7
Upper Bound		0.06	1.61	10.7	0.04	20	160	1.21	0.05	0.23	0.07	17.85	13.1	16	0.39	7.7
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-4-142675 775-45A																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-6-129730 775-45C																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-8-129729 775-44																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-10-129732 775-46																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		0.04	1.22	7.9	<0.02	<10	120	0.28	0.06	0.64	0.06	9.15	7.6	32	0.49	24.2
DUP		0.04	1.24	8.6	<0.02	<10	120	0.27	0.06	0.66	0.08	9.34	8.2	33	0.51	26.0
Target Range - Lower Bound		0.03	1.16	7.7	<0.02	<10	100	0.21	0.05	0.61	0.06	8.76	7.4	30	0.43	24.0
Upper Bound		0.05	1.30	8.8	0.04	20	140	0.34	0.07	0.69	0.08	9.73	8.4	35	0.58	26.2

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description / **LOR**	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
							DUPLICATES								
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	3.26	5.09	<0.05	0.10	0.19	0.032	0.09	7.4	3.6	0.37	274	1.88	0.02	0.15	5.9
DUP	3.21	5.43	<0.05	0.10	0.19	0.033	0.09	8.3	3.2	0.37	277	1.96	0.02	0.16	6.0
Target Range - Lower Bound	3.06	4.95	<0.05	0.08	0.17	0.026	0.08	7.3	3.1	0.34	257	1.77	<0.01	0.10	5.5
Upper Bound	3.41	5.57	0.10	0.13	0.21	0.039	0.10	8.4	3.7	0.40	294	2.07	0.03	0.21	6.4
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-4-142675 775-45A															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-6-129730 775-45C															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-8-129729 775-44															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-10-129732 775-46															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	1.97	3.65	<0.05	0.04	0.02	0.017	0.09	3.9	8.1	0.57	415	0.55	0.03	0.76	17.1
DUP	2.00	3.94	<0.05	0.05	0.02	0.017	0.09	3.9	8.7	0.59	428	0.58	0.03	0.80	18.5
Target Range - Lower Bound	1.88	3.56	<0.05	<0.02	<0.01	0.011	0.08	3.5	7.9	0.54	395	0.49	0.02	0.69	16.7
Upper Bound	2.09	4.03	0.10	0.07	0.03	0.023	0.10	4.3	8.9	0.62	448	0.64	0.04	0.87	18.9

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 2-SEP-2017
Account: APN

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
	DUPLICATES														
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	210	6.0	6.7	<0.001	0.03	0.31	5.0	0.5	0.6	38.9	<0.01	0.18	2.7	0.005	0.11
DUP	210	6.1	7.1	<0.001	0.03	0.32	5.2	0.9	0.6	41.5	<0.01	0.22	2.9	0.005	0.12
Target Range - Lower Bound	190	5.5	6.5	<0.001	0.02	0.24	4.7	0.5	0.4	38.0	<0.01	0.18	2.5	<0.005	0.09
Upper Bound	230	6.6	7.3	0.002	0.04	0.39	5.5	0.9	0.8	42.4	0.02	0.22	3.1	0.010	0.14
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-4-142675 775-45A															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-6-129730 775-45C															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-8-129729 775-44															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-10-129732 775-46															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	270	3.8	9.9	<0.001	<0.01	0.24	3.8	0.4	0.3	46.5	<0.01	0.02	0.8	0.058	0.06
DUP	270	3.6	10.5	<0.001	0.01	0.24	4.2	0.4	0.3	50.1	<0.01	0.01	0.8	0.060	0.06
Target Range - Lower Bound	250	3.3	9.6	<0.001	<0.01	0.17	3.7	<0.2	<0.2	45.7	<0.01	<0.01	0.6	0.051	0.04
Upper Bound	290	4.1	10.8	0.002	0.02	0.31	4.3	0.6	0.4	50.9	0.02	0.02	1.0	0.067	0.08

QC CERTIFICATE OF ANALYSIS VA17165021

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05
Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2
Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
Sample Description **LOR**	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	0.86	66	0.08	6.33	25	2.4									
DUP	0.94	65	0.09	6.94	25	2.6									
Target Range - Lower Bound	0.81	61	<0.05	6.25	22	1.8									
Upper Bound	1.00	70	0.10	7.02	28	3.2									
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-4-142675 775-45A													0.01		
DUP													0.01		
Target Range - Lower Bound													<0.01		
Upper Bound													0.02		
L1968927-6-129730 775-45C												8.9			
DUP												8.9			
Target Range - Lower Bound												8.4			
Upper Bound												9.4			
L1968927-8-129729 775-44							2	2.5	35	37	14.80				
DUP							2	2.5	35	37	14.80				
Target Range - Lower Bound							<1	2.1	32	34	14.05				
Upper Bound							3	2.9	38	40	15.55				
L1968927-10-129732 775-46														0.68	2.5
DUP														0.68	2.5
Target Range - Lower Bound														0.60	2.2
Upper Bound														0.76	2.8
ORIGINAL	0.34	46	0.09	2.35	28	1.5									
DUP	0.36	48	0.10	2.46	29	1.6									
Target Range - Lower Bound	0.28	44	<0.05	2.23	25	0.9									
Upper Bound	0.42	50	0.10	2.58	32	2.2									

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 2-SEP-2017
Account: APN

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

Sample Description	Method Analyte Units LOR	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01
DUPLICATES				
ORIGINAL				0.18
DUP				0.20
Target Range - Lower Bound				0.17
Upper Bound				0.21
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				0.01
DUP				0.01
Target Range - Lower Bound				<0.01
Upper Bound				0.02
L1968927-4-142675 775-45A			0.67	
DUP			0.68	
Target Range - Lower Bound			0.65	
Upper Bound			0.70	
L1968927-6-129730 775-45C				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1968927-8-129729 775-44		<0.01		
DUP		<0.01		
Target Range - Lower Bound		<0.01		
Upper Bound		0.02		
L1968927-10-129732 775-46		0.03		
DUP		0.04		
Target Range - Lower Bound		0.02		
Upper Bound		0.05		
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				

Project: L1968927

QC CERTIFICATE OF ANALYSIS VA17165021

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	S-CAL06a
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

Chain of Custody (COC) / Analytica Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1968927-COFC

COC Number: [illegible] #17-23

Page of

Report To Contact and company name below will appear on the final report

Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659

Company address below will appear on the final report

Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To
Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:
PO#
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
—		—		Composite	R	R	R	R	R	R	
	142672 775-43	10-JUL-17		WASTE	X	X	X	X	X	X	
	142673 775-43	10-JUL-17		WASTE	X	X	X	X	X	X	
	142674 775-45A	11-JUL-17		WASTE	X	X	X	X	X	X	
	142675 775-45A	11-JUL-17		WASTE	X	X	X	X	X	X	
	129726 775-45B	13-JUL-17		WASTE	X	X	X	X	X	X	
	129730 775-45C	18-JUL-17		WASTE	X	X	X	X	X	X	
	129731 775-45C	18-JUL-17		WASTE	X	X	X	X	X	X	
	129729 775-44	15-JUL-17		WASTE	X	X	X	X	X	X	
	129728 775-44	15-JUL-17		WASTE	X	X	X	X	X	X	
	129732 775-46	20/07/17		WASTE	X	X	X	X	X	X	
—		—									

Drinking Water (DW) Samples ^{1} **(client use)**

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐
Ice Packs ☑ Ice Cubes ☐
Cooling Initiated ☑
SIF Observations Yes ☐ No ☐
Custody seal intact Yes ☐ No ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
10.0			5.4	7.5	9.5

SHIPMENT RELEASE (client use)
Released by:
Date:
Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: EHF
Date: 2 Aug 2017
Time: 13:30

FINAL SHIPMENT RECEPTION (lab use only)
Received by: Shayan
Date: Aug.3
Time: 1130.

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 02-AUG-17
Report Date: 18-SEP-17 19:29 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L1968933

Project P.O. #:	226298
Job Reference:	
C of C Numbers:	17-24
Legal Site Desc:	

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968933-1	L1968933-2	L1968933-3	L1968933-4	L1968933-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	20-JUL-17	20-JUL-17	22-JUL-17	25-JUL-17	17-JUL-17
	Sampled Time					
	Client ID	129733 775-46	129734 775-46	129735 775-50	129739	129727
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.8	9.0	8.7	9.0	9.1
Organic / Inorganic Carbon	Carbon (C) (%)	0.74	0.23	0.48	0.07	0.28
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	3.4	0.3	0.9	0.3	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	48	24	44	12	26
	NNP (tCaCO3/1Kt)	45	24	43	12	25
	Ratio (NP/MPA) (Unity)	13.96	76.80	46.93	38.40	41.60
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	<0.01	<0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.10	0.01	0.03	0.01	0.02
	Total Sulfur (combustion) (%)	0.11	0.01	0.03	0.01	0.02
Total Metals	Aluminum (Al) (%)	0.84	1.36	0.60	1.34	1.05
	Antimony (Sb) (ppm)	0.06	0.06	0.07	<0.05	<0.05
	Arsenic (As) (ppm)	1.2	2.1	2.5	1.6	0.8
	Barium (Ba) (ppm)	90	70	90	350	250
	Beryllium (Be) (ppm)	0.33	0.47	0.44	0.25	0.30
	Bismuth (Bi) (ppm)	0.06	0.02	0.15	0.05	0.02
	Boron (B) (ppm)	<10	10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.14	0.02	0.17	0.05	0.07
	Calcium (Ca) (%)	2.02	1.13	1.79	0.55	1.10
	Cerium (Ce) (ppm)	28.3	29.0	30.5	30.6	21.5
	Cesium (Cs) (ppm)	0.33	0.40	0.56	0.46	0.49
	Chromium (Cr) (ppm)	5	11	3	7	5
	Cobalt (Co) (ppm)	5.4	6.1	5.6	6.3	5.4
	Copper (Cu) (ppm)	857	41.9	1315	289	221
	Gallium (Ga) (ppm)	4.79	6.95	3.63	6.71	5.20
	Germanium (Ge) (ppm)	<0.05	0.05	0.05	0.07	0.07
	Gold (Au) (ppm)	<0.02	<0.02	<0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.03	0.05	0.05	0.04	0.06
	Indium (In) (ppm)	0.045	0.023	0.056	0.026	0.024
	Iron (Fe) (%)	2.41	2.29	2.41	2.71	2.27
	Lanthanum (La) (ppm)	14.8	16.1	16.3	16.0	10.8
	Lead (Pb) (ppm)	4.0	3.7	6.0	1.8	2.1
	Lithium (Li) (ppm)	5.1	12.6	2.4	7.9	4.8
	Magnesium (Mg) (%)	0.63	1.03	0.22	0.78	0.66
	Manganese (Mn) (ppm)	578	550	720	775	617

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968933-6	L1968933-7	L1968933-8
	Description	Waste	Waste	Waste
	Sampled Date	22-JUL-17	22-JUL-17	22-JUL-17
	Sampled Time			
	Client ID	129737	129738	129736
Grouping	**Analyte**			
SOIL				
Physical Tests	pH (Unity)	8.8	8.9	9.0
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	0.11	0.17
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2
	MPA (tCaCO3/1Kt)	0.6	<0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	17	18
	NNP (tCaCO3/1Kt)	7	17	18
	Ratio (NP/MPA) (Unity)	12.80	108.80	57.60
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.02	<0.01	<0.01
	Total Sulfur (combustion) (%)	0.02	<0.01	0.01
Total Metals	Aluminum (Al) (%)	0.97	1.21	1.22
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	0.7	1.8	0.6
	Barium (Ba) (ppm)	260	220	260
	Beryllium (Be) (ppm)	0.21	0.28	0.25
	Bismuth (Bi) (ppm)	0.04	0.02	0.04
	Boron (B) (ppm)	<10	<10	<10
	Cadmium (Cd) (ppm)	0.18	0.11	0.14
	Calcium (Ca) (%)	0.31	0.82	0.83
	Cerium (Ce) (ppm)	23.2	25.1	27.8
	Cesium (Cs) (ppm)	0.34	0.35	0.42
	Chromium (Cr) (ppm)	6	5	7
	Cobalt (Co) (ppm)	5.1	6.0	6.0
	Copper (Cu) (ppm)	969	274	715
	Gallium (Ga) (ppm)	4.85	5.93	6.11
	Germanium (Ge) (ppm)	0.05	0.06	0.05
	Gold (Au) (ppm)	0.13	<0.02	0.03
	Hafnium (Hf) (ppm)	0.04	0.08	0.04
	Indium (In) (ppm)	0.023	0.024	0.028
	Iron (Fe) (%)	2.12	2.38	2.51
	Lanthanum (La) (ppm)	12.5	13.2	14.9
	Lead (Pb) (ppm)	1.8	1.8	2.2
	Lithium (Li) (ppm)	4.7	7.2	6.7
	Magnesium (Mg) (%)	0.46	0.66	0.70
	Manganese (Mn) (ppm)	533	703	628

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968933-1	L1968933-2	L1968933-3	L1968933-4	L1968933-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	20-JUL-17	20-JUL-17	22-JUL-17	25-JUL-17	17-JUL-17
	Sampled Time					
	Client ID	129733 775-46	129734 775-46	129735 775-50	129739	129727
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	0.92	2.04	3.51	0.55	0.39
	Nickel (Ni) (ppm)	2.3	10.4	2.0	3.0	2.1
	Niobium (Nb) (ppm)	0.05	<0.05	0.05	0.16	0.20
	Phosphorus (P) (ppm)	700	710	730	710	670
	Potassium (K) (%)	0.16	0.12	0.17	0.76	0.53
	Rhenium (Re) (ppm)	0.002	0.007	0.002	<0.001	<0.001
	Rubidium (Rb) (ppm)	7.9	6.3	9.6	36.6	23.9
	Scandium (Sc) (ppm)	4.4	3.1	4.5	4.4	4.4
	Selenium (Se) (ppm)	1.1	0.5	1.0	0.3	0.5
	Silver (Ag) (ppm)	0.22	0.05	0.24	0.06	0.06
	Sodium (Na) (%)	0.05	0.05	0.04	0.06	0.08
	Strontium (Sr) (ppm)	111.5	159.0	74.7	34.7	80.2
	Sulfur (S) (%)	0.11	0.01	0.03	<0.01	0.02
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.01	0.06	0.01	0.01
	Thallium (Tl) (ppm)	0.05	0.03	0.05	0.21	0.13
	Thorium (Th) (ppm)	3.3	2.9	4.4	3.5	2.0
	Tin (Sn) (ppm)	0.7	0.4	0.6	0.6	0.5
	Titanium (Ti) (%)	0.012	0.012	0.012	0.134	0.092
	Tungsten (W) (ppm)	0.44	0.49	0.28	0.39	0.47
	Uranium (U) (ppm)	0.68	0.41	0.51	0.14	0.22
	Vanadium (V) (ppm)	46	42	46	61	47
	Yttrium (Y) (ppm)	9.32	6.64	8.16	6.81	10.00
	Zinc (Zn) (ppm)	59	72	74	87	65
	Zirconium (Zr) (ppm)	1.0	1.3	1.5	0.7	1.1
Permanent Gases	Carbon Dioxide (CO2) (%)	2.7	0.8	1.8	0.3	1.0
Miscellaneous	Carbon (C) (%)	0.80	0.31	0.57	0.12	0.37

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1968933-6	L1968933-7	L1968933-8		
	Description	Waste	Waste	Waste		
	Sampled Date	22-JUL-17	22-JUL-17	22-JUL-17		
	Sampled Time					
	Client ID	129737	129738	129736		
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01		
	Molybdenum (Mo) (ppm)	0.99	0.64	0.78		
	Nickel (Ni) (ppm)	2.5	3.3	4.7		
	Niobium (Nb) (ppm)	0.10	0.16	0.13		
	Phosphorus (P) (ppm)	570	780	730		
	Potassium (K) (%)	0.52	0.48	0.55		
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001		
	Rubidium (Rb) (ppm)	24.8	21.6	25.4		
	Scandium (Sc) (ppm)	3.0	4.7	4.3		
	Selenium (Se) (ppm)	0.4	0.3	0.6		
	Silver (Ag) (ppm)	0.15	0.08	0.15		
	Sodium (Na) (%)	0.06	0.08	0.07		
	Strontium (Sr) (ppm)	28.2	49.9	64.9		
	Sulfur (S) (%)	0.02	<0.01	0.01		
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01		
	Tellurium (Te) (ppm)	0.02	<0.01	0.03		
	Thallium (Tl) (ppm)	0.13	0.12	0.15		
	Thorium (Th) (ppm)	2.4	2.6	2.8		
	Tin (Sn) (ppm)	0.5	0.6	0.5		
	Titanium (Ti) (%)	0.084	0.086	0.091		
	Tungsten (W) (ppm)	0.34	0.44	0.99		
	Uranium (U) (ppm)	0.14	0.20	0.20		
	Vanadium (V) (ppm)	45	53	52		
	Yttrium (Y) (ppm)	7.20	9.16	7.29		
	Zinc (Zn) (ppm)	63	70	81		
	Zirconium (Zr) (ppm)	0.8	1.8	0.7		
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	0.4	0.6		
Miscellaneous	Carbon (C) (%)	0.05	0.16	0.22		

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-24

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 1-SEP-2017
Account: APN

CERTIFICATE VA17166066

Project: L1968933

P.O. No.: ALSM-CW16-102-APN

This report is for 8 Other samples submitted to our lab in Vancouver, BC, Canada on 9-AUG-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE
SOFTWARE DEVELOPMENT GROUP
SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1968933

CERTIFICATE OF ANALYSIS VA17166066

Method	WEI-21	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Recvd Wt.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs
Units	kg	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.02	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05
L1968933-1-129733-775-46	1.06	0.22	0.84	1.2	<0.02	<10	90	0.33	0.06	2.02	0.14	28.3	5.4	5	0.33
L1968933-2-129734-775-46	1.08	0.05	1.36	2.1	<0.02	10	70	0.47	0.02	1.13	0.02	29.0	6.1	11	0.40
L1968933-3-129735-775-50	1.08	0.24	0.60	2.5	<0.02	<10	90	0.44	0.15	1.79	0.17	30.5	5.6	3	0.56
L1968933-4-129739	1.04	0.06	1.34	1.6	<0.02	<10	350	0.25	0.05	0.55	0.05	30.6	6.3	7	0.46
L1968933-5-129727	1.14	0.06	1.05	0.8	<0.02	<10	250	0.30	0.02	1.10	0.07	21.5	5.4	5	0.49
L1968933-6-129737	1.10	0.15	0.97	0.7	0.13	<10	260	0.21	0.04	0.31	0.18	23.2	5.1	6	0.34
L1968933-7-129738	1.08	0.08	1.21	1.8	<0.02	<10	220	0.28	0.02	0.82	0.11	25.1	6.0	5	0.35
L1968933-8-129736	1.06	0.15	1.22	0.6	0.03	<10	260	0.25	0.04	0.83	0.14	27.8	6.0	7	0.42

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method Analyte Units LOR	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05
L1968933-1-129733-775-46		857	2.41	4.79	<0.05	0.03	<0.01	0.045	0.16	14.8	5.1	0.63	578	0.92	0.05	0.05
L1968933-2-129734-775-46		41.9	2.29	6.95	0.05	0.05	<0.01	0.023	0.12	16.1	12.6	1.03	550	2.04	0.05	<0.05
L1968933-3-129735-775-50		1315	2.41	3.63	0.05	0.05	0.01	0.056	0.17	16.3	2.4	0.22	720	3.51	0.04	0.05
L1968933-4-129739		289	2.71	6.71	0.07	0.04	<0.01	0.026	0.76	16.0	7.9	0.78	775	0.55	0.06	0.16
L1968933-5-129727		221	2.27	5.20	0.07	0.06	0.01	0.024	0.53	10.8	4.8	0.66	617	0.39	0.08	0.20
L1968933-6-129737		969	2.12	4.85	0.05	0.04	<0.01	0.023	0.52	12.5	4.7	0.46	533	0.99	0.06	0.10
L1968933-7-129738		274	2.38	5.93	0.06	0.08	<0.01	0.024	0.48	13.2	7.2	0.66	703	0.64	0.08	0.16
L1968933-8-129736		715	2.51	6.11	0.05	0.04	<0.01	0.028	0.55	14.9	6.7	0.70	628	0.78	0.07	0.13

Project: L1968933

CERTIFICATE OF ANALYSIS VA17166066

Method Analyte Units LOR Sample Description	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005
L1968933-1-129733-775-46	2.3	700	4.0	7.9	0.002	0.11	0.06	4.4	1.1	0.7	111.5	<0.01	0.02	3.3	0.012
L1968933-2-129734-775-46	10.4	710	3.7	6.3	0.007	0.01	0.06	3.1	0.5	0.4	159.0	<0.01	0.01	2.9	0.012
L1968933-3-129735-775-50	2.0	730	6.0	9.6	0.002	0.03	0.07	4.5	1.0	0.6	74.7	<0.01	0.06	4.4	0.012
L1968933-4-129739	3.0	710	1.8	36.6	<0.001	<0.01	<0.05	4.4	0.3	0.6	34.7	<0.01	0.01	3.5	0.134
L1968933-5-129727	2.1	670	2.1	23.9	<0.001	0.02	<0.05	4.4	0.5	0.5	80.2	<0.01	0.01	2.0	0.092
L1968933-6-129737	2.5	570	1.8	24.8	<0.001	0.02	<0.05	3.0	0.4	0.5	28.2	<0.01	0.02	2.4	0.084
L1968933-7-129738	3.3	780	1.8	21.6	<0.001	<0.01	<0.05	4.7	0.3	0.6	49.9	<0.01	<0.01	2.6	0.086
L1968933-8-129736	4.7	730	2.2	25.4	<0.001	0.01	<0.05	4.3	0.6	0.5	64.9	<0.01	0.03	2.8	0.091

CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method Analyte Units LOR	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01
L1968933-1-129733-775-46		0.05	0.68	46	0.44	9.32	59	1.0	2	3.4	45	48	13.96	8.8	0.11	0.10
L1968933-2-129734-775-46		0.03	0.41	42	0.49	6.64	72	1.3	2	0.3	24	24	76.80	9.0	0.01	0.01
L1968933-3-129735-775-50		0.05	0.51	46	0.28	8.16	74	1.5	2	0.9	43	44	46.93	8.7	0.03	0.03
L1968933-4-129739		0.21	0.14	61	0.39	6.81	87	0.7	2	0.3	12	12	38.40	9.0	0.01	0.01
L1968933-5-129727		0.13	0.22	47	0.47	10.00	65	1.1	2	0.6	25	26	41.60	9.1	0.02	0.02
L1968933-6-129737		0.13	0.14	45	0.34	7.20	63	0.8	1	0.6	7	8	12.80	8.8	0.02	0.02
L1968933-7-129738		0.12	0.20	53	0.44	9.16	70	1.8	2	<0.3	17	17	108.80	8.9	<0.01	<0.01
L1968933-8-129736		0.15	0.20	52	0.99	7.29	81	0.7	2	0.3	18	18	57.60	9.0	0.01	<0.01

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 1-SEP-2017
Account: APN

Project: L1968933

CERTIFICATE OF ANALYSIS VA17166066

Method	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06
Analyte	C	CO2	S	C	S
Units	%	%	%	%	%
Sample Description / **LOR**	0.05	0.2	0.01	0.01	0.01
L1968933-1-129733-775-46	0.74	2.7	0.01	0.80	0.01
L1968933-2-129734-775-46	0.23	0.8	<0.01	0.31	0.01
L1968933-3-129735-775-50	0.48	1.8	<0.01	0.57	<0.01
L1968933-4-129739	0.07	0.3	<0.01	0.12	<0.01
L1968933-5-129727	0.28	1.0	<0.01	0.37	0.01
L1968933-6-129737	<0.05	<0.2	<0.01	0.05	<0.01
L1968933-7-129738	0.11	0.4	<0.01	0.16	<0.01
L1968933-8-129736	0.17	0.6	0.01	0.22	<0.01

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 1-SEP-2017
Account: APN

Project: L1968933

CERTIFICATE OF ANALYSIS VA17166066

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	S-CAL06a
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 1-SEP-2017
Account: APN

QC CERTIFICATE VA17166066

Project: L1968933

P.O. No.: ALSM-CW16-102-APN

This report is for 8 Other samples submitted to our lab in Vancouver, BC, Canada on 9-AUG-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE	SOFTWARE DEVELOPMENT GROUP	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um
SPL-21	Split sample - riffle splitter

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	19.55	2.19	119.5	0.07	<10	80	0.68	10.30	0.88	18.75	60.1	92.7	81	9.12	8350
Target Range - Lower Bound	18.15	2.05	107.0	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800
Upper Bound	22.2	2.53	131.0	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980
OREAS 920	0.10	2.49	4.5	<0.02	<10	80	0.70	0.66	0.35	0.07	76.9	14.1	43	2.12	108.5
Target Range - Lower Bound	0.07	2.18	3.8	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0
Upper Bound	0.12	2.68	4.9	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0
SY-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method Analyte Units LOR	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		5.05	8.34	0.12	0.73	0.45	1.375	1.04	28.9	30.0	0.94	385	876	0.28	0.99	8810
Target Range - Lower Bound		4.51	8.05	0.21	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760
Upper Bound		5.53	9.95	0.45	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480
OREAS 920		3.68	6.84	0.07	0.59	<0.01	0.032	0.44	38.3	19.8	1.10	533	0.33	0.02	0.38	36.8
Target Range - Lower Bound		3.26	6.12	<0.05	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4
Upper Bound		4.00	7.60	0.22	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4
SY-4																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Method Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	780	7130	115.5	1.335	2.70	20.0	6.1	10.2	12.2	62.1	0.01	0.14	16.1	0.302	1.33
Target Range - Lower Bound	700	6520	109.5	1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14
Upper Bound	880	7970	134.5	1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58
OREAS 920	730	23.8	24.9	<0.001	0.03	0.63	2.9	0.7	1.1	17.4	0.01	0.02	16.1	0.137	0.16
Target Range - Lower Bound		19.2	22.2	<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07
Upper Bound		23.9	27.4	0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18
SY-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17166066

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05
Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2
Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
Sample Description LOR	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2
STANDARDS															
Buffer pH6												6.1			
Buffer pH6												6.0			
Target Range - Lower Bound												5.3			
Upper Bound												6.7			
CO-ASSAY														0.52	1.9
Target Range - Lower Bound														0.42	1.5
Upper Bound														0.64	2.4
GS310-10													0.27		
Target Range - Lower Bound													0.25		
Upper Bound													0.29		
KZK-1							2	25.0	31	56	2.24				
KZK-1							2	25.0	30	55	2.20				
Target Range - Lower Bound							<1	22.9	30	54	2.18				
Upper Bound							>4	27.1	38	64	2.53				
MA-1b													1.12		
Target Range - Lower Bound													1.12		
Upper Bound													1.22		
MA-2c														1.55	5.7
Target Range - Lower Bound														1.50	5.5
Upper Bound														1.84	6.8
MA-3a														2.40	8.8
Target Range - Lower Bound														2.31	8.4
Upper Bound														2.77	10.2
OGGeo08	4.56	78	2.89	16.25	6790	22.5									
Target Range - Lower Bound	4.45	70	2.58	15.35	6500	19.5									
Upper Bound	5.55	88	3.60	18.85	7950	27.5									
OREAS 920	2.10	26	0.49	18.95	107	23.8									
Target Range - Lower Bound	1.89	23	0.31	16.85	93	17.6									
Upper Bound	2.42	30	0.61	20.7	119	25.0									
SY-4														0.91	3.3
Target Range - Lower Bound														0.84	3.0
Upper Bound														1.08	4.0

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 1-SEP-2017
Account: APN

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	**Method**	S-GRA06a	C-IR07	S-GRA06
	Analyte	S	C	S
	Units	%	%	%
	LOR	0.01	0.01	0.01

STANDARDS

Sample Description	S-GRA06a	C-IR07	S-GRA06
Buffer pH6			
Buffer pH6			
Target Range - Lower Bound			
Upper Bound			
CO-ASSAY			
Target Range - Lower Bound			
Upper Bound			
GS310-10		1.09	
Target Range - Lower Bound		1.03	
Upper Bound		1.13	
KZK-1			
KZK-1			
Target Range - Lower Bound			
Upper Bound			
MA-1b		2.53	
Target Range - Lower Bound		2.34	
Upper Bound		2.54	
MA-2c			
Target Range - Lower Bound			
Upper Bound			
MA-3a			
Target Range - Lower Bound			
Upper Bound			
OGGeo08			
Target Range - Lower Bound			
Upper Bound			
OREAS 920			
Target Range - Lower Bound			
Upper Bound			
SY-4			
Target Range - Lower Bound			
Upper Bound			

QC CERTIFICATE OF ANALYSIS VA17166066

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
Sample Description LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound	0.02	0.02	0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound	0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound	<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound	20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05
Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2
Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
LOR	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2
Sample Description															
STANDARDS															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK														<0.05	<0.2
BLANK														<0.05	<0.2
Target Range - Lower Bound														<0.05	<0.2
Upper Bound														0.10	0.4
BLANK	<0.05	<1	<0.05	<0.05	<2	<0.5									
Target Range - Lower Bound	<0.05	<1	<0.05	<0.05	<2	<0.5									
Upper Bound	0.10	2	0.10	0.10	4	1.0									
BLANK												6.3			
Target Range - Lower Bound												5.5			
Upper Bound												6.9			
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK													0.01		
Target Range - Lower Bound													<0.01		
Upper Bound													0.02		

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method Analyte Units LOR	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01
			STANDARDS	
UTS-1				0.93
UTS-1				0.87
UTS-1				0.88
Target Range - Lower Bound				0.83
Upper Bound				0.93
UTS-1		0.90		
UTS-1		0.89		
UTS-1		0.87		
Target Range - Lower Bound		0.81		
Upper Bound		0.95		
UTS-4				1.79
Target Range - Lower Bound				1.64
Upper Bound				1.84
UTS-4		1.73		
Target Range - Lower Bound		1.61		
Upper Bound		1.87		
			BLANKS	
BLANK				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				<0.01
BLANK				<0.01
Target Range - Lower Bound				<0.01
Upper Bound				0.02
BLANK		<0.01		
BLANK		<0.01		
Target Range - Lower Bound		<0.01		
Upper Bound		0.02		
BLANK			<0.01	
Target Range - Lower Bound			<0.01	
Upper Bound			0.02	

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
		DUPLICATES														
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-6-129730 775-45C																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-8-129729 775-44																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968933-1-129733-775-46																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968933-4-129739		0.06	1.34	1.6	<0.02	<10	350	0.25	0.05	0.55	0.05	30.6	6.3	7	0.46	289
DUP		0.06	1.36	1.5	<0.02	<10	360	0.22	0.06	0.55	0.06	31.5	6.5	7	0.46	300
Target Range - Lower Bound		0.05	1.27	1.4	<0.02	<10	320	0.17	0.04	0.51	0.04	29.5	6.0	6	0.39	284
Upper Bound		0.07	1.43	1.7	0.04	20	390	0.30	0.07	0.59	0.07	32.6	6.8	8	0.53	305
L1968933-8-129736																
DUP																
Target Range - Lower Bound																
Upper Bound																

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2

DUPLICATES

Sample Description		Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-6-129730 775-45C																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-8-129729 775-44																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968933-1-129733-775-46																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968933-4-129739		2.71	6.71	0.07	0.04	<0.01	0.026	0.76	16.0	7.9	0.78	775	0.55	0.06	0.16	3.0
DUP		2.74	6.86	0.07	0.04	<0.01	0.026	0.76	16.6	8.5	0.79	775	0.56	0.07	0.19	3.1
Target Range - Lower Bound		2.58	6.40	<0.05	<0.02	<0.01	0.020	0.71	15.3	7.7	0.74	731	0.48	0.05	0.12	2.7
Upper Bound		2.87	7.17	0.10	0.06	0.02	0.032	0.81	17.3	8.7	0.83	819	0.63	0.08	0.23	3.4
L1968933-8-129736																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description **LOR**	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
	DUPLICATES														
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-6-129730 775-45C															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968927-8-129729 775-44															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968933-1-129733-775-46															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1968933-4-129739	710	1.8	36.6	<0.001	<0.01	<0.05	4.4	0.3	0.6	34.7	<0.01	0.01	3.5	0.134	0.21
DUP	710	2.0	36.9	<0.001	<0.01	<0.05	4.6	0.3	0.6	35.7	<0.01	0.02	3.6	0.135	0.22
Target Range - Lower Bound	660	1.6	34.8	<0.001	<0.01	<0.05	4.2	<0.2	0.4	33.2	<0.01	<0.01	3.2	0.123	0.18
Upper Bound	760	2.2	38.7	0.002	0.02	0.10	4.8	0.4	0.8	37.2	0.02	0.02	3.9	0.146	0.25
L1968933-8-129736															
DUP															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 1-SEP-2017
Account: APN

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05
	Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2
	Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
	LOR	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2
		DUPLICATES														
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL														0.01		
DUP														0.01		
Target Range - Lower Bound														<0.01		
Upper Bound														0.02		
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1968927-6-129730 775-45C													8.9			
DUP													8.9			
Target Range - Lower Bound													8.4			
Upper Bound													9.4			
L1968927-8-129729 775-44								2	2.5	35	37	14.80				
DUP								2	2.5	35	37	14.80				
Target Range - Lower Bound								<1	2.1	32	34	14.05				
Upper Bound								3	2.9	38	40	15.55				
L1968933-1-129733-775-46															0.74	2.7
DUP															0.76	2.8
Target Range - Lower Bound															0.66	2.4
Upper Bound															0.84	3.1
L1968933-4-129739		0.14	61	0.39	6.81	87	0.7									
DUP		0.14	62	0.42	6.97	87	0.7									
Target Range - Lower Bound		0.08	57	0.32	6.50	81	<0.5									
Upper Bound		0.20	66	0.49	7.28	93	1.0									
L1968933-8-129736															0.17	0.6
DUP															0.18	0.7
Target Range - Lower Bound															0.12	0.4
Upper Bound															0.23	0.9

QC CERTIFICATE OF ANALYSIS VA17166066

Sample Description	Method	S-GRA06a	C-IR07	S-GRA06
	Analyte	S	C	S
	Units	%	%	%
	LOR	0.01	0.01	0.01
DUPLICATES				
ORIGINAL				0.18
DUP				0.20
Target Range - Lower Bound				0.17
Upper Bound				0.21
ORIGINAL			5.81	
DUP			5.58	
Target Range - Lower Bound			5.54	
Upper Bound			5.85	
ORIGINAL				0.01
DUP				0.01
Target Range - Lower Bound				<0.01
Upper Bound				0.02
L1968927-6-129730 775-45C				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1968927-8-129729 775-44		<0.01		
DUP		<0.01		
Target Range - Lower Bound		<0.01		
Upper Bound		0.02		
L1968933-1-129733-775-46				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1968933-4-129739				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1968933-8-129736		0.01		
DUP		<0.01		
Target Range - Lower Bound		<0.01		
Upper Bound		0.02		

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1968933

QC CERTIFICATE OF ANALYSIS VA17166066

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	S-CAL06a
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1968933-COFC

COC Number: 17 - 24

Page of

Report To Contact and company name below will appear on the final report

Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659

Company address below will appear on the final report

Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3

Invoice To
Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO

Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

Oil and Gas Required Fields (client use)
AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)
ALS Contact:
Sampler:

Analysis Request
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)		Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
					Composite	R	R	R	R	R	R	
	129733	775-46	20/07/17		waste	X	X	X	X	X	X	
	129734	775-46	20/07/17		waste	X	X	X	X	X	X	
	129735	775-50	22/07/17		waste	X	X	X	X	X	X	
	129739		25/07/17		WASTE	X	X	X	X	X	X	
	129727		17/07/17		WASTE	X	X	X	X	X	X	
	129737		22/07/17		WASTE	X	X	X	X	X	X	
	129738		22/07/17		WASTE	X	X	X	X	X	X	
	129736		22/07/17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)
Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
10,0			17.4		

SHIPMENT RELEASE (client use)
Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: EHF Date: 2 Aug 2017 Time: 13:30

FINAL SHIPMENT RECEPTION (lab use only)
Received by: Date: Aug 3 Time: 1130

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

OCTOBER 2015 FRONT

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 03-AUG-17
Report Date: 03-OCT-17 17:02 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1969816

Project P.O. #: 220826
Job Reference:
C of C Numbers: 17-25
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

	Sample ID	L1969816-1	L1969816-2	L1969816-3	L1969816-4	L1969816-5
	Description	Tails	Tails	Tails	Waste	Waste
	Sampled Date	05-JUN-17	12-JUN-17	21-JUN-17	01-AUG-17	01-AUG-17
	Sampled Time					
	Client ID	JUN TAL 2017	JUN TAL 2017	JUN TAL 2017	129740	129741
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	7.8	7.9	7.8	8.7	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.20	0.25	0.25	0.15	0.28
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	2.8	3.8	3.4	0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	21	23	23	19	27
	NNP (tCaCO3/1Kt)	18	19	20	19	27
	Ratio (NP/MPA) (Unity)	7.47	6.13	6.69	60.80	86.40
	Sulfate Sulfur (carbonate leach) (%)	0.04	0.04	0.04	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.04	0.06	0.05	0.01	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.05	0.06	0.06	<0.01	<0.01
	Total Sulfur (combustion) (%)	0.09	0.12	0.11	0.01	0.01
Total Metals	Aluminum (Al) (%)	1.14	1.14	1.02	1.18	1.14
	Antimony (Sb) (ppm)	0.05	0.06	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	1.0	1.3	1.7	0.8	1.0
	Barium (Ba) (ppm)	170	210	190	340	210
	Beryllium (Be) (ppm)	0.26	0.25	0.25	0.22	0.39
	Bismuth (Bi) (ppm)	0.68	0.52	0.42	0.04	0.01
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.25	0.40	0.28	0.12	0.13
	Calcium (Ca) (%)	0.89	0.94	0.98	0.78	1.18
	Cerium (Ce) (ppm)	15.95	17.30	20.5	25.1	24.4
	Cesium (Cs) (ppm)	0.38	0.51	0.41	0.37	0.49
	Chromium (Cr) (ppm)	6	7	6	7	5
	Cobalt (Co) (ppm)	7.4	7.1	6.6	5.7	6.0
	Copper (Cu) (ppm)	2100	2280	2690	491	85.5
	Gallium (Ga) (ppm)	8.30	7.57	6.13	5.40	5.34
	Germanium (Ge) (ppm)	0.11	0.12	0.10	0.10	0.11
	Gold (Au) (ppm)	0.17	0.15	0.12	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.04	0.04	0.05	0.05	0.07
	Indium (In) (ppm)	0.075	0.083	0.067	0.026	0.033
	Iron (Fe) (%)	4.33	4.18	3.67	2.45	2.49
	Lanthanum (La) (ppm)	8.4	9.2	10.8	12.7	12.5
	Lead (Pb) (ppm)	3.4	3.4	3.3	1.8	2.7
	Lithium (Li) (ppm)	6.1	5.1	4.4	5.6	6.4
	Magnesium (Mg) (%)	0.63	0.60	0.55	0.60	0.68
	Manganese (Mn) (ppm)	698	723	640	660	736

	Sample ID	L1969816-6	L1969816-7	L1969816-8	L1969816-9	L1969816-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17
	Sampled Time					
	Client ID	129742	129743	129744	129745	129746
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.7	8.8	9.0	8.8	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.47	0.15	0.23	0.30	0.19
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	1.3	0.9	0.6	0.3	1.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	34	20	26	32	21
	NNP (tCaCO3/1Kt)	33	19	25	32	19
	Ratio (NP/MPA) (Unity)	27.20	21.33	41.60	102.40	11.20
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.01	0.03	<0.01	0.02
	Sulfide Sulfur (T minus HCl leach) (%)	0.03	0.02	<0.01	0.01	0.04
	Total Sulfur (combustion) (%)	0.04	0.03	0.02	0.01	0.06
Total Metals	Aluminum (Al) (%)	1.01	1.15	1.27	1.24	1.17
	Antimony (Sb) (ppm)	0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	1.2	0.6	0.8	0.9	0.7
	Barium (Ba) (ppm)	160	200	270	110	290
	Beryllium (Be) (ppm)	0.35	0.31	0.29	0.50	0.24
	Bismuth (Bi) (ppm)	0.09	0.05	0.06	0.03	0.10
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.08	0.04	0.04	0.04	0.19
	Calcium (Ca) (%)	1.30	0.94	1.19	1.53	0.81
	Cerium (Ce) (ppm)	29.7	20.3	19.15	16.60	21.2
	Cesium (Cs) (ppm)	0.44	0.33	0.38	0.44	0.48
	Chromium (Cr) (ppm)	8	5	8	5	7
	Cobalt (Co) (ppm)	6.0	5.6	5.1	5.0	5.9
	Copper (Cu) (ppm)	579	367	344	110.0	2260
	Gallium (Ga) (ppm)	5.33	5.42	5.30	5.82	5.53
	Germanium (Ge) (ppm)	0.11	0.12	0.11	0.09	0.11
	Gold (Au) (ppm)	<0.02	0.02	<0.02	<0.02	0.03
	Hafnium (Hf) (ppm)	0.05	0.06	0.05	0.05	0.03
	Indium (In) (ppm)	0.036	0.022	0.021	0.018	0.039
	Iron (Fe) (%)	2.54	2.15	2.47	2.10	2.50
	Lanthanum (La) (ppm)	15.5	10.7	9.8	8.8	11.4
	Lead (Pb) (ppm)	3.1	2.3	2.7	4.2	2.4
	Lithium (Li) (ppm)	5.8	6.1	5.3	7.7	5.6
	Magnesium (Mg) (%)	0.71	0.67	0.69	0.71	0.66
	Manganese (Mn) (ppm)	594	528	602	550	555

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1969816-1	L1969816-2	L1969816-3	L1969816-4	L1969816-5
	Description	Tails	Tails	Tails	Waste	Waste
	Sampled Date	05-JUN-17	12-JUN-17	21-JUN-17	01-AUG-17	01-AUG-17
	Sampled Time					
	Client ID	JUN TAL 2017	JUN TAL 2017	JUN TAL 2017	129740	129741
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	1.45	2.08	2.12	0.68	0.89
	Nickel (Ni) (ppm)	2.9	3.5	3.7	2.9	2.5
	Niobium (Nb) (ppm)	0.12	0.18	0.15	0.10	0.10
	Phosphorus (P) (ppm)	710	650	710	650	700
	Potassium (K) (%)	0.45	0.58	0.44	0.63	0.37
	Rhenium (Re) (ppm)	0.001	0.002	0.001	<0.001	<0.001
	Rubidium (Rb) (ppm)	22.4	29.1	21.5	28.0	16.4
	Scandium (Sc) (ppm)	3.5	3.6	3.7	4.8	5.4
	Selenium (Se) (ppm)	2.2	2.5	2.2	0.2	0.4
	Silver (Ag) (ppm)	0.78	0.74	0.73	0.07	0.02
	Sodium (Na) (%)	0.06	0.06	0.06	0.08	0.10
	Strontium (Sr) (ppm)	58.5	75.6	72.3	51.7	71.6
	Sulfur (S) (%)	0.08	0.10	0.09	<0.01	<0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.37	0.30	0.23	0.01	<0.01
	Thallium (Tl) (ppm)	0.14	0.18	0.13	0.16	0.08
	Thorium (Th) (ppm)	3.2	3.1	3.4	2.8	2.3
	Tin (Sn) (ppm)	0.7	0.8	0.7	0.6	0.6
	Titanium (Ti) (%)	0.078	0.099	0.077	0.102	0.079
	Tungsten (W) (ppm)	0.05	0.07	0.06	0.26	0.25
	Uranium (U) (ppm)	0.29	0.32	0.34	0.15	0.23
	Vanadium (V) (ppm)	64	64	61	51	51
	Yttrium (Y) (ppm)	5.43	5.71	6.37	7.83	8.83
	Zinc (Zn) (ppm)	101	109	90	78	78
	Zirconium (Zr) (ppm)	0.9	1.1	1.1	0.7	1.5
Permanent Gases	Carbon Dioxide (CO2) (%)	0.7	0.9	0.9	0.5	1.0
Miscellaneous	Carbon (C) (%)	0.25	0.30	0.32	0.21	0.36

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1969816-6	L1969816-7	L1969816-8	L1969816-9	L1969816-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17	01-AUG-17
	Sampled Time					
	Client ID	129742	129743	129744	129745	129746
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.63	0.63	0.51	0.29	0.77
	Nickel (Ni) (ppm)	5.8	2.5	3.3	2.4	3.1
	Niobium (Nb) (ppm)	0.07	0.14	0.10	0.08	0.12
	Phosphorus (P) (ppm)	700	650	620	610	630
	Potassium (K) (%)	0.26	0.41	0.50	0.21	0.58
	Rhenium (Re) (ppm)	0.001	0.002	0.001	<0.001	0.001
	Rubidium (Rb) (ppm)	12.1	18.5	20.2	9.1	26.9
	Scandium (Sc) (ppm)	5.6	3.3	3.1	3.2	2.7
	Selenium (Se) (ppm)	0.6	0.4	0.4	0.2	1.2
	Silver (Ag) (ppm)	0.19	0.11	0.10	0.04	0.78
	Sodium (Na) (%)	0.09	0.09	0.12	0.10	0.09
	Strontium (Sr) (ppm)	97.9	62.8	80.2	89.8	64.6
	Sulfur (S) (%)	0.02	0.02	<0.01	<0.01	0.05
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.05	0.03	0.02	0.01	0.15
	Thallium (Tl) (ppm)	0.06	0.10	0.11	0.04	0.14
	Thorium (Th) (ppm)	3.2	2.1	2.0	1.6	2.3
	Tin (Sn) (ppm)	0.6	0.5	0.5	0.4	0.6
	Titanium (Ti) (%)	0.038	0.088	0.092	0.039	0.098
	Tungsten (W) (ppm)	0.37	0.49	0.79	0.35	0.50
	Uranium (U) (ppm)	0.23	0.28	0.34	0.32	0.19
	Vanadium (V) (ppm)	46	46	48	37	49
	Yttrium (Y) (ppm)	8.16	6.92	8.36	8.24	5.55
	Zinc (Zn) (ppm)	74	61	68	56	81
	Zirconium (Zr) (ppm)	1.0	1.0	0.7	0.7	0.6
Permanent Gases	Carbon Dioxide (CO2) (%)	1.7	0.6	0.8	1.1	0.7
Miscellaneous	Carbon (C) (%)	0.58	0.24	0.32	0.40	0.27

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-25

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 8-SEP-2017
Account: APN

CERTIFICATE VA17166068

Project: L1969816

P.O. No.: ALSM-CW16-102-APN

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 8-AUG-2017.

The following have access to data associated with this certificate:

SHANE STACK		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1969816

CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05
L1969816-1-JUN-TAL 2017		0.54	0.78	1.14	1.0	0.17	<10	170	0.26	0.68	0.89	0.25	15.95	7.4	6	0.38
L1969816-2-JUN-TAL 2018		0.54	0.74	1.14	1.3	0.15	<10	210	0.25	0.52	0.94	0.40	17.30	7.1	7	0.51
L1969816-3-JUN-TAL 2019		0.54	0.73	1.02	1.7	0.12	<10	190	0.25	0.42	0.98	0.28	20.5	6.6	6	0.41
L1969816-4-129740		1.10	0.07	1.18	0.8	<0.02	<10	340	0.22	0.04	0.78	0.12	25.1	5.7	7	0.37
L1969816-5-129741		1.08	0.02	1.14	1.0	<0.02	<10	210	0.39	0.01	1.18	0.13	24.4	6.0	5	0.49
L1969816-6-129742		1.10	0.19	1.01	1.2	<0.02	<10	160	0.35	0.09	1.30	0.08	29.7	6.0	8	0.44
L1969816-7-129743		1.04	0.11	1.15	0.6	0.02	<10	200	0.31	0.05	0.94	0.04	20.3	5.6	5	0.33
L1969816-8-129744		1.06	0.10	1.27	0.8	<0.02	<10	270	0.29	0.06	1.19	0.04	19.15	5.1	8	0.38
L1969816-9-129745		0.94	0.04	1.24	0.9	<0.02	<10	110	0.50	0.03	1.53	0.04	16.60	5.0	5	0.44
L1969816-10-129746		1.08	0.78	1.17	0.7	0.03	<10	290	0.24	0.10	0.81	0.19	21.2	5.9	7	0.48

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05
L1969816-1-JUN-TAL 2017		2100	4.33	8.30	0.11	0.04	0.01	0.075	0.45	8.4	6.1	0.63	698	1.45	0.06	0.12
L1969816-2-JUN-TAL 2018		2280	4.18	7.57	0.12	0.04	<0.01	0.083	0.58	9.2	5.1	0.60	723	2.08	0.06	0.18
L1969816-3-JUN-TAL 2019		2690	3.67	6.13	0.10	0.05	<0.01	0.067	0.44	10.8	4.4	0.55	640	2.12	0.06	0.15
L1969816-4-129740		491	2.45	5.40	0.10	0.05	<0.01	0.026	0.63	12.7	5.6	0.60	660	0.68	0.08	0.10
L1969816-5-129741		85.5	2.49	5.34	0.11	0.07	<0.01	0.033	0.37	12.5	6.4	0.68	736	0.89	0.10	0.10
L1969816-6-129742		579	2.54	5.33	0.11	0.05	<0.01	0.036	0.26	15.5	5.8	0.71	594	0.63	0.09	0.07
L1969816-7-129743		367	2.15	5.42	0.12	0.06	<0.01	0.022	0.41	10.7	6.1	0.67	528	0.63	0.09	0.14
L1969816-8-129744		344	2.47	5.30	0.11	0.05	<0.01	0.021	0.50	9.8	5.3	0.69	602	0.51	0.12	0.10
L1969816-9-129745		110.0	2.10	5.82	0.09	0.05	<0.01	0.018	0.21	8.8	7.7	0.71	550	0.29	0.10	0.08
L1969816-10-129746		2260	2.50	5.53	0.11	0.03	<0.01	0.039	0.58	11.4	5.6	0.66	555	0.77	0.09	0.12

***** See Appendix Page for comments regarding this certificate *****

Project: L1969816

CERTIFICATE OF ANALYSIS VA17166068

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description / **LOR**	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
L1969816-1-JUN-TAL 2017	2.9	710	3.4	22.4	0.001	0.08	0.05	3.5	2.2	0.7	58.5	<0.01	0.37	3.2	0.078
L1969816-2-JUN-TAL 2018	3.5	650	3.4	29.1	0.002	0.10	0.06	3.6	2.5	0.8	75.6	<0.01	0.30	3.1	0.099
L1969816-3-JUN-TAL 2019	3.7	710	3.3	21.5	0.001	0.09	<0.05	3.7	2.2	0.7	72.3	<0.01	0.23	3.4	0.077
L1969816-4-129740	2.9	650	1.8	28.0	<0.001	<0.01	<0.05	4.8	0.2	0.6	51.7	<0.01	0.01	2.8	0.102
L1969816-5-129741	2.5	700	2.7	16.4	<0.001	<0.01	<0.05	5.4	0.4	0.6	71.6	<0.01	<0.01	2.3	0.079
L1969816-6-129742	5.8	700	3.1	12.1	0.001	0.02	0.05	5.6	0.6	0.6	97.9	<0.01	0.05	3.2	0.038
L1969816-7-129743	2.5	650	2.3	18.5	0.002	0.02	<0.05	3.3	0.4	0.5	62.8	<0.01	0.03	2.1	0.088
L1969816-8-129744	3.3	620	2.7	20.2	0.001	<0.01	<0.05	3.1	0.4	0.5	80.2	<0.01	0.02	2.0	0.092
L1969816-9-129745	2.4	610	4.2	9.1	<0.001	<0.01	<0.05	3.2	0.2	0.4	89.8	<0.01	0.01	1.6	0.039
L1969816-10-129746	3.1	630	2.4	26.9	0.001	0.05	<0.05	2.7	1.2	0.6	64.6	<0.01	0.15	2.3	0.098

Project: L1969816

CERTIFICATE OF ANALYSIS VA17166068

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a
Method / **Analyte**	Tl	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S
Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%
LOR	0.02	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.01
L1969816-1-JUN-TAL 2017	0.14	0.29	64	0.05	5.43	101	0.9	2	2.8	18	21	7.47	7.8	0.09	0.05
L1969816-2-JUN-TAL 2018	0.18	0.32	64	0.07	5.71	109	1.1	2	3.8	19	23	6.13	7.9	0.12	0.06
L1969816-3-JUN-TAL 2019	0.13	0.34	61	0.06	6.37	90	1.1	2	3.4	20	23	6.69	7.8	0.11	0.06
L1969816-4-129740	0.16	0.15	51	0.26	7.83	78	0.7	2	0.3	19	19	60.80	8.7	0.01	<0.01
L1969816-5-129741	0.08	0.23	51	0.25	8.83	78	1.5	2	0.3	27	27	86.40	8.7	0.01	<0.01
L1969816-6-129742	0.06	0.23	46	0.37	8.16	74	1.0	2	1.3	33	34	27.20	8.7	0.04	0.03
L1969816-7-129743	0.10	0.28	46	0.49	6.92	61	1.0	2	0.9	19	20	21.33	8.8	0.03	0.02
L1969816-8-129744	0.11	0.34	48	0.79	8.36	68	0.7	2	0.6	25	26	41.60	9.0	0.02	<0.01
L1969816-9-129745	0.04	0.32	37	0.35	8.24	56	0.7	2	0.3	32	32	102.40	8.8	0.01	0.01
L1969816-10-129746	0.14	0.19	49	0.50	5.55	81	0.6	2	1.9	19	21	11.20	8.9	0.06	0.04

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 8-SEP-2017
Account: APN

Project: L1969816

CERTIFICATE OF ANALYSIS VA17166068

Sample Description / **Method** **Analyte** **Units** **LOR**	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01
L1969816-1-JUN-TAL 2017	0.20	0.7	0.04	0.25	0.04
L1969816-2-JUN-TAL 2018	0.25	0.9	0.06	0.30	0.04
L1969816-3-JUN-TAL 2019	0.25	0.9	0.05	0.32	0.04
L1969816-4-129740	0.15	0.5	0.01	0.21	0.01
L1969816-5-129741	0.28	1.0	0.01	0.36	<0.01
L1969816-6-129742	0.47	1.7	0.01	0.58	<0.01
L1969816-7-129743	0.15	0.6	0.01	0.24	<0.01
L1969816-8-129744	0.23	0.8	0.03	0.32	<0.01
L1969816-9-129745	0.30	1.1	<0.01	0.40	<0.01
L1969816-10-129746	0.19	0.7	0.02	0.27	<0.01

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 8-SEP-2017
Account: APN

Project: L1969816

CERTIFICATE OF ANALYSIS VA17166068

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

QC CERTIFICATE VA17166068

Project: L1969816

P.O. No.: ALSM-CW16-102-APN

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 8-AUG-2017.

The following have access to data associated with this certificate:

SHANE STACK		

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		20.2	2.27	120.0	0.07	<10	50	0.80	11.10	0.90	19.10	61.2	96.0	79	10.40	8170
Target Range - Lower Bound		18.15	2.05	107.0	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800
Upper Bound		22.2	2.53	131.0	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980
OREAS 920		0.11	2.38	4.4	<0.02	<10	70	0.69	0.59	0.33	0.05	74.4	14.1	41	1.95	109.0
Target Range - Lower Bound		0.07	2.18	3.8	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0
Upper Bound		0.12	2.68	4.9	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 8-SEP-2017
Account: APN

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description **LOR**	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	4.98	8.41	0.23	0.82	0.52	1.460	1.05	29.6	30.8	0.94	386	869	0.30	0.79	8680
Target Range - Lower Bound	4.51	8.05	0.21	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760
Upper Bound	5.53	9.95	0.45	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480
OREAS 920	3.49	6.26	0.13	0.48	<0.01	0.032	0.40	36.8	21.2	1.05	501	0.33	0.02	0.27	37.0
Target Range - Lower Bound	3.26	6.12	<0.05	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4
Upper Bound	4.00	7.60	0.22	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		770	7040	122.5	1.450	2.69	19.35	6.1	12.1	13.2	65.8	0.01	0.16	16.7	0.302	1.35
Target Range - Lower Bound		700	6520	109.5	1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14
Upper Bound		880	7970	134.5	1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58
OREAS 920		690	22.6	22.8	<0.001	0.02	0.55	2.6	0.6	1.0	16.8	0.01	0.02	15.7	0.120	0.14
Target Range - Lower Bound			19.2	22.2	<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07
Upper Bound			23.9	27.4	0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01	C-GAS05 C % 0.05
STANDARDS																
Buffer pH6													6.1			
Buffer pH6													6.1			
Target Range - Lower Bound													5.3			
Upper Bound													6.7			
CO-ASSAY																0.50
Target Range - Lower Bound																0.42
Upper Bound																0.64
DS-1														2.57		
Target Range - Lower Bound														2.51		
Upper Bound														2.71		
GS313-8														1.25		
Target Range - Lower Bound														1.19		
Upper Bound														1.29		
KZK-1								2	25.0	33	58	2.32				
KZK-1								2	25.0	31	56	2.24				
Target Range - Lower Bound								<1	22.9	30	54	2.18				
Upper Bound								>4	27.1	38	64	2.53				
MA-2c																1.54
Target Range - Lower Bound																1.50
Upper Bound																1.84
OGGeo08		5.29	78	3.01	16.80	7000	24.3									
Target Range - Lower Bound		4.45	70	2.58	15.35	6500	19.5									
Upper Bound		5.55	88	3.60	18.85	7950	27.5									
OREAS 920		2.02	24	0.47	17.05	104	18.3									
Target Range - Lower Bound		1.89	23	0.31	16.85	93	17.6									
Upper Bound		2.42	30	0.61	20.7	119	25.0									
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description Method	C-GAS05	S-GRA06a	C-IR07	S-GRA06
Analyte	CO2	S	C	S
Units	%	%	%	%
LOR	0.2	0.01	0.01	0.01
	STANDARDS			
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CO-ASSAY	1.8			
Target Range - Lower Bound	1.5			
Upper Bound	2.4			
DS-1			3.04	
Target Range - Lower Bound			3.01	
Upper Bound			3.25	
GS313-8			0.93	
Target Range - Lower Bound			0.90	
Upper Bound			0.98	
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-2c	5.6			
Target Range - Lower Bound	5.5			
Upper Bound	6.8			
OGGeo08				
Target Range - Lower Bound				
Upper Bound				
OREAS 920				
Target Range - Lower Bound				
Upper Bound				
UTS-1				0.89
Target Range - Lower Bound				0.83
Upper Bound				0.93
UTS-1		0.90		
UTS-1		0.88		
Target Range - Lower Bound		0.81		
Upper Bound		0.95		
UTS-4				1.72
Target Range - Lower Bound				1.64
Upper Bound				1.84
UTS-4		1.75		

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
LOR	0.01	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.01	0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.01	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound	0.02	0.02	0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.42	0.35	104.5	<0.02	10	90	0.26	0.03	14.20	2.37	17.85	1.9	37	1.67	6.9
DUP	0.48	0.39	108.5	<0.02	<10	90	0.36	0.03	14.60	2.52	18.95	2.0	39	1.84	7.4
Target Range - Lower Bound	0.42	0.34	101.0	<0.02	<10	70	0.24	0.02	13.65	2.31	17.45	1.8	35	1.62	6.7
Upper Bound	0.48	0.40	112.0	0.04	20	110	0.38	0.04	15.15	2.58	19.35	2.1	41	1.89	7.6

QC CERTIFICATE OF ANALYSIS VA17166068

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
Sample Description **LOR**	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.01	<0.05	0.06	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound	<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound	0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.87	1.09	0.10	0.17	0.56	0.010	0.09	16.7	4.6	5.61	135	14.30	0.05	<0.05	14.5
DUP	0.91	1.25	0.10	0.17	0.61	0.010	0.09	17.8	5.5	5.77	140	15.15	0.05	<0.05	15.6
Target Range - Lower Bound	0.84	1.06	<0.05	0.14	0.53	<0.005	0.08	16.2	4.7	5.40	126	13.95	0.04	<0.05	14.1
Upper Bound	0.94	1.28	0.16	0.20	0.64	0.016	0.10	18.3	5.4	5.98	149	15.50	0.06	0.10	16.0

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<10	<0.2	<0.1	<0.001	<0.01	0.09	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound	<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound	20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	2060	3.8	5.0	0.180	0.17	3.78	2.0	5.5	0.2	111.5	<0.01	0.02	1.7	<0.005	1.08
DUP	2140	4.1	5.5	0.188	0.18	3.86	2.2	5.6	0.2	117.0	<0.01	0.01	1.9	<0.005	1.14
Target Range - Lower Bound	1990	3.6	4.9	0.174	0.16	3.48	1.9	5.1	<0.2	108.5	<0.01	<0.01	1.5	<0.005	1.01
Upper Bound	2220	4.3	5.6	0.194	0.19	4.16	2.3	6.0	0.4	120.0	0.02	0.02	2.1	0.010	1.21

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01	C-GAS05 C % 0.05
STANDARDS																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																<0.05
Target Range - Lower Bound																<0.05
Upper Bound																0.10
BLANK		<0.05	<1	<0.05	<0.05	<2	<0.5									
Target Range - Lower Bound		<0.05	<1	<0.05	<0.05	<2	<0.5									
Upper Bound		0.10	2	0.10	0.10	4	1.0									
BLANK													6.1			
Target Range - Lower Bound													5.5			
Upper Bound													6.9			
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK														<0.01		
Target Range - Lower Bound														<0.01		
Upper Bound														0.02		
DUPLICATES																
ORIGINAL		6.22	20	0.41	14.25	238	5.1									
DUP		6.58	21	0.42	15.15	243	5.4									
Target Range - Lower Bound		6.03	18	0.33	13.90	226	4.4									
Upper Bound		6.77	23	0.50	15.50	255	6.1									

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01
STANDARDS					
UTS-4			1.78		
Target Range - Lower Bound			1.61		
Upper Bound			1.87		
BLANKS					
BLANK		<0.2			
Target Range - Lower Bound		<0.2			
Upper Bound		0.4			
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					<0.01
Target Range - Lower Bound					<0.01
Upper Bound					0.02
BLANK			<0.01		
BLANK			<0.01		
Target Range - Lower Bound			<0.01		
Upper Bound			0.02		
BLANK				<0.01	
Target Range - Lower Bound				<0.01	
Upper Bound				0.02	
DUPLICATES					
ORIGINAL					
DUP					
Target Range - Lower Bound					
Upper Bound					

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 8-SEP-2017
Account: APN

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method Analyte Units LOR	ME-MS41 Ag ppm 0.01	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2
DUPLICATES																
L1968927-10-129732 775-46																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1969816-10-129746																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
									DUPLICATES							
L1968927-10-129732 775-46																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1969816-10-129746																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

Sample Description	Method Analyte Units LOR	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02
								DUPLICATES								
L1968927-10-129732 775-46																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1969816-10-129746																
DUP																
Target Range - Lower Bound																
Upper Bound																

Project: L1969816

QC CERTIFICATE OF ANALYSIS VA17166068

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05
Analyte	U	V	W	Y	Zn	Zr	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C
Units	ppm	ppm	ppm	ppm	ppm	ppm	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%
Sample Description / **LOR**	0.05	1	0.05	0.05	2	0.5	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05
DUPLICATES															
L1968927-10-129732 775-46															0.68
DUP															0.68
Target Range - Lower Bound															0.60
Upper Bound															0.76
L1969816-10-129746							2	1.9	19	21	11.20	8.9	0.06	0.04	
DUP							2	1.6	19	21	13.44	8.9	0.05	0.04	
Target Range - Lower Bound							<1	1.4	17	19	11.69	8.4	0.04	0.03	
Upper Bound							3	2.1	21	23	12.95	9.4	0.07	0.05	

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17166068

Sample Description	**Method**	C-GAS05	S-GRA06a	C-IR07	S-GRA06
	Analyte	CO2	S	C	S
	Units	%	%	%	%
	LOR	0.2	0.01	0.01	0.01

DUPLICATES

Sample Description	C-GAS05 CO2 %	S-GRA06a S %	C-IR07 C %	S-GRA06 S %
L1968927-10-129732 775-46	2.5			
DUP	2.5			
Target Range - Lower Bound	2.2			
Upper Bound	2.8			
L1969816-10-129746		0.02	0.27	<0.01
DUP		0.01	0.28	<0.01
Target Range - Lower Bound		<0.01	0.26	<0.01
Upper Bound		0.02	0.29	0.02

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05
C-IR07
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06a
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1969816-COFC

COC Number [illegible]- 17 -25.

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Project Information

ALS Account # / Quote #
Job #
PO / AFE TBD
LSD

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center PO#
Major/Minor Code Routing Code:
Requisitioner
Location:

ALS Contact: Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	—	—	—	Composite	R	R	R	R	R	R	
	JUN TAL 2017	05-JUN-17		TAILS	X	X	X	X	X	X	
	JUN TAL 2017	12-JUN-17		TAILS	X	X	X	X	X	X	
	JUN TAL 2017	21-JUN-17		TAILS	X	X	X	X	X	X	
	129740	01-AUG-17		WASTE	X	X	X	X	X	X	
	129741	01-AUG-17		WASTE	X	X	X	X	X	X	
	129742	01-AUG-17		WASTE	X	X	X	X	X	X	
	129743	01-AUG-17		WASTE	X	X	X	X	X	X	
	129744	01-AUG-17		WASTE	X	X	X	X	X	X	
	129745	01-AUG-17		WASTE	X	X	X	X	X	X	
	129746	01-AUG-17		WASTE	X	X	X	X	X	X	
	—	—	—	—							

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 21°C
FINAL COOLER TEMPERATURES °C: 19.6

SHIPMENT RELEASE (client use)
Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: JMS Date: Aug 3, 2017 Time: 14:23

FINAL SHIPMENT RECEPTION (lab use only)
Received by: MS Date: Aug 5/17 Time: 10:40

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 24-AUG-17
Report Date: 14-NOV-17 18:08 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1980572
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 17-26, 17-27
Legal Site Desc:

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980572-1	L1980572-2	L1980572-3	L1980572-4	L1980572-5
	Description	Waste	Waste	Waste	Tail	Waste
	Sampled Date	03-AUG-17	05-AUG-17	05-AUG-17	08-AUG-17	04-AUG-17
	Sampled Time					
	Client ID	129747 769-42	129750 769-40	129751 769-40	JULY TAILS 2017	129748
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	9.2	8.9	8.9	8.1	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.52	0.19	<0.05	0.19	0.38
Acid Base Accounting	FIZZ RATING (Unity)	2	1	1	2	2
	MPA (tCaCO3/1Kt)	1.6	0.6	0.6	4.7	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	39	22	11	18	30
	NNP (tCaCO3/1Kt)	37	21	10	13	29
	Ratio (NP/MPA) (Unity)	24.96	35.20	17.60	3.84	48.00
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	0.05	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	0.08	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.05	0.02	0.02	0.07	0.02
	Total Sulfur (combustion) (%)	0.05	0.02	0.02	0.15	0.02
Total Metals	Aluminum (Al) (%)	1.05	1.01	1.15	0.96	0.64
	Antimony (Sb) (ppm)	0.05	0.05	<0.05	0.05	<0.05
	Arsenic (As) (ppm)	0.8	2.1	0.8	1.3	2.1
	Barium (Ba) (ppm)	260	220	230	200	100
	Beryllium (Be) (ppm)	0.26	0.29	0.26	0.20	0.35
	Bismuth (Bi) (ppm)	0.09	0.13	0.03	0.58	0.04
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.07	0.18	0.13	0.57	0.10
	Calcium (Ca) (%)	1.38	0.81	0.52	0.74	1.04
	Cerium (Ce) (ppm)	28.2	24.3	22.7	18.20	36.6
	Cesium (Cs) (ppm)	0.52	0.39	0.35	0.41	0.59
	Chromium (Cr) (ppm)	5	5	7	6	4
	Cobalt (Co) (ppm)	5.5	5.7	6.0	8.1	6.0
	Copper (Cu) (ppm)	472	1245	432	4730	524
	Gallium (Ga) (ppm)	5.44	5.36	5.49	6.84	3.77
	Germanium (Ge) (ppm)	0.06	0.05	0.08	0.07	0.06
	Gold (Au) (ppm)	<0.02	0.03	<0.02	0.23	<0.02
	Hafnium (Hf) (ppm)	0.04	0.05	0.10	0.04	0.04
	Indium (In) (ppm)	0.038	0.038	0.021	0.110	0.050
	Iron (Fe) (%)	2.40	2.31	2.22	4.20	2.38
	Lanthanum (La) (ppm)	15.4	12.5	11.5	9.1	20.1
	Lead (Pb) (ppm)	3.0	2.6	1.7	9.3	3.2
	Lithium (Li) (ppm)	5.9	5.8	6.8	4.9	2.9
	Magnesium (Mg) (%)	0.74	0.57	0.64	0.54	0.36
	Manganese (Mn) (ppm)	525	670	623	659	619

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980572-6	L1980572-7	L1980572-8	L1980572-9	L1980572-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-AUG-17	06-AUG-17	06-AUG-17	10-AUG-17	10-AUG-17
	Sampled Time					
	Client ID	129749	128153	128152	128154	128155 763-35
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.9	9.1	8.7	8.8	9.1
Organic / Inorganic Carbon	Carbon (C) (%)	0.35	0.06	0.25	0.34	0.24
Acid Base Accounting	FIZZ RATING (Unity)	2	1	2	2	2
	MPA (tCaCO3/1Kt)	1.6	1.3	0.9	2.2	0.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	28	10	25	33	26
	NNP (tCaCO3/1Kt)	26	9	24	31	25
	Ratio (NP/MPA) (Unity)	17.92	8.00	26.67	15.09	27.73
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.04	0.04	0.03	0.07	0.03
	Total Sulfur (combustion) (%)	0.05	0.04	0.03	0.07	0.03
Total Metals	Aluminum (Al) (%)	1.09	1.32	1.08	1.15	0.94
	Antimony (Sb) (ppm)	0.15	<0.05	<0.05	<0.05	0.11
	Arsenic (As) (ppm)	1.7	1.5	0.7	1.0	2.0
	Barium (Ba) (ppm)	70	300	240	180	190
	Beryllium (Be) (ppm)	0.29	0.18	0.32	0.34	0.25
	Bismuth (Bi) (ppm)	0.16	0.36	0.67	0.11	0.13
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.05	0.09	0.26	0.11	0.08
	Calcium (Ca) (%)	1.06	0.34	0.92	1.36	0.99
	Cerium (Ce) (ppm)	41.5	37.1	32.2	24.2	19.70
	Cesium (Cs) (ppm)	0.23	0.64	0.52	0.45	0.34
	Chromium (Cr) (ppm)	3	5	4	6	5
	Cobalt (Co) (ppm)	5.4	6.8	6.7	6.0	5.1
	Copper (Cu) (ppm)	593	4760	4940	834	498
	Gallium (Ga) (ppm)	6.56	6.98	6.44	6.10	5.04
	Germanium (Ge) (ppm)	0.06	0.07	0.09	0.06	0.05
	Gold (Au) (ppm)	<0.02	0.04	0.08	0.02	0.03
	Hafnium (Hf) (ppm)	0.06	0.03	0.08	0.05	0.03
	Indium (In) (ppm)	0.088	0.050	0.080	0.039	0.030
	Iron (Fe) (%)	2.74	2.82	3.14	2.44	2.11
	Lanthanum (La) (ppm)	22.8	19.7	17.2	12.7	9.4
	Lead (Pb) (ppm)	5.4	2.9	3.5	3.1	3.3
	Lithium (Li) (ppm)	9.1	6.6	5.6	7.6	5.4
	Magnesium (Mg) (%)	0.82	0.71	0.60	0.69	0.58
	Manganese (Mn) (ppm)	437	698	672	673	512

	Sample ID	L1980572-11	L1980572-12	L1980572-13	L1980572-14	L1980572-15
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	10-AUG-17	10-AUG-17	11-AUG-17	08-AUG-17	08-AUG-17
	Sampled Time					
	Client ID	128156 763-35	128157 763-35	128158 763-36B	128161 763-34	128160 763-34
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	9.1	8.7	9.1	8.8	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.28	0.36	0.33	0.40	1.29
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	3
	MPA (tCaCO3/1Kt)	1.9	2.5	3.4	2.2	1.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	29	34	28	37	96
	NNP (tCaCO3/1Kt)	27	32	25	35	94
	Ratio (NP/MPA) (Unity)	15.47	13.60	8.15	16.91	51.20
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.02	<0.01	<0.01	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.06	0.06	0.11	0.07	0.05
	Total Sulfur (combustion) (%)	0.06	0.08	0.11	0.07	0.06
Total Metals	Aluminum (Al) (%)	1.12	1.01	1.35	0.90	0.73
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	0.08	0.10
	Arsenic (As) (ppm)	0.9	0.9	0.6	1.2	1.7
	Barium (Ba) (ppm)	130	140	470	70	70
	Beryllium (Be) (ppm)	0.34	0.28	0.25	0.25	0.37
	Bismuth (Bi) (ppm)	0.16	0.09	0.19	0.10	0.11
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.16	0.09	0.12	0.08	0.10
	Calcium (Ca) (%)	1.16	1.29	1.17	1.48	2.89
	Cerium (Ce) (ppm)	23.2	29.2	21.4	26.5	22.6
	Cesium (Cs) (ppm)	0.39	0.29	0.62	0.34	0.36
	Chromium (Cr) (ppm)	5	11	6	4	4
	Cobalt (Co) (ppm)	6.0	5.8	7.6	4.7	5.3
	Copper (Cu) (ppm)	824	1245	3150	884	823
	Gallium (Ga) (ppm)	6.49	5.99	6.33	5.38	4.61
	Germanium (Ge) (ppm)	0.06	0.05	0.08	<0.05	0.05
	Gold (Au) (ppm)	0.07	0.02	0.09	0.04	0.02
	Hafnium (Hf) (ppm)	0.03	0.03	0.08	0.02	0.03
	Indium (In) (ppm)	0.020	0.034	0.052	0.027	0.031
	Iron (Fe) (%)	2.58	2.64	3.02	1.97	2.18
	Lanthanum (La) (ppm)	11.8	15.5	10.5	13.7	11.6
	Lead (Pb) (ppm)	3.6	2.7	2.3	3.4	3.6
	Lithium (Li) (ppm)	8.3	6.9	5.5	6.3	3.9
	Magnesium (Mg) (%)	0.71	0.68	0.73	0.55	0.99
	Manganese (Mn) (ppm)	589	590	701	461	586

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980572-16	L1980572-17	L1980572-18	L1980572-19
	Description	Waste	Waste	Waste	Waste
	Sampled Date	14-AUG-17	15-AUG-17	17-AUG-17	17-AUG-17
	Sampled Time				
	Client ID	128159 763-37	128162 763-39	128163 763-38	128164 763-38
Grouping	**Analyte**				
SOIL					
Physical Tests	pH (Unity)	9.0	9.0	8.7	9.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.51	0.23	0.84	0.33
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2
	MPA (tCaCO3/1Kt)	0.9	0.6	4.4	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	37	23	50	31
	NNP (tCaCO3/1Kt)	36	22	46	31
	Ratio (NP/MPA) (Unity)	39.47	36.80	11.43	99.20
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.01	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.03	0.02	0.13	<0.01
	Total Sulfur (combustion) (%)	0.03	0.02	0.14	0.01
Total Metals	Aluminum (Al) (%)	0.81	0.95	0.58	1.05
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	0.9	0.9	1.8	0.9
	Barium (Ba) (ppm)	100	180	190	200
	Beryllium (Be) (ppm)	0.26	0.23	0.30	0.32
	Bismuth (Bi) (ppm)	0.07	0.07	1.13	0.02
	Boron (B) (ppm)	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.06	0.09	0.28	0.07
	Calcium (Ca) (%)	1.31	0.82	1.39	1.16
	Cerium (Ce) (ppm)	31.7	32.5	25.7	24.6
	Cesium (Cs) (ppm)	0.37	0.58	0.29	0.38
	Chromium (Cr) (ppm)	4	5	4	5
	Cobalt (Co) (ppm)	5.6	6.2	7.0	5.8
	Copper (Cu) (ppm)	384	523	6470	178.5
	Gallium (Ga) (ppm)	4.83	5.05	3.72	5.65
	Germanium (Ge) (ppm)	0.05	0.07	0.06	0.05
	Gold (Au) (ppm)	<0.02	0.05	0.21	<0.02
	Hafnium (Hf) (ppm)	0.04	0.08	0.05	0.04
	Indium (In) (ppm)	0.031	0.038	0.058	0.025
	Iron (Fe) (%)	2.20	2.54	3.26	2.34
	Lanthanum (La) (ppm)	17.4	17.4	13.7	13.1
	Lead (Pb) (ppm)	3.0	2.5	4.2	2.7
	Lithium (Li) (ppm)	4.8	4.3	2.4	6.1
	Magnesium (Mg) (%)	0.59	0.60	0.69	0.69
	Manganese (Mn) (ppm)	512	605	671	621

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980572-1	L1980572-2	L1980572-3	L1980572-4	L1980572-5
	Description	Waste	Waste	Waste	Tail	Waste
	Sampled Date	03-AUG-17	05-AUG-17	05-AUG-17	08-AUG-17	04-AUG-17
	Sampled Time					
	Client ID	129747 769-42	129750 769-40	129751 769-40	JULY TAILS 2017	129748
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	0.02	0.01
	Molybdenum (Mo) (ppm)	7.40	2.36	0.63	2.69	0.95
	Nickel (Ni) (ppm)	2.6	2.3	5.0	3.4	2.1
	Niobium (Nb) (ppm)	0.19	0.12	0.14	0.20	0.08
	Phosphorus (P) (ppm)	720	670	730	700	710
	Potassium (K) (%)	0.51	0.43	0.55	0.46	0.24
	Rhenium (Re) (ppm)	0.021	0.003	<0.001	0.002	0.001
	Rubidium (Rb) (ppm)	27.3	22.2	27.3	25.3	13.2
	Scandium (Sc) (ppm)	4.1	5.1	4.4	3.9	6.7
	Selenium (Se) (ppm)	0.5	0.9	0.4	3.1	0.9
	Silver (Ag) (ppm)	0.16	0.30	0.05	1.38	0.24
	Sodium (Na) (%)	0.07	0.06	0.09	0.05	0.05
	Strontium (Sr) (ppm)	119.5	61.5	40.8	65.8	78.3
	Sulfur (S) (%)	0.05	0.03	0.01	0.16	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.07	0.01	0.39	0.02
	Thallium (Tl) (ppm)	0.16	0.13	0.16	0.17	0.07
	Thorium (Th) (ppm)	3.7	2.6	2.1	3.7	4.4
	Tin (Sn) (ppm)	0.7	0.6	0.6	0.8	0.7
	Titanium (Ti) (%)	0.083	0.069	0.099	0.085	0.031
	Tungsten (W) (ppm)	0.40	0.36	0.47	0.09	0.17
	Uranium (U) (ppm)	0.73	0.20	0.20	0.42	0.28
	Vanadium (V) (ppm)	51	47	50	69	49
	Yttrium (Y) (ppm)	6.79	9.05	8.92	5.28	8.78
	Zinc (Zn) (ppm)	69	74	66	107	79
	Zirconium (Zr) (ppm)	1.0	0.8	1.8	1.0	1.1
Permanent Gases	Carbon Dioxide (CO2) (%)	1.9	0.7	<0.2	0.7	1.4
Miscellaneous	Carbon (C) (%)	0.62	0.24	0.07	0.24	0.45

	Sample ID	L1980572-6	L1980572-7	L1980572-8	L1980572-9	L1980572-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	04-AUG-17	06-AUG-17	06-AUG-17	10-AUG-17	10-AUG-17
	Sampled Time					
	Client ID	129749	128153	128152	128154	128155 763-35
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	7.62	1.39	2.19	1.09	0.51
	Nickel (Ni) (ppm)	2.2	3.5	2.7	2.7	2.4
	Niobium (Nb) (ppm)	<0.05	0.38	0.18	0.10	0.13
	Phosphorus (P) (ppm)	1020	780	860	710	600
	Potassium (K) (%)	0.11	0.86	0.52	0.31	0.40
	Rhenium (Re) (ppm)	0.027	0.001	0.002	0.002	0.001
	Rubidium (Rb) (ppm)	6.2	47.4	29.2	14.8	18.7
	Scandium (Sc) (ppm)	4.6	3.7	5.0	4.9	3.6
	Selenium (Se) (ppm)	0.8	2.1	3.1	1.0	1.0
	Silver (Ag) (ppm)	0.30	0.66	1.54	0.20	0.34
	Sodium (Na) (%)	0.04	0.07	0.04	0.07	0.05
	Strontium (Sr) (ppm)	65.1	27.7	52.0	84.1	64.6
	Sulfur (S) (%)	0.06	0.04	0.02	0.07	0.04
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.04	0.21	0.18	0.04	0.09
	Thallium (Tl) (ppm)	0.04	0.35	0.19	0.08	0.11
	Thorium (Th) (ppm)	8.2	5.7	6.1	2.7	2.2
	Tin (Sn) (ppm)	1.0	0.7	0.7	0.6	0.5
	Titanium (Ti) (%)	0.006	0.144	0.084	0.048	0.066
	Tungsten (W) (ppm)	0.30	0.98	0.50	0.69	0.68
	Uranium (U) (ppm)	1.05	0.22	0.50	0.31	0.28
	Vanadium (V) (ppm)	55	59	59	47	42
	Yttrium (Y) (ppm)	11.90	4.65	9.23	9.05	7.29
	Zinc (Zn) (ppm)	52	88	84	71	69
	Zirconium (Zr) (ppm)	1.4	0.6	1.5	0.8	0.6
Permanent Gases	Carbon Dioxide (CO2) (%)	1.3	0.2	0.9	1.2	0.9
Miscellaneous	Carbon (C) (%)	0.47	0.10	0.30	0.43	0.31

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1980572-11	L1980572-12	L1980572-13	L1980572-14	L1980572-15
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	10-AUG-17	10-AUG-17	11-AUG-17	08-AUG-17	08-AUG-17
	Sampled Time					
	Client ID	128156 763-35	128157 763-35	128158 763-36B	128161 763-34	128160 763-34
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.30	5.66	0.61	0.65	0.57
	Nickel (Ni) (ppm)	2.4	3.1	2.6	2.0	2.7
	Niobium (Nb) (ppm)	0.09	0.05	0.22	<0.05	<0.05
	Phosphorus (P) (ppm)	580	670	860	550	610
	Potassium (K) (%)	0.26	0.25	0.92	0.13	0.14
	Rhenium (Re) (ppm)	<0.001	0.002	<0.001	0.001	0.001
	Rubidium (Rb) (ppm)	13.3	12.0	46.2	7.3	7.4
	Scandium (Sc) (ppm)	2.7	3.8	4.1	3.0	2.6
	Selenium (Se) (ppm)	1.2	1.3	2.2	1.1	1.1
	Silver (Ag) (ppm)	0.53	0.40	0.87	0.30	0.87
	Sodium (Na) (%)	0.06	0.04	0.08	0.03	0.05
	Strontium (Sr) (ppm)	63.6	83.0	73.2	61.0	307
	Sulfur (S) (%)	0.06	0.09	0.11	0.07	0.05
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.14	0.09	0.12	0.06	0.33
	Thallium (Tl) (ppm)	0.07	0.07	0.27	0.04	0.04
	Thorium (Th) (ppm)	2.8	3.4	2.3	2.9	2.5
	Tin (Sn) (ppm)	0.4	0.6	0.7	0.4	0.4
	Titanium (Ti) (%)	0.044	0.033	0.176	0.006	0.009
	Tungsten (W) (ppm)	0.67	0.41	0.34	0.25	0.36
	Uranium (U) (ppm)	0.37	0.24	0.17	0.24	0.43
	Vanadium (V) (ppm)	43	44	67	31	33
	Yttrium (Y) (ppm)	5.61	6.10	5.96	5.24	6.21
	Zinc (Zn) (ppm)	82	81	90	62	74
	Zirconium (Zr) (ppm)	0.5	0.6	2.4	0.5	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	1.3	1.2	1.5	4.7
Miscellaneous	Carbon (C) (%)	0.33	0.46	0.43	0.50	1.44

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1980572-16 Waste 14-AUG-17 128159 763-37	L1980572-17 Waste 15-AUG-17 128162 763-39	L1980572-18 Waste 17-AUG-17 128163 763-38	L1980572-19 Waste 17-AUG-17 128164 763-38	
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	
	Molybdenum (Mo) (ppm)	2.96	0.96	2.14	0.64	
	Nickel (Ni) (ppm)	2.4	2.1	2.2	2.5	
	Niobium (Nb) (ppm)	0.06	0.12	0.08	0.08	
	Phosphorus (P) (ppm)	700	860	820	640	
	Potassium (K) (%)	0.23	0.63	0.25	0.39	
	Rhenium (Re) (ppm)	0.009	0.001	0.003	<0.001	
	Rubidium (Rb) (ppm)	12.7	40.4	12.2	19.0	
	Scandium (Sc) (ppm)	3.7	4.8	3.5	4.1	
	Selenium (Se) (ppm)	0.5	0.9	5.8	0.4	
	Silver (Ag) (ppm)	0.19	0.22	4.10	0.04	
	Sodium (Na) (%)	0.05	0.05	0.03	0.08	
	Strontium (Sr) (ppm)	92.0	62.5	116.0	100.5	
	Sulfur (S) (%)	0.03	0.01	0.20	<0.01	
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	
	Tellurium (Te) (ppm)	0.02	0.03	0.74	0.02	
	Thallium (Tl) (ppm)	0.08	0.29	0.07	0.10	
	Thorium (Th) (ppm)	4.7	5.6	3.4	2.5	
	Tin (Sn) (ppm)	0.5	0.6	0.5	0.5	
	Titanium (Ti) (%)	0.028	0.096	0.033	0.063	
	Tungsten (W) (ppm)	0.35	0.41	0.30	0.52	
	Uranium (U) (ppm)	0.57	0.56	0.39	0.17	
	Vanadium (V) (ppm)	40	58	52	47	
	Yttrium (Y) (ppm)	8.02	9.93	6.39	7.59	
	Zinc (Zn) (ppm)	62	90	97	71	
	Zirconium (Zr) (ppm)	1.0	1.6	1.7	0.7	
Permanent Gases	Carbon Dioxide (CO2) (%)	1.9	0.9	3.1	1.2	
Miscellaneous	Carbon (C) (%)	0.59	0.31	1.01	0.41	

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-26 17-27

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17186398

Project: L1980572

This report is for 19 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 1-SEP-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1980572

CERTIFICATE OF ANALYSIS VA17186398

Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
Sample Description **LOR**	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L1980572-1 129747 769-42	1.08	2	1.6	37	39	24.96	9.2	0.05	0.05	0.52	1.9	<0.01	0.62	<0.01	0.16
L1980572-2 129750 769-40	1.10	1	0.6	21	22	35.20	8.9	0.02	0.02	0.19	0.7	<0.01	0.24	<0.01	0.30
L1980572-3 129751 769-40	1.10	1	0.6	10	11	17.60	8.9	0.02	0.02	<0.05	<0.2	<0.01	0.07	<0.01	0.05
L1980572-4 JULY TAILS 2017	1.12	2	4.7	13	18	3.84	8.1	0.15	0.07	0.19	0.7	0.08	0.24	0.05	1.38
L1980572-5 129748	1.10	2	0.6	29	30	48.00	8.9	0.02	0.02	0.38	1.4	<0.01	0.45	<0.01	0.24
L1980572-6 129749	1.06	2	1.6	26	28	17.92	8.9	0.05	0.04	0.35	1.3	0.01	0.47	<0.01	0.30
L1980572-7 128153	1.14	1	1.3	9	10	8.00	9.1	0.04	0.04	0.06	0.2	<0.01	0.10	<0.01	0.66
L1980572-8 128152	1.14	2	0.9	24	25	26.67	8.7	0.03	0.03	0.25	0.9	<0.01	0.30	<0.01	1.54
L1980572-9 128154	1.10	2	2.2	31	33	15.09	8.8	0.07	0.07	0.34	1.2	<0.01	0.43	0.01	0.20
L1980572-10 128155 763-35	1.10	2	0.9	25	26	27.73	9.1	0.03	0.03	0.24	0.9	<0.01	0.31	<0.01	0.34
L1980572-11 128156 763-35	1.08	2	1.9	27	29	15.47	9.1	0.06	0.06	0.28	1.0	<0.01	0.33	0.01	0.53
L1980572-12 128157 763-35	1.08	2	2.5	32	34	13.60	8.7	0.08	0.06	0.36	1.3	0.02	0.46	<0.01	0.40
L1980572-13 128158 763-36B	1.08	2	3.4	25	28	8.15	9.1	0.11	0.11	0.33	1.2	<0.01	0.43	<0.01	0.87
L1980572-14 128161 763-34	1.06	2	2.2	35	37	16.91	8.8	0.07	0.07	0.40	1.5	<0.01	0.50	<0.01	0.30
L1980572-15 128160 763-34	1.06	3	1.9	94	96	51.20	8.9	0.06	0.05	1.29	4.7	0.01	1.44	<0.01	0.87
L1980572-16 128159 763-37	1.08	2	0.9	36	37	39.47	9.0	0.03	0.03	0.51	1.9	<0.01	0.59	<0.01	0.19
L1980572-17 128162 763-39	1.06	2	0.6	22	23	36.80	9.0	0.02	0.02	0.23	0.9	<0.01	0.31	<0.01	0.22
L1980572-18 128163 763-38	1.08	2	4.4	46	50	11.43	8.7	0.14	0.13	0.84	3.1	0.01	1.01	<0.01	4.10
L1980572-19 128164 763-38	1.00	2	0.3	31	31	99.20	9.0	0.01	<0.01	0.33	1.2	0.01	0.41	<0.01	0.04

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1980572

CERTIFICATE OF ANALYSIS VA17186398

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description **LOR**	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L1980572-1 129747 769-42	1.05	0.8	<0.02	<10	260	0.26	0.09	1.38	0.07	28.2	5.5	5	0.52	472	2.40
L1980572-2 129750 769-40	1.01	2.1	0.03	<10	220	0.29	0.13	0.81	0.18	24.3	5.7	5	0.39	1245	2.31
L1980572-3 129751 769-40	1.15	0.8	<0.02	<10	230	0.26	0.03	0.52	0.13	22.7	6.0	7	0.35	432	2.22
L1980572-4 JULY TAILS 2017	0.96	1.3	0.23	<10	200	0.20	0.58	0.74	0.57	18.20	8.1	6	0.41	4730	4.20
L1980572-5 129748	0.64	2.1	<0.02	<10	100	0.35	0.04	1.04	0.10	36.6	6.0	4	0.59	524	2.38
L1980572-6 129749	1.09	1.7	<0.02	<10	70	0.29	0.16	1.06	0.05	41.5	5.4	3	0.23	593	2.74
L1980572-7 128153	1.32	1.5	0.04	<10	300	0.18	0.36	0.34	0.09	37.1	6.8	5	0.64	4760	2.82
L1980572-8 128152	1.08	0.7	0.08	<10	240	0.32	0.67	0.92	0.26	32.2	6.7	4	0.52	4940	3.14
L1980572-9 128154	1.15	1.0	0.02	<10	180	0.34	0.11	1.36	0.11	24.2	6.0	6	0.45	834	2.44
L1980572-10 128155 763-35	0.94	2.0	0.03	<10	190	0.25	0.13	0.99	0.08	19.70	5.1	5	0.34	498	2.11
L1980572-11 128156 763-35	1.12	0.9	0.07	<10	130	0.34	0.16	1.16	0.16	23.2	6.0	5	0.39	824	2.58
L1980572-12 128157 763-35	1.01	0.9	0.02	<10	140	0.28	0.09	1.29	0.09	29.2	5.8	11	0.29	1245	2.64
L1980572-13 128158 763-36B	1.35	0.6	0.09	<10	470	0.25	0.19	1.17	0.12	21.4	7.6	6	0.62	3150	3.02
L1980572-14 128161 763-34	0.90	1.2	0.04	<10	70	0.25	0.10	1.48	0.08	26.5	4.7	4	0.34	884	1.97
L1980572-15 128160 763-34	0.73	1.7	0.02	<10	70	0.37	0.11	2.89	0.10	22.6	5.3	4	0.36	823	2.18
L1980572-16 128159 763-37	0.81	0.9	<0.02	<10	100	0.26	0.07	1.31	0.06	31.7	5.6	4	0.37	384	2.20
L1980572-17 128162 763-39	0.95	0.9	0.05	<10	180	0.23	0.07	0.82	0.09	32.5	6.2	5	0.58	523	2.54
L1980572-18 128163 763-38	0.58	1.8	0.21	<10	190	0.30	1.13	1.39	0.28	25.7	7.0	4	0.29	6470	3.26
L1980572-19 128164 763-38	1.05	0.9	<0.02	<10	200	0.32	0.02	1.16	0.07	24.6	5.8	5	0.38	178.5	2.34

Project: L1980572

CERTIFICATE OF ANALYSIS VA17186398

Sample Description / **Method** **Analyte** **Units** **LOR**	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10
L1980572-1 129747 769-42	5.44	0.06	0.04	<0.01	0.038	0.51	15.4	5.9	0.74	525	7.40	0.07	0.19	2.6	720
L1980572-2 129750 769-40	5.36	0.05	0.05	<0.01	0.038	0.43	12.5	5.8	0.57	670	2.36	0.06	0.12	2.3	670
L1980572-3 129751 769-40	5.49	0.08	0.10	<0.01	0.021	0.55	11.5	6.8	0.64	623	0.63	0.09	0.14	5.0	730
L1980572-4 JULY TAILS 2017	6.84	0.07	0.04	0.02	0.110	0.46	9.1	4.9	0.54	659	2.69	0.05	0.20	3.4	700
L1980572-5 129748	3.77	0.06	0.04	0.01	0.050	0.24	20.1	2.9	0.36	619	0.95	0.05	0.08	2.1	710
L1980572-6 129749	6.56	0.06	0.06	<0.01	0.088	0.11	22.8	9.1	0.82	437	7.62	0.04	<0.05	2.2	1020
L1980572-7 128153	6.98	0.07	0.03	0.01	0.050	0.86	19.7	6.6	0.71	698	1.39	0.07	0.38	3.5	780
L1980572-8 128152	6.44	0.09	0.08	<0.01	0.080	0.52	17.2	5.6	0.60	672	2.19	0.04	0.18	2.7	860
L1980572-9 128154	6.10	0.06	0.05	<0.01	0.039	0.31	12.7	7.6	0.69	673	1.09	0.07	0.10	2.7	710
L1980572-10 128155 763-35	5.04	0.05	0.03	<0.01	0.030	0.40	9.4	5.4	0.58	512	0.51	0.05	0.13	2.4	600
L1980572-11 128156 763-35	6.49	0.06	0.03	<0.01	0.020	0.26	11.8	8.3	0.71	589	0.30	0.06	0.09	2.4	580
L1980572-12 128157 763-35	5.99	0.05	0.03	<0.01	0.034	0.25	15.5	6.9	0.68	590	5.66	0.04	0.05	3.1	670
L1980572-13 128158 763-36B	6.33	0.08	0.08	0.01	0.052	0.92	10.5	5.5	0.73	701	0.61	0.08	0.22	2.6	860
L1980572-14 128161 763-34	5.38	<0.05	0.02	<0.01	0.027	0.13	13.7	6.3	0.55	461	0.65	0.03	<0.05	2.0	550
L1980572-15 128160 763-34	4.61	0.05	0.03	<0.01	0.031	0.14	11.6	3.9	0.99	586	0.57	0.05	<0.05	2.7	610
L1980572-16 128159 763-37	4.83	0.05	0.04	<0.01	0.031	0.23	17.4	4.8	0.59	512	2.96	0.05	0.06	2.4	700
L1980572-17 128162 763-39	5.05	0.07	0.08	<0.01	0.038	0.63	17.4	4.3	0.60	605	0.96	0.05	0.12	2.1	860
L1980572-18 128163 763-38	3.72	0.06	0.05	<0.01	0.058	0.25	13.7	2.4	0.69	671	2.14	0.03	0.08	2.2	820
L1980572-19 128164 763-38	5.65	0.05	0.04	<0.01	0.025	0.39	13.1	6.1	0.69	621	0.64	0.08	0.08	2.5	640

CERTIFICATE OF ANALYSIS VA17186398

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description / **LOR**	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05
L1980572-1 129747 769-42	3.0	27.3	0.021	0.05	0.05	4.1	0.5	0.7	119.5	<0.01	0.03	3.7	0.083	0.16	0.73
L1980572-2 129750 769-40	2.6	22.2	0.003	0.03	0.05	5.1	0.9	0.6	61.5	<0.01	0.07	2.6	0.069	0.13	0.20
L1980572-3 129751 769-40	1.7	27.3	<0.001	0.01	<0.05	4.4	0.4	0.6	40.8	<0.01	0.01	2.1	0.099	0.16	0.20
L1980572-4 JULY TAILS 2017	9.3	25.3	0.002	0.16	0.05	3.9	3.1	0.8	65.8	<0.01	0.39	3.7	0.085	0.17	0.42
L1980572-5 129748	3.2	13.2	0.001	0.01	<0.05	6.7	0.9	0.7	78.3	<0.01	0.02	4.4	0.031	0.07	0.28
L1980572-6 129749	5.4	6.2	0.027	0.06	0.15	4.6	0.8	1.0	65.1	<0.01	0.04	8.2	0.006	0.04	1.05
L1980572-7 128153	2.9	47.4	0.001	0.04	<0.05	3.7	2.1	0.7	27.7	<0.01	0.21	5.7	0.144	0.35	0.22
L1980572-8 128152	3.5	29.2	0.002	0.02	<0.05	5.0	3.1	0.7	52.0	<0.01	0.18	6.1	0.084	0.19	0.50
L1980572-9 128154	3.1	14.8	0.002	0.07	<0.05	4.9	1.0	0.6	84.1	<0.01	0.04	2.7	0.048	0.08	0.31
L1980572-10 128155 763-35	3.3	18.7	0.001	0.04	0.11	3.6	1.0	0.5	64.6	<0.01	0.09	2.2	0.066	0.11	0.28
L1980572-11 128156 763-35	3.6	13.3	<0.001	0.06	<0.05	2.7	1.2	0.4	63.6	<0.01	0.14	2.8	0.044	0.07	0.37
L1980572-12 128157 763-35	2.7	12.0	0.002	0.09	<0.05	3.8	1.3	0.6	83.0	<0.01	0.09	3.4	0.033	0.07	0.24
L1980572-13 128158 763-36B	2.3	46.2	<0.001	0.11	<0.05	4.1	2.2	0.7	73.2	<0.01	0.12	2.3	0.176	0.27	0.17
L1980572-14 128161 763-34	3.4	7.3	0.001	0.07	0.08	3.0	1.1	0.4	61.0	<0.01	0.06	2.9	0.006	0.04	0.24
L1980572-15 128160 763-34	3.6	7.4	0.001	0.05	0.10	2.6	1.1	0.4	307	<0.01	0.33	2.5	0.009	0.04	0.43
L1980572-16 128159 763-37	3.0	12.7	0.009	0.03	<0.05	3.7	0.5	0.5	92.0	<0.01	0.02	4.7	0.028	0.08	0.57
L1980572-17 128162 763-39	2.5	40.4	0.001	0.01	<0.05	4.8	0.9	0.6	62.5	<0.01	0.03	5.6	0.096	0.29	0.56
L1980572-18 128163 763-38	4.2	12.2	0.003	0.20	<0.05	3.5	5.8	0.5	116.0	<0.01	0.74	3.4	0.033	0.07	0.39
L1980572-19 128164 763-38	2.7	19.0	<0.001	<0.01	<0.05	4.1	0.4	0.5	100.5	<0.01	0.02	2.5	0.063	0.10	0.17

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17186398

Sample Description / **Method** **Analyte** **Units** **LOR**	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1980572-1 129747 769-42	51	0.40	6.79	69	1.0
L1980572-2 129750 769-40	47	0.36	9.05	74	0.8
L1980572-3 129751 769-40	50	0.47	8.92	66	1.8
L1980572-4 JULY TAILS 2017	69	0.09	5.28	107	1.0
L1980572-5 129748	49	0.17	8.78	79	1.1
L1980572-6 129749	55	0.30	11.90	52	1.4
L1980572-7 128153	59	0.98	4.65	88	0.6
L1980572-8 128152	59	0.50	9.23	84	1.5
L1980572-9 128154	47	0.69	9.05	71	0.8
L1980572-10 128155 763-35	42	0.68	7.29	69	0.6
L1980572-11 128156 763-35	43	0.67	5.61	82	0.5
L1980572-12 128157 763-35	44	0.41	6.10	81	0.6
L1980572-13 128158 763-36B	67	0.34	5.96	90	2.4
L1980572-14 128161 763-34	31	0.25	5.24	62	0.5
L1980572-15 128160 763-34	33	0.36	6.21	74	1.0
L1980572-16 128159 763-37	40	0.35	8.02	62	1.0
L1980572-17 128162 763-39	58	0.41	9.93	90	1.6
L1980572-18 128163 763-38	52	0.30	6.39	97	1.7
L1980572-19 128164 763-38	47	0.52	7.59	71	0.7

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 6-OCT-2017
Account: APN

Project: L1980572

CERTIFICATE OF ANALYSIS VA17186398

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1980572-COFC

Number: 17-26

Page 1 of 2

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)		EMERGENCY	
4 day [P4]	☐	1 Business day [E1]	☐
3 day [P3]	☐	Same Day, Weekend or Statutory holiday [E0]	☐
2 day [P2]	☐		

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)		Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
					Composite	R	R	R	R	R	R	
	129747	769-42	03-AUG-17		WASTE	X	X	X	X	X	X	
	129750	769-40	05/08/17		waste	X	X	X	X	X	X	
	129751	769-40	05/08/17		waste	X	X	X	X	X	X	
	JULY TAILS 2017		8/8/17		TAIL	X	X	X	X	X	X	
	129748		04/Aug-17		WASTE	X	X	X	X	X	X	
	129749		04-Aug-17		WASTE	X	X	X	X	X	X	
	128153		06-Aug-17		WASTE	X	X	X	X	X	X	
	128152		06-Aug-17		WASTE	X	X	X	X	X	X	
	128154		10-Aug-17		WASTE	X	X	X	X	X	X	
	~~76~~ 128155	763-35	10/8/17		waste	X	X	X	X	X	X	

Drinking Water (DW) Samples[1] **(client use)**

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
15,0			3.4	4.2	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Thomas Sett	Date: Aug. 18 /17	Time: 9:30A	Received by: EHF	Date: 24 Aug 2017	Time: 11:20	Received by: MS	Date: Aug25/17	Time: 11:50

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

Aff L1980572-COFC

ber: 15 27

Page 2 of 2

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days):
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY:
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)		Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
					Composite	R	R	R	R	R	R	
	128156	763-35	10/08/17		WASTE	X	X	X	X	X	X	
	128157	763-35	10/08/17		WASTE	X	X	X	X	X	X	
	128158	763-36B	11/08/17		WASTE	X	X	X	X	X	X	
	128161	763-34	08/08/17		WASTE	X	X	X	X	X	X	
	128160	763-34	08/08/17		WASTE	X	X	X	X	X	X	
	128159	763-37	14/08/17		WASTE	X	X	X	X	X	X	
	128162	763-39	15/08/17		WASTE	X	X	X	X	X	X	
	128163	763-38	17/08/17		WASTE	X	X	X	X	X	X	
	128164	763-38	17/08/17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
15.0			3.4	4.2	

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Thomo Sat	Date: Aug. 18/17	Time: 9:30A	Received by: EHF	Date: 24 Aug 2017	Time: 11:20	Received by: MS	Date: Aug 25/17	Time: 11:50

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-SEP-17
Report Date: 22-NOV-17 16:33 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1985339

Project P.O. #:	227382
Job Reference:	
C of C Numbers:	17 28
Legal Site Desc:	

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1985339-1	L1985339-2	L1985339-3	L1985339-4	L1985339-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17
	Sampled Time					
	Client ID	128560	128561	128562	128563	128564
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	9.1	9.1	8.8	8.7	9.1
Organic / Inorganic Carbon	Carbon (C) (%)	0.21	0.16	0.20	0.20	0.20
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	10.3	6.3	8.1	9.1	7.2
	Neutralization Potential (NP) (tCaCO3/1Kt)	19	17	20	19	19
	NNP (tCaCO3/1Kt)	9	11	12	10	12
	Ratio (NP/MPA) (Unity)	1.84	2.72	2.46	2.10	2.64
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.03	0.03	0.05	0.03	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.30	0.17	0.21	0.26	0.22
	Total Sulfur (combustion) (%)	0.33	0.20	0.26	0.29	0.23
Total Metals	Aluminum (Al) (%)	1.05	1.12	1.15	1.19	1.08
	Antimony (Sb) (ppm)	0.06	0.08	0.07	0.05	0.05
	Arsenic (As) (ppm)	0.6	0.9	0.8	0.8	0.8
	Barium (Ba) (ppm)	240	250	270	260	240
	Beryllium (Be) (ppm)	0.19	0.21	0.22	0.20	0.19
	Bismuth (Bi) (ppm)	0.77	0.54	0.40	0.68	0.51
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.46	0.17	0.24	0.22	0.19
	Calcium (Ca) (%)	0.76	0.69	0.81	0.76	0.77
	Cerium (Ce) (ppm)	20.7	21.6	24.5	23.9	21.9
	Cesium (Cs) (ppm)	0.31	0.33	0.32	0.32	0.31
	Chromium (Cr) (ppm)	6	7	6	7	7
	Cobalt (Co) (ppm)	5.5	5.3	5.7	5.6	5.2
	Copper (Cu) (ppm)	5310	3120	3400	3850	3170
	Gallium (Ga) (ppm)	5.81	5.59	5.73	6.00	5.56
	Germanium (Ge) (ppm)	0.07	0.07	0.08	0.08	0.08
	Gold (Au) (ppm)	0.24	0.07	0.12	0.12	0.27
	Hafnium (Hf) (ppm)	0.03	0.03	0.03	0.04	0.04
	Indium (In) (ppm)	0.049	0.035	0.044	0.048	0.037
	Iron (Fe) (%)	3.25	3.03	2.98	3.03	2.88
	Lanthanum (La) (ppm)	11.2	11.5	13.0	12.7	11.6
	Lead (Pb) (ppm)	2.3	2.1	2.3	2.1	2.1
	Lithium (Li) (ppm)	5.0	5.0	5.3	5.6	5.0
	Magnesium (Mg) (%)	0.58	0.56	0.62	0.63	0.57
	Manganese (Mn) (ppm)	547	522	569	559	531

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1985339-6	L1985339-7	L1985339-8	L1985339-9	L1985339-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17
	Sampled Time					
	Client ID	128565	128566	128567	128568	128569
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	9.1	9.0	9.0	9.1	9.1
Organic / Inorganic Carbon	Carbon (C) (%)	0.21	0.20	0.23	0.18	0.18
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	7.5	9.1	8.4	7.5	8.1
	Neutralization Potential (NP) (tCaCO3/1Kt)	19	20	22	19	19
	NNP (tCaCO3/1Kt)	12	11	14	12	11
	Ratio (NP/MPA) (Unity)	2.53	2.21	2.61	2.53	2.34
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.01	0.03	0.02	0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.23	0.26	0.25	0.23	0.26
	Total Sulfur (combustion) (%)	0.24	0.29	0.27	0.24	0.26
Total Metals	Aluminum (Al) (%)	1.15	1.11	1.15	1.09	1.13
	Antimony (Sb) (ppm)	0.07	0.14	0.08	0.11	0.05
	Arsenic (As) (ppm)	0.8	1.0	0.7	0.7	0.9
	Barium (Ba) (ppm)	240	250	250	240	240
	Beryllium (Be) (ppm)	0.23	0.22	0.21	0.20	0.21
	Bismuth (Bi) (ppm)	0.52	0.53	0.64	0.44	0.53
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.19	0.21	0.26	0.23	0.20
	Calcium (Ca) (%)	0.77	0.78	0.89	0.75	0.74
	Cerium (Ce) (ppm)	21.3	21.7	22.8	22.6	21.4
	Cesium (Cs) (ppm)	0.33	0.32	0.33	0.31	0.32
	Chromium (Cr) (ppm)	7	6	7	7	7
	Cobalt (Co) (ppm)	5.4	5.4	5.6	5.2	5.8
	Copper (Cu) (ppm)	3780	4280	3970	3490	3610
	Gallium (Ga) (ppm)	5.91	5.74	5.90	5.71	6.24
	Germanium (Ge) (ppm)	0.07	0.07	0.07	0.06	0.08
	Gold (Au) (ppm)	0.12	0.16	0.11	0.54	0.16
	Hafnium (Hf) (ppm)	0.04	0.03	0.04	0.04	0.04
	Indium (In) (ppm)	0.047	0.056	0.044	0.044	0.046
	Iron (Fe) (%)	3.09	3.03	3.09	2.91	2.97
	Lanthanum (La) (ppm)	11.3	11.9	12.0	12.2	11.6
	Lead (Pb) (ppm)	2.5	2.4	2.2	2.2	2.5
	Lithium (Li) (ppm)	5.2	5.2	5.2	5.1	5.3
	Magnesium (Mg) (%)	0.60	0.59	0.59	0.58	0.59
	Manganese (Mn) (ppm)	563	552	550	524	535

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1985339-1	L1985339-2	L1985339-3	L1985339-4	L1985339-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17
	Sampled Time					
	Client ID	128560	128561	128562	128563	128564
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.68	0.79	1.05	1.00	1.37
	Nickel (Ni) (ppm)	1.7	1.9	1.8	1.8	1.7
	Niobium (Nb) (ppm)	0.24	0.22	0.23	0.23	0.21
	Phosphorus (P) (ppm)	540	570	620	620	570
	Potassium (K) (%)	0.59	0.61	0.65	0.64	0.59
	Rhenium (Re) (ppm)	0.002	0.001	0.001	0.002	0.003
	Rubidium (Rb) (ppm)	27.8	28.1	29.7	29.6	28.2
	Scandium (Sc) (ppm)	2.9	3.2	3.3	3.3	3.1
	Selenium (Se) (ppm)	4.8	2.8	3.4	3.6	3.2
	Silver (Ag) (ppm)	2.04	1.04	1.00	1.31	1.04
	Sodium (Na) (%)	0.08	0.09	0.09	0.10	0.09
	Strontium (Sr) (ppm)	64.0	62.5	74.6	71.9	63.4
	Sulfur (S) (%)	0.36	0.21	0.27	0.29	0.24
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.34	0.17	0.20	0.24	0.22
	Thallium (Tl) (ppm)	0.16	0.18	0.19	0.18	0.19
	Thorium (Th) (ppm)	2.7	2.8	3.1	3.2	3.0
	Tin (Sn) (ppm)	0.6	0.6	0.6	0.6	0.5
	Titanium (Ti) (%)	0.113	0.113	0.121	0.120	0.108
	Tungsten (W) (ppm)	<0.05	0.05	0.05	0.18	0.07
	Uranium (U) (ppm)	0.27	0.24	0.27	0.26	0.31
	Vanadium (V) (ppm)	52	53	54	55	50
	Yttrium (Y) (ppm)	3.97	4.26	5.18	4.61	4.33
	Zinc (Zn) (ppm)	83	70	76	78	70
	Zirconium (Zr) (ppm)	0.7	0.8	0.8	0.8	0.7
Permanent Gases	Carbon Dioxide (CO2) (%)	0.8	0.6	0.7	0.7	0.7
Miscellaneous	Carbon (C) (%)	0.25	0.21	0.22	0.19	0.22

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1985339-6	L1985339-7	L1985339-8	L1985339-9	L1985339-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17	12-AUG-17
	Sampled Time					
	Client ID	128565	128566	128567	128568	128569
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	<0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	0.56	0.75	1.25	1.24	0.95
	Nickel (Ni) (ppm)	1.8	1.7	1.8	1.7	2.0
	Niobium (Nb) (ppm)	0.22	0.27	0.25	0.21	0.26
	Phosphorus (P) (ppm)	580	600	570	570	560
	Potassium (K) (%)	0.61	0.61	0.63	0.59	0.61
	Rhenium (Re) (ppm)	<0.001	0.002	0.003	0.003	0.002
	Rubidium (Rb) (ppm)	28.1	28.7	29.3	27.1	29.7
	Scandium (Sc) (ppm)	3.4	3.4	3.3	3.2	3.5
	Selenium (Se) (ppm)	3.2	3.7	3.7	2.9	3.7
	Silver (Ag) (ppm)	1.20	1.34	1.30	1.19	1.14
	Sodium (Na) (%)	0.11	0.09	0.10	0.08	0.09
	Strontium (Sr) (ppm)	69.3	66.0	68.9	61.2	65.4
	Sulfur (S) (%)	0.27	0.32	0.28	0.25	0.28
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.21	0.27	0.27	0.22	0.23
	Thallium (Tl) (ppm)	0.19	0.19	0.19	0.17	0.18
	Thorium (Th) (ppm)	2.9	2.9	2.9	2.9	2.9
	Tin (Sn) (ppm)	0.6	0.6	0.6	0.6	0.6
	Titanium (Ti) (%)	0.112	0.113	0.117	0.109	0.113
	Tungsten (W) (ppm)	0.07	0.09	<0.05	0.05	<0.05
	Uranium (U) (ppm)	0.25	0.22	0.28	0.27	0.32
	Vanadium (V) (ppm)	52	52	54	51	51
	Yttrium (Y) (ppm)	4.38	4.51	4.67	4.55	4.68
	Zinc (Zn) (ppm)	74	75	76	71	75
	Zirconium (Zr) (ppm)	0.8	0.8	0.8	0.7	0.8
Permanent Gases	Carbon Dioxide (CO2) (%)	0.8	0.8	0.9	0.7	0.7
Miscellaneous	Carbon (C) (%)	0.23	0.24	0.28	0.21	0.21

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17 28

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

CERTIFICATE VA17194473

Project: L1985339

P.O. No.: ALSM-CW16-102-APN

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 11-SEP-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE RAMOS	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985339

CERTIFICATE OF ANALYSIS VA17194473

Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
Sample Description / **LOR**	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L1985339-1 128560	1.08	2	10.3	9	19	1.84	9.1	0.33	0.30	0.21	0.8	0.03	0.25	<0.01	2.04
L1985339-2 128561	1.24	2	6.3	11	17	2.72	9.1	0.20	0.17	0.16	0.6	0.03	0.21	<0.01	1.04
L1985339-3 128562	1.06	2	8.1	12	20	2.46	8.8	0.26	0.21	0.20	0.7	0.05	0.22	0.01	1.00
L1985339-4 128563	1.28	2	9.1	10	19	2.10	8.7	0.29	0.26	0.20	0.7	0.03	0.19	0.01	1.31
L1985339-5 128564	1.08	2	7.2	12	19	2.64	9.1	0.23	0.22	0.20	0.7	0.01	0.22	<0.01	1.04
L1985339-6 128565	1.24	2	7.5	12	19	2.53	9.1	0.24	0.23	0.21	0.8	0.01	0.23	0.01	1.20
L1985339-7 128566	1.30	2	9.1	11	20	2.21	9.0	0.29	0.26	0.20	0.8	0.03	0.24	0.01	1.34
L1985339-8 128567	1.08	2	8.4	14	22	2.61	9.0	0.27	0.25	0.23	0.9	0.02	0.28	<0.01	1.30
L1985339-9 128568	1.14	2	7.5	12	19	2.53	9.1	0.24	0.23	0.18	0.7	0.01	0.21	0.01	1.19
L1985339-10 128569	1.42	2	8.1	11	19	2.34	9.1	0.26	0.26	0.18	0.7	<0.01	0.21	<0.01	1.14

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985339

CERTIFICATE OF ANALYSIS VA17194473

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description / **LOR**	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L1985339-1 128560	1.05	0.6	0.24	<10	240	0.19	0.77	0.76	0.46	20.7	5.5	6	0.31	5310	3.25
L1985339-2 128561	1.12	0.9	0.07	<10	250	0.21	0.54	0.69	0.17	21.6	5.3	7	0.33	3120	3.03
L1985339-3 128562	1.15	0.8	0.12	<10	270	0.22	0.40	0.81	0.24	24.5	5.7	6	0.32	3400	2.98
L1985339-4 128563	1.19	0.8	0.12	<10	260	0.20	0.68	0.76	0.22	23.9	5.6	7	0.32	3850	3.03
L1985339-5 128564	1.08	0.8	0.27	<10	240	0.19	0.51	0.77	0.19	21.9	5.2	7	0.31	3170	2.88
L1985339-6 128565	1.15	0.8	0.12	<10	240	0.23	0.52	0.77	0.19	21.3	5.4	7	0.33	3780	3.09
L1985339-7 128566	1.11	1.0	0.16	<10	250	0.22	0.53	0.78	0.21	21.7	5.4	6	0.32	4280	3.03
L1985339-8 128567	1.15	0.7	0.11	<10	250	0.21	0.64	0.89	0.26	22.8	5.6	7	0.33	3970	3.09
L1985339-9 128568	1.09	0.7	0.54	<10	240	0.20	0.44	0.75	0.23	22.6	5.2	7	0.31	3490	2.91
L1985339-10 128569	1.13	0.9	0.16	<10	240	0.21	0.53	0.74	0.20	21.4	5.8	7	0.32	3610	2.97

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985339

CERTIFICATE OF ANALYSIS VA17194473

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
LOR	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L1985339-1 128560	5.81	0.07	0.03	0.01	0.049	0.59	11.2	5.0	0.58	547	0.68	0.08	0.24	1.7	540
L1985339-2 128561	5.59	0.07	0.03	<0.01	0.035	0.61	11.5	5.0	0.56	522	0.79	0.09	0.22	1.9	570
L1985339-3 128562	5.73	0.08	0.03	0.01	0.044	0.65	13.0	5.3	0.62	569	1.05	0.09	0.23	1.8	620
L1985339-4 128563	6.00	0.08	0.04	<0.01	0.048	0.64	12.7	5.6	0.63	559	1.00	0.10	0.23	1.8	620
L1985339-5 128564	5.56	0.08	0.04	<0.01	0.037	0.59	11.6	5.0	0.57	531	1.37	0.09	0.21	1.7	570
L1985339-6 128565	5.91	0.07	0.04	0.01	0.047	0.61	11.3	5.2	0.60	563	0.56	0.11	0.22	1.8	580
L1985339-7 128566	5.74	0.07	0.03	0.01	0.056	0.61	11.9	5.2	0.59	552	0.75	0.09	0.27	1.7	600
L1985339-8 128567	5.90	0.07	0.04	<0.01	0.044	0.63	12.0	5.2	0.59	550	1.25	0.10	0.25	1.8	570
L1985339-9 128568	5.71	0.06	0.04	<0.01	0.044	0.59	12.2	5.1	0.58	524	1.24	0.08	0.21	1.7	570
L1985339-10 128569	6.24	0.08	0.04	0.01	0.046	0.61	11.6	5.3	0.59	535	0.95	0.09	0.26	2.0	560

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985339

CERTIFICATE OF ANALYSIS VA17194473

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L1985339-1 128560		2.3	27.8	0.002	0.36	0.06	2.9	4.8	0.6	64.0	<0.01	0.34	2.7	0.113	0.16	0.27
L1985339-2 128561		2.1	28.1	0.001	0.21	0.08	3.2	2.8	0.6	62.5	<0.01	0.17	2.8	0.113	0.18	0.24
L1985339-3 128562		2.3	29.7	0.001	0.27	0.07	3.3	3.4	0.6	74.6	<0.01	0.20	3.1	0.121	0.19	0.27
L1985339-4 128563		2.1	29.6	0.002	0.29	0.05	3.3	3.6	0.6	71.9	<0.01	0.24	3.2	0.120	0.18	0.26
L1985339-5 128564		2.1	28.2	0.003	0.24	0.05	3.1	3.2	0.5	63.4	<0.01	0.22	3.0	0.108	0.19	0.31
L1985339-6 128565		2.5	28.1	<0.001	0.27	0.07	3.4	3.2	0.6	69.3	<0.01	0.21	2.9	0.112	0.19	0.25
L1985339-7 128566		2.4	28.7	0.002	0.32	0.14	3.4	3.7	0.6	66.0	<0.01	0.27	2.9	0.113	0.19	0.22
L1985339-8 128567		2.2	29.3	0.003	0.28	0.08	3.3	3.7	0.6	68.9	<0.01	0.27	2.9	0.117	0.19	0.28
L1985339-9 128568		2.2	27.1	0.003	0.25	0.11	3.2	2.9	0.6	61.2	<0.01	0.22	2.9	0.109	0.17	0.27
L1985339-10 128569		2.5	29.7	0.002	0.28	0.05	3.5	3.7	0.6	65.4	<0.01	0.23	2.9	0.113	0.18	0.32

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-OCT-2017
Account: APN

Project: L1985339

CERTIFICATE OF ANALYSIS VA17194473

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	V	W	Y	Zn	Zr
	Units	ppm	ppm	ppm	ppm	ppm
	LOR	1	0.05	0.05	2	0.5
L1985339-1 128560		52	<0.05	3.97	83	0.7
L1985339-2 128561		53	0.05	4.26	70	0.8
L1985339-3 128562		54	0.05	5.18	76	0.8
L1985339-4 128563		55	0.18	4.61	78	0.8
L1985339-5 128564		50	0.07	4.33	70	0.7
L1985339-6 128565		52	0.07	4.38	74	0.8
L1985339-7 128566		52	0.09	4.51	75	0.8
L1985339-8 128567		54	<0.05	4.67	76	0.8
L1985339-9 128568		51	0.05	4.55	71	0.7
L1985339-10 128569		51	<0.05	4.68	75	0.8

***** See Appendix Page for comments regarding this certificate *****

Project: L1985339

CERTIFICATE OF ANALYSIS VA17194473

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-ELE07
S-CAL06a
SPL-21
C-IR07
OA-VOL08m
S-GRA06
WEI-21
LOG-22
PUL-31
S-GRA06a
ME-MS41
PUL-QC
S-IR08

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-OCT-2017
This copy reported on 21-NOV-2017
Account: APN

QC CERTIFICATE VA17194473

Project: L1985339

P.O. No.: ALSM-CW16-102-APN

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 11-SEP-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE RAMOS	SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1985339

QC CERTIFICATE OF ANALYSIS VA17194473

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
STANDARDS															
Buffer pH6						6.0									
Buffer pH6						6.0									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
DS-1											3.10				
Target Range - Lower Bound											3.01				
Upper Bound											3.25				
GS313-8							1.21				0.92				
Target Range - Lower Bound							1.19				0.90				
Upper Bound							1.29				0.98				
KZK-1	2	25.0	33	58	2.32										
KZK-1	2	25.0	33	58	2.32										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MA-3a								2.43	8.9						
Target Range - Lower Bound								2.31	8.4						
Upper Bound								2.77	10.2						
MRGeo08													4.23	2.52	34.5
Target Range - Lower Bound													4.00	2.44	29.6
Upper Bound													4.92	3.00	36.4
OGGeo08													20.4	2.13	121.5
Target Range - Lower Bound													18.15	2.05	107.0
Upper Bound													22.2	2.53	131.0
OREAS 905													0.51	0.81	33.5
Target Range - Lower Bound													0.45	0.73	28.4
Upper Bound													0.58	0.91	35.0
OREAS 920													0.09	2.28	4.8
Target Range - Lower Bound													0.07	2.18	3.8
Upper Bound													0.12	2.68	4.9
SY-4								0.89	3.3						
Target Range - Lower Bound								0.84	3.0						
Upper Bound								1.08	4.0						
UTS-1												0.87			
Target Range - Lower Bound												0.83			
Upper Bound												0.93			
UTS-1										0.87					
Target Range - Lower Bound										0.81					
Upper Bound										0.95					
UTS-4												1.75			

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17194473

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description **LOR**	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
	STANDARDS														
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	<0.02	<10	430	0.76	0.63	1.02	2.18	72.0	18.7	90	10.60	612	3.52	8.84	0.14
Target Range - Lower Bound	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07
Upper Bound	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29
OGGeo08	0.07	<10	120	0.70	9.70	0.84	17.40	56.8	94.6	81	9.01	8310	5.02	8.19	0.19
Target Range - Lower Bound	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21
Upper Bound	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45
OREAS 905	0.39	<10	250	0.96	5.45	0.34	0.34	79.1	14.0	18	1.17	1590	3.51	5.78	0.10
Target Range - Lower Bound	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05
Upper Bound	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22
OREAS 920	<0.02	<10	70	0.73	0.53	0.30	0.06	70.7	15.0	41	1.88	114.5	3.54	6.76	0.12
Target Range - Lower Bound	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05
Upper Bound	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

QC CERTIFICATE OF ANALYSIS VA17194473

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
	STANDARDS														
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.68	0.06	0.153	1.26	35.5	31.0	1.12	410	13.10	0.31	1.04	688	990	1050	139.0
Target Range - Lower Bound	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0
Upper Bound	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0
OGGeo08	0.75	0.45	1.370	1.03	28.2	29.0	0.94	384	876	0.28	1.02	8800	790	7100	120.0
Target Range - Lower Bound	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5
Upper Bound	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5
OREAS 905	1.14	0.01	0.567	0.32	39.2	4.6	0.15	355	2.72	0.09	0.32	8.2	250	15.3	17.9
Target Range - Lower Bound	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3
Upper Bound	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3
OREAS 920	0.54	<0.01	0.029	0.39	35.8	21.2	1.05	511	0.33	0.02	0.33	40.6	710	20.8	22.7
Target Range - Lower Bound	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2
Upper Bound	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

QC CERTIFICATE OF ANALYSIS VA17194473

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description / LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.007	0.30	2.98	6.9	1.2	3.1	75.1	0.01	0.02	21.5	0.378	0.76	5.17	100	2.91
Target Range - Lower Bound	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44
Upper Bound	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42
OGGeo08	1.340	2.72	20.2	6.2	11.0	12.4	60.9	0.01	0.14	15.8	0.306	1.30	4.46	79	3.08
Target Range - Lower Bound	1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58
Upper Bound	1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60
OREAS 905	<0.001	0.07	0.95	1.6	2.7	1.2	12.8	<0.01	0.07	7.9	0.021	0.11	2.16	6	0.63
Target Range - Lower Bound	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44
Upper Bound	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76
OREAS 920	<0.001	0.03	0.60	2.8	0.8	1.0	17.3	0.01	0.02	15.1	0.107	0.14	1.96	24	0.51
Target Range - Lower Bound	<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31
Upper Bound	0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
		STANDARDS		
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
DS-1				
Target Range - Lower Bound				
Upper Bound				
GS313-8				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-3a				
Target Range - Lower Bound				
Upper Bound				
MRGeo08		18.35	758	22.0
Target Range - Lower Bound		17.50	708	18.1
Upper Bound		21.5	870	25.7
OGGeo08		16.30	6860	21.6
Target Range - Lower Bound		15.35	6500	19.5
Upper Bound		18.85	7950	27.5
OREAS 905		6.86	66	43.6
Target Range - Lower Bound		6.32	58	39.9
Upper Bound		7.84	76	55.1
OREAS 920		17.30	103	19.6
Target Range - Lower Bound		16.85	93	17.6
Upper Bound		20.7	119	25.0
SY-4				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-4				

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985339

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description / Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
STANDARDS															
Target Range - Lower Bound												1.64			
Upper Bound												1.84			
UTS-4										1.71					
Target Range - Lower Bound										1.61					
Upper Bound										1.87					
BLANKS															
BLANK								<0.05	<0.2						
Target Range - Lower Bound								<0.05	<0.2						
Upper Bound								0.10	0.4						
BLANK													<0.01	<0.01	<0.1
BLANK													<0.01	<0.01	<0.1
Target Range - Lower Bound													<0.01	<0.01	<0.1
Upper Bound													0.02	0.02	0.2
BLANK						6.0									
Target Range - Lower Bound						5.5									
Upper Bound						6.9									
BLANK												<0.01			
Target Range - Lower Bound												<0.01			
Upper Bound												0.02			
BLANK										<0.01					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
BLANK							0.02				<0.01				
Target Range - Lower Bound							<0.01				<0.01				
Upper Bound							0.02				0.02				

QC CERTIFICATE OF ANALYSIS VA17194473

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Target Range - Lower Bound	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L1985339

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description	Method Analyte Units LOR	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.02	<0.01	<0.005	<0.01	<0.2	0.2	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
BLANK		<0.02	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Target Range - Lower Bound		<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound		0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
BLANK	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

Project: L1985339

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description / **Method** **Analyte** **Units** **LOR**	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS			
Target Range - Lower Bound			
Upper Bound			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
BLANKS			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK	<0.05	<2	<0.5
BLANK	<0.05	<2	<0.5
Target Range - Lower Bound	<0.05	<2	<0.5
Upper Bound	0.10	4	1.0
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			

QC CERTIFICATE OF ANALYSIS VA17194473

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description / **LOR**	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
DUPLICATES															
ORIGINAL													0.56	1.41	345
DUP													0.54	1.39	349
Target Range - Lower Bound													0.51	1.32	330
Upper Bound													0.59	1.48	364
ORIGINAL						8.9									
DUP						8.9									
Target Range - Lower Bound						8.4									
Upper Bound						9.4									
ORIGINAL										0.02					
DUP										0.01					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
ORIGINAL	2	6.3	40	46	7.36										
DUP	2	6.3	40	46	7.36										
Target Range - Lower Bound	<1	5.7	37	43	6.98										
Upper Bound	3	6.9	43	49	7.74										
ORIGINAL												<0.01			
DUP												<0.01			
Target Range - Lower Bound												<0.01			
Upper Bound												0.02			
L1985339-9 128568								0.18	0.7						
DUP								0.20	0.7						
Target Range - Lower Bound								0.13	0.5						
Upper Bound								0.25	0.9						
L1985339-10 128569							0.26				0.21				
DUP							0.28				0.22				
Target Range - Lower Bound							0.25				0.20				
Upper Bound							0.29				0.23				
ORIGINAL													0.11	1.68	53.4
DUP													0.12	1.71	56.8
Target Range - Lower Bound													0.10	1.60	52.2
Upper Bound													0.13	1.79	58.0

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
	LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
		DUPLICATES														
ORIGINAL		0.10	<10	100	0.40	0.68	0.10	2.13	26.6	15.0	33	3.48	29.1	3.30	4.01	0.05
DUP		0.12	<10	100	0.42	0.63	0.10	2.15	26.9	14.7	32	3.41	30.1	3.26	3.99	<0.05
Target Range - Lower Bound		0.08	<10	80	0.34	0.61	0.09	2.02	25.4	14.0	30	3.22	28.4	3.11	3.75	<0.05
Upper Bound		0.14	20	120	0.48	0.70	0.12	2.26	28.1	15.7	35	3.67	30.8	3.45	4.25	0.10
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1985339-9 128568																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1985339-10 128569																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		<0.02	<10	60	0.81	0.86	1.27	0.41	42.3	9.0	21	2.16	17.0	2.29	4.80	0.07
DUP		<0.02	<10	60	0.82	0.91	1.31	0.44	42.8	9.7	21	2.24	21.8	2.30	5.12	0.07
Target Range - Lower Bound		<0.02	<10	50	0.72	0.83	1.22	0.39	40.4	8.8	19	2.04	18.5	2.17	4.66	<0.05
Upper Bound		0.04	20	70	0.91	0.94	1.36	0.46	44.7	9.9	23	2.36	20.3	2.42	5.26	0.10

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17194473

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description **LOR**	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
	DUPLICATES														
ORIGINAL	0.03	0.51	0.076	0.06	12.9	14.0	0.32	525	1.04	0.01	0.73	33.4	540	78.1	7.0
DUP	0.02	0.49	0.071	0.06	13.4	14.0	0.32	514	0.95	0.01	0.68	33.6	530	76.6	6.9
Target Range - Lower Bound	<0.02	0.45	0.065	0.05	12.3	13.2	0.29	489	0.90	<0.01	0.62	31.6	500	73.3	6.5
Upper Bound	0.04	0.55	0.082	0.07	14.0	14.8	0.35	550	1.09	0.02	0.79	35.4	570	81.4	7.4
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1985339-9 128568															
DUP															
Target Range - Lower Bound															
Upper Bound															
L1985339-10 128569															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	0.06	0.03	0.048	0.10	21.1	25.6	0.72	456	0.32	0.04	0.80	19.3	1090	18.0	14.7
DUP	0.06	0.03	0.051	0.10	21.7	25.4	0.73	447	0.35	0.04	0.84	20.1	1100	18.1	15.6
Target Range - Lower Bound	0.04	0.02	0.042	0.09	20.1	24.1	0.68	424	0.27	0.03	0.73	18.5	1030	16.9	14.3
Upper Bound	0.08	0.04	0.057	0.12	22.7	26.9	0.77	479	0.40	0.05	0.91	20.9	1160	19.2	16.0

Project: L1985339

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description	Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
								DUPLICATES								
ORIGINAL		<0.001	0.03	2.40	3.4	0.8	0.7	19.8	<0.01	0.05	1.8	0.040	0.13	0.64	50	0.20
DUP		<0.001	0.03	2.35	3.3	0.7	0.7	20.3	<0.01	0.05	1.7	0.037	0.12	0.63	50	0.30
Target Range - Lower Bound		<0.001	0.02	2.15	3.1	0.5	0.5	18.8	<0.01	0.04	1.5	0.032	0.10	0.55	47	0.18
Upper Bound		0.002	0.04	2.60	3.6	1.0	0.9	21.3	0.02	0.06	2.0	0.045	0.15	0.72	54	0.32
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1985339-9 128568																
DUP																
Target Range - Lower Bound																
Upper Bound																
L1985339-10 128569																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		<0.001	0.06	1.10	2.9	0.6	1.0	90.5	<0.01	0.02	3.2	0.026	0.14	0.61	19	0.17
DUP		<0.001	0.06	1.14	3.1	0.8	1.1	94.5	<0.01	0.02	3.2	0.026	0.13	0.64	19	0.15
Target Range - Lower Bound		<0.001	0.05	0.99	2.8	0.5	0.8	87.7	<0.01	<0.01	2.8	0.020	0.10	0.54	17	0.10
Upper Bound		0.002	0.07	1.25	3.3	0.9	1.3	97.3	0.02	0.03	3.6	0.032	0.17	0.71	21	0.22

QC CERTIFICATE OF ANALYSIS VA17194473

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
DUPLICATES				
ORIGINAL		3.99	240	0.7
DUP		3.98	240	0.5
Target Range - Lower Bound		3.74	226	<0.5
Upper Bound		4.23	254	1.0
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1985339-9 128568				
DUP				
Target Range - Lower Bound				
Upper Bound				
L1985339-10 128569				
DUP				
Target Range - Lower Bound				
Upper Bound				
ORIGINAL		10.70	72	1.9
DUP		11.25	73	2.0
Target Range - Lower Bound		10.40	67	1.3
Upper Bound		11.55	78	2.6

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 5-OCT-2017
Account: APN

Project: L1985339

QC CERTIFICATE OF ANALYSIS VA17194473

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-ELE07
S-CAL06a
SPL-21
C-IR07
OA-VOL08m
S-GRA06
WEI-21
LOG-22
PUL-31
S-GRA06a
ME-MS41
PUL-QC
S-IR08

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1985339-COFC

COC Number: 17 28

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- 4 day [P4] ☐
- 3 day [P3] ☐
- 2 day [P2] ☐

EMERGENCY
- 1 Business day [E1] ☐
- Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
		~~12~~		Composite	R	R	R	R	R	R	
	128560	12-AUG-17		WASTE	X	X	X	X	X	X	
	128561	12-AUG-17		WASTE	X	X	X	X	X	X	
	128562	12-AUG-17		WASTE	X	X	X	X	X	X	
	128563	12-AUG-17		WASTE	X	X	X	X	X	X	
	128564	12-AUG-17		WASTE	X	X	X	X	X	X	
	128565	12-AUG-17		WASTE	X	X	X	X	X	X	
	128566	12-AUG-17		WASTE	X	X	X	X	X	X	
	128567	12-AUG-17		WASTE	X	X	X	X	X	X	
	128568	12-AUG-17		WASTE	X	X	X	X	X	X	
	128569	12-AUG-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
20.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: EHF	Date: 1 Sep 2017	Time: 15:08	Received by: Michelle	Date: Sept. 6 '17	Time: 12:55

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

4, 9, 4, 4, 5, 6, 9, 11, 10, 8

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 01-SEP-17
Report Date: 14-NOV-17 18:34 (MT)
Version: FINAL

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L1985340
Project P.O. #: PO#227382
Job Reference:
C of C Numbers: 17 29
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L1985340-1	L1985340-2	L1985340-3	L1985340-4	L1985340-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	16-AUG-17	19-AUG-17	20-AUG-17	20-AUG-17	21-AUG-17
	Sampled Time					
	Client ID	128165	128166	128167	128168	128169
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.6	8.6	9.0	8.6	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.27	0.22	0.24	0.51	0.47
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	<0.3	0.3	8.1	10.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	26	23	23	37	34
	NNP (tCaCO3/1Kt)	25	23	23	29	23
	Ratio (NP/MPA) (Unity)	41.60	147.20	73.60	4.55	3.20
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.02	0.02	0.01	0.02	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	<0.01	<0.01	<0.01	0.24	0.33
	Total Sulfur (combustion) (%)	0.02	<0.01	0.01	0.26	0.34
Total Metals	Aluminum (Al) (%)	1.26	0.99	1.22	1.15	1.48
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	0.8	1.3	0.6	1.1	1.0
	Barium (Ba) (ppm)	370	200	260	120	310
	Beryllium (Be) (ppm)	0.26	0.37	0.36	0.36	0.29
	Bismuth (Bi) (ppm)	0.08	0.16	0.02	0.24	0.60
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.12	0.16	0.04	0.21	0.39
	Calcium (Ca) (%)	1.02	0.90	0.99	1.39	1.32
	Cerium (Ce) (ppm)	30.2	24.1	23.6	27.5	28.9
	Cesium (Cs) (ppm)	0.49	0.34	0.36	0.30	0.74
	Chromium (Cr) (ppm)	9	5	6	5	12
	Cobalt (Co) (ppm)	7.5	5.8	6.5	6.8	10.2
	Copper (Cu) (ppm)	1225	1020	88.2	2640	4640
	Gallium (Ga) (ppm)	6.22	5.72	6.44	6.89	8.25
	Germanium (Ge) (ppm)	0.13	0.13	0.14	0.12	0.15
	Gold (Au) (ppm)	<0.02	0.02	<0.02	0.06	0.09
	Hafnium (Hf) (ppm)	0.08	0.05	0.05	0.05	0.15
	Indium (In) (ppm)	0.029	0.024	0.032	0.060	0.091
	Iron (Fe) (%)	2.52	2.17	2.42	2.73	3.61
	Lanthanum (La) (ppm)	16.6	12.9	12.2	14.2	15.5
	Lead (Pb) (ppm)	3.0	3.3	2.4	4.1	4.6
	Lithium (Li) (ppm)	5.9	6.8	7.5	8.4	7.6
	Magnesium (Mg) (%)	0.70	0.53	0.74	0.74	1.04
	Manganese (Mn) (ppm)	617	579	650	538	820

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1985340-6 Waste 24-AUG-17 128170	L1985340-7 Waste 24-AUG-17 128171	L1985340-8 Waste 25-AUG-17 128172	L1985340-9 Waste 25-AUG-17 128173	
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.8	8.7	9.0	8.8	
Organic / Inorganic Carbon	Carbon (C) (%)	0.67	0.93	0.38	1.02	
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	
	MPA (tCaCO3/1Kt)	1.6	0.9	0.9	0.3	
	Neutralization Potential (NP) (tCaCO3/1Kt)	38	47	28	60	
	NNP (tCaCO3/1Kt)	36	46	27	60	
	Ratio (NP/MPA) (Unity)	24.32	50.13	29.87	192.00	
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	0.01	<0.01	
	Sulfate Sulfur (HCl leach) (%)	0.04	0.02	0.02	0.01	
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	0.01	0.01	<0.01	
	Total Sulfur (combustion) (%)	0.05	0.03	0.03	0.01	
Total Metals	Aluminum (Al) (%)	0.89	0.78	1.10	0.50	
	Antimony (Sb) (ppm)	0.07	0.07	<0.05	0.12	
	Arsenic (As) (ppm)	1.7	1.4	0.8	4.8	
	Barium (Ba) (ppm)	120	130	250	40	
	Beryllium (Be) (ppm)	0.40	0.46	0.28	0.56	
	Bismuth (Bi) (ppm)	0.11	0.06	0.09	0.01	
	Boron (B) (ppm)	<10	<10	<10	<10	
	Cadmium (Cd) (ppm)	0.06	0.07	0.04	0.03	
	Calcium (Ca) (%)	1.37	1.71	1.00	1.88	
	Cerium (Ce) (ppm)	27.6	26.9	23.5	25.0	
	Cesium (Cs) (ppm)	0.46	0.43	0.31	0.23	
	Chromium (Cr) (ppm)	5	4	5	3	
	Cobalt (Co) (ppm)	6.5	6.8	6.1	6.1	
	Copper (Cu) (ppm)	685	392	420	32.2	
	Gallium (Ga) (ppm)	5.32	4.98	6.16	3.36	
	Germanium (Ge) (ppm)	0.13	0.12	0.13	0.11	
	Gold (Au) (ppm)	0.02	<0.02	0.02	<0.02	
	Hafnium (Hf) (ppm)	0.05	0.04	0.04	0.03	
	Indium (In) (ppm)	0.041	0.031	0.022	0.031	
	Iron (Fe) (%)	2.44	2.63	2.44	2.22	
	Lanthanum (La) (ppm)	14.8	14.5	12.4	13.6	
	Lead (Pb) (ppm)	3.5	4.4	2.1	4.2	
	Lithium (Li) (ppm)	5.0	4.3	6.3	1.5	
	Magnesium (Mg) (%)	0.67	0.62	0.69	0.52	
	Manganese (Mn) (ppm)	576	646	579	592	

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1985340-1	L1985340-2	L1985340-3	L1985340-4	L1985340-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	16-AUG-17	19-AUG-17	20-AUG-17	20-AUG-17	21-AUG-17
	Sampled Time					
	Client ID	128165	128166	128167	128168	128169
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	2.15	1.17	0.66	1.86	1.86
	Nickel (Ni) (ppm)	10.4	2.3	2.7	3.1	21.4
	Niobium (Nb) (ppm)	0.34	0.10	0.18	0.06	0.24
	Phosphorus (P) (ppm)	710	550	650	800	810
	Potassium (K) (%)	0.85	0.31	0.58	0.24	0.96
	Rhenium (Re) (ppm)	0.001	<0.001	0.001	0.005	0.005
	Rubidium (Rb) (ppm)	41.8	15.0	26.2	11.9	48.2
	Scandium (Sc) (ppm)	4.9	4.5	7.7	4.5	6.8
	Selenium (Se) (ppm)	0.7	0.4	0.4	2.2	3.7
	Silver (Ag) (ppm)	0.70	0.26	0.03	0.50	1.53
	Sodium (Na) (%)	0.07	0.06	0.10	0.06	0.07
	Strontium (Sr) (ppm)	61.2	56.8	88.5	91.2	83.4
	Sulfur (S) (%)	0.03	0.01	0.01	0.28	0.35
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.04	0.01	0.10	0.37
	Thallium (Tl) (ppm)	0.25	0.07	0.14	0.07	0.32
	Thorium (Th) (ppm)	4.1	2.8	2.7	4.0	4.0
	Tin (Sn) (ppm)	0.7	0.5	0.6	0.9	0.8
	Titanium (Ti) (%)	0.140	0.040	0.091	0.026	0.165
	Tungsten (W) (ppm)	0.52	0.46	0.76	0.27	0.70
	Uranium (U) (ppm)	0.28	0.26	0.20	0.30	0.32
	Vanadium (V) (ppm)	61	40	48	48	70
	Yttrium (Y) (ppm)	8.08	9.22	8.90	8.35	8.31
	Zinc (Zn) (ppm)	75	68	76	66	111
	Zirconium (Zr) (ppm)	1.9	1.0	0.9	1.7	4.5
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	0.8	0.9	1.9	1.7
Miscellaneous	Carbon (C) (%)	0.34	0.27	0.31	0.56	0.53

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1985340-6	L1985340-7	L1985340-8	L1985340-9
	Description	Waste	Waste	Waste	Waste
	Sampled Date	24-AUG-17	24-AUG-17	25-AUG-17	25-AUG-17
	Sampled Time				
	Client ID	128170	128171	128172	128173
Grouping	**Analyte**				
SOIL					
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	1.51	0.80	1.34	0.63
	Nickel (Ni) (ppm)	2.3	2.1	2.5	2.2
	Niobium (Nb) (ppm)	0.13	<0.05	0.09	<0.05
	Phosphorus (P) (ppm)	750	670	560	580
	Potassium (K) (%)	0.29	0.14	0.52	0.15
	Rhenium (Re) (ppm)	0.005	0.001	<0.001	<0.001
	Rubidium (Rb) (ppm)	15.3	7.3	25.3	7.9
	Scandium (Sc) (ppm)	4.5	3.8	4.2	4.8
	Selenium (Se) (ppm)	0.9	0.5	0.5	0.3
	Silver (Ag) (ppm)	0.26	0.22	0.16	0.01
	Sodium (Na) (%)	0.06	0.06	0.07	0.05
	Strontium (Sr) (ppm)	114.5	111.5	99.6	183.5
	Sulfur (S) (%)	0.05	0.03	0.02	<0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.03	0.03	<0.01
	Thallium (Tl) (ppm)	0.09	0.03	0.13	0.03
	Thorium (Th) (ppm)	4.1	4.0	2.6	2.5
	Tin (Sn) (ppm)	0.6	0.5	0.5	0.4
	Titanium (Ti) (%)	0.042	0.006	0.079	<0.005
	Tungsten (W) (ppm)	0.30	0.38	0.57	0.10
	Uranium (U) (ppm)	0.48	0.34	0.20	0.29
	Vanadium (V) (ppm)	45	41	48	34
	Yttrium (Y) (ppm)	9.70	8.69	7.10	8.49
	Zinc (Zn) (ppm)	71	76	77	75
	Zirconium (Zr) (ppm)	1.3	1.0	0.7	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	2.5	3.4	1.4	3.8
Miscellaneous	Carbon (C) (%)	0.72	1.02	0.44	1.08

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17 29

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 13-OCT-2017
Account: APN

CERTIFICATE VA17194480

Project: L1985340

P.O. No.: ALSM-CW16-102-APN

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 11-SEP-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L1985340

CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
	Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
	Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
	LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L1985340-1 128165		1.08	2	0.6	25	26	41.60	8.6	0.02	<0.01	0.27	1.0	0.02	0.34	<0.01	0.70
L1985340-2 128166		1.10	2	<0.3	23	23	147.20	8.6	<0.01	<0.01	0.22	0.8	0.02	0.27	<0.01	0.26
L1985340-3 128167		1.06	2	0.3	23	23	73.60	9.0	0.01	<0.01	0.24	0.9	0.01	0.31	<0.01	0.03
L1985340-4 128168		0.92	2	8.1	29	37	4.55	8.6	0.26	0.24	0.51	1.9	0.02	0.56	<0.01	0.50
L1985340-5 128169		1.06	2	10.6	23	34	3.20	8.7	0.34	0.33	0.47	1.7	0.01	0.53	<0.01	1.53
L1985340-6 128170		1.20	2	1.6	36	38	24.32	8.8	0.05	0.01	0.67	2.5	0.04	0.72	<0.01	0.26
L1985340-7 128171		1.04	2	0.9	46	47	50.13	8.7	0.03	0.01	0.93	3.4	0.02	1.02	<0.01	0.22
L1985340-8 128172		1.20	2	0.9	27	28	29.87	9.0	0.03	0.01	0.38	1.4	0.02	0.44	0.01	0.16
L1985340-9 128173		1.04	2	0.3	60	60	192.00	8.8	0.01	<0.01	1.02	3.8	0.01	1.08	<0.01	0.01

CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01
L1985340-1 128165		1.26	0.8	<0.02	<10	370	0.26	0.08	1.02	0.12	30.2	7.5	9	0.49	1225	2.52
L1985340-2 128166		0.99	1.3	0.02	<10	200	0.37	0.16	0.90	0.16	24.1	5.8	5	0.34	1020	2.17
L1985340-3 128167		1.22	0.6	<0.02	<10	260	0.36	0.02	0.99	0.04	23.6	6.5	6	0.36	88.2	2.42
L1985340-4 128168		1.15	1.1	0.06	<10	120	0.36	0.24	1.39	0.21	27.5	6.8	5	0.30	2640	2.73
L1985340-5 128169		1.48	1.0	0.09	<10	310	0.29	0.60	1.32	0.39	28.9	10.2	12	0.74	4640	3.61
L1985340-6 128170		0.89	1.7	0.02	<10	120	0.40	0.11	1.37	0.06	27.6	6.5	5	0.46	685	2.44
L1985340-7 128171		0.78	1.4	<0.02	<10	130	0.46	0.06	1.71	0.07	26.9	6.8	4	0.43	392	2.63
L1985340-8 128172		1.10	0.8	0.02	<10	250	0.28	0.09	1.00	0.04	23.5	6.1	5	0.31	420	2.44
L1985340-9 128173		0.50	4.8	<0.02	<10	40	0.56	0.01	1.88	0.03	25.0	6.1	3	0.23	32.2	2.22

Project: L1985340

CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10
L1985340-1 128165		6.22	0.13	0.08	<0.01	0.029	0.85	16.6	5.9	0.70	617	2.15	0.07	0.34	10.4	710
L1985340-2 128166		5.72	0.13	0.05	<0.01	0.024	0.31	12.9	6.8	0.53	579	1.17	0.06	0.10	2.3	550
L1985340-3 128167		6.44	0.14	0.05	<0.01	0.032	0.58	12.2	7.5	0.74	650	0.66	0.10	0.18	2.7	650
L1985340-4 128168		6.89	0.12	0.05	<0.01	0.060	0.24	14.2	8.4	0.74	538	1.86	0.06	0.06	3.1	800
L1985340-5 128169		8.25	0.15	0.15	0.01	0.091	0.96	15.5	7.6	1.04	820	1.86	0.07	0.24	21.4	810
L1985340-6 128170		5.32	0.13	0.05	<0.01	0.041	0.29	14.8	5.0	0.67	576	1.51	0.06	0.13	2.3	750
L1985340-7 128171		4.98	0.12	0.04	<0.01	0.031	0.14	14.5	4.3	0.62	646	0.80	0.06	<0.05	2.1	670
L1985340-8 128172		6.16	0.13	0.04	<0.01	0.022	0.52	12.4	6.3	0.69	579	1.34	0.07	0.09	2.5	560
L1985340-9 128173		3.36	0.11	0.03	<0.01	0.031	0.15	13.6	1.5	0.52	592	0.63	0.05	<0.05	2.2	580

CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L1985340-1 128165		3.0	41.8	0.001	0.03	<0.05	4.9	0.7	0.7	61.2	<0.01	0.02	4.1	0.140	0.25	0.28
L1985340-2 128166		3.3	15.0	<0.001	0.01	<0.05	4.5	0.4	0.5	56.8	<0.01	0.04	2.8	0.040	0.07	0.26
L1985340-3 128167		2.4	26.2	0.001	0.01	<0.05	7.7	0.4	0.6	88.5	<0.01	0.01	2.7	0.091	0.14	0.20
L1985340-4 128168		4.1	11.9	0.005	0.28	<0.05	4.5	2.2	0.9	91.2	<0.01	0.10	4.0	0.026	0.07	0.30
L1985340-5 128169		4.6	48.2	0.005	0.35	<0.05	6.8	3.7	0.8	83.4	<0.01	0.37	4.0	0.165	0.32	0.32
L1985340-6 128170		3.5	15.3	0.005	0.05	0.07	4.5	0.9	0.6	114.5	<0.01	0.03	4.1	0.042	0.09	0.48
L1985340-7 128171		4.4	7.3	0.001	0.03	0.07	3.8	0.5	0.5	111.5	<0.01	0.03	4.0	0.006	0.03	0.34
L1985340-8 128172		2.1	25.3	<0.001	0.02	<0.05	4.2	0.5	0.5	99.6	<0.01	0.03	2.6	0.079	0.13	0.20
L1985340-9 128173		4.2	7.9	<0.001	<0.01	0.12	4.8	0.3	0.4	183.5	<0.01	<0.01	2.5	<0.005	0.03	0.29

CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L1985340-1 128165		61	0.52	8.08	75	1.9
L1985340-2 128166		40	0.46	9.22	68	1.0
L1985340-3 128167		48	0.76	8.90	76	0.9
L1985340-4 128168		48	0.27	8.35	66	1.7
L1985340-5 128169		70	0.70	8.31	111	4.5
L1985340-6 128170		45	0.30	9.70	71	1.3
L1985340-7 128171		41	0.38	8.69	76	1.0
L1985340-8 128172		48	0.57	7.10	77	0.7
L1985340-9 128173		34	0.10	8.49	75	1.0

Project: L1985340

CERTIFICATE OF ANALYSIS VA17194480

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

QC CERTIFICATE VA17194480

Project: L1985340

P.O. No.: ALSM-CW16-102-APN

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 11-SEP-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
STANDARDS															
Buffer pH6						6.0									
Buffer pH6						6.1									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
CO-ASSAY								0.51	1.9						
Target Range - Lower Bound								0.42	1.5						
Upper Bound								0.64	2.4						
DS-1							2.54				3.12				
Target Range - Lower Bound							2.51				3.01				
Upper Bound							2.71				3.25				
GS313-8							1.22				0.97				
Target Range - Lower Bound							1.19				0.90				
Upper Bound							1.29				0.98				
KZK-1	2	25.0	32	57	2.28										
KZK-1	2	25.0	33	58	2.32										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MA-2c								1.61	5.9						
Target Range - Lower Bound								1.50	5.5						
Upper Bound								1.84	6.8						
OGGeo08													19.45	2.11	119.5
Target Range - Lower Bound													18.15	2.05	107.0
Upper Bound													22.2	2.53	131.0
OREAS 920													0.09	2.18	4.6
Target Range - Lower Bound													0.07	2.18	3.8
Upper Bound													0.12	2.68	4.9
UTS-1												0.87			
Target Range - Lower Bound												0.83			
Upper Bound												0.93			
UTS-1										0.90					
UTS-1										0.90					
Target Range - Lower Bound										0.81					
Upper Bound										0.95					
UTS-4												1.73			
Target Range - Lower Bound												1.64			
Upper Bound												1.84			
UTS-4										1.73					

***** See Appendix Page for comments regarding this certificate *****

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description / **LOR**	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	0.07	<10	90	0.74	10.25	0.86	18.00	58.7	96.3	78	8.97	8220	4.96	8.68	0.20
Target Range - Lower Bound	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21
Upper Bound	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45
OREAS 920	<0.02	<10	70	0.64	0.54	0.29	0.06	70.4	14.1	39	1.90	109.0	3.41	6.50	0.15
Target Range - Lower Bound	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05
Upper Bound	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985340

QC CERTIFICATE OF ANALYSIS   VA17194480

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	0.77	0.47	1.350	1.08	28.5	31.8	0.93	376	857	0.27	1.23	8600	770	7000	122.0
Target Range - Lower Bound	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5
Upper Bound	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5
OREAS 920	0.53	<0.01	0.028	0.39	35.3	19.0	1.02	488	0.33	0.01	0.35	36.0	670	20.2	22.8
Target Range - Lower Bound	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2
Upper Bound	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															

***** See Appendix Page for comments regarding this certificate *****

Project: L1985340

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
		STANDARDS														
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		1.335	2.72	21.3	6.5	10.7	12.5	62.1	0.01	0.15	16.4	0.303	1.32	4.66	78	3.10
Target Range - Lower Bound		1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58
Upper Bound		1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60
OREAS 920		<0.001	0.03	0.67	2.6	0.6	1.0	16.7	0.01	0.02	15.0	0.106	0.14	1.93	23	0.47
Target Range - Lower Bound		<0.001	<0.01	0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31
Upper Bound		0.002	0.05	0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																

Project: L1985340

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS				
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
DS-1				
Target Range - Lower Bound				
Upper Bound				
GS313-8				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-2c				
Target Range - Lower Bound				
Upper Bound				
OGGeo08		17.45	6680	23.3
Target Range - Lower Bound		15.35	6500	19.5
Upper Bound		18.85	7950	27.5
OREAS 920		17.30	99	20.8
Target Range - Lower Bound		16.85	93	17.6
Upper Bound		20.7	119	25.0
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4				

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17194480

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description **LOR**	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
STANDARDS															
UTS-4										1.75					
Target Range - Lower Bound										1.61					
Upper Bound										1.87					
BLANKS															
BLANK								<0.05	<0.2						
Target Range - Lower Bound								<0.05	<0.2						
Upper Bound								0.10	0.4						
BLANK													<0.01	<0.01	<0.1
Target Range - Lower Bound													<0.01	<0.01	<0.1
Upper Bound													0.02	0.02	0.2
BLANK						6.0									
Target Range - Lower Bound						5.5									
Upper Bound						6.9									
BLANK												<0.01			
Target Range - Lower Bound												<0.01			
Upper Bound												0.02			
BLANK										<0.01					
BLANK										<0.01					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
BLANK							<0.01				0.01				
Target Range - Lower Bound							<0.01				<0.01				
Upper Bound							0.02				0.02				
DUPLICATES															
ORIGINAL							0.28								
DUP							0.29				2.59				
Target Range - Lower Bound							0.27				2.52				
Upper Bound							0.30				2.66				

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	0.08
Target Range - Lower Bound	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L1985340

QC CERTIFICATE OF ANALYSIS VA17194480

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description **LOR**	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
STANDARDS															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Target Range - Lower Bound	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
	LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
STANDARDS																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound		<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound		0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41
Analyte	Y	Zn	Zr
Units	ppm	ppm	ppm
LOR	0.05	2	0.5
STANDARDS			
UTS-4			
Target Range - Lower Bound			
Upper Bound			
BLANKS			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK	<0.05	<2	<0.5
Target Range - Lower Bound	<0.05	<2	<0.5
Upper Bound	0.10	4	1.0
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
BLANK			
Target Range - Lower Bound			
Upper Bound			
BLANK			
Target Range - Lower Bound			
Upper Bound			
DUPLICATES			
ORIGINAL			
DUP			
Target Range - Lower Bound			
Upper Bound			

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description / Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
DUPLICATES															
ORIGINAL													4.75	0.59	28.3
DUP													4.83	0.59	28.7
Target Range - Lower Bound													4.54	0.55	27.0
Upper Bound													5.04	0.63	30.0
L1985340-9 128173	2	0.3	60	60	192.00	8.8		1.02	3.8	0.01		<0.01			
DUP	2	0.3	60	60	192.00	8.9		0.97	3.5	0.01		<0.01			
Target Range - Lower Bound	<1	<0.3	56	56	182.39	8.3		0.90	3.3	<0.01		<0.01			
Upper Bound	3	0.6	64	64	201.61	9.4		1.09	4.0	0.03		0.02			

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
								DUPLICATES								
ORIGINAL		<0.02	20	60	0.58	0.07	2.41	13.15	11.20	3.3	93	1.01	160.0	1.20	3.68	0.20
DUP		<0.02	20	60	0.72	0.08	2.33	12.95	10.70	3.5	93	1.01	157.0	1.18	3.76	0.21
Target Range - Lower Bound		<0.02	<10	50	0.57	0.06	2.24	12.40	10.40	3.1	87	0.91	153.0	1.12	3.48	0.14
Upper Bound		0.04	30	70	0.73	0.09	2.50	13.70	11.50	3.7	99	1.11	164.0	1.26	3.96	0.27
L1985340-9 128173																
DUP																
Target Range - Lower Bound																
Upper Bound																

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
	DUPLICATES														
ORIGINAL	0.22	1.49	0.022	0.27	8.8	2.2	0.46	216	40.9	0.01	0.14	132.0	7800	4.6	12.2
DUP	0.18	1.49	0.017	0.27	8.6	2.7	0.46	211	41.0	0.01	0.15	131.5	7620	4.7	12.9
Target Range - Lower Bound	0.17	1.37	0.014	0.25	8.1	2.2	0.43	198	38.9	<0.01	0.09	125.0	7310	4.2	11.8
Upper Bound	0.23	1.61	0.025	0.29	9.3	2.7	0.49	229	43.0	0.02	0.20	138.5	8110	5.1	13.3
L1985340-9 128173															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
	DUPLICATES														
ORIGINAL	0.065	0.94	11.10	1.9	33.6	0.7	96.1	<0.01	0.23	1.6	0.006	0.31	8.52	639	2.79
DUP	0.066	0.93	11.00	2.1	34.6	0.6	95.9	<0.01	0.28	1.6	0.006	0.31	8.50	639	3.75
Target Range - Lower Bound	0.061	0.88	10.15	1.8	32.2	0.4	91.0	<0.01	0.23	1.3	<0.005	0.27	8.03	606	2.97
Upper Bound	0.070	0.99	11.95	2.2	36.0	0.9	101.0	0.02	0.28	1.9	0.010	0.35	8.99	672	3.57
L1985340-9 128173															
DUP															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L1985340

QC CERTIFICATE OF ANALYSIS VA17194480

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
		DUPLICATES		
ORIGINAL		29.9	1240	10.1
DUP		29.9	1220	9.5
Target Range - Lower Bound		28.4	1165	8.6
Upper Bound		31.4	1295	11.0
L1985340-9 128173				
DUP				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L1985340-COFC

COC Number: 17- 29

Page 1 of 1

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact: **Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	—	—		Composite	R	R	R	R	R	R	
	128165	16-AUG-17		WASTE	X	X	X	X	X	X	
	128166	19-AUG-17		WASTE	X	X	X	X	X	X	
	128167	20-AUG-17		WASTE	X	X	X	X	X	X	
	128168	20-AUG-17		WASTE	X	X	X	X	X	X	
	128169	21-AUG-17		WASTE	X	X	X	X	X	X	
	128170	24-AUG-17		WASTE	X	X	X	X	X	X	
	128171	24-AUG-17		WASTE	X	X	X	X	X	X	
	128172	25-AUG-17		WASTE	X	X	X	X	X	X	
	128173	25-AUG-17		WASTE	X	X	X	X	X	X	
	—	—		—							

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
20.0					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: EHF	Date: 1 Sep 2017	Time: 15:08	Received by: Michelle	Date: Sept. 6, '17	Time: 12:55

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

4;9,4,4,5,6,9,16,10.8 °C

[1] If any water samples are taken from aRegulated Drinking Water (DW) Systemplease submit using anAuthorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 04-OCT-17
Report Date: 18-DEC-17 14:23 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2002449
Project P.O. #: 228594
Job Reference:
C of C Numbers: 17-30
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002449-1	L2002449-2	L2002449-3	L2002449-4	L2002449-5
	Description	Tails	Waste	Waste	Waste	Waste
	Sampled Date		30-AUG-17	15-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time					
	Client ID	AUGUST TAL 2017	128174 751-31B	128175 745-2813	144852 799-64	144851 805-26
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	9.0	8.9	8.5	8.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.33	1.04	0.96	0.25	0.13
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	3.1	6.3	0.6	0.9	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	23	62	65	26	17
	NNP (tCaCO3/1Kt)	20	56	64	25	16
	Ratio (NP/MPA) (Unity)	7.36	9.92	104.00	27.73	27.20
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.01	0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.10	0.19	0.01	0.03	0.02
	Total Sulfur (combustion) (%)	0.10	0.20	0.02	0.03	0.02
Total Metals	Aluminum (Al) (%)	1.03	0.70	0.73	1.24	1.04
	Antimony (Sb) (ppm)	0.06	0.05	0.11	0.40	0.16
	Arsenic (As) (ppm)	1.6	0.9	2.1	4.9	2.5
	Barium (Ba) (ppm)	230	120	100	250	240
	Beryllium (Be) (ppm)	0.25	0.32	0.54	0.42	0.35
	Bismuth (Bi) (ppm)	0.42	0.41	0.01	0.10	0.06
	Boron (B) (ppm)	<10	<10	10	<10	<10
	Cadmium (Cd) (ppm)	0.38	0.13	0.04	0.25	0.14
	Calcium (Ca) (%)	0.90	2.03	2.42	1.10	0.74
	Cerium (Ce) (ppm)	20.5	42.4	29.8	28.7	27.5
	Cesium (Cs) (ppm)	0.53	0.31	0.36	0.82	0.75
	Chromium (Cr) (ppm)	6	4	4	21	9
	Cobalt (Co) (ppm)	7.2	6.5	5.4	8.5	6.8
	Copper (Cu) (ppm)	2510	2430	15.7	290	539
	Gallium (Ga) (ppm)	6.68	4.16	4.56	4.84	4.94
	Germanium (Ge) (ppm)	0.08	0.07	0.05	0.06	0.06
	Gold (Au) (ppm)	0.11	0.07	<0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.04	0.03	0.03	0.22	0.10
	Indium (In) (ppm)	0.085	0.051	0.045	0.031	0.040
	Iron (Fe) (%)	3.85	2.74	2.27	2.55	2.81
	Lanthanum (La) (ppm)	10.6	21.8	15.4	14.9	14.8
	Lead (Pb) (ppm)	3.2	4.5	7.0	6.2	4.2
	Lithium (Li) (ppm)	4.6	3.3	3.2	8.0	4.9
	Magnesium (Mg) (%)	0.63	0.78	0.62	0.71	0.48
	Manganese (Mn) (ppm)	669	587	583	546	651

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002449-6	L2002449-7	L2002449-8	L2002449-9	L2002449-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	26-SEP-17	26-SEP-17	26-SEP-17	25-SEP-17	25-SEP-17
	Sampled Time					
	Client ID	144853 799-65	144854 799-65	144855 799-65	144856 799-66	144857 799-66
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	9.2	8.9	8.8	9.0	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.06	0.51	0.44	0.34	0.10
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	2	2
	MPA (tCaCO3/1Kt)	0.6	0.3	0.3	0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	12	47	43	37	16
	NNP (tCaCO3/1Kt)	11	47	43	37	16
	Ratio (NP/MPA) (Unity)	19.20	150.40	137.60	118.40	51.20
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.02	0.01	0.01	0.01	0.01
	Total Sulfur (combustion) (%)	0.02	0.01	0.01	0.01	0.01
Total Metals	Aluminum (Al) (%)	1.03	0.55	0.79	0.92	0.87
	Antimony (Sb) (ppm)	<0.05	<0.05	0.06	<0.05	<0.05
	Arsenic (As) (ppm)	0.7	3.6	1.2	1.1	0.8
	Barium (Ba) (ppm)	190	170	190	270	230
	Beryllium (Be) (ppm)	0.27	0.41	0.47	0.22	0.31
	Bismuth (Bi) (ppm)	0.02	0.10	0.04	0.45	0.02
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.08	0.09	0.08	0.20	0.05
	Calcium (Ca) (%)	0.52	2.03	1.80	1.48	0.63
	Cerium (Ce) (ppm)	21.6	36.6	27.1	20.8	24.9
	Cesium (Cs) (ppm)	0.35	0.71	0.89	0.54	0.47
	Chromium (Cr) (ppm)	4	3	4	4	4
	Cobalt (Co) (ppm)	4.9	6.4	6.1	5.7	5.6
	Copper (Cu) (ppm)	288	878	121.5	1255	78.8
	Gallium (Ga) (ppm)	5.18	3.12	4.24	4.60	4.62
	Germanium (Ge) (ppm)	0.05	0.05	0.06	0.06	0.07
	Gold (Au) (ppm)	<0.02	0.05	<0.02	0.05	<0.02
	Hafnium (Hf) (ppm)	0.04	0.03	0.05	0.05	0.05
	Indium (In) (ppm)	0.020	0.036	0.054	0.033	0.028
	Iron (Fe) (%)	2.11	2.36	2.52	2.43	2.27
	Lanthanum (La) (ppm)	12.2	19.7	13.4	11.3	12.9
	Lead (Pb) (ppm)	3.2	4.5	4.5	2.7	2.5
	Lithium (Li) (ppm)	5.8	1.8	3.0	3.4	4.2
	Magnesium (Mg) (%)	0.52	0.14	0.30	0.43	0.41
	Manganese (Mn) (ppm)	539	799	831	753	610

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002449-1	L2002449-2	L2002449-3	L2002449-4	L2002449-5
	Description	Tails	Waste	Waste	Waste	Waste
	Sampled Date		30-AUG-17	15-SEP-17	26-SEP-17	26-SEP-17
	Sampled Time					
	Client ID	AUGUST TAL 2017	128174 751-31B	128175 745-2813	144852 799-64	144851 805-26
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	0.02	<0.01
	Molybdenum (Mo) (ppm)	2.45	0.83	0.26	1.99	2.93
	Nickel (Ni) (ppm)	3.2	2.5	2.0	18.5	7.3
	Niobium (Nb) (ppm)	0.18	0.09	<0.05	0.73	0.37
	Phosphorus (P) (ppm)	740	950	630	800	790
	Potassium (K) (%)	0.54	0.22	0.10	0.23	0.46
	Rhenium (Re) (ppm)	0.002	0.003	<0.001	0.001	0.001
	Rubidium (Rb) (ppm)	27.7	12.1	5.4	13.6	25.3
	Scandium (Sc) (ppm)	4.2	5.4	4.7	4.6	5.0
	Selenium (Se) (ppm)	2.0	2.0	<0.2	0.3	0.4
	Silver (Ag) (ppm)	0.69	0.64	0.01	0.11	0.09
	Sodium (Na) (%)	0.06	0.05	0.05	0.05	0.05
	Strontium (Sr) (ppm)	64.7	198.5	114.0	51.4	35.3
	Sulfur (S) (%)	0.10	0.20	0.01	0.01	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.22	0.09	0.01	0.02	0.02
	Thallium (Tl) (ppm)	0.22	0.08	0.03	0.13	0.21
	Thorium (Th) (ppm)	3.8	6.1	2.7	4.4	4.3
	Tin (Sn) (ppm)	0.9	0.7	0.7	0.5	0.7
	Titanium (Ti) (%)	0.094	0.026	<0.005	0.070	0.081
	Tungsten (W) (ppm)	0.09	0.23	0.16	0.27	0.35
	Uranium (U) (ppm)	0.34	0.32	0.34	0.70	0.39
	Vanadium (V) (ppm)	67	49	40	50	58
	Yttrium (Y) (ppm)	6.01	8.67	10.05	9.08	9.36
	Zinc (Zn) (ppm)	101	70	78	78	79
	Zirconium (Zr) (ppm)	1.1	1.0	0.7	7.2	2.8
Permanent Gases	Carbon Dioxide (CO2) (%)	1.2	3.8	3.5	0.9	0.5
Miscellaneous	Carbon (C) (%)	0.35	1.13	1.04	0.50	0.21

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2002449-6	L2002449-7	L2002449-8	L2002449-9	L2002449-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	26-SEP-17	26-SEP-17	26-SEP-17	25-SEP-17	25-SEP-17
	Sampled Time					
	Client ID	144853 799-65	144854 799-65	144855 799-65	144856 799-66	144857 799-66
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	0.96	1.76	1.07	0.90	1.00
	Nickel (Ni) (ppm)	2.6	4.3	3.4	2.5	2.7
	Niobium (Nb) (ppm)	0.13	0.07	0.06	0.14	0.08
	Phosphorus (P) (ppm)	560	730	670	700	640
	Potassium (K) (%)	0.41	0.20	0.37	0.59	0.37
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	<0.001	<0.001
	Rubidium (Rb) (ppm)	19.8	13.2	20.0	29.7	18.8
	Scandium (Sc) (ppm)	3.3	3.8	8.6	4.4	5.2
	Selenium (Se) (ppm)	<0.2	0.5	0.2	0.5	<0.2
	Silver (Ag) (ppm)	0.06	0.36	0.04	0.51	0.02
	Sodium (Na) (%)	0.07	0.05	0.05	0.06	0.06
	Strontium (Sr) (ppm)	31.6	35.3	62.6	46.4	34.9
	Sulfur (S) (%)	<0.01	<0.01	<0.01	0.01	<0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	<0.01	0.02	0.01	0.15	<0.01
	Thallium (Tl) (ppm)	0.12	0.06	0.13	0.18	0.10
	Thorium (Th) (ppm)	3.2	5.6	3.4	3.8	2.6
	Tin (Sn) (ppm)	0.5	0.5	0.8	0.6	0.6
	Titanium (Ti) (%)	0.073	0.016	0.043	0.096	0.052
	Tungsten (W) (ppm)	0.35	0.38	0.28	0.60	0.34
	Uranium (U) (ppm)	0.19	0.25	0.28	0.25	0.19
	Vanadium (V) (ppm)	45	39	51	56	46
	Yttrium (Y) (ppm)	4.68	5.76	12.65	7.85	9.65
	Zinc (Zn) (ppm)	60	67	74	72	63
	Zirconium (Zr) (ppm)	0.9	0.9	1.2	1.2	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	0.2	1.9	1.6	1.2	0.4
Miscellaneous	Carbon (C) (%)	0.09	0.57	0.49	0.40	0.13

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-30

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 14-NOV-2017
Account: APN

CERTIFICATE VA17220118

Project: L2002449

P.O. No.: 226298

This report is for 10 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 11-OCT-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2002449

CERTIFICATE OF ANALYSIS   VA17220118

Sample Description / Method / Analyte / Units / LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01	ME-MS41 Ag ppm 0.01
L2002449-1 AUGUST TAL 2017	1.14	2	3.1	20	23	7.36	8.2	0.10	0.10	0.33	1.2	<0.01	0.35	0.01	0.69
L2002449-2 128174 751-31B	1.14	2	6.3	56	62	9.92	9.0	0.20	0.19	1.04	3.8	0.01	1.13	0.01	0.64
L2002449-3 128175 745-2813	1.10	2	0.6	64	65	104.00	8.9	0.02	0.01	0.96	3.5	0.01	1.04	<0.01	0.01
L2002449-4 144852 799-64	1.10	2	0.9	25	26	27.73	8.5	0.03	0.03	0.25	0.9	<0.01	0.50	<0.01	0.11
L2002449-5 144851 805-26	1.12	2	0.6	16	17	27.20	8.8	0.02	0.02	0.13	0.5	<0.01	0.21	<0.01	0.09
L2002449-6 144853 799-65	1.16	1	0.6	11	12	19.20	9.2	0.02	0.02	0.06	0.2	<0.01	0.09	<0.01	0.06
L2002449-7 144854 799-65	1.10	2	0.3	47	47	150.40	8.9	0.01	0.01	0.51	1.9	<0.01	0.57	<0.01	0.36
L2002449-8 144855 799-65	1.08	2	0.3	43	43	137.60	8.8	0.01	0.01	0.44	1.6	<0.01	0.49	<0.01	0.04
L2002449-9 144856 799-66	1.14	2	0.3	37	37	118.40	9.0	0.01	0.01	0.34	1.2	<0.01	0.40	<0.01	0.51
L2002449-10 144857 799-66	1.08	2	0.3	16	16	51.20	8.7	0.01	0.01	0.10	0.4	<0.01	0.13	<0.01	0.02

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2002449

CERTIFICATE OF ANALYSIS VA17220118

Sample Description	Method Analyte Units LOR	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01
L2002449-1 AUGUST TAL 2017		1.03	1.6	0.11	<10	230	0.25	0.42	0.90	0.38	20.5	7.2	6	0.53	2510	3.85
L2002449-2 128174 751-31B		0.70	0.9	0.07	<10	120	0.32	0.41	2.03	0.13	42.4	6.5	4	0.31	2430	2.74
L2002449-3 128175 745-2813		0.73	2.1	<0.02	10	100	0.54	0.01	2.42	0.04	29.8	5.4	4	0.36	15.7	2.27
L2002449-4 144852 799-64		1.24	4.9	<0.02	<10	250	0.42	0.10	1.10	0.25	28.7	8.5	21	0.82	290	2.55
L2002449-5 144851 805-26		1.04	2.5	<0.02	<10	240	0.35	0.06	0.74	0.14	27.5	6.8	9	0.75	539	2.81
L2002449-6 144853 799-65		1.03	0.7	<0.02	<10	190	0.27	0.02	0.52	0.08	21.6	4.9	4	0.35	288	2.11
L2002449-7 144854 799-65		0.55	3.6	0.05	<10	170	0.41	0.10	2.03	0.09	36.6	6.4	3	0.71	878	2.36
L2002449-8 144855 799-65		0.79	1.2	<0.02	<10	190	0.47	0.04	1.80	0.08	27.1	6.1	4	0.89	121.5	2.52
L2002449-9 144856 799-66		0.92	1.1	0.05	<10	270	0.22	0.45	1.48	0.20	20.8	5.7	4	0.54	1255	2.43
L2002449-10 144857 799-66		0.87	0.8	<0.02	<10	230	0.31	0.02	0.63	0.05	24.9	5.6	4	0.47	78.8	2.27

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17220118

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
Sample Description / **LOR**	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2002449-1 AUGUST TAL 2017	6.68	0.08	0.04	<0.01	0.085	0.54	10.6	4.6	0.63	669	2.45	0.06	0.18	3.2	740
L2002449-2 128174 751-31B	4.16	0.07	0.03	<0.01	0.051	0.22	21.8	3.3	0.78	587	0.83	0.05	0.09	2.5	950
L2002449-3 128175 745-2813	4.56	0.05	0.03	<0.01	0.045	0.10	15.4	3.2	0.62	583	0.26	0.05	<0.05	2.0	630
L2002449-4 144852 799-64	4.84	0.06	0.22	0.02	0.031	0.23	14.9	8.0	0.71	546	1.99	0.05	0.73	18.5	800
L2002449-5 144851 805-26	4.94	0.06	0.10	<0.01	0.040	0.46	14.8	4.9	0.48	651	2.93	0.05	0.37	7.3	790
L2002449-6 144853 799-65	5.18	0.05	0.04	<0.01	0.020	0.41	12.2	5.8	0.52	539	0.96	0.07	0.13	2.6	560
L2002449-7 144854 799-65	3.12	0.05	0.03	<0.01	0.036	0.20	19.7	1.8	0.14	799	1.76	0.05	0.07	4.3	730
L2002449-8 144855 799-65	4.24	0.06	0.05	<0.01	0.054	0.37	13.4	3.0	0.30	831	1.07	0.05	0.06	3.4	670
L2002449-9 144856 799-66	4.60	0.06	0.05	<0.01	0.033	0.59	11.3	3.4	0.43	753	0.90	0.06	0.14	2.5	700
L2002449-10 144857 799-66	4.62	0.07	0.05	<0.01	0.028	0.37	12.9	4.2	0.41	610	1.00	0.06	0.08	2.7	640

CERTIFICATE OF ANALYSIS VA17220118

Method Analyte Units LOR Sample Description	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2002449-1 AUGUST TAL 2017	3.2	27.7	0.002	0.10	0.06	4.2	2.0	0.9	64.7	<0.01	0.22	3.8	0.094	0.22	0.34
L2002449-2 128174 751-31B	4.5	12.1	0.003	0.20	0.05	5.4	2.0	0.7	198.5	<0.01	0.09	6.1	0.026	0.08	0.32
L2002449-3 128175 745-2813	7.0	5.4	<0.001	0.01	0.11	4.7	<0.2	0.7	114.0	<0.01	0.01	2.7	<0.005	0.03	0.34
L2002449-4 144852 799-64	6.2	13.6	0.001	0.01	0.40	4.6	0.3	0.5	51.4	<0.01	0.02	4.4	0.070	0.13	0.70
L2002449-5 144851 805-26	4.2	25.3	0.001	0.01	0.16	5.0	0.4	0.7	35.3	<0.01	0.02	4.3	0.081	0.21	0.39
L2002449-6 144853 799-65	3.2	19.8	<0.001	<0.01	<0.05	3.3	<0.2	0.5	31.6	<0.01	<0.01	3.2	0.073	0.12	0.19
L2002449-7 144854 799-65	4.5	13.2	<0.001	<0.01	<0.05	3.8	0.5	0.5	35.3	<0.01	0.02	5.6	0.016	0.06	0.25
L2002449-8 144855 799-65	4.5	20.0	<0.001	<0.01	0.06	8.6	0.2	0.8	62.6	<0.01	0.01	3.4	0.043	0.13	0.28
L2002449-9 144856 799-66	2.7	29.7	<0.001	0.01	<0.05	4.4	0.5	0.6	46.4	<0.01	0.15	3.8	0.096	0.18	0.25
L2002449-10 144857 799-66	2.5	18.8	<0.001	<0.01	<0.05	5.2	<0.2	0.6	34.9	<0.01	<0.01	2.6	0.052	0.10	0.19

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 14-NOV-2017
Account: APN

Project: L2002449

CERTIFICATE OF ANALYSIS VA17220118

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	V	W	Y	Zn	Zr
Units	ppm	ppm	ppm	ppm	ppm
LOR	1	0.05	0.05	2	0.5
L2002449-1 AUGUST TAL 2017	67	0.09	6.01	101	1.1
L2002449-2 128174 751-31B	49	0.23	8.67	70	1.0
L2002449-3 128175 745-2813	40	0.16	10.05	78	0.7
L2002449-4 144852 799-64	50	0.27	9.08	78	7.2
L2002449-5 144851 805-26	58	0.35	9.36	79	2.8
L2002449-6 144853 799-65	45	0.35	4.68	60	0.9
L2002449-7 144854 799-65	39	0.38	5.76	67	0.9
L2002449-8 144855 799-65	51	0.28	12.65	74	1.2
L2002449-9 144856 799-66	56	0.60	7.85	72	1.2
L2002449-10 144857 799-66	46	0.34	9.65	63	0.9

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 14-NOV-2017
Account: APN

Project: L2002449

CERTIFICATE OF ANALYSIS VA17220118

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	S-CAL06a
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 3 (A - E)
Plus Appendix Pages
Finalized Date: 14-NOV-2017
Account: APN

QC CERTIFICATE VA17230122

Project: L2010504

This report is for 8 Soil samples submitted to our lab in Vancouver, BC, Canada on 23-OCT-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE SHANE STACK	ALSEV DATASUBLET	SOFTWARE DEVELOPMENT GROUP

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
SCR-41	Screen to -180um and save both

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	Ag	Al	As	Au	B
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	ppm	%	ppm	ppm	ppm
Sample Description LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.1	0.02	10
STANDARDS															
Buffer pH6						6.0									
Buffer pH6						6.0									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
CO-ASSAY								0.47	1.7						
Target Range - Lower Bound								0.42	1.5						
Upper Bound								0.64	2.4						
DS-1							2.63								
Target Range - Lower Bound							2.51								
Upper Bound							2.71								
GS313-8							1.23								
Target Range - Lower Bound							1.19								
Upper Bound							1.29								
KZK-1	2	25.0	31	56	2.24										
KZK-1	2	25.0	32	57	2.28										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MA-2c								1.56	5.7						
Target Range - Lower Bound								1.50	5.5						
Upper Bound								1.84	6.8						
OGGeo08											19.30	2.12	122.5	0.07	<10
Target Range - Lower Bound											18.15	2.05	107.0	0.03	<10
Upper Bound											22.2	2.53	131.0	0.11	30
OREAS 920											0.10	2.22	4.9	<0.02	<10
Target Range - Lower Bound											0.07	2.18	3.8	<0.02	<10
Upper Bound											0.12	2.68	4.9	0.04	20
UTS-1										0.87					
Target Range - Lower Bound										0.81					
Upper Bound										0.95					
UTS-4										1.75					
Target Range - Lower Bound										1.61					
Upper Bound										1.87					

QC CERTIFICATE OF ANALYSIS VA17230122

Sample Description Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	Hg
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
LOR	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02	0.01
	STANDARDS														
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	90	0.80	11.55	0.85	18.65	65.8	96.4	79	9.66	8160	4.93	8.15	0.19	0.76	0.48
Target Range - Lower Bound	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21	0.72	0.41
Upper Bound	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45	0.92	0.57
OREAS 920	70	0.79	0.59	0.30	0.06	77.0	13.7	40	1.88	110.0	3.42	6.25	0.10	0.54	<0.01
Target Range - Lower Bound	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05	0.53	<0.01
Upper Bound	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22	0.69	0.02
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 14-NOV-2017
Account: APN

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S
Units	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description **LOR**	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001	0.01
								STANDARDS							
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	1.535	1.05	32.2	32.3	0.92	368	843	0.28	0.90	8570	780	7000	125.5	1.450	2.64
Target Range - Lower Bound	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5	1.295	2.51
Upper Bound	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5	1.585	3.09
OREAS 920	0.029	0.40	38.6	21.7	1.01	480	0.33	0.01	0.34	37.6	680	22.4	24.1	<0.001	0.03
Target Range - Lower Bound	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2	<0.001	<0.01
Upper Bound	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4	0.002	0.05
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W	Y	Zn
	Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05	0.05	2
	STANDARDS															
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		18.55	6.2	10.5	13.5	67.0	0.01	0.19	18.3	0.297	1.24	4.61	77	2.78	17.75	6730
Target Range - Lower Bound		17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58	15.35	6500
Upper Bound		24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60	18.85	7950
OREAS 920		0.55	2.7	0.4	1.0	18.0	0.01	0.01	16.3	0.115	0.13	1.94	23	0.45	18.30	98
Target Range - Lower Bound		0.45	2.5	0.4	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31	16.85	93
Upper Bound		0.77	3.3	1.3	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61	20.7	119
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Sample Description	Method Analyte Units LOR	ME-MS41 Zr ppm 0.5
STANDARDS		
Buffer pH6		
Buffer pH6		
Target Range - Lower Bound		
Upper Bound		
CO-ASSAY		
Target Range - Lower Bound		
Upper Bound		
DS-1		
Target Range - Lower Bound		
Upper Bound		
GS313-8		
Target Range - Lower Bound		
Upper Bound		
KZK-1		
KZK-1		
Target Range - Lower Bound		
Upper Bound		
MA-2c		
Target Range - Lower Bound		
Upper Bound		
OGGeo08		23.7
Target Range - Lower Bound		19.5
Upper Bound		27.5
OREAS 920		21.7
Target Range - Lower Bound		17.6
Upper Bound		25.0
UTS-1		
Target Range - Lower Bound		
Upper Bound		
UTS-4		
Target Range - Lower Bound		
Upper Bound		

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	Ag	Al	As	Au	B
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	ppm	%	ppm	ppm	ppm
LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.1	0.02	10
Sample Description															
BLANKS															
BLANK								<0.05	<0.2						
Target Range - Lower Bound								<0.05	<0.2						
Upper Bound								0.10	0.4						
BLANK											<0.01	<0.01	<0.1	<0.02	<10
Target Range - Lower Bound											<0.01	<0.01	<0.1	<0.02	<10
Upper Bound											0.02	0.02	0.2	0.04	20
BLANK						6.0									
Target Range - Lower Bound						5.5									
Upper Bound						6.9									
BLANK										<0.01					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
BLANK							<0.01								
Target Range - Lower Bound							<0.01								
Upper Bound							0.02								
DUPLICATES															
L2010504-5 GTP17-16 S1							0.08								
DUP							0.08								
Target Range - Lower Bound							0.07								
Upper Bound							0.09								
L2010504-8 TP31	1	0.9	9	10	10.67			<0.05	<0.2	0.01					
DUP	1	0.9	9	10	10.67			<0.05	<0.2	0.02					
Target Range - Lower Bound	<1	0.6	8	9	10.13			<0.05	<0.2	<0.01					
Upper Bound	2	1.2	10	12	11.21			0.10	0.4	0.02					
ORIGINAL											0.03	0.81	62.2	<0.02	<10
DUP											0.05	0.84	64.4	<0.02	<10
Target Range - Lower Bound											0.03	0.77	60.0	<0.02	<10
Upper Bound											0.05	0.88	66.6	0.04	20
ORIGINAL						8.1									
DUP						8.1									
Target Range - Lower Bound						7.6									
Upper Bound						8.6									

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 14-NOV-2017
Account: APN

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	Hg
	Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description	**LOR**	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05	0.02	0.01
								BLANKS								
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02	<0.01
Target Range - Lower Bound		<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05	<0.02	<0.01
Upper Bound		20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10	0.04	0.02
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
								DUPLICATES								
L2010504-5 GTP17-16 S1																
DUP																
Target Range - Lower Bound																
Upper Bound																
L2010504-8 TP31																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		90	0.41	0.10	0.12	0.08	37.3	6.7	14	0.91	9.7	1.62	2.81	0.05	0.02	0.03
DUP		90	0.36	0.09	0.13	0.10	39.8	6.8	15	0.98	12.4	1.65	2.87	0.05	0.02	0.05
Target Range - Lower Bound		70	0.32	0.08	0.11	0.08	36.6	6.3	13	0.85	10.5	1.54	2.65	<0.05	<0.02	0.03
Upper Bound		110	0.45	0.11	0.14	0.10	40.5	7.2	16	1.04	11.6	1.73	3.03	0.10	0.04	0.05
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 14-NOV-2017
Account: APN

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S
Units	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
LOR	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1	0.001	0.01
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001	<0.01
Target Range - Lower Bound	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1	<0.001	<0.01
Upper Bound	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2	0.002	0.02
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
L2010504-5 GTP17-16 S1															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2010504-8 TP31															
DUP															
Target Range - Lower Bound															
Upper Bound															
ORIGINAL	0.017	0.08	19.2	6.2	0.16	898	0.85	0.01	1.51	6.7	320	9.4	10.0	<0.001	0.01
DUP	0.019	0.08	20.5	6.2	0.17	918	1.14	0.01	1.54	9.4	330	11.7	10.6	<0.001	0.01
Target Range - Lower Bound	0.012	0.07	18.7	5.8	0.15	858	0.90	<0.01	1.40	7.4	300	9.8	9.7	<0.001	<0.01
Upper Bound	0.024	0.09	21.0	6.6	0.18	958	1.09	0.02	1.65	8.7	350	11.3	10.9	0.002	0.02
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17230122

Sample Description	Method Analyte Units LOR	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05	<2
Target Range - Lower Bound		<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05	<0.05	<2
Upper Bound		0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10	0.10	4
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
L2010504-5 GTP17-16 S1																
DUP																
Target Range - Lower Bound																
Upper Bound																
L2010504-8 TP31																
DUP																
Target Range - Lower Bound																
Upper Bound																
ORIGINAL		1.40	2.5	<0.2	0.4	12.9	<0.01	<0.01	13.0	0.044	0.12	3.79	26	0.11	9.25	38
DUP		1.52	2.6	<0.2	0.5	14.1	<0.01	<0.01	14.1	0.047	0.13	4.07	27	0.11	9.85	40
Target Range - Lower Bound		1.30	2.3	<0.2	<0.2	12.6	<0.01	<0.01	12.7	0.038	0.10	3.68	24	<0.05	9.02	35
Upper Bound		1.62	2.8	0.4	0.7	14.4	0.02	0.02	14.4	0.053	0.15	4.18	29	0.17	10.10	43
ORIGINAL																
DUP																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 14-NOV-2017
Account: APN

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

Sample Description **Method** **Analyte** **Units** **LOR**	ME-MS41 Zr ppm 0.5
	BLANKS
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	<0.5
Target Range - Lower Bound	<0.5
Upper Bound	1.0
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	
BLANK	
Target Range - Lower Bound	
Upper Bound	
	DUPLICATES
L2010504-5 GTP17-16 S1	
DUP	
Target Range - Lower Bound	
Upper Bound	
L2010504-8 TP31	
DUP	
Target Range - Lower Bound	
Upper Bound	
ORIGINAL	0.9
DUP	0.9
Target Range - Lower Bound	<0.5
Upper Bound	1.0
ORIGINAL	
DUP	
Target Range - Lower Bound	
Upper Bound	

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2010504

QC CERTIFICATE OF ANALYSIS VA17230122

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	LOG-22	ME-MS41	OA-ELE07
OA-VOL08m	S-CAL06a	SCR-41	S-GRA06a
S-IR08	WEI-21		

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2002449-COFC

COC Number: 17-30

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	AUGUST TAL 2017	AUG. 2017		TAILS	X	X	X	X	X	X	
	128174 751-31B	30/08/17		WASTE	X	X	X	X	X	X	
	128175 745-2813	15/09/17		waste	X	X	X	X	X	X	
	144852 799-64	26/09/17		waste	X	X	X	X	X	X	
	144851 805-26	26/09/17		waste	X	X	X	X	X	X	
	144853 799-65	26/09/17		waste	X	X	X	X	X	X	
	144854 799-65	26/09/17		waste	X	X	X	X	X	X	
	144855 799-65	26/09/17		waste	X	X	X	X	X	X	
	144856 799-66	25/09/17		WASTE	X	X	X	X	X	X	
	144857 799-66	25/09/17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: 14.0

FINAL COOLER TEMPERATURES °C: 14

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: EHF	Date: 4Oct2017	Time: 14:50	Received by: (B) JC	Date: 10/5/17	Time: 13:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	30-OCT-17
Report Date:	15-JAN-18 13:25 (MT)
Version:	FINAL REV. 3

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2015579

Project P.O. #:	228594
Job Reference:	
C of C Numbers:	
Legal Site Desc:	

Comments: Please note,the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

15-JAN-2018 Please note, the sample type, COC and sampling date for L2015579-10 have been revised for this report as requested.

Shane Stack
Account Manager

	Sample ID	L2015579-1	L2015579-2	L2015579-3	L2015579-4	L2015579-5
	Description	Tails	Waste	Waste	Waste	Waste
	Sampled Date	04-SEP-17	30-SEP-17	03-OCT-17	03-OCT-17	07-OCT-17
	Sampled Time					
	Client ID	SEP TAC 2017	144858	144859	144860	144861
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	8.2	8.9	8.8	7.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.30	0.22	0.19	0.44	0.31
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	2.5	0.6	3.1	0.3	1.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	24	24	20	39	25
	NNP (tCaCO3/1Kt)	22	23	17	39	23
	Ratio (NP/MPA) (Unity)	9.60	38.40	6.40	124.80	16.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.01	0.03	<0.01	0.02
	Sulfate Sulfur (HCl leach) (%)	0.05	0.03	0.03	<0.01	0.02
	Sulfide Sulfur (T minus HCl leach) (%)	0.03	<0.01	0.07	0.01	0.03
	Total Sulfur (combustion) (%)	0.08	0.02	0.10	0.01	0.05
Total Metals	Aluminum (Al) (%)	1.04	1.08	1.15	0.94	1.20
	Antimony (Sb) (ppm)	0.06	0.39	<0.05	<0.05	0.57
	Arsenic (As) (ppm)	1.4	5.2	1.0	1.0	7.5
	Barium (Ba) (ppm)	170	290	260	230	280
	Beryllium (Be) (ppm)	0.26	0.40	0.22	0.35	0.51
	Bismuth (Bi) (ppm)	0.55	0.09	0.11	0.05	0.13
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.40	0.23	0.15	0.03	0.29
	Calcium (Ca) (%)	0.94	1.04	0.71	1.51	1.30
	Cerium (Ce) (ppm)	19.35	29.9	46.8	36.6	32.0
	Cesium (Cs) (ppm)	0.48	0.80	0.92	0.82	0.85
	Chromium (Cr) (ppm)	6	19	5	5	31
	Cobalt (Co) (ppm)	7.5	8.1	6.7	6.7	9.8
	Copper (Cu) (ppm)	3190	224	1110	18.5	78.3
	Gallium (Ga) (ppm)	7.47	4.40	6.20	5.32	4.38
	Germanium (Ge) (ppm)	0.11	0.10	0.13	0.12	0.09
	Gold (Au) (ppm)	0.15	<0.02	0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.04	0.20	0.04	0.06	0.27
	Indium (In) (ppm)	0.094	0.029	0.039	0.031	0.025
	Iron (Fe) (%)	4.07	2.41	2.61	2.88	2.41
	Lanthanum (La) (ppm)	10.4	15.3	25.9	18.3	16.2
	Lead (Pb) (ppm)	3.8	4.8	6.0	2.4	6.8
	Lithium (Li) (ppm)	5.9	7.3	5.8	4.0	9.2
	Magnesium (Mg) (%)	0.63	0.57	0.63	0.54	0.59
	Manganese (Mn) (ppm)	735	526	596	692	534

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2015579-6	L2015579-7	L2015579-8	L2015579-9	L2015579-10
	Sample ID	L2015579-6	L2015579-7	L2015579-8	L2015579-9	L2015579-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-OCT-17	10-OCT-17	12-OCT-17	14-OCT-17	15-OCT-17
	Sampled Time					
	Client ID	144862	144863	144864	144865	144866
SOIL						
Physical Tests	pH (Unity)	7.8	8.6	7.5	7.9	7.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.22	0.08	0.19	0.30	0.20
Acid Base Accounting	FIZZ RATING (Unity)	2	1	1	2	2
	MPA (tCaCO3/1Kt)	1.3	0.6	1.6	1.6	1.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	19	12	12	30	18
	NNP (tCaCO3/1Kt)	18	11	10	28	17
	Ratio (NP/MPA) (Unity)	15.20	19.20	7.68	19.20	14.40
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	0.03	0.01	0.01	0.01	0.03
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	0.01	0.04	0.04	0.01
	Total Sulfur (combustion) (%)	0.04	0.02	0.05	0.05	0.04
Total Metals	Aluminum (Al) (%)	1.28	1.16	1.19	1.57	1.82
	Antimony (Sb) (ppm)	0.55	<0.05	0.55	0.77	0.77
	Arsenic (As) (ppm)	7.2	1.5	7.2	9.3	10.4
	Barium (Ba) (ppm)	290	110	280	400	380
	Beryllium (Be) (ppm)	0.50	0.22	0.49	0.69	0.74
	Bismuth (Bi) (ppm)	0.12	0.10	0.11	0.16	0.20
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.25	0.31	0.23	0.40	0.37
	Calcium (Ca) (%)	1.01	0.44	0.84	1.37	0.94
	Cerium (Ce) (ppm)	30.2	27.1	28.2	35.7	38.4
	Cesium (Cs) (ppm)	0.88	0.93	0.80	1.46	1.58
	Chromium (Cr) (ppm)	29	6	27	38	40
	Cobalt (Co) (ppm)	9.3	6.6	9.0	12.4	13.5
	Copper (Cu) (ppm)	90.9	2440	105.0	96.6	124.0
	Gallium (Ga) (ppm)	4.43	6.89	4.32	5.33	5.92
	Germanium (Ge) (ppm)	0.09	0.13	0.09	0.10	0.11
	Gold (Au) (ppm)	<0.02	0.04	<0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.26	0.05	0.24	0.31	0.31
	Indium (In) (ppm)	0.026	0.053	0.027	0.029	0.035
	Iron (Fe) (%)	2.54	3.20	2.42	2.97	3.24
	Lanthanum (La) (ppm)	15.0	14.9	14.3	17.8	19.3
	Lead (Pb) (ppm)	6.7	9.4	6.2	8.8	10.2
	Lithium (Li) (ppm)	9.2	6.1	8.9	12.2	14.5
	Magnesium (Mg) (%)	0.58	0.54	0.55	0.82	0.84
	Manganese (Mn) (ppm)	515	890	541	654	653

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2015579-1	L2015579-2	L2015579-3	L2015579-4	L2015579-5
	Description	Tails	Waste	Waste	Waste	Waste
	Sampled Date	04-SEP-17	30-SEP-17	03-OCT-17	03-OCT-17	07-OCT-17
	Sampled Time					
	Client ID	SEP TAC 2017	144858	144859	144860	144861
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.05	<0.01	<0.01	0.04
	Molybdenum (Mo) (ppm)	2.42	1.16	5.25	5.77	1.25
	Nickel (Ni) (ppm)	3.8	15.7	2.3	2.3	24.6
	Niobium (Nb) (ppm)	0.15	0.59	0.28	0.11	1.19
	Phosphorus (P) (ppm)	770	840	780	780	880
	Potassium (K) (%)	0.43	0.34	0.74	0.45	0.17
	Rhenium (Re) (ppm)	0.002	0.001	0.004	0.001	0.002
	Rubidium (Rb) (ppm)	22.8	19.6	40.6	21.9	10.7
	Scandium (Sc) (ppm)	4.4	5.2	6.0	6.9	5.8
	Selenium (Se) (ppm)	2.1	0.4	0.6	0.2	0.3
	Silver (Ag) (ppm)	0.93	0.07	0.30	0.02	0.11
	Sodium (Na) (%)	0.04	0.04	0.06	0.06	0.05
	Strontium (Sr) (ppm)	68.9	53.2	44.6	105.5	73.2
	Sulfur (S) (%)	0.08	0.02	0.10	0.01	0.05
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.26	0.01	0.05	0.02	0.02
	Thallium (Tl) (ppm)	0.19	0.16	0.32	0.13	0.13
	Thorium (Th) (ppm)	4.0	3.7	8.2	4.6	4.2
	Tin (Sn) (ppm)	0.8	0.6	1.0	0.7	0.5
	Titanium (Ti) (%)	0.077	0.090	0.126	0.068	0.079
	Tungsten (W) (ppm)	0.06	0.76	0.38	0.16	0.64
	Uranium (U) (ppm)	0.37	0.47	0.27	0.35	0.87
	Vanadium (V) (ppm)	66	53	61	63	52
	Yttrium (Y) (ppm)	5.93	9.88	7.05	11.45	10.30
	Zinc (Zn) (ppm)	108	68	86	69	61
	Zirconium (Zr) (ppm)	1.2	6.2	1.2	1.3	8.9
Permanent Gases	Carbon Dioxide (CO2) (%)	1.1	0.8	0.7	1.6	1.1
Miscellaneous	Carbon (C) (%)	0.36	0.44	0.26	0.50	1.06

	Sample ID	L2015579-6	L2015579-7	L2015579-8	L2015579-9	L2015579-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-OCT-17	10-OCT-17	12-OCT-17	14-OCT-17	15-OCT-17
	Sampled Time					
	Client ID	144862	144863	144864	144865	144866
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.04	<0.01	0.02	0.05	0.07
	Molybdenum (Mo) (ppm)	1.33	9.99	3.20	2.87	1.48
	Nickel (Ni) (ppm)	22.7	2.3	23.2	39.1	38.4
	Niobium (Nb) (ppm)	1.03	0.26	1.10	0.82	0.90
	Phosphorus (P) (ppm)	830	780	770	900	800
	Potassium (K) (%)	0.19	0.63	0.17	0.24	0.27
	Rhenium (Re) (ppm)	0.001	0.001	0.001	0.003	0.002
	Rubidium (Rb) (ppm)	11.8	40.8	11.4	14.4	16.5
	Scandium (Sc) (ppm)	5.4	6.0	5.2	6.5	6.8
	Selenium (Se) (ppm)	0.3	0.8	0.2	0.5	0.4
	Silver (Ag) (ppm)	0.11	0.44	0.10	0.16	0.18
	Sodium (Na) (%)	0.05	0.05	0.04	0.04	0.04
	Strontium (Sr) (ppm)	61.9	24.7	53.8	74.4	61.2
	Sulfur (S) (%)	0.04	0.02	0.04	0.04	0.04
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.04	0.07	0.04	0.03	0.03
	Thallium (Tl) (ppm)	0.12	0.39	0.11	0.17	0.18
	Thorium (Th) (ppm)	4.1	8.8	3.8	5.1	5.6
	Tin (Sn) (ppm)	0.5	1.4	0.5	0.6	0.7
	Titanium (Ti) (%)	0.086	0.113	0.074	0.074	0.072
	Tungsten (W) (ppm)	0.62	0.37	1.02	1.23	0.46
	Uranium (U) (ppm)	0.86	0.29	0.81	1.05	1.26
	Vanadium (V) (ppm)	55	67	52	60	62
	Yttrium (Y) (ppm)	9.56	7.39	9.23	12.20	12.70
	Zinc (Zn) (ppm)	63	135	61	87	95
	Zirconium (Zr) (ppm)	8.8	1.7	8.0	10.3	10.8
Permanent Gases	Carbon Dioxide (CO2) (%)	0.8	0.3	0.7	1.1	0.7
Miscellaneous	Carbon (C) (%)	1.10	0.10	1.58	1.17	1.19

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 30-NOV-2017
Account: APN

CERTIFICATE VA17240482

Project: L2015579

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 3-NOV-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET
SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2015579

CERTIFICATE OF ANALYSIS VA17240482

Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
Sample Description / LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L2015579-1 SEP TAC 2017	1.12	2	2.5	22	24	9.60	8.2	0.08	0.03	0.30	1.1	0.05	0.36	0.01	0.93
L2015579-2 144858	1.08	2	0.6	23	24	38.40	8.2	0.02	<0.01	0.22	0.8	0.03	0.44	0.01	0.07
L2015579-3 144859	1.06	2	3.1	17	20	6.40	8.9	0.10	0.07	0.19	0.7	0.03	0.26	0.03	0.30
L2015579-4 144860	0.98	2	0.3	39	39	124.80	8.8	0.01	0.01	0.44	1.6	<0.01	0.50	<0.01	0.02
L2015579-5 144861	1.08	2	1.6	23	25	16.00	7.9	0.05	0.03	0.31	1.1	0.02	1.06	0.02	0.11
L2015579-6 144862	1.08	2	1.3	18	19	15.20	7.8	0.04	0.01	0.22	0.8	0.03	1.10	0.01	0.11
L2015579-7 144863	1.06	1	0.6	11	12	19.20	8.6	0.02	0.01	0.08	0.3	0.01	0.10	<0.01	0.44
L2015579-8 144864	1.16	1	1.6	10	12	7.68	7.5	0.05	0.04	0.19	0.7	0.01	1.58	<0.01	0.10
L2015579-9 144865	1.08	2	1.6	28	30	19.20	7.9	0.05	0.04	0.30	1.1	0.01	1.17	<0.01	0.16
L2015579-10 144866	1.08	2	1.3	17	18	14.40	7.7	0.04	0.01	0.20	0.7	0.03	1.19	<0.01	0.18

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2015579

CERTIFICATE OF ANALYSIS VA17240482

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description LOR	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L2015579-1 SEP TAC 2017	1.04	1.4	0.15	<10	170	0.26	0.55	0.94	0.40	19.35	7.5	6	0.48	3190	4.07
L2015579-2 144858	1.08	5.2	<0.02	<10	290	0.40	0.09	1.04	0.23	29.9	8.1	19	0.80	224	2.41
L2015579-3 144859	1.15	1.0	0.02	<10	260	0.22	0.11	0.71	0.15	46.8	6.7	5	0.92	1110	2.61
L2015579-4 144860	0.94	1.0	<0.02	<10	230	0.35	0.05	1.51	0.03	36.6	6.7	5	0.82	18.5	2.88
L2015579-5 144861	1.20	7.5	<0.02	<10	280	0.51	0.13	1.30	0.29	32.0	9.8	31	0.85	78.3	2.41
L2015579-6 144862	1.28	7.2	<0.02	<10	290	0.50	0.12	1.01	0.25	30.2	9.3	29	0.88	90.9	2.54
L2015579-7 144863	1.16	1.5	0.04	<10	110	0.22	0.10	0.44	0.31	27.1	6.6	6	0.93	2440	3.20
L2015579-8 144864	1.19	7.2	<0.02	<10	280	0.49	0.11	0.84	0.23	28.2	9.0	27	0.80	105.0	2.42
L2015579-9 144865	1.57	9.3	<0.02	<10	400	0.69	0.16	1.37	0.40	35.7	12.4	38	1.46	96.6	2.97
L2015579-10 144866	1.82	10.4	<0.02	<10	380	0.74	0.20	0.94	0.37	38.4	13.5	40	1.58	124.0	3.24

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17240482

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
	LOR	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2015579-1 SEP TAC 2017		7.47	0.11	0.04	0.01	0.094	0.43	10.4	5.9	0.63	735	2.42	0.04	0.15	3.8	770
L2015579-2 144858		4.40	0.10	0.20	0.05	0.029	0.34	15.3	7.3	0.57	526	1.16	0.04	0.59	15.7	840
L2015579-3 144859		6.20	0.13	0.04	<0.01	0.039	0.74	25.9	5.8	0.63	596	5.25	0.06	0.28	2.3	780
L2015579-4 144860		5.32	0.12	0.06	<0.01	0.031	0.45	18.3	4.0	0.54	692	5.77	0.06	0.11	2.3	780
L2015579-5 144861		4.38	0.09	0.27	0.04	0.025	0.17	16.2	9.2	0.59	534	1.25	0.05	1.19	24.6	880
L2015579-6 144862		4.43	0.09	0.26	0.04	0.026	0.19	15.0	9.2	0.58	515	1.33	0.05	1.03	22.7	830
L2015579-7 144863		6.89	0.13	0.05	<0.01	0.053	0.63	14.9	6.1	0.54	890	9.99	0.05	0.26	2.3	780
L2015579-8 144864		4.32	0.09	0.24	0.02	0.027	0.17	14.3	8.9	0.55	541	3.20	0.04	1.10	23.2	770
L2015579-9 144865		5.33	0.10	0.31	0.05	0.029	0.24	17.8	12.2	0.82	654	2.87	0.04	0.82	39.1	900
L2015579-10 144866		5.92	0.11	0.31	0.07	0.035	0.27	19.3	14.5	0.84	653	1.48	0.04	0.90	38.4	800

CERTIFICATE OF ANALYSIS VA17240482

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05
L2015579-1 SEP TAC 2017	3.8	22.8	0.002	0.08	0.06	4.4	2.1	0.8	68.9	<0.01	0.26	4.0	0.077	0.19	0.37
L2015579-2 144858	4.8	19.6	0.001	0.02	0.39	5.2	0.4	0.6	53.2	<0.01	0.01	3.7	0.090	0.16	0.47
L2015579-3 144859	6.0	40.6	0.004	0.10	<0.05	6.0	0.6	1.0	44.6	<0.01	0.05	8.2	0.126	0.32	0.27
L2015579-4 144860	2.4	21.9	0.001	0.01	<0.05	6.9	0.2	0.7	105.5	<0.01	0.02	4.6	0.068	0.13	0.35
L2015579-5 144861	6.8	10.7	0.002	0.05	0.57	5.8	0.3	0.5	73.2	<0.01	0.02	4.2	0.079	0.13	0.87
L2015579-6 144862	6.7	11.8	0.001	0.04	0.55	5.4	0.3	0.5	61.9	<0.01	0.04	4.1	0.086	0.12	0.86
L2015579-7 144863	9.4	40.8	0.001	0.02	<0.05	6.0	0.8	1.4	24.7	<0.01	0.07	8.8	0.113	0.39	0.29
L2015579-8 144864	6.2	11.4	0.001	0.04	0.55	5.2	0.2	0.5	53.8	<0.01	0.04	3.8	0.074	0.11	0.81
L2015579-9 144865	8.8	14.4	0.003	0.04	0.77	6.5	0.5	0.6	74.4	<0.01	0.03	5.1	0.074	0.17	1.05
L2015579-10 144866	10.2	16.5	0.002	0.04	0.77	6.8	0.4	0.7	61.2	<0.01	0.03	5.6	0.072	0.18	1.26

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2015579

CERTIFICATE OF ANALYSIS VA17240482

Sample Description / Method Analyte Units LOR	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L2015579-1 SEP TAC 2017	66	0.06	5.93	108	1.2
L2015579-2 144858	53	0.76	9.88	68	6.2
L2015579-3 144859	61	0.38	7.05	86	1.2
L2015579-4 144860	63	0.16	11.45	69	1.3
L2015579-5 144861	52	0.64	10.30	61	8.9
L2015579-6 144862	55	0.62	9.56	63	8.8
L2015579-7 144863	67	0.37	7.39	135	1.7
L2015579-8 144864	52	1.02	9.23	61	8.0
L2015579-9 144865	60	1.23	12.20	87	10.3
L2015579-10 144866	62	0.46	12.70	95	10.8

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2015579

CERTIFICATE OF ANALYSIS VA17240482

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05
C-IR07
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06a
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2015579-COFC

COC Number 17-31

Page 1 of 1

Report To Contact and company name below will appear on the final report
Company: Minto Explorations Ltd.
Contact: Minto Environment - Coordinator
Phone: 1-604-759-4659
Company address below will appear on the final report
Street: 2100-510 West Georgia St.
City/Province: Vancouver, British Columbia
Postal Code: V6B 0M3

Invoice To Same as Report To ☐ YES ☑ NO
Copy of Invoice with Report ☐ YES ☑ NO
Company: Minto Explorations Ltd.
Contact: Ruth Cayetano

Project Information
ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

ALS Lab Work Order # (lab use only):

Report Format / Distribution
Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: minto_environment@mintomine.com
Email 2:
Email 3:

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax: ap@mintomine.com
Email 2:

Oil and Gas Required Fields (client use)
AFE/Cost Center:
PO#:
Major/Minor Code:
Routing Code:
Requisitioner:
Location:

ALS Contact:
Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply
Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply
PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐
EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐
Date and Time Required for all E&P TATs:
For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals - Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	SEP TAC 2017. ✓	24-Sep-17	✓	TAILS	x	x	x	x	x	x	
	144855	30-Sep-17	WASTE	Tails	x	x	x	x	x	x	
	144859	3-Oct-17		Tails	x	x	x	x	x	x	
	144860	3-Oct-17		Tails	x	x	x	x	x	x	
	144861	7-Oct-17		Tails	x	x	x	x	—	x	
	144862	9-Oct-17		Tails	x	x	x	x	x	x	
	144863	12-Oct-17		Tails	x	x	x	x	x	x	
	144864	12-Oct-17		Tails	x	x	x	x	x	x	
	144865	14-Oct-17		Tails	x	x	x	x	x	x	
	144866	17-Oct-17		Tails	x	x	x	x	x	x	
				Tails							

Drinking Water (DW) Samples¹ (client use)
Are samples taken from a Regulated DW System? ☐ YES ☑ NO
Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐
INITIAL COOLER TEMPERATURES °C
FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)
Released by: Date: 26 Oct 2017 Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: Date: Time:

FINAL SHIPMENT RECEPTION (lab use only)
Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 10-NOV-17
Report Date: 15-JAN-18 13:18 (MT)
Version: FINAL REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2021778
Project P.O. #: PO#228594
Job Reference:
C of C Numbers: 17-32
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

15-JAN-2018 Please note, the sample type and COC have been revised for this report as requested.

Shane Stack
Account Manager

	Sample ID	L2021778-1	L2021778-2	L2021778-3	L2021778-4	L2021778-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	16-OCT-17	18-OCT-17	19-OCT-17	21-OCT-17	22-OCT-17
	Sampled Time					
	Client ID	144867	144868	144869	144870	144871
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.6	8.0	7.9	8.2	8.5
Organic / Inorganic Carbon	Carbon (C) (%)	0.19	0.23	0.24	0.28	<0.05
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	1
	MPA (tCaCO3/1Kt)	0.3	1.3	2.2	1.3	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	22	23	22	27	10
	NNP (tCaCO3/1Kt)	22	22	20	26	9
	Ratio (NP/MPA) (Unity)	70.40	18.40	10.06	21.60	16.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.05	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	<0.01	0.07	0.04	0.02
	Total Sulfur (combustion) (%)	0.01	0.04	0.07	0.04	0.02
Total Metals	Aluminum (Al) (%)	0.96	1.18	1.58	0.98	1.08
	Antimony (Sb) (ppm)	<0.05	0.55	0.72	0.44	0.06
	Arsenic (As) (ppm)	1.6	7.0	9.8	7.6	1.7
	Barium (Ba) (ppm)	220	290	340	290	190
	Beryllium (Be) (ppm)	0.27	0.48	0.65	0.37	0.35
	Bismuth (Bi) (ppm)	0.16	0.09	0.16	0.08	0.03
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.18	0.22	0.35	0.20	0.14
	Calcium (Ca) (%)	0.98	1.11	1.17	1.33	0.54
	Cerium (Ce) (ppm)	27.1	29.5	34.9	23.0	27.8
	Cesium (Cs) (ppm)	0.40	0.92	1.42	0.68	0.32
	Chromium (Cr) (ppm)	5	23	36	24	4
	Cobalt (Co) (ppm)	6.5	8.1	13.4	7.5	6.0
	Copper (Cu) (ppm)	1475	132.0	81.5	68.5	474
	Gallium (Ga) (ppm)	5.28	4.56	5.36	3.48	5.70
	Germanium (Ge) (ppm)	0.07	0.06	0.07	0.06	0.06
	Gold (Au) (ppm)	0.03	<0.02	<0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.04	0.20	0.28	0.22	0.04
	Indium (In) (ppm)	0.035	0.027	0.029	0.019	0.025
	Iron (Fe) (%)	2.67	2.48	2.99	2.31	2.33
	Lanthanum (La) (ppm)	14.8	15.2	17.4	11.7	15.2
	Lead (Pb) (ppm)	5.5	5.9	8.4	4.7	3.1
	Lithium (Li) (ppm)	4.7	7.6	11.7	6.5	8.4
	Magnesium (Mg) (%)	0.46	0.58	0.81	0.52	0.54
	Manganese (Mn) (ppm)	819	513	639	420	708

	Sample ID	L2021778-6	L2021778-7	L2021778-8	L2021778-9
	Description	Waste	Waste	Waste	Waste
	Sampled Date	22-OCT-17	25-OCT-17	24-OCT-17	24-OCT-17
	Sampled Time				
	Client ID	144872	144873	144874	144875
Grouping	**Analyte**				
SOIL					
Physical Tests	pH (Unity)	8.6	8.5	8.5	8.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.15	0.36	<0.05	0.10
Acid Base Accounting	FIZZ RATING (Unity)	2	2	1	2
	MPA (tCaCO3/1Kt)	0.6	0.9	0.3	0.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	19	36	5	16
	NNP (tCaCO3/1Kt)	18	35	5	15
	Ratio (NP/MPA) (Unity)	30.40	38.40	16.00	25.60
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.03	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.02	0.03	<0.01	0.01
	Total Sulfur (combustion) (%)	0.02	0.03	0.01	0.02
Total Metals	Aluminum (Al) (%)	0.93	0.79	0.84	1.15
	Antimony (Sb) (ppm)	<0.05	0.40	0.07	<0.05
	Arsenic (As) (ppm)	1.2	7.2	2.7	0.8
	Barium (Ba) (ppm)	230	230	180	320
	Beryllium (Be) (ppm)	0.32	0.31	0.40	0.28
	Bismuth (Bi) (ppm)	0.24	0.07	0.02	0.05
	Boron (B) (ppm)	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.18	0.17	0.12	0.07
	Calcium (Ca) (%)	0.81	1.61	0.29	0.69
	Cerium (Ce) (ppm)	28.6	20.3	32.7	28.7
	Cesium (Cs) (ppm)	0.56	0.57	1.16	0.57
	Chromium (Cr) (ppm)	4	22	4	5
	Cobalt (Co) (ppm)	6.4	6.6	6.4	6.1
	Copper (Cu) (ppm)	871	26.2	135.5	665
	Gallium (Ga) (ppm)	4.94	2.84	4.50	5.83
	Germanium (Ge) (ppm)	0.09	0.06	0.10	0.08
	Gold (Au) (ppm)	0.03	<0.02	<0.02	0.02
	Hafnium (Hf) (ppm)	0.07	0.20	0.05	0.05
	Indium (In) (ppm)	0.037	0.015	0.036	0.041
	Iron (Fe) (%)	2.56	1.92	2.55	2.62
	Lanthanum (La) (ppm)	15.6	10.4	17.0	15.1
	Lead (Pb) (ppm)	2.5	4.0	2.7	2.2
	Lithium (Li) (ppm)	4.3	5.4	4.2	5.3
	Magnesium (Mg) (%)	0.47	0.46	0.32	0.59
	Manganese (Mn) (ppm)	777	362	460	636

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2021778-1	L2021778-2	L2021778-3	L2021778-4	L2021778-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	16-OCT-17	18-OCT-17	19-OCT-17	21-OCT-17	22-OCT-17
	Sampled Time					
	Client ID	144867	144868	144869	144870	144871
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.04	0.06	0.04	<0.01
	Molybdenum (Mo) (ppm)	2.54	2.01	1.37	1.08	2.90
	Nickel (Ni) (ppm)	2.3	20.3	35.8	19.7	2.4
	Niobium (Nb) (ppm)	0.16	1.06	0.94	0.78	0.23
	Phosphorus (P) (ppm)	770	770	810	750	700
	Potassium (K) (%)	0.44	0.27	0.24	0.15	0.34
	Rhenium (Re) (ppm)	0.001	0.004	0.002	0.001	0.001
	Rubidium (Rb) (ppm)	22.2	14.7	15.5	8.3	16.1
	Scandium (Sc) (ppm)	4.5	5.4	6.5	4.7	3.9
	Selenium (Se) (ppm)	0.6	0.4	0.5	0.4	<0.2
	Silver (Ag) (ppm)	0.34	0.10	0.15	0.08	0.09
	Sodium (Na) (%)	0.05	0.05	0.04	0.06	0.05
	Strontium (Sr) (ppm)	40.8	63.0	65.9	69.4	43.5
	Sulfur (S) (%)	0.02	0.05	0.06	0.04	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.09	0.02	0.03	0.01	0.01
	Thallium (Tl) (ppm)	0.12	0.12	0.15	0.08	0.09
	Thorium (Th) (ppm)	4.8	3.8	4.8	3.0	3.2
	Tin (Sn) (ppm)	0.6	0.5	0.6	0.4	0.6
	Titanium (Ti) (%)	0.062	0.070	0.069	0.074	0.055
	Tungsten (W) (ppm)	0.19	0.42	0.33	0.44	0.25
	Uranium (U) (ppm)	0.33	0.71	1.21	0.66	0.25
	Vanadium (V) (ppm)	51	50	58	50	49
	Yttrium (Y) (ppm)	8.35	9.87	11.40	8.18	7.44
	Zinc (Zn) (ppm)	86	76	86	48	71
	Zirconium (Zr) (ppm)	1.1	6.5	9.3	7.5	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	0.7	0.9	0.9	1.0	0.2
Miscellaneous	Carbon (C) (%)	0.25	0.70	0.99	0.60	0.09

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2021778-6	L2021778-7	L2021778-8	L2021778-9
	Description	Waste	Waste	Waste	Waste
	Sampled Date	22-OCT-17	25-OCT-17	24-OCT-17	24-OCT-17
	Sampled Time				
	Client ID	144872	144873	144874	144875
Grouping	**Analyte**				
SOIL					
Total Metals	Mercury (Hg) (ppm)	<0.01	0.04	0.01	<0.01
	Molybdenum (Mo) (ppm)	1.84	0.71	1.60	0.93
	Nickel (Ni) (ppm)	2.3	17.2	2.7	2.6
	Niobium (Nb) (ppm)	0.18	0.41	0.13	0.23
	Phosphorus (P) (ppm)	800	790	790	710
	Potassium (K) (%)	0.51	0.12	0.42	0.70
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.001
	Rubidium (Rb) (ppm)	26.8	6.5	25.0	32.5
	Scandium (Sc) (ppm)	4.9	4.5	8.3	7.4
	Selenium (Se) (ppm)	0.3	0.3	0.2	0.5
	Silver (Ag) (ppm)	0.27	0.05	0.01	0.11
	Sodium (Na) (%)	0.05	0.05	0.05	0.07
	Strontium (Sr) (ppm)	44.9	76.6	23.9	42.6
	Sulfur (S) (%)	0.01	0.03	0.01	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.07	0.01	<0.01	0.01
	Thallium (Tl) (ppm)	0.15	0.07	0.12	0.18
	Thorium (Th) (ppm)	5.0	2.6	4.5	3.6
	Tin (Sn) (ppm)	0.5	0.3	0.8	0.6
	Titanium (Ti) (%)	0.077	0.064	0.057	0.107
	Tungsten (W) (ppm)	0.24	0.51	0.27	0.27
	Uranium (U) (ppm)	0.22	0.54	0.18	0.18
	Vanadium (V) (ppm)	55	42	51	59
	Yttrium (Y) (ppm)	10.10	7.77	11.85	9.10
	Zinc (Zn) (ppm)	83	40	63	74
	Zirconium (Zr) (ppm)	1.4	6.6	1.2	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	0.5	1.3	<0.2	0.4
Miscellaneous	Carbon (C) (%)	0.20	0.59	0.04	0.15

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-32

GLOSSARY OF REPORT TERMS
Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 7-DEC-2017
Account: APN

CERTIFICATE VA17252208

Project: L2021778

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 16-NOV-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2021778

CERTIFICATE OF ANALYSIS VA17252208

Sample Description	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
	Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
	Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
	LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L2021778-1 144867		1.10	2	0.3	22	22	70.40	8.6	0.01	0.01	0.19	0.7	<0.01	0.25	0.01	0.34
L2021778-2 144868		1.08	2	1.3	22	23	18.40	8.0	0.04	<0.01	0.23	0.9	0.05	0.70	<0.01	0.10
L2021778-3 144869		1.08	2	2.2	20	22	10.06	7.9	0.07	0.07	0.24	0.9	<0.01	0.99	<0.01	0.15
L2021778-4 144870		1.08	2	1.3	26	27	21.60	8.2	0.04	0.04	0.28	1.0	<0.01	0.60	0.01	0.08
L2021778-5 144871		1.12	1	0.6	9	10	16.00	8.5	0.02	0.02	<0.05	0.2	<0.01	0.09	<0.01	0.09
L2021778-6 144872		1.00	2	0.6	18	19	30.40	8.6	0.02	0.02	0.15	0.5	<0.01	0.20	<0.01	0.27
L2021778-7 144873		1.12	2	0.9	35	36	38.40	8.5	0.03	0.03	0.36	1.3	<0.01	0.59	0.01	0.05
L2021778-8 144874		1.08	1	0.3	5	5	16.00	8.5	0.01	<0.01	<0.05	<0.2	0.03	0.04	0.01	0.01
L2021778-9 144875		1.06	2	0.6	15	16	25.60	8.8	0.02	0.01	0.10	0.4	0.01	0.15	<0.01	0.11

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17252208

Sample Description	Method Analyte Units LOR	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01
L2021778-1 144867		0.96	1.6	0.03	<10	220	0.27	0.16	0.98	0.18	27.1	6.5	5	0.40	1475	2.67
L2021778-2 144868		1.18	7.0	<0.02	<10	290	0.48	0.09	1.11	0.22	29.5	8.1	23	0.92	132.0	2.48
L2021778-3 144869		1.58	9.8	<0.02	<10	340	0.65	0.16	1.17	0.35	34.9	13.4	36	1.42	81.5	2.99
L2021778-4 144870		0.98	7.6	<0.02	<10	290	0.37	0.08	1.33	0.20	23.0	7.5	24	0.68	68.5	2.31
L2021778-5 144871		1.08	1.7	<0.02	<10	190	0.35	0.03	0.54	0.14	27.8	6.0	4	0.32	474	2.33
L2021778-6 144872		0.93	1.2	0.03	<10	230	0.32	0.24	0.81	0.18	28.6	6.4	4	0.56	871	2.56
L2021778-7 144873		0.79	7.2	<0.02	<10	230	0.31	0.07	1.61	0.17	20.3	6.6	22	0.57	26.2	1.92
L2021778-8 144874		0.84	2.7	<0.02	<10	180	0.40	0.02	0.29	0.12	32.7	6.4	4	1.16	135.5	2.55
L2021778-9 144875		1.15	0.8	0.02	<10	320	0.28	0.05	0.69	0.07	28.7	6.1	5	0.57	665	2.62

Project: L2021778

CERTIFICATE OF ANALYSIS VA17252208

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
	LOR	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2021778-1 144867		5.28	0.07	0.04	<0.01	0.035	0.44	14.8	4.7	0.46	819	2.54	0.05	0.16	2.3	770
L2021778-2 144868		4.56	0.06	0.20	0.04	0.027	0.27	15.2	7.6	0.58	513	2.01	0.05	1.06	20.3	770
L2021778-3 144869		5.36	0.07	0.28	0.06	0.029	0.24	17.4	11.7	0.81	639	1.37	0.04	0.94	35.8	810
L2021778-4 144870		3.48	0.06	0.22	0.04	0.019	0.15	11.7	6.5	0.52	420	1.08	0.06	0.78	19.7	750
L2021778-5 144871		5.70	0.06	0.04	<0.01	0.025	0.34	15.2	8.4	0.54	708	2.90	0.05	0.23	2.4	700
L2021778-6 144872		4.94	0.09	0.07	<0.01	0.037	0.51	15.6	4.3	0.47	777	1.84	0.05	0.18	2.3	800
L2021778-7 144873		2.84	0.06	0.20	0.04	0.015	0.12	10.4	5.4	0.46	362	0.71	0.05	0.41	17.2	790
L2021778-8 144874		4.50	0.10	0.05	0.01	0.036	0.42	17.0	4.2	0.32	460	1.60	0.05	0.13	2.7	790
L2021778-9 144875		5.83	0.08	0.05	<0.01	0.041	0.70	15.1	5.3	0.59	636	0.93	0.07	0.23	2.6	710

CERTIFICATE OF ANALYSIS VA17252208

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2021778-1 144867		5.5	22.2	0.001	0.02	<0.05	4.5	0.6	0.6	40.8	<0.01	0.09	4.8	0.062	0.12	0.33
L2021778-2 144868		5.9	14.7	0.004	0.05	0.55	5.4	0.4	0.5	63.0	<0.01	0.02	3.8	0.070	0.12	0.71
L2021778-3 144869		8.4	15.5	0.002	0.06	0.72	6.5	0.5	0.6	65.9	<0.01	0.03	4.8	0.069	0.15	1.21
L2021778-4 144870		4.7	8.3	0.001	0.04	0.44	4.7	0.4	0.4	69.4	<0.01	0.01	3.0	0.074	0.08	0.66
L2021778-5 144871		3.1	16.1	0.001	0.01	0.06	3.9	<0.2	0.6	43.5	<0.01	0.01	3.2	0.055	0.09	0.25
L2021778-6 144872		2.5	26.8	<0.001	0.01	<0.05	4.9	0.3	0.5	44.9	<0.01	0.07	5.0	0.077	0.15	0.22
L2021778-7 144873		4.0	6.5	<0.001	0.03	0.40	4.5	0.3	0.3	76.6	<0.01	0.01	2.6	0.064	0.07	0.54
L2021778-8 144874		2.7	25.0	<0.001	0.01	0.07	8.3	0.2	0.8	23.9	<0.01	<0.01	4.5	0.057	0.12	0.18
L2021778-9 144875		2.2	32.5	0.001	0.01	<0.05	7.4	0.5	0.6	42.6	<0.01	0.01	3.6	0.107	0.18	0.18

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 7-DEC-2017
Account: APN

Project: L2021778

CERTIFICATE OF ANALYSIS VA17252208

Sample Description	Method Analyte Units LOR	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L2021778-1 144867		51	0.19	8.35	86	1.1
L2021778-2 144868		50	0.42	9.87	76	6.5
L2021778-3 144869		58	0.33	11.40	86	9.3
L2021778-4 144870		50	0.44	8.18	48	7.5
L2021778-5 144871		49	0.25	7.44	71	0.9
L2021778-6 144872		55	0.24	10.10	83	1.4
L2021778-7 144873		42	0.51	7.77	40	6.6
L2021778-8 144874		51	0.27	11.85	63	1.2
L2021778-9 144875		59	0.27	9.10	74	0.9

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05
C-IR07
LOG-22
ME-MS41
OA-ELE07
OA-VOL08m
PUL-31
PUL-QC
S-CAL06a
S-GRA06
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2021778-COFC

COC Number 17 - 32

Page 1 of 1

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

ALS Lab Work Order # (lab use only)

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Oil and Gas Required Fields (client use)

AFE/Cost Center: | PO#

Major/Minor Code: | Routing Code:

Requisitioner:

Location:

ALS Contact: | Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)								Number of Containers
				Composite	R	R	R	R	R	R								
	144567	11-Oct-17	WASTE	tails	X	X	X	X	X	X								
	144568	18-Oct-17	↓	tails	X	X	X	X	X	X								
	144569	19-Oct-17		tails	X	X	X	X	X	X								
	144870	21-Oct-17		tails	X	X	X	X	X	X								
	144871	22-Oct-17		tails	X	X	X	X	X	X								
	144872	22-Oct-17		Tails	X	X	X	X	X	X								
	144873	25-Oct-17		Tails	X	X	X	X	X	X								
	144874	24-Oct-17		Tails	X	X	X	X	X	X								
	144875	24-Oct-17		Tails	X	X	X	X	X	X								

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: BCK | Date: 31 Oct 2017 | Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: | Date: | Time:

FINAL SHIPMENT RECEPTION (lab use only)

Received by: | Date: | Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 20-NOV-17
Report Date: 17-JAN-18 13:20 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2024827
Project P.O. #: PO#228594
Job Reference:
C of C Numbers: 17-33
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L2024827-1	L2024827-2	L2024827-3	L2024827-4	L2024827-5
	Description	waste	waste	waste	waste	tail
	Sampled Date	27-OCT-17	27-OCT-17	29-OCT-17	29-OCT-17	31-OCT-17
	Sampled Time					
	Client ID	145576	145577	145578	145579	OCT TAIL 2017
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	7.9	8.1	8.3	8.3	8.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.27	0.44	0.20	<0.05	0.26
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	1	2
	MPA (tCaCO3/1Kt)	1.6	0.9	0.6	0.3	3.1
	Neutralization Potential (NP) (tCaCO3/1Kt)	23	42	22	9	21
	NNP (tCaCO3/1Kt)	21	41	21	9	18
	Ratio (NP/MPA) (Unity)	14.72	44.80	35.20	28.80	6.72
	Sulfate Sulfur (carbonate leach) (%)	0.02	<0.01	0.01	<0.01	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.05	0.03	0.02	0.01	0.10
	Total Sulfur (combustion) (%)	0.05	0.03	0.02	0.01	0.10
Total Metals	Aluminum (Al) (%)	1.36	1.35	1.02	1.10	1.15
	Antimony (Sb) (ppm)	0.62	0.84	0.37	0.05	0.06
	Arsenic (As) (ppm)	8.6	8.3	3.4	1.2	1.1
	Barium (Ba) (ppm)	320	330	220	150	240
	Beryllium (Be) (ppm)	0.55	0.63	0.43	0.38	0.27
	Bismuth (Bi) (ppm)	0.15	0.13	0.07	0.03	0.49
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.30	0.36	0.18	0.09	0.33
	Calcium (Ca) (%)	1.18	1.75	0.95	0.39	0.88
	Cerium (Ce) (ppm)	29.3	32.1	23.6	20.5	20.0
	Cesium (Cs) (ppm)	1.21	1.41	0.60	0.28	0.55
	Chromium (Cr) (ppm)	32	33	18	4	7
	Cobalt (Co) (ppm)	11.2	10.7	7.1	5.8	7.4
	Copper (Cu) (ppm)	134.5	59.1	85.5	184.5	2260
	Gallium (Ga) (ppm)	4.48	4.45	4.10	5.74	7.64
	Germanium (Ge) (ppm)	0.06	0.08	0.06	0.07	0.09
	Gold (Au) (ppm)	<0.02	<0.02	<0.02	<0.02	0.09
	Hafnium (Hf) (ppm)	0.23	0.29	0.18	0.05	0.05
	Indium (In) (ppm)	0.028	0.028	0.025	0.024	0.083
	Iron (Fe) (%)	2.85	2.72	2.12	2.21	4.23
	Lanthanum (La) (ppm)	14.7	15.7	12.1	10.0	9.9
	Lead (Pb) (ppm)	8.1	7.9	4.4	2.9	3.4
	Lithium (Li) (ppm)	10.1	11.1	8.2	9.7	5.5
	Magnesium (Mg) (%)	0.76	0.80	0.56	0.53	0.67
	Manganese (Mn) (ppm)	610	566	494	632	676

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2024827-6	L2024827-7	L2024827-8	L2024827-9	L2024827-10
	Description	waste	waste	waste	waste	waste
	Sampled Date	30-OCT-17	30-OCT-17	01-NOV-17	01-NOV-17	04-NOV-17
	Sampled Time					
	Client ID	145580	145581	145583	145582	145584
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.4	8.2	8.3	8.4	8.2
Organic / Inorganic Carbon	Carbon (C) (%)	0.22	<0.05	<0.05	0.36	0.29
Acid Base Accounting	FIZZ RATING (Unity)	2	1	1	2	2
	MPA (tCaCO3/1Kt)	0.3	0.3	0.3	0.6	0.9
	Neutralization Potential (NP) (tCaCO3/1Kt)	24	6	8	36	32
	NNP (tCaCO3/1Kt)	24	6	8	35	31
	Ratio (NP/MPA) (Unity)	76.80	19.20	25.60	57.60	34.13
	Sulfate Sulfur (carbonate leach) (%)	<0.01	0.02	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.01	0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	0.01	<0.01	0.01	0.03
	Total Sulfur (combustion) (%)	0.01	0.01	0.01	0.02	0.03
Total Metals	Aluminum (Al) (%)	0.93	0.84	1.18	0.84	1.10
	Antimony (Sb) (ppm)	0.32	0.05	0.06	0.39	0.61
	Arsenic (As) (ppm)	5.2	3.2	3.3	6.4	7.8
	Barium (Ba) (ppm)	240	220	340	230	520
	Beryllium (Be) (ppm)	0.37	0.33	0.33	0.34	0.55
	Bismuth (Bi) (ppm)	0.06	0.06	0.05	0.07	0.11
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.15	0.16	0.12	0.19	0.27
	Calcium (Ca) (%)	1.03	0.30	0.38	1.49	1.41
	Cerium (Ce) (ppm)	24.4	26.3	22.6	23.5	30.8
	Cesium (Cs) (ppm)	0.64	0.44	0.73	0.61	1.01
	Chromium (Cr) (ppm)	16	4	6	25	26
	Cobalt (Co) (ppm)	6.5	6.0	6.2	6.6	9.2
	Copper (Cu) (ppm)	170.5	1040	1325	49.4	401
	Gallium (Ga) (ppm)	3.88	4.45	5.89	3.08	4.13
	Germanium (Ge) (ppm)	0.06	0.08	0.09	0.06	0.07
	Gold (Au) (ppm)	<0.02	0.02	<0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.17	0.07	0.08	0.22	0.29
	Indium (In) (ppm)	0.026	0.054	0.038	0.019	0.029
	Iron (Fe) (%)	2.20	2.38	2.65	1.99	2.39
	Lanthanum (La) (ppm)	12.4	14.1	10.4	12.2	15.0
	Lead (Pb) (ppm)	3.9	3.8	2.6	4.0	6.0
	Lithium (Li) (ppm)	6.3	4.5	6.3	6.1	9.3
	Magnesium (Mg) (%)	0.48	0.33	0.53	0.50	0.67
	Manganese (Mn) (ppm)	452	409	459	406	449

	Sample ID	L2024827-1	L2024827-2	L2024827-3	L2024827-4	L2024827-5
	Description	waste	waste	waste	waste	tail
	Sampled Date	27-OCT-17	27-OCT-17	29-OCT-17	29-OCT-17	31-OCT-17
	Sampled Time					
	Client ID	145576	145577	145578	145579	OCT TAIL 2017
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.05	0.05	0.02	<0.01	0.01
	Molybdenum (Mo) (ppm)	1.33	1.43	1.07	2.25	2.78
	Nickel (Ni) (ppm)	30.4	30.9	15.0	2.0	2.8
	Niobium (Nb) (ppm)	0.45	0.28	0.51	0.16	0.28
	Phosphorus (P) (ppm)	820	970	800	640	750
	Potassium (K) (%)	0.20	0.21	0.25	0.30	0.61
	Rhenium (Re) (ppm)	0.002	0.001	0.001	0.001	0.003
	Rubidium (Rb) (ppm)	12.7	12.2	13.1	14.9	31.5
	Scandium (Sc) (ppm)	5.3	5.4	4.3	3.6	4.2
	Selenium (Se) (ppm)	0.4	0.4	0.3	0.3	1.9
	Silver (Ag) (ppm)	0.16	0.13	0.05	0.04	0.75
	Sodium (Na) (%)	0.04	0.04	0.04	0.04	0.05
	Strontium (Sr) (ppm)	68.0	80.4	46.9	30.8	61.3
	Sulfur (S) (%)	0.06	0.03	0.01	<0.01	0.11
	Tantalum (Ta) (ppm)	<0.01	0.03	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.02	0.01	0.01	0.26
	Thallium (Tl) (ppm)	0.14	0.15	0.11	0.10	0.26
	Thorium (Th) (ppm)	4.4	4.2	3.0	2.3	3.6
	Tin (Sn) (ppm)	0.5	0.5	0.5	0.5	0.9
	Titanium (Ti) (%)	0.067	0.069	0.068	0.042	0.104
	Tungsten (W) (ppm)	0.50	0.82	0.47	0.18	0.10
	Uranium (U) (ppm)	0.86	0.87	0.48	0.30	0.36
	Vanadium (V) (ppm)	53	51	43	44	74
	Yttrium (Y) (ppm)	9.93	11.60	8.84	10.10	6.12
	Zinc (Zn) (ppm)	81	76	59	65	116
	Zirconium (Zr) (ppm)	7.9	9.2	5.4	0.9	1.2
Permanent Gases	Carbon Dioxide (CO2) (%)	1.0	1.6	0.7	<0.2	1.0
Miscellaneous	Carbon (C) (%)	0.91	0.89	0.39	0.06	0.30

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2024827-6	L2024827-7	L2024827-8	L2024827-9	L2024827-10
	Description	waste	waste	waste	waste	waste
	Sampled Date	30-OCT-17	30-OCT-17	01-NOV-17	01-NOV-17	04-NOV-17
	Sampled Time					
	Client ID	145580	145581	145583	145582	145584
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02	<0.01	0.01	0.03	0.05
	Molybdenum (Mo) (ppm)	1.68	2.53	1.37	2.64	1.75
	Nickel (Ni) (ppm)	12.2	2.6	3.2	15.1	22.6
	Niobium (Nb) (ppm)	0.47	0.24	0.36	0.34	0.36
	Phosphorus (P) (ppm)	760	820	1040	790	940
	Potassium (K) (%)	0.26	0.40	0.64	0.14	0.15
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.001	0.001
	Rubidium (Rb) (ppm)	14.1	21.1	38.0	8.4	9.3
	Scandium (Sc) (ppm)	4.5	5.6	6.7	4.4	4.7
	Selenium (Se) (ppm)	0.6	0.5	0.6	0.6	0.6
	Silver (Ag) (ppm)	0.05	0.11	0.12	0.06	0.15
	Sodium (Na) (%)	0.03	0.03	0.04	0.04	0.04
	Strontium (Sr) (ppm)	50.2	21.3	25.0	67.6	58.4
	Sulfur (S) (%)	0.01	<0.01	<0.01	0.01	0.03
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.02	0.06	0.01	0.03
	Thallium (Tl) (ppm)	0.11	0.14	0.25	0.10	0.10
	Thorium (Th) (ppm)	3.3	2.9	2.3	3.3	4.7
	Tin (Sn) (ppm)	0.5	0.7	1.0	0.3	0.6
	Titanium (Ti) (%)	0.067	0.054	0.115	0.061	0.063
	Tungsten (W) (ppm)	0.50	0.24	0.32	0.49	0.17
	Uranium (U) (ppm)	0.38	0.23	0.19	0.47	0.81
	Vanadium (V) (ppm)	46	52	67	43	50
	Yttrium (Y) (ppm)	8.52	11.45	10.10	7.93	10.65
	Zinc (Zn) (ppm)	55	72	76	43	61
	Zirconium (Zr) (ppm)	5.2	1.5	2.0	6.7	10.1
Permanent Gases	Carbon Dioxide (CO2) (%)	0.8	<0.2	<0.2	1.3	1.1
Miscellaneous	Carbon (C) (%)	0.40	0.03	0.05	0.60	0.60

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-33

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.
2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

CERTIFICATE VA17259183

Project: L2024827

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 24-NOV-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET
SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2024827

CERTIFICATE OF ANALYSIS VA17259183

Sample Description / **Method**	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L2024827-1-145576	1.10	2	1.6	21	23	14.72	7.9	0.05	0.05	0.27	1.0	<0.01	0.91	0.02	0.16
L2024827-2-145577	1.06	2	0.9	41	42	44.80	8.1	0.03	0.03	0.44	1.6	<0.01	0.89	<0.01	0.13
L2024827-3-145578	1.06	2	0.6	21	22	35.20	8.3	0.02	0.02	0.20	0.7	<0.01	0.39	0.01	0.05
L2024827-4-145579	1.04	1	0.3	9	9	28.80	8.3	0.01	0.01	<0.05	<0.2	<0.01	0.06	<0.01	0.04
L2024827-5 OCT TAIL 2017	1.02	2	3.1	18	21	6.72	8.0	0.10	0.10	0.26	1.0	<0.01	0.30	0.01	0.75
L2024827-6-145580	1.06	2	0.3	24	24	76.80	8.4	0.01	0.01	0.22	0.8	<0.01	0.40	<0.01	0.05
L2024827-7-145581	1.04	1	0.3	6	6	19.20	8.2	0.01	0.01	<0.05	<0.2	<0.01	0.03	0.02	0.11
L2024827-8-145583	1.06	1	0.3	8	8	25.60	8.3	0.01	<0.01	<0.05	<0.2	0.01	0.05	<0.01	0.12
L2024827-9-145582	1.06	2	0.6	35	36	57.60	8.4	0.02	0.01	0.36	1.3	0.01	0.60	<0.01	0.06
L2024827-10-145584	1.06	2	0.9	31	32	34.13	8.2	0.03	0.03	0.29	1.1	<0.01	0.60	<0.01	0.15

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 19-DEC-2017
Account: APN

Project: L2024827

CERTIFICATE OF ANALYSIS VA17259183

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description / **LOR**	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L2024827-1-145576	1.36	8.6	<0.02	<10	320	0.55	0.15	1.18	0.30	29.3	11.2	32	1.21	134.5	2.85
L2024827-2-145577	1.35	8.3	<0.02	<10	330	0.63	0.13	1.75	0.36	32.1	10.7	33	1.41	59.1	2.72
L2024827-3-145578	1.02	3.4	<0.02	<10	220	0.43	0.07	0.95	0.18	23.6	7.1	18	0.60	85.5	2.12
L2024827-4-145579	1.10	1.2	<0.02	<10	150	0.38	0.03	0.39	0.09	20.5	5.8	4	0.28	184.5	2.21
L2024827-5 OCT TAIL 2017	1.15	1.1	0.09	<10	240	0.27	0.49	0.88	0.33	20.0	7.4	7	0.55	2260	4.23
L2024827-6-145580	0.93	5.2	<0.02	<10	240	0.37	0.06	1.03	0.15	24.4	6.5	16	0.64	170.5	2.20
L2024827-7-145581	0.84	3.2	0.02	<10	220	0.33	0.06	0.30	0.16	26.3	6.0	4	0.44	1040	2.38
L2024827-8-145583	1.18	3.3	<0.02	<10	340	0.33	0.05	0.38	0.12	22.6	6.2	6	0.73	1325	2.65
L2024827-9-145582	0.84	6.4	<0.02	<10	230	0.34	0.07	1.49	0.19	23.5	6.6	25	0.61	49.4	1.99
L2024827-10-145584	1.10	7.8	<0.02	<10	520	0.55	0.11	1.41	0.27	30.8	9.2	26	1.01	401	2.39

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 19-DEC-2017
Account: APN

Project: L2024827

CERTIFICATE OF ANALYSIS VA17259183

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
LOR	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2024827-1-145576	4.48	0.06	0.23	0.05	0.028	0.20	14.7	10.1	0.76	610	1.33	0.04	0.45	30.4	820
L2024827-2-145577	4.45	0.08	0.29	0.05	0.028	0.21	15.7	11.1	0.80	566	1.43	0.04	0.28	30.9	970
L2024827-3-145578	4.10	0.06	0.18	0.02	0.025	0.25	12.1	8.2	0.56	494	1.07	0.04	0.51	15.0	800
L2024827-4-145579	5.74	0.07	0.05	<0.01	0.024	0.30	10.0	9.7	0.53	632	2.25	0.04	0.16	2.0	640
L2024827-5 OCT TAIL 2017	7.64	0.09	0.05	0.01	0.083	0.61	9.9	5.5	0.67	676	2.78	0.05	0.28	2.8	750
L2024827-6-145580	3.88	0.06	0.17	0.02	0.026	0.26	12.4	6.3	0.48	452	1.68	0.03	0.47	12.2	760
L2024827-7-145581	4.45	0.08	0.07	<0.01	0.054	0.40	14.1	4.5	0.33	409	2.53	0.03	0.24	2.6	820
L2024827-8-145583	5.89	0.09	0.08	0.01	0.038	0.64	10.4	6.3	0.53	459	1.37	0.04	0.36	3.2	1040
L2024827-9-145582	3.08	0.06	0.22	0.03	0.019	0.14	12.2	6.1	0.50	406	2.64	0.04	0.34	15.1	790
L2024827-10-145584	4.13	0.07	0.29	0.05	0.029	0.15	15.0	9.3	0.67	449	1.75	0.04	0.36	22.6	940

Project: L2024827

CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2024827-1-145576		8.1	12.7	0.002	0.06	0.62	5.3	0.4	0.5	68.0	<0.01	0.02	4.4	0.067	0.14	0.86
L2024827-2-145577		7.9	12.2	0.001	0.03	0.84	5.4	0.4	0.5	80.4	0.03	0.02	4.2	0.069	0.15	0.87
L2024827-3-145578		4.4	13.1	0.001	0.01	0.37	4.3	0.3	0.5	46.9	<0.01	0.01	3.0	0.068	0.11	0.48
L2024827-4-145579		2.9	14.9	0.001	<0.01	0.05	3.6	0.3	0.5	30.8	<0.01	0.01	2.3	0.042	0.10	0.30
L2024827-5 OCT TAIL 2017		3.4	31.5	0.003	0.11	0.06	4.2	1.9	0.9	61.3	<0.01	0.26	3.6	0.104	0.26	0.36
L2024827-6-145580		3.9	14.1	<0.001	0.01	0.32	4.5	0.6	0.5	50.2	<0.01	0.01	3.3	0.067	0.11	0.38
L2024827-7-145581		3.8	21.1	<0.001	<0.01	0.05	5.6	0.5	0.7	21.3	<0.01	0.02	2.9	0.054	0.14	0.23
L2024827-8-145583		2.6	38.0	<0.001	<0.01	0.06	6.7	0.6	1.0	25.0	<0.01	0.06	2.3	0.115	0.25	0.19
L2024827-9-145582		4.0	8.4	0.001	0.01	0.39	4.4	0.6	0.3	67.6	<0.01	0.01	3.3	0.061	0.10	0.47
L2024827-10-145584		6.0	9.3	0.001	0.03	0.61	4.7	0.6	0.6	58.4	<0.01	0.03	4.7	0.063	0.10	0.81

CERTIFICATE OF ANALYSIS VA17259183

Sample Description **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	V	W	Y	Zn	Zr
Units	ppm	ppm	ppm	ppm	ppm
LOR	1	0.05	0.05	2	0.5
L2024827-1-145576	53	0.50	9.93	81	7.9
L2024827-2-145577	51	0.82	11.60	76	9.2
L2024827-3-145578	43	0.47	8.84	59	5.4
L2024827-4-145579	44	0.18	10.10	65	0.9
L2024827-5 OCT TAIL 2017	74	0.10	6.12	116	1.2
L2024827-6-145580	46	0.50	8.52	55	5.2
L2024827-7-145581	52	0.24	11.45	72	1.5
L2024827-8-145583	67	0.32	10.10	76	2.0
L2024827-9-145582	43	0.49	7.93	43	6.7
L2024827-10-145584	50	0.17	10.65	61	10.1

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 19-DEC-2017
Account: APN

Project: L2024827

CERTIFICATE OF ANALYSIS VA17259183

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 4 (A - E)
Plus Appendix Pages
Finalized Date: 19-DEC-2017
Account: APN

QC CERTIFICATE VA17259183

Project: L2024827

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 24-NOV-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17259183

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag	Al
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm	%
Sample Description / LOR	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01
STANDARDS															
Buffer pH6						6.0									
Buffer pH6						6.0									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
DS-1							2.70					3.18			
Target Range - Lower Bound							2.51					3.01			
Upper Bound							2.71					3.25			
GS313-8							1.22					0.96			
Target Range - Lower Bound							1.19					0.90			
Upper Bound							1.29					0.98			
KZK-1	2	25.0	31	56	2.24										
KZK-1	2	25.0	32	57	2.28										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MA-3a									2.34	8.6					
Target Range - Lower Bound									2.31	8.4					
Upper Bound									2.77	10.2					
MRGeo08														4.47	2.59
Target Range - Lower Bound														4.00	2.44
Upper Bound														4.92	3.00
OGGeo08														19.15	2.23
Target Range - Lower Bound														18.15	2.05
Upper Bound														22.2	2.53
OREAS 905														0.53	0.76
Target Range - Lower Bound														0.45	0.73
Upper Bound														0.58	0.91
OREAS 920														0.10	2.36
Target Range - Lower Bound														0.07	2.18
Upper Bound														0.12	2.68
SY-4									0.86	3.1					
Target Range - Lower Bound									0.84	3.0					
Upper Bound									1.08	4.0					
UTS-1													0.87		
UTS-1													0.86		
Target Range - Lower Bound													0.83		
Upper Bound													0.93		
UTS-1											0.85				

***** See Appendix Page for comments regarding this certificate *****

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	32.4	<0.02	<10	440	0.75	0.64	1.09	2.24	72.2	18.1	92	11.55	646	3.72	8.92
Target Range - Lower Bound	29.6	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73
Upper Bound	36.4	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80
OGGeo08	120.0	0.06	10	120	0.81	9.91	0.89	18.95	59.0	92.5	81	9.25	8400	4.99	8.39
Target Range - Lower Bound	107.0	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05
Upper Bound	131.0	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95
OREAS 905	33.3	0.40	<10	240	0.94	5.41	0.34	0.34	75.9	13.8	16	1.17	1605	3.53	5.83
Target Range - Lower Bound	28.4	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74
Upper Bound	35.0	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12
OREAS 920	4.9	<0.02	<10	80	0.81	0.61	0.31	0.06	69.1	14.0	43	1.86	111.0	3.50	6.50
Target Range - Lower Bound	3.8	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12
Upper Bound	4.9	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
		STANDARDS														
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		0.13	0.71	0.07	0.155	1.29	36.2	30.3	1.18	436	14.05	0.33	1.04	736	1050	1115
Target Range - Lower Bound		0.07	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959
Upper Bound		0.29	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175
OGGeo08		0.20	0.73	0.45	1.390	1.06	30.1	30.3	0.95	394	880	0.28	1.00	8810	810	7210
Target Range - Lower Bound		0.21	0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520
Upper Bound		0.45	0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970
OREAS 905		0.09	1.18	0.03	0.566	0.31	37.9	4.4	0.15	359	2.93	0.08	0.23	8.4	250	15.3
Target Range - Lower Bound		<0.05	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2
Upper Bound		0.22	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0
OREAS 920		0.11	0.58	<0.01	0.031	0.40	34.9	22.2	1.08	518	0.34	0.02	0.36	37.4	710	20.7
Target Range - Lower Bound		<0.05	0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2
Upper Bound		0.22	0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method Analyte Units LOR	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		142.5	0.007	0.33	3.00	6.8	1.0	3.3	81.2	0.01	0.02	22.2	0.407	0.80	5.44	102
Target Range - Lower Bound		132.0	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90
Upper Bound		162.0	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112
OGGeo08		121.5	1.345	2.68	18.15	6.1	9.9	13.2	62.2	<0.01	0.16	15.9	0.299	1.40	4.54	80
Target Range - Lower Bound		109.5	1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70
Upper Bound		134.5	1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88
OREAS 905		17.9	<0.001	0.07	0.94	1.7	2.0	1.2	13.7	<0.01	0.07	8.0	0.021	0.11	2.16	6
Target Range - Lower Bound		17.3	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4
Upper Bound		21.3	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8
OREAS 920		22.7	<0.001	0.02	0.56	2.8	0.2	1.0	16.0	0.01	0.01	14.8	0.114	0.15	2.01	24
Target Range - Lower Bound		22.2	<0.001	<0.01	0.45	2.5	<0.2	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23
Upper Bound		27.4	0.002	0.05	0.77	3.3	0.7	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS					
Buffer pH6					
Buffer pH6					
Target Range - Lower Bound					
Upper Bound					
DS-1					
Target Range - Lower Bound					
Upper Bound					
GS313-8					
Target Range - Lower Bound					
Upper Bound					
KZK-1					
KZK-1					
Target Range - Lower Bound					
Upper Bound					
MA-3a					
Target Range - Lower Bound					
Upper Bound					
MRGeo08		2.98	19.05	830	21.5
Target Range - Lower Bound		2.44	17.50	708	18.1
Upper Bound		3.42	21.5	870	25.7
OGGeo08		3.03	15.65	7000	23.6
Target Range - Lower Bound		2.58	15.35	6500	19.5
Upper Bound		3.60	18.85	7950	27.5
OREAS 905		0.60	6.88	67	44.5
Target Range - Lower Bound		0.44	6.32	58	39.9
Upper Bound		0.76	7.84	76	55.1
OREAS 920		0.45	17.30	104	20.9
Target Range - Lower Bound		0.31	16.85	93	17.6
Upper Bound		0.61	20.7	119	25.0
SY-4					
Target Range - Lower Bound					
Upper Bound					
UTS-1					
UTS-1					
Target Range - Lower Bound					
Upper Bound					
UTS-1					

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

STANDARDS

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag	Al
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm	%
LOR	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01
Sample Description															
Target Range - Lower Bound											0.81				
Upper Bound											0.95				
UTS-4													1.78		
Target Range - Lower Bound													1.64		
Upper Bound													1.84		
UTS-4											1.67				
Target Range - Lower Bound											1.61				
Upper Bound											1.87				

BLANKS

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag	Al
BLANK									<0.05	<0.2					
Target Range - Lower Bound									<0.05	<0.2					
Upper Bound									0.10	0.4					
BLANK														<0.01	<0.01
BLANK														<0.01	<0.01
Target Range - Lower Bound														<0.01	<0.01
Upper Bound														0.02	0.02
BLANK						6.0									
Target Range - Lower Bound						5.5									
Upper Bound						6.9									
BLANK													<0.01		
BLANK													<0.01		
Target Range - Lower Bound													<0.01		
Upper Bound													0.02		
BLANK											<0.01				
Target Range - Lower Bound											<0.01				
Upper Bound											0.02				
BLANK							<0.01					<0.01			
Target Range - Lower Bound							<0.01					<0.01			
Upper Bound							0.02					0.02			

***** See Appendix Page for comments regarding this certificate *****

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method Analyte Units LOR	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05
STANDARDS																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.1	<0.02	<10	<10	<0.05	0.01	<0.01	0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05
BLANK		0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05
Target Range - Lower Bound		<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05
Upper Bound		0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA17259183

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description **LOR**	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	0.06	<0.2	<10	<0.2
BLANK	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2
Target Range - Lower Bound	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2
Upper Bound	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
Sample Description / **LOR**	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
STANDARDS															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.1	<0.001	<0.01	0.06	0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1
BLANK	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1
Target Range - Lower Bound	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1
Upper Bound	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS					
Target Range - Lower Bound					
Upper Bound					
UTS-4					
Target Range - Lower Bound					
Upper Bound					
UTS-4					
Target Range - Lower Bound					
Upper Bound					
BLANKS					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK		<0.05	<0.05	<2	<0.5
BLANK		<0.05	<0.05	<2	<0.5
Target Range - Lower Bound		<0.05	<0.05	<2	<0.5
Upper Bound		0.10	0.10	4	1.0
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
Target Range - Lower Bound					
Upper Bound					

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag	Al
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm	%
	LOR	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01
		DUPLICATES														
ORIGINAL															0.07	2.22
DUP															0.07	2.25
Target Range - Lower Bound															0.06	2.11
Upper Bound															0.08	2.36
L2024827-5 OCT TAIL 2017															0.75	1.15
DUP															0.78	1.18
Target Range - Lower Bound															0.72	1.10
Upper Bound															0.81	1.23
L2024827-7-145581														0.02		
DUP														0.02		
Target Range - Lower Bound														<0.01		
Upper Bound														0.03		
L2024827-10-145584		2	0.9	31	32	34.13		0.03	0.03	0.29	1.1	<0.01	0.60	<0.01		
DUP		2	1.3	31	32	25.60		0.04	0.04	0.30	1.1	<0.01	0.62	0.01		
Target Range - Lower Bound		<1	0.7	28	29	28.36		0.02	0.02	0.23	0.8	<0.01	0.58	<0.01		
Upper Bound		3	1.5	34	35	31.37		0.05	0.05	0.36	1.4	0.02	0.64	0.02		
L2027460-5 145589							8.6									
DUP							8.6									
Target Range - Lower Bound							8.1									
Upper Bound							9.1									

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
LOR	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05
DUPLICATES															
ORIGINAL	10.0	<0.02	10	130	0.57	0.04	3.23	0.03	26.8	19.0	159	2.16	30.1	3.23	10.30
DUP	10.4	<0.02	<10	130	0.55	0.04	3.29	0.02	27.5	18.7	160	2.26	29.5	3.26	10.10
Target Range - Lower Bound	9.6	<0.02	<10	110	0.48	0.03	3.09	<0.01	25.8	17.8	151	2.05	28.6	3.07	9.64
Upper Bound	10.8	0.04	20	150	0.64	0.05	3.43	0.04	28.5	19.9	168	2.37	31.0	3.42	10.75
L2024827-5 OCT TAIL 2017	1.1	0.09	<10	240	0.27	0.49	0.88	0.33	20.0	7.4	7	0.55	2260	4.23	7.64
DUP	1.1	0.14	<10	240	0.26	0.47	0.90	0.32	19.95	7.6	7	0.56	2320	4.33	7.73
Target Range - Lower Bound	0.9	0.09	<10	210	0.20	0.45	0.84	0.30	18.95	7.0	6	0.48	2210	4.06	7.25
Upper Bound	1.3	0.14	20	270	0.33	0.51	0.94	0.35	21.0	8.0	8	0.63	2370	4.50	8.12
L2024827-7-145581															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2024827-10-145584															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2027460-5 145589															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description / **Method** / **Analyte** / **Units** / **LOR**	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
DUPLICATES															
ORIGINAL	0.23	0.62	0.01	0.018	0.04	12.0	51.4	2.93	689	0.39	0.05	0.09	35.7	610	20.7
DUP	0.21	0.65	0.01	0.016	0.04	12.6	50.3	2.93	694	0.38	0.05	0.10	35.3	620	20.2
Target Range - Lower Bound	0.16	0.58	<0.01	0.011	0.03	11.5	48.2	2.77	652	0.32	0.04	<0.05	33.5	570	19.2
Upper Bound	0.28	0.69	0.02	0.023	0.05	13.1	53.5	3.09	731	0.45	0.06	0.10	37.5	660	21.7
L2024827-5 OCT TAIL 2017	0.09	0.05	0.01	0.083	0.61	9.9	5.5	0.67	676	2.78	0.05	0.28	2.8	750	3.4
DUP	0.08	0.04	0.01	0.090	0.62	10.3	5.2	0.68	686	3.01	0.05	0.26	2.9	760	3.4
Target Range - Lower Bound	<0.05	<0.02	<0.01	0.077	0.57	9.4	5.0	0.63	642	2.70	0.04	0.21	2.5	710	3.0
Upper Bound	0.10	0.07	0.02	0.096	0.66	10.8	5.7	0.72	720	3.09	0.06	0.33	3.2	800	3.8
L2024827-7-145581															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2024827-10-145584															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2027460-5 145589															
DUP															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
								DUPLICATES							
ORIGINAL	1.3	<0.001	0.11	0.54	6.5	<0.2	0.6	871	<0.01	0.02	1.1	0.232	<0.02	0.66	71
DUP	1.4	<0.001	0.11	0.56	6.3	<0.2	0.6	883	<0.01	0.01	1.1	0.239	<0.02	0.66	73
Target Range - Lower Bound	1.2	<0.001	0.09	0.46	6.0	<0.2	0.4	833	<0.01	<0.01	0.8	0.219	<0.02	0.58	67
Upper Bound	1.5	0.002	0.13	0.64	6.8	0.4	0.8	921	0.02	0.02	1.4	0.252	0.04	0.74	77
L2024827-5 OCT TAIL 2017	31.5	0.003	0.11	0.06	4.2	1.9	0.9	61.3	<0.01	0.26	3.6	0.104	0.26	0.36	74
DUP	32.1	0.004	0.11	<0.05	4.2	2.1	1.0	62.5	<0.01	0.26	3.3	0.106	0.24	0.35	75
Target Range - Lower Bound	30.1	0.002	0.09	<0.05	3.9	1.7	0.7	58.6	<0.01	0.24	3.1	0.095	0.21	0.29	70
Upper Bound	33.5	0.005	0.13	0.10	4.5	2.3	1.2	65.2	0.02	0.28	3.8	0.115	0.29	0.42	79
L2024827-7-145581															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2024827-10-145584															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2027460-5 145589															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17259183

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	W	Y	Zn	Zr
Units	ppm	ppm	ppm	ppm
LOR	0.05	0.05	2	0.5
DUPLICATES				
ORIGINAL	0.15	7.42	65	17.5
DUP	0.15	7.37	66	17.7
Target Range - Lower Bound	0.09	6.98	60	15.8
Upper Bound	0.21	7.81	71	19.4
L2024827-5 OCT TAIL 2017	0.10	6.12	116	1.2
DUP	0.08	6.26	117	1.2
Target Range - Lower Bound	<0.05	5.83	109	0.6
Upper Bound	0.10	6.55	124	1.8
L2024827-7-145581				
DUP				
Target Range - Lower Bound				
Upper Bound				
L2024827-10-145584				
DUP				
Target Range - Lower Bound				
Upper Bound				
L2027460-5 145589				
DUP				
Target Range - Lower Bound				
Upper Bound				

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2024827

QC CERTIFICATE OF ANALYSIS VA17259183

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05 C-IR07 LOG-22 ME-MS41
OA-ELE07 OA-VOL08m PUL-31 PUL-QC
S-CAL06a S-GRA06 S-GRA06a S-IR08
SPL-21 WEI-21

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2024827-COFC

COC Number: 17-33

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)
- **4 day [P4]** ☐
- **3 day [P3]** ☐
- **2 day [P2]** ☐

EMERGENCY
- **1 Business day [E1]** ☐
- **Same Day, Weekend or Statutory holiday [E0]** ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:

PO#

Major/Minor Code:

Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
1	145576	27-OCT-17		WASTE	X	X	X	X	X	X	
2	145577	27-OCT-17		WASTE	X	X	X	X	X	X	
3	145578	29-OCT-17		WASTE	X	X	X	X	X	X	
4	145579	29-OCT-17		WASTE	X	X	X	X	X	X	
5	OCT TAIL 2017	31/10/17		TAIL	X	X	X	X	X	X	
6	145580	30-OCT-17		WASTE	X	X	X	X	X	X	
7	145581	30-OCT-17		WASTE	X	X	X	X	X	X	
8	145583	1-NOV-17		WASTE	X	X	X	X	X	X	
9	145582	1-NOV-17		WASTE	X	X	X	X	X	X	
10	145584	4-NOV-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO

Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
3.0			10		

SHIPMENT RELEASE (client use)

Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF Date: 20 Nov 2017 Time: 1622

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Cade Date: Nov 22 Time: 1130

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received:	27-NOV-17
Report Date:	12-JAN-18 18:39 (MT)
Version:	FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2027460

Project P.O. #:	228594
Job Reference:	
C of C Numbers:	17-34
Legal Site Desc:	

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L2027460-1	L2027460-2	L2027460-3	L2027460-4	L2027460-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	05-NOV-17	02-NOV-17	02-NOV-17	06-NOV-17	06-NOV-17
	Sampled Time					
	Client ID	145585	145586	145587	145588	145589
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.6	8.4	8.1	8.5	8.6
Organic / Inorganic Carbon	Carbon (C) (%)	0.66	0.35	0.15	0.62	0.70
Acid Base Accounting	FIZZ RATING (Unity)	2	2	1	2	2
	MPA (tCaCO3/1Kt)	9.7	0.6	0.3	4.4	10.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	38	32	12	39	46
	NNP (tCaCO3/1Kt)	28	31	12	35	35
	Ratio (NP/MPA) (Unity)	3.92	51.20	38.40	8.91	4.33
	Sulfate Sulfur (carbonate leach) (%)	0.01	0.02	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.02	0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.31	<0.01	<0.01	0.14	0.34
	Total Sulfur (combustion) (%)	0.31	0.02	0.01	0.14	0.34
Total Metals	Aluminum (Al) (%)	0.66	0.95	1.08	0.54	0.90
	Antimony (Sb) (ppm)	<0.05	0.36	0.12	<0.05	<0.05
	Arsenic (As) (ppm)	3.1	6.1	4.1	1.6	1.3
	Barium (Ba) (ppm)	210	240	170	90	310
	Beryllium (Be) (ppm)	0.34	0.38	0.32	0.35	0.43
	Bismuth (Bi) (ppm)	0.06	0.18	0.65	0.05	0.10
	Boron (B) (ppm)	10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.19	0.21	0.10	0.11	0.13
	Calcium (Ca) (%)	1.19	1.40	0.49	1.39	1.38
	Cerium (Ce) (ppm)	25.7	25.1	21.0	24.9	32.7
	Cesium (Cs) (ppm)	0.30	0.60	0.52	0.35	0.51
	Chromium (Cr) (ppm)	3	20	8	3	3
	Cobalt (Co) (ppm)	8.8	7.4	6.4	7.3	11.7
	Copper (Cu) (ppm)	1330	304	8790	1490	2030
	Gallium (Ga) (ppm)	3.57	3.78	5.16	3.39	4.70
	Germanium (Ge) (ppm)	<0.05	0.05	0.05	<0.05	0.06
	Gold (Au) (ppm)	<0.02	<0.02	0.13	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.05	0.22	0.12	0.03	0.05
	Indium (In) (ppm)	0.064	0.022	0.114	0.069	0.096
	Iron (Fe) (%)	2.63	2.14	2.40	2.35	3.33
	Lanthanum (La) (ppm)	14.0	13.1	10.2	14.1	17.5
	Lead (Pb) (ppm)	5.6	4.5	5.4	5.2	5.3
	Lithium (Li) (ppm)	2.5	7.0	5.2	2.0	3.1
	Magnesium (Mg) (%)	0.52	0.47	0.40	0.32	0.72
	Manganese (Mn) (ppm)	698	421	301	574	1040

	Sample ID	L2027460-6	L2027460-7	L2027460-8	L2027460-9	L2027460-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	11-NOV-17	13-NOV-17	05-NOV-17	17-NOV-17	14-NOV-17
	Sampled Time					
	Client ID	145590	145591	145592	145593	145594
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.0	8.6	8.3	7.7	8.3
Organic / Inorganic Carbon	Carbon (C) (%)	0.35	0.44	0.38	0.34	0.09
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	1
	MPA (tCaCO3/1Kt)	1.6	3.8	0.6	1.9	1.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	31	33	35	28	11
	NNP (tCaCO3/1Kt)	29	29	34	26	10
	Ratio (NP/MPA) (Unity)	19.84	8.80	56.00	14.93	8.80
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.01	0.01	0.02	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.05	0.11	0.01	0.04	0.03
	Total Sulfur (combustion) (%)	0.05	0.12	0.02	0.06	0.04
Total Metals	Aluminum (Al) (%)	1.47	1.07	0.93	1.30	0.83
	Antimony (Sb) (ppm)	0.67	<0.05	0.44	0.57	<0.05
	Arsenic (As) (ppm)	8.7	1.1	5.9	7.5	3.1
	Barium (Ba) (ppm)	320	250	230	280	160
	Beryllium (Be) (ppm)	0.64	0.37	0.35	0.51	0.29
	Bismuth (Bi) (ppm)	0.19	0.19	0.10	0.15	0.27
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.33	0.29	0.21	0.30	0.52
	Calcium (Ca) (%)	1.43	1.12	1.54	1.39	0.41
	Cerium (Ce) (ppm)	33.9	32.2	25.1	29.8	29.5
	Cesium (Cs) (ppm)	1.23	0.63	0.61	0.80	0.46
	Chromium (Cr) (ppm)	33	5	22	29	4
	Cobalt (Co) (ppm)	11.5	7.5	7.2	9.8	7.9
	Copper (Cu) (ppm)	258	2200	76.1	107.0	5220
	Gallium (Ga) (ppm)	4.84	5.45	3.31	4.33	4.29
	Germanium (Ge) (ppm)	0.05	0.06	<0.05	0.06	0.05
	Gold (Au) (ppm)	<0.02	0.03	0.03	<0.02	0.07
	Hafnium (Hf) (ppm)	0.28	0.06	0.24	0.28	0.06
	Indium (In) (ppm)	0.030	0.057	0.017	0.024	0.099
	Iron (Fe) (%)	2.72	2.93	1.99	2.43	2.39
	Lanthanum (La) (ppm)	17.4	17.8	13.3	15.2	16.4
	Lead (Pb) (ppm)	7.9	3.9	4.7	6.6	6.6
	Lithium (Li) (ppm)	11.2	3.9	6.7	9.5	3.4
	Magnesium (Mg) (%)	0.73	0.61	0.49	0.61	0.31
	Manganese (Mn) (ppm)	595	753	403	487	657

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2027460-1	L2027460-2	L2027460-3	L2027460-4	L2027460-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	05-NOV-17	02-NOV-17	02-NOV-17	06-NOV-17	06-NOV-17
	Sampled Time					
	Client ID	145585	145586	145587	145588	145589
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.04	0.04	0.01	0.01
	Molybdenum (Mo) (ppm)	22.6	1.05	2.70	13.65	28.7
	Nickel (Ni) (ppm)	2.3	16.1	5.8	2.1	2.7
	Niobium (Nb) (ppm)	0.15	0.35	0.56	0.06	0.27
	Phosphorus (P) (ppm)	870	770	820	660	890
	Potassium (K) (%)	0.32	0.21	0.49	0.17	0.48
	Rhenium (Re) (ppm)	0.040	0.001	0.001	0.049	0.044
	Rubidium (Rb) (ppm)	16.2	11.7	29.3	9.2	25.0
	Scandium (Sc) (ppm)	5.0	5.0	5.4	3.8	5.4
	Selenium (Se) (ppm)	1.2	0.3	1.1	0.9	1.5
	Silver (Ag) (ppm)	0.23	0.10	0.93	0.30	0.36
	Sodium (Na) (%)	0.05	0.06	0.05	0.05	0.05
	Strontium (Sr) (ppm)	86.9	69.5	32.8	65.0	109.0
	Sulfur (S) (%)	0.30	<0.01	<0.01	0.14	0.33
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.02	0.13	0.04	0.06
	Thallium (Tl) (ppm)	0.11	0.11	0.27	0.06	0.18
	Thorium (Th) (ppm)	3.8	3.0	5.7	3.3	3.2
	Tin (Sn) (ppm)	0.8	0.5	0.8	0.8	1.0
	Titanium (Ti) (%)	0.036	0.075	0.099	0.008	0.060
	Tungsten (W) (ppm)	0.24	0.45	0.28	0.12	0.21
	Uranium (U) (ppm)	0.88	0.48	0.42	0.40	0.46
	Vanadium (V) (ppm)	55	46	59	44	67
	Yttrium (Y) (ppm)	9.95	9.17	9.23	7.89	10.10
	Zinc (Zn) (ppm)	71	51	68	60	101
	Zirconium (Zr) (ppm)	1.6	6.7	4.0	1.1	1.6
Permanent Gases	Carbon Dioxide (CO2) (%)	2.4	1.3	0.6	2.3	2.6
Miscellaneous	Carbon (C) (%)	0.79	0.48	0.19	0.73	0.82

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2027460-6	L2027460-7	L2027460-8	L2027460-9	L2027460-10
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	11-NOV-17	13-NOV-17	05-NOV-17	17-NOV-17	14-NOV-17
	Sampled Time					
	Client ID	145590	145591	145592	145593	145594
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.06	0.01	0.03	0.05	0.01
	Molybdenum (Mo) (ppm)	1.66	15.70	1.32	1.12	7.50
	Nickel (Ni) (ppm)	29.6	2.5	16.7	23.5	2.5
	Niobium (Nb) (ppm)	0.80	0.32	0.30	1.15	0.18
	Phosphorus (P) (ppm)	830	810	770	820	860
	Potassium (K) (%)	0.23	0.67	0.15	0.17	0.44
	Rhenium (Re) (ppm)	0.001	0.025	0.001	0.001	0.001
	Rubidium (Rb) (ppm)	14.1	34.7	8.4	10.7	25.4
	Scandium (Sc) (ppm)	6.0	6.5	4.4	5.6	5.5
	Selenium (Se) (ppm)	0.5	1.5	0.2	0.4	1.6
	Silver (Ag) (ppm)	0.14	0.52	0.07	0.10	0.77
	Sodium (Na) (%)	0.06	0.06	0.06	0.05	0.05
	Strontium (Sr) (ppm)	76.5	58.2	74.8	75.7	34.5
	Sulfur (S) (%)	0.03	0.11	0.01	0.05	0.04
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.03	0.07	0.01	0.02	0.12
	Thallium (Tl) (ppm)	0.15	0.28	0.09	0.12	0.21
	Thorium (Th) (ppm)	4.6	5.1	3.3	3.8	5.6
	Tin (Sn) (ppm)	0.6	0.8	0.4	0.5	0.9
	Titanium (Ti) (%)	0.073	0.100	0.071	0.086	0.063
	Tungsten (W) (ppm)	0.36	0.48	0.43	0.33	0.56
	Uranium (U) (ppm)	0.90	0.33	0.53	0.83	0.40
	Vanadium (V) (ppm)	56	70	44	53	58
	Yttrium (Y) (ppm)	11.10	9.11	8.65	10.20	10.15
	Zinc (Zn) (ppm)	74	82	43	59	79
	Zirconium (Zr) (ppm)	9.2	1.4	7.2	9.4	1.5
Permanent Gases	Carbon Dioxide (CO2) (%)	1.3	1.6	1.4	1.3	0.3
Miscellaneous	Carbon (C) (%)	0.89	0.50	0.55	1.23	0.11

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-34

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 17-DEC-2017
Account: APN

CERTIFICATE VA17263693

Project: L2027460

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 28-NOV-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET
SHANE STACK

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2027460

CERTIFICATE OF ANALYSIS VA17263693

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01	ME-MS41 Ag ppm 0.01
L2027460-1 145585		1.06	2	9.7	28	38	3.92	8.6	0.31	0.31	0.66	2.4	<0.01	0.79	0.01	0.23
L2027460-2 145586		1.08	2	0.6	31	32	51.20	8.4	0.02	<0.01	0.35	1.3	0.02	0.48	0.02	0.10
L2027460-3 145587		1.12	1	0.3	12	12	38.40	8.1	0.01	<0.01	0.15	0.6	0.01	0.19	<0.01	0.93
L2027460-4 145588		1.12	2	4.4	35	39	8.91	8.5	0.14	0.14	0.62	2.3	<0.01	0.73	0.01	0.30
L2027460-5 145589		1.12	2	10.6	35	46	4.33	8.6	0.34	0.34	0.70	2.6	<0.01	0.82	<0.01	0.36
L2027460-6 145590		1.14	2	1.6	29	31	19.84	8.0	0.05	0.05	0.35	1.3	<0.01	0.89	0.01	0.14
L2027460-7 145591		1.12	2	3.8	29	33	8.80	8.6	0.12	0.11	0.44	1.6	0.01	0.50	<0.01	0.52
L2027460-8 145592		1.12	2	0.6	34	35	56.00	8.3	0.02	0.01	0.38	1.4	0.01	0.55	0.01	0.07
L2027460-9 145593		1.10	2	1.9	26	28	14.93	7.7	0.06	0.04	0.34	1.3	0.02	1.23	0.01	0.10
L2027460-10 145594		1.12	1	1.3	10	11	8.80	8.3	0.04	0.03	0.09	0.3	0.01	0.11	<0.01	0.77

***** See Appendix Page for comments regarding this certificate *****

Project: L2027460

CERTIFICATE OF ANALYSIS VA17263693

Sample Description	Method Analyte Units LOR	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01
L2027460-1 145585		0.66	3.1	<0.02	10	210	0.34	0.06	1.19	0.19	25.7	8.8	3	0.30	1330	2.63
L2027460-2 145586		0.95	6.1	<0.02	<10	240	0.38	0.18	1.40	0.21	25.1	7.4	20	0.60	304	2.14
L2027460-3 145587		1.08	4.1	0.13	<10	170	0.32	0.65	0.49	0.10	21.0	6.4	8	0.52	8790	2.40
L2027460-4 145588		0.54	1.6	<0.02	<10	90	0.35	0.05	1.39	0.11	24.9	7.3	3	0.35	1490	2.35
L2027460-5 145589		0.90	1.3	<0.02	<10	310	0.43	0.10	1.38	0.13	32.7	11.7	3	0.51	2030	3.33
L2027460-6 145590		1.47	8.7	<0.02	<10	320	0.64	0.19	1.43	0.33	33.9	11.5	33	1.23	258	2.72
L2027460-7 145591		1.07	1.1	0.03	<10	250	0.37	0.19	1.12	0.29	32.2	7.5	5	0.63	2200	2.93
L2027460-8 145592		0.93	5.9	0.03	<10	230	0.35	0.10	1.54	0.21	25.1	7.2	22	0.61	76.1	1.99
L2027460-9 145593		1.30	7.5	<0.02	<10	280	0.51	0.15	1.39	0.30	29.8	9.8	29	0.80	107.0	2.43
L2027460-10 145594		0.83	3.1	0.07	<10	160	0.29	0.27	0.41	0.52	29.5	7.9	4	0.46	5220	2.39

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2027460

CERTIFICATE OF ANALYSIS VA17263693

Sample Description	Method Analyte Units LOR	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10
L2027460-1 145585		3.57	<0.05	0.05	0.01	0.064	0.32	14.0	2.5	0.52	698	22.6	0.05	0.15	2.3	870
L2027460-2 145586		3.78	0.05	0.22	0.04	0.022	0.21	13.1	7.0	0.47	421	1.05	0.06	0.35	16.1	770
L2027460-3 145587		5.16	0.05	0.12	0.04	0.114	0.49	10.2	5.2	0.40	301	2.70	0.05	0.56	5.8	820
L2027460-4 145588		3.39	<0.05	0.03	0.01	0.069	0.17	14.1	2.0	0.32	574	13.65	0.05	0.06	2.1	660
L2027460-5 145589		4.70	0.06	0.05	0.01	0.096	0.48	17.5	3.1	0.72	1040	28.7	0.05	0.27	2.7	890
L2027460-6 145590		4.84	0.05	0.28	0.06	0.030	0.23	17.4	11.2	0.73	595	1.66	0.06	0.80	29.6	830
L2027460-7 145591		5.45	0.06	0.06	0.01	0.057	0.67	17.8	3.9	0.61	753	15.70	0.06	0.32	2.5	810
L2027460-8 145592		3.31	<0.05	0.24	0.03	0.017	0.15	13.3	6.7	0.49	403	1.32	0.06	0.30	16.7	770
L2027460-9 145593		4.33	0.06	0.28	0.05	0.024	0.17	15.2	9.5	0.61	487	1.12	0.05	1.15	23.5	820
L2027460-10 145594		4.29	0.05	0.06	0.01	0.099	0.44	16.4	3.4	0.31	657	7.50	0.05	0.18	2.5	860

CERTIFICATE OF ANALYSIS VA17263693

Method **Analyte** **Units** **LOR**	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
Sample Description															
L2027460-1 145585	5.6	16.2	0.040	0.30	<0.05	5.0	1.2	0.8	86.9	<0.01	0.03	3.8	0.036	0.11	0.88
L2027460-2 145586	4.5	11.7	0.001	<0.01	0.36	5.0	0.3	0.5	69.5	<0.01	0.02	3.0	0.075	0.11	0.48
L2027460-3 145587	5.4	29.3	0.001	<0.01	0.12	5.4	1.1	0.8	32.8	<0.01	0.13	5.7	0.099	0.27	0.42
L2027460-4 145588	5.2	9.2	0.049	0.14	<0.05	3.8	0.9	0.8	65.0	<0.01	0.04	3.3	0.008	0.06	0.40
L2027460-5 145589	5.3	25.0	0.044	0.33	<0.05	5.4	1.5	1.0	109.0	<0.01	0.06	3.2	0.060	0.18	0.46
L2027460-6 145590	7.9	14.1	0.001	0.03	0.67	6.0	0.5	0.6	76.5	<0.01	0.03	4.6	0.073	0.15	0.90
L2027460-7 145591	3.9	34.7	0.025	0.11	<0.05	6.5	1.5	0.8	58.2	<0.01	0.07	5.1	0.100	0.28	0.33
L2027460-8 145592	4.7	8.4	0.001	0.01	0.44	4.4	0.2	0.4	74.8	<0.01	0.01	3.3	0.071	0.09	0.53
L2027460-9 145593	6.6	10.7	0.001	0.05	0.57	5.6	0.4	0.5	75.7	<0.01	0.02	3.8	0.086	0.12	0.83
L2027460-10 145594	6.6	25.4	0.001	0.04	<0.05	5.5	1.6	0.9	34.5	<0.01	0.12	5.6	0.063	0.21	0.40

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA17263693

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L2027460-1 145585		55	0.24	9.95	71	1.6
L2027460-2 145586		46	0.45	9.17	51	6.7
L2027460-3 145587		59	0.28	9.23	68	4.0
L2027460-4 145588		44	0.12	7.89	60	1.1
L2027460-5 145589		67	0.21	10.10	101	1.6
L2027460-6 145590		56	0.36	11.10	74	9.2
L2027460-7 145591		70	0.48	9.11	82	1.4
L2027460-8 145592		44	0.43	8.65	43	7.2
L2027460-9 145593		53	0.33	10.20	59	9.4
L2027460-10 145594		58	0.56	10.15	79	1.5

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05 C-IR07 LOG-22 ME-MS41
OA-ELE07 OA-VOL08m PUL-31 PUL-QC
S-CAL06a S-GRA06 S-GRA06a S-IR08
SPL-21 WEI-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 3 (A - E)
Plus Appendix Pages
Finalized Date: 17-DEC-2017
Account: APN

QC CERTIFICATE VA17263693

Project: L2027460

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 28-NOV-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag	Al
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm	%
LOR	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01
STANDARDS															
Buffer pH6						6.0									
Buffer pH6						6.0									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
CO-ASSAY									0.53	1.9					
Target Range - Lower Bound									0.42	1.5					
Upper Bound									0.64	2.4					
DS-1							2.67					3.12			
Target Range - Lower Bound							2.51					3.01			
Upper Bound							2.71					3.25			
GS313-8							1.29					0.95			
Target Range - Lower Bound							1.19					0.90			
Upper Bound							1.29					0.98			
KZK-1	2	25.0	32	57	2.28										
KZK-1	2	25.0	32	57	2.28										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MRGeo08														4.39	2.69
Target Range - Lower Bound														4.00	2.44
Upper Bound														4.92	3.00
OREAS 905														0.50	0.84
Target Range - Lower Bound														0.45	0.73
Upper Bound														0.58	0.91
SY-4									0.86	3.2					
Target Range - Lower Bound									0.84	3.0					
Upper Bound									1.08	4.0					
UTS-1													0.86		
Target Range - Lower Bound													0.83		
Upper Bound													0.93		
UTS-1											0.80				
Target Range - Lower Bound											0.81				
Upper Bound											0.95				
UTS-4													1.76		
Target Range - Lower Bound													1.64		
Upper Bound													1.84		
UTS-4											1.74				
Target Range - Lower Bound											1.61				
Upper Bound											1.87				

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA17263693

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description / **LOR**	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	32.3	<0.02	<10	440	0.81	0.64	1.08	2.25	73.7	19.6	89	10.80	630	3.55	9.33
Target Range - Lower Bound	29.6	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73
Upper Bound	36.4	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80
OREAS 905	32.1	0.39	<10	240	0.92	5.28	0.33	0.34	78.8	14.1	17	1.26	1540	3.34	6.16
Target Range - Lower Bound	28.4	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74
Upper Bound	35.0	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 17-DEC-2017
Account: APN

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb
Units	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.11	0.75	0.06	0.160	1.27	37.0	30.6	1.14	408	14.15	0.35	0.82	696	970	1060
Target Range - Lower Bound	0.07	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959
Upper Bound	0.29	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175
OREAS 905	0.08	1.20	0.02	0.576	0.33	39.3	4.9	0.15	336	2.90	0.10	0.34	8.9	230	15.8
Target Range - Lower Bound	<0.05	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2
Upper Bound	0.22	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 17-DEC-2017
Account: APN

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description															
Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	143.0	0.009	0.29	3.16	7.1	0.7	3.4	79.9	0.01	0.03	21.8	0.373	0.81	5.34	98
Target Range - Lower Bound	132.0	0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90
Upper Bound	162.0	0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112
OREAS 905	19.9	<0.001	0.05	1.05	1.8	2.4	1.3	12.8	<0.01	0.07	8.2	0.021	0.12	2.21	5
Target Range - Lower Bound	17.3	<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4
Upper Bound	21.3	0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS					
Buffer pH6					
Buffer pH6					
Target Range - Lower Bound					
Upper Bound					
CO-ASSAY					
Target Range - Lower Bound					
Upper Bound					
DS-1					
Target Range - Lower Bound					
Upper Bound					
GS313-8					
Target Range - Lower Bound					
Upper Bound					
KZK-1					
KZK-1					
Target Range - Lower Bound					
Upper Bound					
MRGeo08		2.82	19.75	762	22.5
Target Range - Lower Bound		2.44	17.50	708	18.1
Upper Bound		3.42	21.5	870	25.7
OREAS 905		0.61	7.17	65	47.3
Target Range - Lower Bound		0.44	6.32	58	39.9
Upper Bound		0.76	7.84	76	55.1
SY-4					
Target Range - Lower Bound					
Upper Bound					
UTS-1					
Target Range - Lower Bound					
Upper Bound					
UTS-1					
Target Range - Lower Bound					
Upper Bound					
UTS-4					
Target Range - Lower Bound					
Upper Bound					
UTS-4					
Target Range - Lower Bound					
Upper Bound					

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 17-DEC-2017
Account: APN

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description	**Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag	Al
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm	%
	LOR	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01
BLANKS																
BLANK										<0.05	<0.2					
BLANK										<0.05	<0.2					
Target Range - Lower Bound										<0.05	<0.2					
Upper Bound										0.10	0.4					
BLANK															<0.01	<0.01
Target Range - Lower Bound															<0.01	<0.01
Upper Bound															0.02	0.02
BLANK							6.0									
Target Range - Lower Bound							5.5									
Upper Bound							6.9									
BLANK														<0.01		
Target Range - Lower Bound														<0.01		
Upper Bound														0.02		
BLANK												<0.01				
Target Range - Lower Bound												<0.01				
Upper Bound												0.02				
BLANK								0.01					<0.01			
Target Range - Lower Bound								<0.01					<0.01			
Upper Bound								0.02					0.02			
DUPLICATES																
ORIGINAL															0.05	1.84
DUP															0.05	1.98
Target Range - Lower Bound															0.04	1.80
Upper Bound															0.06	2.02
L2027460-5 145589							8.6			0.70	2.6					
DUP							8.6			0.70	2.6					
Target Range - Lower Bound							8.1			0.62	2.3					
Upper Bound							9.1			0.79	2.9					
L2027460-10 145594		1	1.3	10	11	8.80		0.04	0.03	0.09	0.3	0.01	0.11	<0.01		
DUP		1	1.3	10	11	8.80		0.04	0.03	0.09	0.3	0.01	0.12	<0.01		
Target Range - Lower Bound		<1	0.9	9	9	8.35		0.03	0.02	<0.05	<0.2	<0.01	0.10	<0.01		
Upper Bound		2	1.7	12	13	9.25		0.05	0.04	0.10	0.4	0.02	0.13	0.02		

QC CERTIFICATE OF ANALYSIS VA17263693

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga
Units	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
Sample Description LOR	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05
Target Range - Lower Bound	<0.1	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05
Upper Bound	0.2	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	19.0	<0.02	<10	50	0.24	0.14	0.08	0.02	73.3	4.5	20	0.25	14.6	4.41	5.22
DUP	20.0	<0.02	<10	50	0.23	0.15	0.08	0.03	81.8	4.6	22	0.28	15.0	4.73	5.50
Target Range - Lower Bound	18.4	<0.02	<10	40	0.17	0.13	0.07	<0.01	73.7	4.2	19	0.20	14.1	4.33	5.04
Upper Bound	20.6	0.04	20	60	0.30	0.16	0.09	0.04	81.4	4.9	23	0.33	15.5	4.81	5.68
L2027460-5 145589															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2027460-10 145594															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description	Method Analyte Units LOR	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2
								BLANKS								
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2
Target Range - Lower Bound		<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2
Upper Bound		0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
								DUPLICATES								
ORIGINAL		0.08	0.38	0.01	0.017	0.16	35.9	8.9	0.68	749	4.32	0.01	<0.05	16.5	570	5.0
DUP		0.07	0.29	0.01	0.018	0.17	39.9	7.8	0.73	800	4.70	0.01	<0.05	16.7	600	5.3
Target Range - Lower Bound		<0.05	0.30	<0.01	0.012	0.15	35.8	7.8	0.66	731	4.23	<0.01	<0.05	15.6	550	4.7
Upper Bound		0.10	0.37	0.02	0.023	0.18	40.0	8.9	0.75	818	4.79	0.02	0.10	17.6	620	5.6
L2027460-5 145589																
DUP																
Target Range - Lower Bound																
Upper Bound																
L2027460-10 145594																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V
Units	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm
LOR	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1
BLANKS															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1
Target Range - Lower Bound	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1
Upper Bound	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	6.8	<0.001	0.02	0.26	1.6	<0.2	0.2	7.2	<0.01	0.02	9.3	<0.005	0.07	1.78	22
DUP	7.4	<0.001	0.02	0.28	1.6	0.3	0.2	7.8	<0.01	0.01	10.0	<0.005	0.08	1.94	24
Target Range - Lower Bound	6.6	<0.001	<0.01	0.20	1.4	<0.2	<0.2	6.9	<0.01	<0.01	9.0	<0.005	0.05	1.72	21
Upper Bound	7.6	0.002	0.03	0.34	1.8	0.4	0.4	8.1	0.02	0.02	10.3	0.010	0.10	2.00	25
L2027460-5 145589															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2027460-10 145594															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

Sample Description	Method Analyte Units LOR	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
BLANKS					
BLANK					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK		<0.05	<0.05	<2	<0.5
Target Range - Lower Bound		<0.05	<0.05	<2	<0.5
Upper Bound		0.10	0.10	4	1.0
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
Target Range - Lower Bound					
Upper Bound					
BLANK					
Target Range - Lower Bound					
Upper Bound					
DUPLICATES					
ORIGINAL		<0.05	5.06	77	17.5
DUP		<0.05	5.43	83	12.5
Target Range - Lower Bound		<0.05	4.93	74	13.4
Upper Bound		0.10	5.56	86	16.6
L2027460-5 145589					
DUP					
Target Range - Lower Bound					
Upper Bound					
L2027460-10 145594					
DUP					
Target Range - Lower Bound					
Upper Bound					

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 17-DEC-2017
Account: APN

Project: L2027460

QC CERTIFICATE OF ANALYSIS VA17263693

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2027460-COFC

COC Number: 18-17-34

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

ALS Lab Work Order # (lab use only)

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Contact: Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	145585	05-NOV-17		WASTE	X	X	X	X	X	X	
	145586	02-NOV-17		WASTE	X	X	X	X	X	X	
	145587	02-NOV-17		WASTE	X	X	X	X	X	X	
	145588	06-NOV-17		WASTE	X	X	X	X	X	X	
	145589	06-NOV-17		WASTE	X	X	X	X	X	X	
	145590	11-NOV-17		WASTE	X	X	X	X	X	X	
	145591	13-NOV-17		WASTE	X	X	X	X	X	X	
	145592	05-NOV.-17		WASTE	X	X	X	X	X	X	
	145593	17-NOV-17		WASTE	X	X	X	X	X	X	
	145594	14-NOV-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INIITIAL COOLER TEMPERATURES °C: 5.0

FINAL COOLER TEMPERATURES °C: 1.0

SHIPMENT RELEASE (client use)

Released by: Date: Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: EHF Date: 27 NOV 2017 Time: 10:30

FINAL SHIPMENT RECEPTION (lab use only)

Received by: JC Date: 11/28/17 Time: 15:10

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 08-DEC-17
Report Date: 17-JAN-18 15:19 (MT)
Version: FINAL REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2032841
Project P.O. #: PO#228594
Job Reference:
C of C Numbers: 17-35
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2032841-1	L2032841-2	L2032841-3	L2032841-4	L2032841-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-NOV-17	19-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time					
	Client ID	145596	145595	144248	144249	144250
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.1	8.5	8.2	8.5	8.7
Organic / Inorganic Carbon	Carbon (C) (%)	0.39	0.24	0.28	0.26	0.38
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	0.9	1.6	20.9	5.0	23.1
	Neutralization Potential (NP) (tCaCO3/1Kt)	35	22	22	23	30
	NNP (tCaCO3/1Kt)	34	20	1	18	7
	Ratio (NP/MPA) (Unity)	37.33	14.08	1.05	4.60	1.30
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	0.02	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.03	0.05	0.66	0.16	0.74
	Total Sulfur (combustion) (%)	0.03	0.05	0.67	0.16	0.74
Total Metals	Aluminum (Al) (%)	0.99	0.85	1.15	1.31	1.11
	Antimony (Sb) (ppm)	0.48	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	6.8	1.6	0.4	0.4	0.7
	Barium (Ba) (ppm)	250	240	200	280	240
	Beryllium (Be) (ppm)	0.39	0.25	0.22	0.21	0.23
	Bismuth (Bi) (ppm)	0.08	0.08	0.53	0.09	0.46
	Boron (B) (ppm)	<10	10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.23	0.23	0.42	0.09	0.19
	Calcium (Ca) (%)	1.56	0.82	0.83	0.90	1.04
	Cerium (Ce) (ppm)	24.3	28.3	15.00	21.8	25.0
	Cesium (Cs) (ppm)	0.71	0.37	0.36	0.43	0.34
	Chromium (Cr) (ppm)	25	4	6	7	6
	Cobalt (Co) (ppm)	7.5	7.1	7.2	6.5	8.1
	Copper (Cu) (ppm)	37.1	2360	4990	859	3350
	Gallium (Ga) (ppm)	3.41	4.24	6.12	6.20	5.90
	Germanium (Ge) (ppm)	0.05	0.05	0.05	0.06	0.06
	Gold (Au) (ppm)	<0.02	0.02	0.10	0.02	0.07
	Hafnium (Hf) (ppm)	0.24	0.06	0.05	0.04	0.03
	Indium (In) (ppm)	0.017	0.085	0.090	0.031	0.069
	Iron (Fe) (%)	2.01	2.33	3.38	2.60	3.25
	Lanthanum (La) (ppm)	12.3	16.0	7.7	11.7	13.5
	Lead (Pb) (ppm)	4.7	3.6	3.3	2.5	4.4
	Lithium (Li) (ppm)	6.8	3.1	5.1	6.1	5.6
	Magnesium (Mg) (%)	0.53	0.31	0.63	0.71	0.65
	Manganese (Mn) (ppm)	409	573	483	482	536

	Sample ID	L2032841-6	L2032841-7	L2032841-8	L2032841-9	L2032841-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time					
	Client ID	144850	144848	144849	144598	144599
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.8	8.8	8.0	8.8	8.8
Organic / Inorganic Carbon	Carbon (C) (%)	0.30	0.25	0.27	0.34	0.42
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	2
	MPA (tCaCO3/1Kt)	13.1	20.3	43.1	10.9	10.6
	Neutralization Potential (NP) (tCaCO3/1Kt)	25	20	22	29	35
	NNP (tCaCO3/1Kt)	12	0	-21	18	24
	Ratio (NP/MPA) (Unity)	1.90	0.98	0.51	2.65	3.29
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	0.31	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.02	0.33	0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.42	0.63	1.05	0.34	0.34
	Total Sulfur (combustion) (%)	0.42	0.65	1.38	0.35	0.34
Total Metals	Aluminum (Al) (%)	1.05	1.14	1.12	1.27	1.19
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	0.5	0.6	0.5	0.7	0.5
	Barium (Ba) (ppm)	190	230	180	270	260
	Beryllium (Be) (ppm)	0.20	0.30	0.19	0.19	0.19
	Bismuth (Bi) (ppm)	0.14	0.46	0.67	0.29	0.14
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.13	0.20	0.88	0.14	0.10
	Calcium (Ca) (%)	0.90	0.74	1.20	1.08	1.29
	Cerium (Ce) (ppm)	17.50	18.50	21.2	22.5	22.3
	Cesium (Cs) (ppm)	0.27	0.28	0.43	0.46	0.38
	Chromium (Cr) (ppm)	7	7	7	7	7
	Cobalt (Co) (ppm)	6.5	10.7	8.0	7.1	8.0
	Copper (Cu) (ppm)	2210	3440	>10000	2350	1500
	Gallium (Ga) (ppm)	5.21	6.12	5.89	6.43	5.55
	Germanium (Ge) (ppm)	0.06	0.06	0.07	0.06	0.06
	Gold (Au) (ppm)	0.08	0.14	0.33	0.07	0.03
	Hafnium (Hf) (ppm)	0.04	0.05	0.04	0.04	0.04
	Indium (In) (ppm)	0.060	0.055	0.159	0.052	0.036
	Iron (Fe) (%)	2.31	3.15	3.43	3.08	2.50
	Lanthanum (La) (ppm)	9.1	9.6	11.5	11.7	11.9
	Lead (Pb) (ppm)	3.2	3.7	3.2	2.8	2.8
	Lithium (Li) (ppm)	5.2	5.7	4.8	5.3	5.2
	Magnesium (Mg) (%)	0.57	0.60	0.64	0.69	0.64
	Manganese (Mn) (ppm)	435	482	471	484	433

	Sample ID	L2032841-1	L2032841-2	L2032841-3	L2032841-4	L2032841-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	09-NOV-17	19-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time					
	Client ID	145596	145595	144248	144249	144250
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.04	<0.01	<0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	1.41	9.68	29.9	6.96	12.45
	Nickel (Ni) (ppm)	18.6	2.3	2.0	2.0	2.3
	Niobium (Nb) (ppm)	0.53	0.21	0.22	0.22	0.16
	Phosphorus (P) (ppm)	840	680	610	700	730
	Potassium (K) (%)	0.16	0.42	0.58	0.66	0.52
	Rhenium (Re) (ppm)	<0.001	0.007	0.046	0.004	0.036
	Rubidium (Rb) (ppm)	9.0	21.5	26.8	30.1	25.0
	Scandium (Sc) (ppm)	4.9	4.8	2.7	4.1	3.6
	Selenium (Se) (ppm)	0.5	0.9	3.6	1.1	2.9
	Silver (Ag) (ppm)	0.06	0.36	1.31	0.24	1.01
	Sodium (Na) (%)	0.05	0.05	0.06	0.08	0.06
	Strontium (Sr) (ppm)	77.5	55.6	51.6	62.1	63.3
	Sulfur (S) (%)	0.04	0.07	0.66	0.17	0.74
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.07	0.22	0.04	0.18
	Thallium (Tl) (ppm)	0.10	0.17	0.19	0.20	0.18
	Thorium (Th) (ppm)	3.2	3.5	2.3	3.4	3.2
	Tin (Sn) (ppm)	0.4	0.9	0.9	0.7	0.9
	Titanium (Ti) (%)	0.074	0.060	0.095	0.117	0.086
	Tungsten (W) (ppm)	0.41	0.29	<0.05	<0.05	<0.05
	Uranium (U) (ppm)	0.57	0.39	0.18	0.32	0.24
	Vanadium (V) (ppm)	47	61	54	56	61
	Yttrium (Y) (ppm)	8.79	8.28	5.63	5.84	6.43
	Zinc (Zn) (ppm)	47	69	84	76	84
	Zirconium (Zr) (ppm)	8.1	1.6	1.1	1.0	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	1.4	0.9	1.0	1.0	1.4
Miscellaneous	Carbon (C) (%)	0.64	0.29	0.30	0.27	0.41

	Sample ID	L2032841-6	L2032841-7	L2032841-8	L2032841-9	L2032841-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17	07-NOV-17
	Sampled Time					
	Client ID	144850	144848	144849	144598	144599
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	0.02	<0.01	<0.01
	Molybdenum (Mo) (ppm)	2.88	5.80	7.17	17.95	21.0
	Nickel (Ni) (ppm)	1.6	3.1	2.1	2.1	1.9
	Niobium (Nb) (ppm)	0.14	0.21	0.34	0.27	0.18
	Phosphorus (P) (ppm)	590	610	690	1210	620
	Potassium (K) (%)	0.42	0.46	0.58	0.71	0.58
	Rhenium (Re) (ppm)	0.019	0.016	0.024	0.039	0.040
	Rubidium (Rb) (ppm)	18.8	21.6	27.3	34.4	27.7
	Scandium (Sc) (ppm)	2.6	3.8	3.4	3.9	3.1
	Selenium (Se) (ppm)	2.0	3.4	7.8	2.2	1.4
	Silver (Ag) (ppm)	0.58	1.17	3.27	0.66	0.44
	Sodium (Na) (%)	0.07	0.08	0.06	0.08	0.07
	Strontium (Sr) (ppm)	53.9	51.9	76.7	66.7	55.9
	Sulfur (S) (%)	0.41	0.64	1.39	0.36	0.36
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.12	0.22	0.80	0.16	0.06
	Thallium (Tl) (ppm)	0.13	0.15	0.21	0.24	0.21
	Thorium (Th) (ppm)	2.8	2.3	3.8	3.0	2.3
	Tin (Sn) (ppm)	0.7	0.8	1.0	0.9	0.8
	Titanium (Ti) (%)	0.066	0.077	0.105	0.127	0.098
	Tungsten (W) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Uranium (U) (ppm)	0.35	0.28	0.36	0.34	0.26
	Vanadium (V) (ppm)	43	51	57	61	51
	Yttrium (Y) (ppm)	5.62	5.81	6.32	9.43	6.44
	Zinc (Zn) (ppm)	65	74	95	72	61
	Zirconium (Zr) (ppm)	0.9	1.2	1.0	1.1	1.0
Permanent Gases	Carbon Dioxide (CO2) (%)	1.1	0.9	1.0	1.2	1.5
Miscellaneous	Carbon (C) (%)	0.32	0.28	0.31	0.37	0.46

Reference Information

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>ABA-OA-VOL08-AX</td><td>Soil</td><td>Acid Base Accounting</td><td>OA-VOL08</td></tr>
<tr><td>CARBON-C-GAS05-AX</td><td>Soil</td><td>Carbon, TOC and CO2</td><td>C-GAS05</td></tr>
<tr><td>CARBON-C-IR07-AX</td><td>Soil</td><td>Carbon (C) using LECO analyzer</td><td>Total Carbon - Method Code C-IR07</td></tr>
<tr><td colspan="4">Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.</td></tr>
<tr><td>ME-MS41-AX</td><td>Soil</td><td>Aqua Regia ICPMS</td><td>Aqua Regia ICPMS</td></tr>
<tr><td colspan="4">A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.</td></tr>
<tr><td>PH-OA-ELE07-AX</td><td>Soil</td><td>pH</td><td>OA-ELE07</td></tr>
<tr><td>SULPHUR-S-CAL06A-AX</td><td>Soil</td><td>Sulfide Sulfur Calc from HCl Leach</td><td>ALS Minerals S-CAL06A</td></tr>
<tr><td colspan="4">Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.</td></tr>
<tr><td>SULPHUR-S-GRA06-AX</td><td>Soil</td><td>Sulfate Sulfur in Soil (Carbonate Leach)</td><td>ALS Minerals S-GRA06</td></tr>
<tr><td colspan="4">A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).</td></tr>
<tr><td>SULPHUR-S-GRA06A-AX</td><td>Soil</td><td>Sulfate Sulfur in Soil (HCl Leach)</td><td>ALS Minerals S-GRA06A</td></tr>
<tr><td colspan="4">A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).</td></tr>
<tr><td>SULPHUR-S-IR08-AX</td><td>Soil</td><td>Total Sulfur in Soil by Combustion</td><td>ALS Minerals S-IR08</td></tr>
<tr><td colspan="4">The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.</td></tr>
</table>

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-35

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA17276191

Project: L2032841

This report is for 10 Crushed Rock samples submitted to our lab in Vancouver, BC, Canada on 12-DEC-2017.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
ME-OG46	Ore Grade Elements - AquaRegia	ICP-AES
Cu-OG46	Ore Grade Cu - Aqua Regia	ICP-AES
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2032841

CERTIFICATE OF ANALYSIS VA17276191

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01	ME-MS41 Ag ppm 0.01
L2032841-1 145596		1.08	2	0.9	34	35	37.33	8.1	0.03	0.03	0.39	1.4	<0.01	0.64	<0.01	0.06
L2032841-2 145595		1.10	2	1.6	20	22	14.08	8.5	0.05	0.05	0.24	0.9	<0.01	0.29	<0.01	0.36
L2032841-3 144248		1.12	2	20.9	1	22	1.05	8.2	0.67	0.66	0.28	1.0	0.01	0.30	<0.01	1.31
L2032841-4 144249		1.10	2	5.0	18	23	4.60	8.5	0.16	0.16	0.26	1.0	<0.01	0.27	0.02	0.24
L2032841-5 144250		1.24	2	23.1	7	30	1.30	8.7	0.74	0.74	0.38	1.4	<0.01	0.41	<0.01	1.01
L2032841-6 144850		1.18	2	13.1	12	25	1.90	8.8	0.42	0.42	0.30	1.1	<0.01	0.32	<0.01	0.58
L2032841-7 144848		1.10	2	20.3	0	20	0.98	8.8	0.65	0.63	0.25	0.9	0.02	0.28	<0.01	1.17
L2032841-8 144849		1.18	2	43.1	-21	22	0.51	8.0	1.38	1.05	0.27	1.0	0.33	0.31	0.31	3.27
L2032841-9 144598		1.18	2	10.9	18	29	2.65	8.8	0.35	0.34	0.34	1.2	0.01	0.37	<0.01	0.66
L2032841-10 144599		1.12	2	10.6	24	35	3.29	8.8	0.34	0.34	0.42	1.5	<0.01	0.46	<0.01	0.44

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2032841

CERTIFICATE OF ANALYSIS VA17276191

Sample Description	Method Analyte Units LOR	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01
L2032841-1 145596		0.99	6.8	<0.02	<10	250	0.39	0.08	1.56	0.23	24.3	7.5	25	0.71	37.1	2.01
L2032841-2 145595		0.85	1.6	0.02	10	240	0.25	0.08	0.82	0.23	28.3	7.1	4	0.37	2360	2.33
L2032841-3 144248		1.15	0.4	0.10	<10	200	0.22	0.53	0.83	0.42	15.00	7.2	6	0.36	4990	3.38
L2032841-4 144249		1.31	0.4	0.02	<10	280	0.21	0.09	0.90	0.09	21.8	6.5	7	0.43	859	2.60
L2032841-5 144250		1.11	0.7	0.07	<10	240	0.23	0.46	1.04	0.19	25.0	8.1	6	0.34	3350	3.25
L2032841-6 144850		1.05	0.5	0.08	<10	190	0.20	0.14	0.90	0.13	17.50	6.5	7	0.27	2210	2.31
L2032841-7 144848		1.14	0.6	0.14	<10	230	0.30	0.46	0.74	0.20	18.50	10.7	7	0.28	3440	3.15
L2032841-8 144849		1.12	0.5	0.33	<10	180	0.19	0.67	1.20	0.88	21.2	8.0	7	0.43	>10000	3.43
L2032841-9 144598		1.27	0.7	0.07	<10	270	0.19	0.29	1.08	0.14	22.5	7.1	7	0.46	2350	3.08
L2032841-10 144599		1.19	0.5	0.03	<10	260	0.19	0.14	1.29	0.10	22.3	8.0	7	0.38	1500	2.50

Project: L2032841

CERTIFICATE OF ANALYSIS VA17276191

Sample Description	Method Analyte Units LOR	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10
L2032841-1 145596		3.41	0.05	0.24	0.04	0.017	0.16	12.3	6.8	0.53	409	1.41	0.05	0.53	18.6	840
L2032841-2 145595		4.24	0.05	0.06	<0.01	0.085	0.42	16.0	3.1	0.31	573	9.68	0.05	0.21	2.3	680
L2032841-3 144248		6.12	0.05	0.05	<0.01	0.090	0.58	7.7	5.1	0.63	483	29.9	0.06	0.22	2.0	610
L2032841-4 144249		6.20	0.06	0.04	<0.01	0.031	0.66	11.7	6.1	0.71	482	6.96	0.08	0.22	2.0	700
L2032841-5 144250		5.90	0.06	0.03	0.01	0.069	0.52	13.5	5.6	0.65	536	12.45	0.06	0.16	2.3	730
L2032841-6 144850		5.21	0.06	0.04	0.01	0.060	0.42	9.1	5.2	0.57	435	2.88	0.07	0.14	1.6	590
L2032841-7 144848		6.12	0.06	0.05	0.01	0.055	0.46	9.6	5.7	0.60	482	5.80	0.08	0.21	3.1	610
L2032841-8 144849		5.89	0.07	0.04	0.02	0.159	0.58	11.5	4.8	0.64	471	7.17	0.06	0.34	2.1	690
L2032841-9 144598		6.43	0.06	0.04	<0.01	0.052	0.71	11.7	5.3	0.69	484	17.95	0.08	0.27	2.1	1210
L2032841-10 144599		5.55	0.06	0.04	<0.01	0.036	0.58	11.9	5.2	0.64	433	21.0	0.07	0.18	1.9	620

CERTIFICATE OF ANALYSIS VA17276191

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2032841-1 145596		4.7	9.0	<0.001	0.04	0.48	4.9	0.5	0.4	77.5	<0.01	0.01	3.2	0.074	0.10	0.57
L2032841-2 145595		3.6	21.5	0.007	0.07	<0.05	4.8	0.9	0.9	55.6	<0.01	0.07	3.5	0.060	0.17	0.39
L2032841-3 144248		3.3	26.8	0.046	0.66	<0.05	2.7	3.6	0.9	51.6	<0.01	0.22	2.3	0.095	0.19	0.18
L2032841-4 144249		2.5	30.1	0.004	0.17	<0.05	4.1	1.1	0.7	62.1	<0.01	0.04	3.4	0.117	0.20	0.32
L2032841-5 144250		4.4	25.0	0.036	0.74	<0.05	3.6	2.9	0.9	63.3	<0.01	0.18	3.2	0.086	0.18	0.24
L2032841-6 144850		3.2	18.8	0.019	0.41	<0.05	2.6	2.0	0.7	53.9	<0.01	0.12	2.8	0.066	0.13	0.35
L2032841-7 144848		3.7	21.6	0.016	0.64	<0.05	3.8	3.4	0.8	51.9	<0.01	0.22	2.3	0.077	0.15	0.28
L2032841-8 144849		3.2	27.3	0.024	1.39	<0.05	3.4	7.8	1.0	76.7	<0.01	0.80	3.8	0.105	0.21	0.36
L2032841-9 144598		2.8	34.4	0.039	0.36	<0.05	3.9	2.2	0.9	66.7	<0.01	0.16	3.0	0.127	0.24	0.34
L2032841-10 144599		2.8	27.7	0.040	0.36	<0.05	3.1	1.4	0.8	55.9	<0.01	0.06	2.3	0.098	0.21	0.26

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 9-JAN-2018
Account: APN

Project: L2032841

CERTIFICATE OF ANALYSIS VA17276191

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5	Cu-OG46 Cu % 0.001
L2032841-1 145596		47	0.41	8.79	47	8.1	
L2032841-2 145595		61	0.29	8.28	69	1.6	
L2032841-3 144248		54	<0.05	5.63	84	1.1	
L2032841-4 144249		56	<0.05	5.84	76	1.0	
L2032841-5 144250		61	<0.05	6.43	84	1.0	
L2032841-6 144850		43	<0.05	5.62	65	0.9	
L2032841-7 144848		51	<0.05	5.81	74	1.2	
L2032841-8 144849		57	<0.05	6.32	95	1.0	1.105
L2032841-9 144598		61	<0.05	9.43	72	1.1	
L2032841-10 144599		51	<0.05	6.44	61	1.0	

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2032841

CERTIFICATE OF ANALYSIS VA17276191

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	Cu-OG46	LOG-22
ME-MS41	ME-OG46	OA-ELE07	OA-VOL08m
PUL-31	PUL-QC	S-CAL06a	S-GRA06
S-GRA06a	S-IR08	SPL-21	WEI-21

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2032841-COFC

COC Number: 18-1735

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		1 Business day [E1]	☐
	3 day [P3]	☐		Same Day, Weekend or Statutory holiday [E0]	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	~~145595~~	~~19-NOV-17~~		Composite	R	R	R	R	R	R	
	145596	9-NOV-17		WASTE	X	X	X	X	X	X	
	145595	19-NOV-17		WASTE	X	X	X	X	X	X	
	144248	07-NOV-17		WASTE	X	X	X	X	X	X	
	144249	07-NOV-17		WASTE	X	X	X	X	X	X	
	144250	07-NOV-17		WASTE	X	X	X	X	X	X	
	144850	07-NOV-17		WASTE	X	X	X	X	X	X	
	144848	07-NOV-17		WASTE	X	X	X	X	X	X	
	144849	07-NOV-17		WASTE	X	X	X	X	X	X	
	144598	07-NOV-17		WASTE	X	X	X	X	X	X	
	144599	07-NOV-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C

FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)

Released by: Date: Dec 02, 2017 Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

FINAL SHIPMENT RECEPTION (lab use only)

Received by: Date: Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 13-DEC-17
Report Date: 19-JAN-18 16:47 (MT)
Version: FINAL REV. 2

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2035058
Project P.O. #: PO#228594
Job Reference:
C of C Numbers: 17-36
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L2035058-2	L2035058-3	L2035058-4	L2035058-5	L2035058-6
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	07-NOV-17	24-NOV-17	24-NOV-17	24-NOV-17	23-NOV-17
	Sampled Time					
	Client ID	144600	146676	146677	146678	145597
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.4	8.5	8.3	8.6	7.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.52	<0.05	<0.05	<0.05	0.26
Acid Base Accounting	FIZZ RATING (Unity)	2	1	1	1	2
	MPA (tCaCO3/1Kt)	9.7	0.6	0.6	0.3	2.2
	Neutralization Potential (NP) (tCaCO3/1Kt)	48	10	8	8	32
	NNP (tCaCO3/1Kt)	38	9	7	8	30
	Ratio (NP/MPA) (Unity)	4.95	16.00	12.80	25.60	14.63
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.01	<0.01	0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.03	0.01	0.02	0.04
	Sulfide Sulfur (T minus HCl leach) (%)	0.31	<0.01	0.01	<0.01	0.03
	Total Sulfur (combustion) (%)	0.31	0.02	0.02	0.01	0.07
Total Metals	Aluminum (Al) (%)	0.98	1.15	1.02	1.04	1.22
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	0.53
	Arsenic (As) (ppm)	0.6	1.8	1.0	0.3	6.2
	Barium (Ba) (ppm)	240	390	220	320	310
	Beryllium (Be) (ppm)	0.22	0.28	0.26	0.27	0.39
	Bismuth (Bi) (ppm)	0.10	0.01	0.08	0.01	0.12
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.15	0.12	0.19	0.05	0.29
	Calcium (Ca) (%)	1.69	0.29	0.27	0.28	1.18
	Cerium (Ce) (ppm)	29.9	26.9	33.0	24.8	25.9
	Cesium (Cs) (ppm)	0.25	0.63	0.57	0.41	0.82
	Chromium (Cr) (ppm)	5	4	3	4	24
	Cobalt (Co) (ppm)	6.5	6.2	6.7	5.5	8.9
	Copper (Cu) (ppm)	1510	407	2470	65.3	976
	Gallium (Ga) (ppm)	4.85	5.67	5.39	5.04	4.65
	Germanium (Ge) (ppm)	0.10	0.10	0.10	0.12	0.10
	Gold (Au) (ppm)	0.04	<0.02	0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.06	0.06	0.06	0.08	0.26
	Indium (In) (ppm)	0.046	0.034	0.087	0.029	0.034
	Iron (Fe) (%)	2.20	2.43	2.53	1.99	2.44
	Lanthanum (La) (ppm)	16.8	14.7	18.2	12.6	13.3
	Lead (Pb) (ppm)	2.9	2.8	4.2	1.4	5.2
	Lithium (Li) (ppm)	4.8	5.0	4.3	5.1	7.9
	Magnesium (Mg) (%)	0.49	0.42	0.41	0.45	0.63
	Manganese (Mn) (ppm)	440	527	551	598	490

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2035058-7	L2035058-8	L2035058-9	L2035058-10	L2035058-11
	Description	Waste	Waste	Waste	Waste	TAILS
	Sampled Date	26-NOV-17	26-NOV-17	26-NOV-17	25-NOV-17	20-NOV-17
	Sampled Time					
	Client ID	145598	145599	145600	146679	NOV TAL 2017
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.2	8.4	8.3	8.4	7.9
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	<0.05	<0.05	0.11	0.22
Acid Base Accounting	FIZZ RATING (Unity)	1	1	1	1	2
	MPA (tCaCO3/1Kt)	0.6	0.6	0.3	2.2	3.4
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	9	5	13	27
	NNP (tCaCO3/1Kt)	7	8	5	11	24
	Ratio (NP/MPA) (Unity)	12.80	14.40	16.00	5.94	7.85
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.01	<0.01	0.01	0.05
	Sulfate Sulfur (HCl leach) (%)	0.04	0.02	0.01	0.02	0.05
	Sulfide Sulfur (T minus HCl leach) (%)	<0.01	<0.01	<0.01	0.05	0.06
	Total Sulfur (combustion) (%)	0.02	0.02	0.01	0.07	0.11
Total Metals	Aluminum (Al) (%)	1.18	0.96	0.66	0.82	1.32
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	1.5	0.6	0.9	0.9	0.8
	Barium (Ba) (ppm)	260	290	210	220	250
	Beryllium (Be) (ppm)	0.27	0.26	0.20	0.21	0.28
	Bismuth (Bi) (ppm)	0.09	<0.01	0.01	0.12	0.25
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.35	0.05	0.23	0.25	0.26
	Calcium (Ca) (%)	0.22	0.32	0.10	0.47	0.87
	Cerium (Ce) (ppm)	26.2	26.9	9.15	24.1	24.9
	Cesium (Cs) (ppm)	0.58	0.31	0.27	0.41	0.53
	Chromium (Cr) (ppm)	4	6	4	4	8
	Cobalt (Co) (ppm)	9.8	5.7	5.9	5.9	7.3
	Copper (Cu) (ppm)	4420	306	1830	2650	1970
	Gallium (Ga) (ppm)	6.71	4.91	3.64	4.20	8.43
	Germanium (Ge) (ppm)	0.12	0.11	0.06	0.09	0.11
	Gold (Au) (ppm)	0.04	<0.02	<0.02	0.05	0.07
	Hafnium (Hf) (ppm)	0.07	0.11	0.05	0.07	0.06
	Indium (In) (ppm)	0.074	0.029	0.027	0.058	0.084
	Iron (Fe) (%)	2.61	2.06	1.56	2.27	3.81
	Lanthanum (La) (ppm)	14.9	14.2	5.2	14.0	13.7
	Lead (Pb) (ppm)	2.8	1.7	2.3	3.1	3.7
	Lithium (Li) (ppm)	4.7	5.3	2.6	3.0	6.0
	Magnesium (Mg) (%)	0.53	0.42	0.20	0.33	0.71
	Manganese (Mn) (ppm)	397	499	259	525	612

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2035058-2	L2035058-3	L2035058-4	L2035058-5	L2035058-6
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	07-NOV-17	24-NOV-17	24-NOV-17	24-NOV-17	23-NOV-17
	Sampled Time					
	Client ID	144600	146676	146677	146678	145597
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	0.01	0.01	0.04
	Molybdenum (Mo) (ppm)	8.81	1.35	5.14	0.81	1.42
	Nickel (Ni) (ppm)	1.6	2.4	2.5	2.6	20.0
	Niobium (Nb) (ppm)	0.21	0.33	0.28	0.22	0.78
	Phosphorus (P) (ppm)	600	670	880	620	860
	Potassium (K) (%)	0.41	0.66	0.60	0.57	0.23
	Rhenium (Re) (ppm)	0.024	<0.001	<0.001	<0.001	0.001
	Rubidium (Rb) (ppm)	19.5	32.9	32.5	25.7	11.9
	Scandium (Sc) (ppm)	3.3	8.0	6.3	5.4	4.9
	Selenium (Se) (ppm)	1.4	0.2	0.8	0.2	0.7
	Silver (Ag) (ppm)	0.40	0.04	0.20	0.02	0.27
	Sodium (Na) (%)	0.05	0.07	0.05	0.05	0.05
	Strontium (Sr) (ppm)	98.2	28.8	38.1	28.1	54.6
	Sulfur (S) (%)	0.35	0.01	0.02	0.01	0.07
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.06	0.01	0.06	<0.01	0.06
	Thallium (Tl) (ppm)	0.13	0.22	0.29	0.17	0.12
	Thorium (Th) (ppm)	3.1	3.5	5.7	2.8	3.4
	Tin (Sn) (ppm)	0.6	0.8	1.2	0.7	0.5
	Titanium (Ti) (%)	0.065	0.102	0.094	0.085	0.081
	Tungsten (W) (ppm)	0.22	0.79	0.20	0.55	0.56
	Uranium (U) (ppm)	0.62	0.17	0.35	0.15	0.67
	Vanadium (V) (ppm)	40	57	70	44	53
	Yttrium (Y) (ppm)	6.52	8.83	10.50	11.95	9.18
	Zinc (Zn) (ppm)	59	69	82	54	67
	Zirconium (Zr) (ppm)	1.4	1.4	1.4	1.3	7.2
Permanent Gases	Carbon Dioxide (CO2) (%)	1.9	<0.2	<0.2	<0.2	1.0
Miscellaneous	Carbon (C) (%)	0.58	0.04	0.05	0.05	0.74

	Sample ID	L2035058-7	L2035058-8	L2035058-9	L2035058-10	L2035058-11
	Description	Waste	Waste	Waste	Waste	TAILS
	Sampled Date	26-NOV-17	26-NOV-17	26-NOV-17	25-NOV-17	20-NOV-17
	Sampled Time					
	Client ID	145598	145599	145600	146679	NOV TAL 2017
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.02	0.01	0.02	0.01	0.01
	Molybdenum (Mo) (ppm)	3.49	0.68	2.53	9.44	3.97
	Nickel (Ni) (ppm)	6.9	7.2	2.9	2.4	3.4
	Niobium (Nb) (ppm)	0.40	0.18	0.30	0.22	0.28
	Phosphorus (P) (ppm)	780	660	230	700	820
	Potassium (K) (%)	0.77	0.49	0.35	0.49	0.66
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	0.003	0.007
	Rubidium (Rb) (ppm)	39.4	25.9	16.3	24.7	34.3
	Scandium (Sc) (ppm)	7.3	5.5	2.7	5.0	4.6
	Selenium (Se) (ppm)	0.8	<0.2	0.4	1.3	1.5
	Silver (Ag) (ppm)	0.44	0.08	0.18	0.42	0.72
	Sodium (Na) (%)	0.04	0.06	0.05	0.05	0.06
	Strontium (Sr) (ppm)	43.9	30.6	28.8	35.1	66.6
	Sulfur (S) (%)	0.01	0.01	0.01	0.06	0.12
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.10	<0.01	0.03	0.04	0.19
	Thallium (Tl) (ppm)	0.31	0.15	0.12	0.17	0.25
	Thorium (Th) (ppm)	3.1	2.2	0.7	3.7	3.5
	Tin (Sn) (ppm)	1.5	0.6	0.5	0.6	1.2
	Titanium (Ti) (%)	0.128	0.084	0.054	0.072	0.118
	Tungsten (W) (ppm)	1.15	0.68	0.93	0.54	0.25
	Uranium (U) (ppm)	0.33	0.16	0.20	0.26	0.37
	Vanadium (V) (ppm)	84	45	35	52	71
	Yttrium (Y) (ppm)	8.68	8.89	4.94	7.21	6.86
	Zinc (Zn) (ppm)	65	66	45	71	113
	Zirconium (Zr) (ppm)	1.7	2.2	1.4	1.6	1.2
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	<0.2	<0.2	0.4	0.8
Miscellaneous	Carbon (C) (%)	0.08	0.05	0.06	0.14	0.25

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-36

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 11-JAN-2018
Account: APN

CERTIFICATE VA17278855

Project: L2035058

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 15-DEC-2017.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE SHANE STACK	ALSEV DATASUBLET	SOFTWARE DEVELOPMENT GROUP

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
LOG-22	Sample login - Rcd w/o BarCode
PUL-QC	Pulverizing QC Test
SPL-21	Split sample - riffle splitter
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08	Basic Acid Base Accounting	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2035058

CERTIFICATE OF ANALYSIS VA17278855

Sample Description / **Method**	WEI-21	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-VOL08	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	ME-MS41	ME-MS41	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	Ag	Al	As
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	ppm	%	ppm
LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.1
L2035058-2 144600	1.08	2	9.7	38	48	4.95	8.4	0.31	0.31	0.52	1.9	<0.01	0.40	0.98	0.6
L2035058-3 146676	1.02	1	0.6	9	10	16.00	8.5	0.02	<0.01	<0.05	<0.2	0.03	0.04	1.15	1.8
L2035058-4 146677	1.06	1	0.6	7	8	12.80	8.3	0.02	0.01	<0.05	<0.2	0.01	0.20	1.02	1.0
L2035058-5 146678	1.12	1	0.3	8	8	25.60	8.6	0.01	<0.01	<0.05	<0.2	0.02	0.02	1.04	0.3
L2035058-6 145597	1.10	2	2.2	30	32	14.63	7.9	0.07	0.03	0.26	1.0	0.04	0.27	1.22	6.2
L2035058-7 145598	1.10	1	0.6	7	8	12.80	8.2	0.02	<0.01	<0.05	<0.2	0.04	0.44	1.18	1.5
L2035058-8 145599	1.10	1	0.6	8	9	14.40	8.4	0.02	<0.01	<0.05	<0.2	0.02	0.08	0.96	0.6
L2035058-9 145600	0.94	1	0.3	5	5	16.00	8.3	0.01	<0.01	<0.05	<0.2	0.01	0.18	0.66	0.9
L2035058-10 146679	1.10	1	2.2	11	13	5.94	8.4	0.07	0.05	0.11	0.4	0.02	0.42	0.82	0.9
L2035058-11	0.90	2	3.4	24	27	7.85	7.9	0.11	0.06	0.22	0.8	0.05	0.72	1.32	0.8

CERTIFICATE OF ANALYSIS VA17278855

Sample Description	Method Analyte Units LOR	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
L2035058-2 144600		0.04	<10	240	0.22	0.10	1.69	0.15	29.9	6.5	5	0.25	1510	2.20	4.85	0.10
L2035058-3 146676		<0.02	<10	390	0.28	0.01	0.29	0.12	26.9	6.2	4	0.63	407	2.43	5.67	0.10
L2035058-4 146677		0.02	<10	220	0.26	0.08	0.27	0.19	33.0	6.7	3	0.57	2470	2.53	5.39	0.10
L2035058-5 146678		<0.02	<10	320	0.27	0.01	0.28	0.05	24.8	5.5	4	0.41	65.3	1.99	5.04	0.12
L2035058-6 145597		<0.02	<10	310	0.39	0.12	1.18	0.29	25.9	8.9	24	0.82	976	2.44	4.65	0.10
L2035058-7 145598		0.04	<10	260	0.27	0.09	0.22	0.35	26.2	9.8	4	0.58	4420	2.61	6.71	0.12
L2035058-8 145599		<0.02	<10	290	0.26	<0.01	0.32	0.05	26.9	5.7	6	0.31	306	2.06	4.91	0.11
L2035058-9 145600		<0.02	<10	210	0.20	0.01	0.10	0.23	9.15	5.9	4	0.27	1830	1.56	3.64	0.06
L2035058-10 146679		0.05	<10	220	0.21	0.12	0.47	0.25	24.1	5.9	4	0.41	2650	2.27	4.20	0.09
L2035058-11		0.07	<10	250	0.28	0.25	0.87	0.26	24.9	7.3	8	0.53	1970	3.81	8.43	0.11

Project: L2035058

CERTIFICATE OF ANALYSIS VA17278855

Method / Analyte / Units / LOR	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Sample Description	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
L2035058-2 144600	0.06	0.01	0.046	0.41	16.8	4.8	0.49	440	8.81	0.05	0.21	1.6	600	2.9	19.5
L2035058-3 146676	0.06	<0.01	0.034	0.66	14.7	5.0	0.42	527	1.35	0.07	0.33	2.4	670	2.8	32.9
L2035058-4 146677	0.06	0.01	0.087	0.60	18.2	4.3	0.41	551	5.14	0.05	0.28	2.5	880	4.2	32.5
L2035058-5 146678	0.08	0.01	0.029	0.57	12.6	5.1	0.45	598	0.81	0.05	0.22	2.6	620	1.4	25.7
L2035058-6 145597	0.26	0.04	0.034	0.23	13.3	7.9	0.63	490	1.42	0.05	0.78	20.0	860	5.2	11.9
L2035058-7 145598	0.07	0.02	0.074	0.77	14.9	4.7	0.53	397	3.49	0.04	0.40	6.9	780	2.8	39.4
L2035058-8 145599	0.11	0.01	0.029	0.49	14.2	5.3	0.42	499	0.68	0.06	0.18	7.2	660	1.7	25.9
L2035058-9 145600	0.05	0.02	0.027	0.35	5.2	2.6	0.20	259	2.53	0.05	0.30	2.9	230	2.3	16.3
L2035058-10 146679	0.07	0.01	0.058	0.49	14.0	3.0	0.33	525	9.44	0.05	0.22	2.4	700	3.1	24.7
L2035058-11	0.06	0.01	0.084	0.66	13.7	6.0	0.71	612	3.97	0.06	0.28	3.4	820	3.7	34.3

CERTIFICATE OF ANALYSIS VA17278855

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
L2035058-2 144600	0.024	0.35	<0.05	3.3	1.4	0.6	98.2	<0.01	0.06	3.1	0.065	0.13	0.62	40	0.22
L2035058-3 146676	<0.001	0.01	<0.05	8.0	0.2	0.8	28.8	<0.01	0.01	3.5	0.102	0.22	0.17	57	0.79
L2035058-4 146677	<0.001	0.02	<0.05	6.3	0.8	1.2	38.1	<0.01	0.06	5.7	0.094	0.29	0.35	70	0.20
L2035058-5 146678	<0.001	0.01	<0.05	5.4	0.2	0.7	28.1	<0.01	<0.01	2.8	0.085	0.17	0.15	44	0.55
L2035058-6 145597	0.001	0.07	0.53	4.9	0.7	0.5	54.6	<0.01	0.06	3.4	0.081	0.12	0.67	53	0.56
L2035058-7 145598	<0.001	0.01	<0.05	7.3	0.8	1.5	43.9	<0.01	0.10	3.1	0.128	0.31	0.33	84	1.15
L2035058-8 145599	<0.001	0.01	<0.05	5.5	<0.2	0.6	30.6	<0.01	<0.01	2.2	0.084	0.15	0.16	45	0.68
L2035058-9 145600	<0.001	0.01	<0.05	2.7	0.4	0.5	28.8	<0.01	0.03	0.7	0.054	0.12	0.20	35	0.93
L2035058-10 146679	0.003	0.06	<0.05	5.0	1.3	0.6	35.1	<0.01	0.04	3.7	0.072	0.17	0.26	52	0.54
L2035058-11	0.007	0.12	<0.05	4.6	1.5	1.2	66.6	<0.01	0.19	3.5	0.118	0.25	0.37	71	0.25

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 2 - E
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 11-JAN-2018
Account: APN

Project: L2035058

CERTIFICATE OF ANALYSIS VA17278855

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L2035058-2 144600		6.52	59	1.4
L2035058-3 146676		8.83	69	1.4
L2035058-4 146677		10.50	82	1.4
L2035058-5 146678		11.95	54	1.3
L2035058-6 145597		9.18	67	7.2
L2035058-7 145598		8.68	65	1.7
L2035058-8 145599		8.89	66	2.2
L2035058-9 145600		4.94	45	1.4
L2035058-10 146679		7.21	71	1.6
L2035058-11		6.86	113	1.2

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05
LOG-22
ME-MS41
OA-ELE07
OA-VOL08
PUL-31
PUL-QC
S-CAL06a
S-GRA06a
S-IR08
SPL-21
WEI-21

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A)
Plus Appendix Pages
Finalized Date: 18-JAN-2018
Account: APN

CERTIFICATE VA18008315

Project: L2035058

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 12-JAN-2018.

The following have access to data associated with this certificate:

ALSE VANCOUVER WEBTRIEVE SHANE STACK	ALSEV DATASUBLET	SOFTWARE DEVELOPMENT GROUP

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
FND-02	Find Sample for Addn Analysis

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 18-JAN-2018
Account: APN

Project: L2035058

CERTIFICATE OF ANALYSIS VA18008315

Sample Description	Method Analyte Units LOR	C-IR07 C % 0.01	S-GRA06 S % 0.01
L2035058-2 144600		0.58	0.02
L2035058-3 146676		0.04	0.01
L2035058-4 146677		0.05	<0.01
L2035058-5 146678		0.05	0.01
L2035058-6 145597		0.74	<0.01
L2035058-7 145598		0.08	0.02
L2035058-8 145599		0.05	0.01
L2035058-9 145600		0.06	<0.01
L2035058-10 146679		0.14	0.01
L2035058-11		0.25	0.05

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2035058

CERTIFICATE OF ANALYSIS VA18008315

CERTIFICATE COMMENTS

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:	C-IR07	FND-02	S-GRA06

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2035058-COFC

COC Number: ~~15~~ 17-36

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact:
Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	144600	27-NOV-17		WASTE	X	X	X	X	X	X	
	146676	24-NOV-17		WASTE	X	X	X	X	X	X	
	146677	24-NOV-17		WASTE	X	X	X	X	X	X	
	146678	24-NOV-17		WASTE	X	X	X	X	X	X	
	145597	23-NOV-17		WASTE	X	X	X	X	X	X	
	145598	26-NOV-17		WASTE	X	X	X	X	X	X	
	145599	26-NOV-17		WASTE	X	X	X	X	X	X	
	145600	26-NOV-17		WASTE	X	X	X	X	X	X	
	146679	25-NOV-17		waste	X	X	X	X	X	X	
	NOV. TAL 2017	NOV-2017		TAILS							

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO
Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
5.0			12.1		

SHIPMENT RELEASE (client use)
Released by: JOEY Date: DEC. 12/17 Time:

INITIAL SHIPMENT RECEPTION (lab use only)
Received by: EHF Date: 13 Dec 2017 Time: 14:45

FINAL SHIPMENT RECEPTION (lab use only)
Received by: TP Date: Dec 14 Time: 16:15

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 28-DEC-17
Report Date: 08-FEB-18 15:06 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2039797
Project P.O. #: PO#228594
Job Reference:
C of C Numbers: 17-38
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2039797-1	L2039797-2	L2039797-3	L2039797-4	L2039797-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	17-DEC-17	17-DEC-17	17-DEC-17	08-DEC-17	06-DEC-17
	Sampled Time					
	Client ID	146698	146699	146700	146685	146684
SOIL						
Physical Tests	pH (Unity)	8.3	8.6	8.6	8.5	8.4
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	<0.05	0.07	0.22	0.29
Acid Base Accounting	FIZZ RATING (Unity)	1	1	2	2	2
	MPA (tCaCO3/1Kt)	0.3	0.3	0.3	0.6	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	6	9	12	23	30
	NNP (tCaCO3/1Kt)	6	9	12	22	30
	Ratio (NP/MPA) (Unity)	19.20	28.80	38.40	36.80	96.00
	Sulfate Sulfur (carbonate leach) (%)	0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	0.01	0.01	0.02	0.01
	Total Sulfur (combustion) (%)	0.01	0.01	0.01	0.02	0.01
Total Metals	Aluminum (Al) (%)	0.74	0.96	1.03	0.79	0.92
	Antimony (Sb) (ppm)	<0.05	<0.05	0.05	0.28	0.36
	Arsenic (As) (ppm)	1.9	1.1	2.1	5.0	5.1
	Barium (Ba) (ppm)	220	200	150	230	220
	Beryllium (Be) (ppm)	0.28	0.20	0.21	0.30	0.30
	Bismuth (Bi) (ppm)	0.18	0.03	0.09	0.05	0.10
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.25	0.11	0.11	0.21	0.20
	Calcium (Ca) (%)	0.25	0.38	0.46	0.95	1.20
	Cerium (Ce) (ppm)	29.8	26.3	27.6	23.6	26.8
	Cesium (Cs) (ppm)	0.40	0.28	0.27	0.58	0.70
	Chromium (Cr) (ppm)	4	4	4	16	19
	Cobalt (Co) (ppm)	6.6	5.1	5.3	6.3	6.8
	Copper (Cu) (ppm)	3310	230	1650	433	2200
	Gallium (Ga) (ppm)	4.52	5.44	6.02	3.33	3.91
	Germanium (Ge) (ppm)	0.05	0.05	0.05	<0.05	0.05
	Gold (Au) (ppm)	0.07	<0.02	0.02	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.04	0.05	0.03	0.18	0.22
	Indium (In) (ppm)	0.058	0.029	0.024	0.029	0.041
	Iron (Fe) (%)	2.33	1.98	2.05	1.95	1.98
	Lanthanum (La) (ppm)	15.8	13.2	14.7	12.6	13.8
	Lead (Pb) (ppm)	3.8	2.7	3.3	4.3	5.1
	Lithium (Li) (ppm)	2.5	4.9	5.7	4.2	5.0
	Magnesium (Mg) (%)	0.26	0.45	0.55	0.40	0.49
	Manganese (Mn) (ppm)	670	577	521	419	424

	Sample ID	L2039797-6	L2039797-7	L2039797-8	L2039797-9	
	Description	WASTE	WASTE	WASTE	WASTE	
	Sampled Date	11-DEC-17	11-DEC-17	10-DEC-17	10-DEC-17	
	Sampled Time					
	Client ID	146686	146687	146688	146689	
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.4	8.6	8.8	9.1	
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	0.16	0.56	0.23	
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	2	
	MPA (tCaCO3/1Kt)	0.3	0.3	3.8	0.6	
	Neutralization Potential (NP) (tCaCO3/1Kt)	6	20	44	21	
	NNP (tCaCO3/1Kt)	6	20	40	20	
	Ratio (NP/MPA) (Unity)	19.20	64.00	11.73	33.60	
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	0.01	0.12	0.02	
	Total Sulfur (combustion) (%)	0.01	0.01	0.12	0.02	
Total Metals	Aluminum (Al) (%)	0.77	1.00	0.70	0.99	
	Antimony (Sb) (ppm)	<0.05	0.22	<0.05	<0.05	
	Arsenic (As) (ppm)	0.8	3.9	0.9	0.6	
	Barium (Ba) (ppm)	110	230	170	270	
	Beryllium (Be) (ppm)	0.25	0.27	0.23	0.21	
	Bismuth (Bi) (ppm)	0.03	0.03	0.18	0.03	
	Boron (B) (ppm)	<10	<10	<10	<10	
	Cadmium (Cd) (ppm)	0.12	0.12	0.17	0.05	
	Calcium (Ca) (%)	0.27	0.88	1.45	0.82	
	Cerium (Ce) (ppm)	24.5	23.5	21.8	25.9	
	Cesium (Cs) (ppm)	0.24	0.54	0.48	0.55	
	Chromium (Cr) (ppm)	3	12	4	5	
	Cobalt (Co) (ppm)	5.4	6.2	5.4	5.3	
	Copper (Cu) (ppm)	813	50.7	2030	155.0	
	Gallium (Ga) (ppm)	4.78	4.56	3.87	5.24	
	Germanium (Ge) (ppm)	<0.05	0.05	0.05	0.05	
	Gold (Au) (ppm)	<0.02	<0.02	0.05	<0.02	
	Hafnium (Hf) (ppm)	0.04	0.16	0.05	0.04	
	Indium (In) (ppm)	0.064	0.021	0.049	0.025	
	Iron (Fe) (%)	1.94	2.00	2.16	2.14	
	Lanthanum (La) (ppm)	13.1	12.3	11.8	13.8	
	Lead (Pb) (ppm)	5.4	3.0	2.9	2.7	
	Lithium (Li) (ppm)	4.1	5.9	2.7	4.8	
	Magnesium (Mg) (%)	0.29	0.51	0.54	0.59	
	Manganese (Mn) (ppm)	493	519	571	541	

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2039797-1	L2039797-2	L2039797-3	L2039797-4	L2039797-5
	Sample ID	L2039797-1	L2039797-2	L2039797-3	L2039797-4	L2039797-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	17-DEC-17	17-DEC-17	17-DEC-17	08-DEC-17	06-DEC-17
	Sampled Time					
	Client ID	146698	146699	146700	146685	146684
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	<0.01	0.02	0.02
	Molybdenum (Mo) (ppm)	1.59	0.93	0.62	1.60	1.16
	Nickel (Ni) (ppm)	8.7	3.5	5.1	12.7	14.2
	Niobium (Nb) (ppm)	0.20	0.17	0.14	0.33	0.37
	Phosphorus (P) (ppm)	690	540	590	710	770
	Potassium (K) (%)	0.38	0.39	0.29	0.21	0.22
	Rhenium (Re) (ppm)	<0.001	<0.001	<0.001	<0.001	0.001
	Rubidium (Rb) (ppm)	21.4	19.5	15.5	12.4	13.8
	Scandium (Sc) (ppm)	4.0	4.7	3.4	4.6	4.6
	Selenium (Se) (ppm)	0.7	<0.2	0.2	0.6	0.7
	Silver (Ag) (ppm)	0.48	0.09	0.31	0.07	0.28
	Sodium (Na) (%)	0.03	0.05	0.05	0.04	0.04
	Strontium (Sr) (ppm)	18.7	30.4	33.3	52.8	61.0
	Sulfur (S) (%)	0.01	0.01	0.02	0.02	0.02
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	0.01
	Tellurium (Te) (ppm)	0.25	0.02	0.06	0.01	0.04
	Thallium (Tl) (ppm)	0.13	0.10	0.09	0.10	0.12
	Thorium (Th) (ppm)	3.6	2.9	3.4	3.6	3.6
	Tin (Sn) (ppm)	0.6	0.6	0.4	0.5	0.6
	Titanium (Ti) (%)	0.060	0.057	0.043	0.057	0.071
	Tungsten (W) (ppm)	0.40	0.51	0.34	0.40	0.36
	Uranium (U) (ppm)	0.32	0.14	0.15	0.40	0.49
	Vanadium (V) (ppm)	55	42	40	44	49
	Yttrium (Y) (ppm)	8.58	9.43	5.93	9.68	9.60
	Zinc (Zn) (ppm)	81	69	79	50	53
	Zirconium (Zr) (ppm)	1.0	0.6	0.6	5.2	6.6
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	<0.2	0.2	0.8	1.1
Miscellaneous	Carbon (C) (%)	0.07	0.07	0.11	0.37	0.49

	Sample ID	L2039797-6	L2039797-7	L2039797-8	L2039797-9
	Description	WASTE	WASTE	WASTE	WASTE
	Sampled Date	11-DEC-17	11-DEC-17	10-DEC-17	10-DEC-17
	Sampled Time				
	Client ID	146686	146687	146688	146689
Grouping	**Analyte**				
SOIL					
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	5.18	0.79	2.52	1.09
	Nickel (Ni) (ppm)	1.9	8.9	2.3	2.4
	Niobium (Nb) (ppm)	0.13	0.31	0.18	0.18
	Phosphorus (P) (ppm)	650	750	580	550
	Potassium (K) (%)	0.21	0.33	0.36	0.58
	Rhenium (Re) (ppm)	<0.001	<0.001	0.003	0.002
	Rubidium (Rb) (ppm)	10.0	18.0	18.1	29.4
	Scandium (Sc) (ppm)	4.3	4.2	3.6	3.6
	Selenium (Se) (ppm)	0.3	0.3	1.5	0.2
	Silver (Ag) (ppm)	0.08	0.03	0.71	0.07
	Sodium (Na) (%)	0.04	0.05	0.04	0.06
	Strontium (Sr) (ppm)	21.7	48.7	79.2	56.7
	Sulfur (S) (%)	0.01	0.02	0.13	0.03
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.01	0.14	<0.01
	Thallium (Tl) (ppm)	0.06	0.12	0.11	0.18
	Thorium (Th) (ppm)	2.8	3.0	2.7	3.0
	Tin (Sn) (ppm)	0.7	0.5	0.5	0.5
	Titanium (Ti) (%)	0.020	0.084	0.055	0.098
	Tungsten (W) (ppm)	0.12	0.38	0.42	0.50
	Uranium (U) (ppm)	0.22	0.35	0.30	0.20
	Vanadium (V) (ppm)	39	45	45	49
	Yttrium (Y) (ppm)	9.63	9.29	7.18	7.61
	Zinc (Zn) (ppm)	67	54	73	65
	Zirconium (Zr) (ppm)	0.8	4.3	1.2	0.7
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	0.6	2.1	0.9
Miscellaneous	Carbon (C) (%)	0.03	0.28	0.66	0.30

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-38

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA18001253

Project: L2039797

P.O. No.: ALSM-CW16-102-APN

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 2-JAN-2018.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2039797

CERTIFICATE OF ANALYSIS VA18001253

Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
Sample Description / **LOR**	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L2039797-1 146698	0.88	1	0.3	6	6	19.20	8.3	0.01	0.01	<0.05	<0.2	<0.01	0.07	0.01	0.48
L2039797-2 146699	1.20	1	0.3	9	9	28.80	8.6	0.01	0.01	<0.05	<0.2	<0.01	0.07	<0.01	0.09
L2039797-3 146700	1.16	2	0.3	12	12	38.40	8.6	0.01	0.01	0.07	0.2	<0.01	0.11	<0.01	0.31
L2039797-4 146685	1.12	2	0.6	22	23	36.80	8.5	0.02	0.02	0.22	0.8	<0.01	0.37	<0.01	0.07
L2039797-5 146684	1.08	2	0.3	30	30	96.00	8.4	0.01	0.01	0.29	1.1	<0.01	0.49	<0.01	0.28
L2039797-6 146686	1.06	1	0.3	6	6	19.20	8.4	0.01	0.01	<0.05	<0.2	<0.01	0.03	<0.01	0.08
L2039797-7 146687	1.10	2	0.3	20	20	64.00	8.6	0.01	0.01	0.16	0.6	<0.01	0.28	<0.01	0.03
L2039797-8 146688	1.04	2	3.8	40	44	11.73	8.8	0.12	0.12	0.56	2.1	<0.01	0.66	<0.01	0.71
L2039797-9 146689	1.08	2	0.6	20	21	33.60	9.1	0.02	0.02	0.23	0.9	<0.01	0.30	<0.01	0.07

***** See Appendix Page for comments regarding this certificate *****

Project: L2039797

CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method Analyte Units LOR	ME-MS41 Al % 0.01	ME-MS41 As ppm 0.1	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01
L2039797-1 146698		0.74	1.9	0.07	<10	220	0.28	0.18	0.25	0.25	29.8	6.6	4	0.40	3310	2.33
L2039797-2 146699		0.96	1.1	<0.02	<10	200	0.20	0.03	0.38	0.11	26.3	5.1	4	0.28	230	1.98
L2039797-3 146700		1.03	2.1	0.02	<10	150	0.21	0.09	0.46	0.11	27.6	5.3	4	0.27	1650	2.05
L2039797-4 146685		0.79	5.0	<0.02	<10	230	0.30	0.05	0.95	0.21	23.6	6.3	16	0.58	433	1.95
L2039797-5 146684		0.92	5.1	<0.02	<10	220	0.30	0.10	1.20	0.20	26.8	6.8	19	0.70	2200	1.98
L2039797-6 146686		0.77	0.8	<0.02	<10	110	0.25	0.03	0.27	0.12	24.5	5.4	3	0.24	813	1.94
L2039797-7 146687		1.00	3.9	<0.02	<10	230	0.27	0.03	0.88	0.12	23.5	6.2	12	0.54	50.7	2.00
L2039797-8 146688		0.70	0.9	0.05	<10	170	0.23	0.18	1.45	0.17	21.8	5.4	4	0.48	2030	2.16
L2039797-9 146689		0.99	0.6	<0.02	<10	270	0.21	0.03	0.82	0.05	25.9	5.3	5	0.55	155.0	2.14

Project: L2039797

CERTIFICATE OF ANALYSIS VA18001253

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
Sample Description	LOR	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2039797-1 146698		4.52	0.05	0.04	0.01	0.058	0.38	15.8	2.5	0.26	670	1.59	0.03	0.20	8.7	690
L2039797-2 146699		5.44	0.05	0.05	<0.01	0.029	0.39	13.2	4.9	0.45	577	0.93	0.05	0.17	3.5	540
L2039797-3 146700		6.02	0.05	0.03	<0.01	0.024	0.29	14.7	5.7	0.55	521	0.62	0.05	0.14	5.1	590
L2039797-4 146685		3.33	<0.05	0.18	0.02	0.029	0.21	12.6	4.2	0.40	419	1.60	0.04	0.33	12.7	710
L2039797-5 146684		3.91	0.05	0.22	0.02	0.041	0.22	13.8	5.0	0.49	424	1.16	0.04	0.37	14.2	770
L2039797-6 146686		4.78	<0.05	0.04	<0.01	0.064	0.21	13.1	4.1	0.29	493	5.18	0.04	0.13	1.9	650
L2039797-7 146687		4.56	0.05	0.16	0.01	0.021	0.33	12.3	5.9	0.51	519	0.79	0.05	0.31	8.9	750
L2039797-8 146688		3.87	0.05	0.05	<0.01	0.049	0.36	11.8	2.7	0.54	571	2.52	0.04	0.18	2.3	580
L2039797-9 146689		5.24	0.05	0.04	<0.01	0.025	0.58	13.8	4.8	0.59	541	1.09	0.06	0.18	2.4	550

Project: L2039797

CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2039797-1 146698		3.8	21.4	<0.001	0.01	<0.05	4.0	0.7	0.6	18.7	<0.01	0.25	3.6	0.060	0.13	0.32
L2039797-2 146699		2.7	19.5	<0.001	0.01	<0.05	4.7	<0.2	0.6	30.4	<0.01	0.02	2.9	0.057	0.10	0.14
L2039797-3 146700		3.3	15.5	<0.001	0.02	0.05	3.4	0.2	0.4	33.3	<0.01	0.06	3.4	0.043	0.09	0.15
L2039797-4 146685		4.3	12.4	<0.001	0.02	0.28	4.6	0.6	0.5	52.8	<0.01	0.01	3.6	0.057	0.10	0.40
L2039797-5 146684		5.1	13.8	0.001	0.02	0.36	4.6	0.7	0.6	61.0	0.01	0.04	3.6	0.071	0.12	0.49
L2039797-6 146686		5.4	10.0	<0.001	0.01	<0.05	4.3	0.3	0.7	21.7	<0.01	0.02	2.8	0.020	0.06	0.22
L2039797-7 146687		3.0	18.0	<0.001	0.02	0.22	4.2	0.3	0.5	48.7	<0.01	0.01	3.0	0.084	0.12	0.35
L2039797-8 146688		2.9	18.1	0.003	0.13	<0.05	3.6	1.5	0.5	79.2	<0.01	0.14	2.7	0.055	0.11	0.30
L2039797-9 146689		2.7	29.4	0.002	0.03	<0.05	3.6	0.2	0.5	56.7	<0.01	<0.01	3.0	0.098	0.18	0.20

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2039797

CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method Analyte Units LOR	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L2039797-1 146698		55	0.40	8.58	81	1.0
L2039797-2 146699		42	0.51	9.43	69	0.6
L2039797-3 146700		40	0.34	5.93	79	0.6
L2039797-4 146685		44	0.40	9.68	50	5.2
L2039797-5 146684		49	0.36	9.60	53	6.6
L2039797-6 146686		39	0.12	9.63	67	0.8
L2039797-7 146687		45	0.38	9.29	54	4.3
L2039797-8 146688		45	0.42	7.18	73	1.2
L2039797-9 146689		49	0.50	7.61	65	0.7

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2039797

CERTIFICATE OF ANALYSIS VA18001253

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	S-CAL06a
S-GRA06	S-GRA06a	S-IR08	SPL-21
WEI-21			

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 4 (A - E)
Plus Appendix Pages
Finalized Date: 30-JAN-2018
Account: APN

QC CERTIFICATE VA18001253

Project: L2039797

P.O. No.: ALSM-CW16-102-APN

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 2-JAN-2018.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1

STANDARDS

Sample Description	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S (S-IR08)	C (C-GAS05)	CO2	S (S-GRA06a)	C (C-IR07)	S (S-GRA06)	Ag	Al	As
Buffer pH6						6.0									
Buffer pH6						6.0									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
GS310-10							0.27				1.10				
Target Range - Lower Bound							0.25				1.03				
Upper Bound							0.29				1.13				
KZK-1	2	25.0	31	56	2.24										
KZK-1	2	25.0	31	56	2.24										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MA-1b							1.17				2.43				
Target Range - Lower Bound							1.12				2.34				
Upper Bound							1.22				2.54				
MA-3a								2.39	8.8						
Target Range - Lower Bound								2.31	8.4						
Upper Bound								2.77	10.2						
OGGeo08													19.20	2.14	119.0
Target Range - Lower Bound													18.15	2.05	107.0
Upper Bound													22.2	2.53	131.0
OREAS 920													0.10	2.27	4.7
Target Range - Lower Bound													0.07	2.18	3.8
Upper Bound													0.12	2.68	4.9
SY-4								0.87	3.2						
Target Range - Lower Bound								0.84	3.0						
Upper Bound								1.08	4.0						
UTS-1												0.85			
Target Range - Lower Bound												0.83			
Upper Bound												0.93			
UTS-1										0.82					
Target Range - Lower Bound										0.81					
Upper Bound										0.95					
UTS-4												1.71			
UTS-4												1.71			
Target Range - Lower Bound												1.64			
Upper Bound												1.84			

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description / Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
GS310-10															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-1b															
Target Range - Lower Bound															
Upper Bound															
MA-3a															
Target Range - Lower Bound															
Upper Bound															
OGGeo08	0.07	<10	60	0.80	9.93	0.87	18.05	58.5	95.8	79	9.46	8040	4.89	8.69	0.13
Target Range - Lower Bound	0.03	<10	60	0.61	9.44	0.82	16.75	56.7	87.2	75	8.68	7800	4.51	8.05	0.21
Upper Bound	0.11	30	110	0.89	11.55	1.02	20.5	69.3	107.0	93	10.70	8980	5.53	9.95	0.45
OREAS 920	<0.02	<10	70	0.64	0.62	0.30	0.06	71.9	14.0	40	1.93	105.0	3.44	6.76	0.06
Target Range - Lower Bound	<0.02	<10	50	0.59	0.60	0.28	0.04	64.8	13.4	37	1.84	102.0	3.26	6.12	<0.05
Upper Bound	0.04	20	110	0.87	0.76	0.37	0.09	79.2	16.6	48	2.36	118.0	4.00	7.60	0.22
SY-4															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
	Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOR	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
		STANDARDS														
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		0.84	0.47	1.395	1.00	28.6	31.5	0.91	380	862	0.28	1.00	8530	770	6860	118.5
Target Range - Lower Bound		0.72	0.41	1.335	0.94	27.7	28.4	0.84	350	811	0.26	0.97	7760	700	6520	109.5
Upper Bound		0.92	0.57	1.645	1.18	34.3	35.0	1.05	438	991	0.34	1.29	9480	880	7970	134.5
OREAS 920		0.56	<0.01	0.032	0.38	35.8	16.3	1.01	493	0.33	0.02	0.32	36.0	680	21.6	22.9
Target Range - Lower Bound		0.53	<0.01	0.019	0.39	33.3	19.0	0.98	472	0.29	<0.01	0.31	34.4		19.2	22.2
Upper Bound		0.69	0.02	0.043	0.50	41.1	23.4	1.22	588	0.53	0.02	0.55	42.4		23.9	27.4
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
	LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
STANDARDS																
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
GS310-10																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-1b																
Target Range - Lower Bound																
Upper Bound																
MA-3a																
Target Range - Lower Bound																
Upper Bound																
OGGeo08		1.345	2.65	18.00	6.2	9.1	12.1	60.9	<0.01	0.14	16.7	0.300	1.39	4.72	77	2.76
Target Range - Lower Bound		1.295	2.51	17.70	6.0	9.7	12.0	59.6	<0.01	0.14	15.6	0.279	1.14	4.45	70	2.58
Upper Bound		1.585	3.09	24.1	7.6	12.3	15.1	73.2	0.03	0.20	19.6	0.353	1.58	5.55	88	3.60
OREAS 920		<0.001	0.04	0.60	2.5	0.2	1.0	16.1	0.01	0.02	16.3	0.112	0.14	2.09	24	0.40
Target Range - Lower Bound		<0.001	<0.01	0.45	2.5	<0.2	0.7	15.0	<0.01	<0.01	13.6	0.106	0.07	1.89	23	0.31
Upper Bound		0.002	0.05	0.77	3.3	0.7	1.7	18.8	0.02	0.04	17.0	0.140	0.18	2.42	30	0.61
SY-4																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS				
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
GS310-10				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-1b				
Target Range - Lower Bound				
Upper Bound				
MA-3a				
Target Range - Lower Bound				
Upper Bound				
OGGeo08		17.10	6760	23.2
Target Range - Lower Bound		15.35	6500	19.5
Upper Bound		18.85	7950	27.5
OREAS 920		17.70	100	19.7
Target Range - Lower Bound		16.85	93	17.6
Upper Bound		20.7	119	25.0
SY-4				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
UTS-4				
Target Range - Lower Bound				
Upper Bound				

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	**Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
								BLANKS								
BLANK									<0.05	<0.2						
Target Range - Lower Bound									<0.05	<0.2						
Upper Bound									0.10	0.4						
BLANK														<0.01	<0.01	<0.1
Target Range - Lower Bound														<0.01	<0.01	<0.1
Upper Bound														0.02	0.02	0.2
BLANK							6.0									
Target Range - Lower Bound							5.5									
Upper Bound							6.9									
BLANK													<0.01			
BLANK													<0.01			
Target Range - Lower Bound													<0.01			
Upper Bound													0.02			
BLANK											<0.01					
Target Range - Lower Bound											<0.01					
Upper Bound											0.02					
BLANK								<0.01				<0.01				
Target Range - Lower Bound								<0.01				<0.01				
Upper Bound								0.02				0.02				
								DUPLICATES								
L2039797-1 146698													0.01			
DUP													<0.01			
Target Range - Lower Bound													<0.01			
Upper Bound													0.02			
L2039797-6 146686								0.01				0.03				
DUP								0.01				0.04				
Target Range - Lower Bound								<0.01				0.02				
Upper Bound								0.02				0.05				
L2039797-8 146688		2	3.8	40	44	11.73										
DUP		2	3.8	39	43	11.47										
Target Range - Lower Bound		<1	3.3	37	40	11.01										
Upper Bound		3	4.3	42	47	12.19										

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	0.06	<0.2	<0.01	<0.05	<0.05
Target Range - Lower Bound	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
L2039797-1 146698															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2039797-6 146686															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2039797-8 146688															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	0.05	<0.2	<10	0.3	<0.1
Target Range - Lower Bound	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
L2039797-1 146698															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2039797-6 146686															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2039797-8 146688															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
	LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
BLANKS																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK		<0.001	0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound		<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound		0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
L2039797-1 146698																
DUP																
Target Range - Lower Bound																
Upper Bound																
L2039797-6 146686																
DUP																
Target Range - Lower Bound																
Upper Bound																
L2039797-8 146688																
DUP																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
BLANKS				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK		<0.05	<2	<0.5
Target Range - Lower Bound		<0.05	<2	<0.5
Upper Bound		0.10	4	1.0
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
DUPLICATES				
L2039797-1 146698				
DUP				
Target Range - Lower Bound				
Upper Bound				
L2039797-6 146686				
DUP				
Target Range - Lower Bound				
Upper Bound				
L2039797-8 146688				
DUP				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
									DUPLICATES							
L2039797-9 146689									0.23	0.9				0.07	0.99	0.6
DUP									0.23	0.9				0.06	1.00	0.8
Target Range - Lower Bound									0.17	0.7				0.05	0.94	0.6
Upper Bound									0.29	1.1				0.08	1.05	0.8
L2041640-1 146693							8.8				<0.01		<0.01			
DUP							8.8				<0.01		<0.01			
Target Range - Lower Bound							8.3				<0.01		<0.01			
Upper Bound							9.3				0.02		0.02			

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
	DUPLICATES														
L2039797-9 146689	<0.02	<10	270	0.21	0.03	0.82	0.05	25.9	5.3	5	0.55	155.0	2.14	5.24	0.05
DUP	<0.02	<10	270	0.27	0.02	0.83	0.06	26.2	5.7	5	0.54	155.5	2.16	5.19	0.07
Target Range - Lower Bound	<0.02	<10	240	0.18	<0.01	0.77	0.04	24.7	5.1	4	0.47	149.5	2.03	4.90	<0.05
Upper Bound	0.04	20	300	0.30	0.04	0.88	0.07	27.4	5.9	6	0.62	161.0	2.27	5.53	0.10
L2041640-1 146693															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

Project: L2039797

QC CERTIFICATE OF ANALYSIS VA18001253

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
Sample Description / **LOR**	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
	DUPLICATES														
L2039797-9 146689	0.04	<0.01	0.025	0.58	13.8	4.8	0.59	541	1.09	0.06	0.18	2.4	550	2.7	29.4
DUP	0.04	<0.01	0.024	0.60	14.0	5.7	0.60	547	0.99	0.06	0.18	2.5	540	2.5	29.1
Target Range - Lower Bound	<0.02	<0.01	0.018	0.55	13.0	4.9	0.56	512	0.94	0.05	0.12	2.1	510	2.3	27.7
Upper Bound	0.06	0.02	0.031	0.63	14.8	5.6	0.63	576	1.14	0.07	0.24	2.8	580	2.9	30.8
L2041640-1 146693															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description / **Method** / **Analyte** / **Units** / **LOR**	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
							DUPLICATES								
L2039797-9 146689	0.002	0.03	<0.05	3.6	0.2	0.5	56.7	<0.01	<0.01	3.0	0.098	0.18	0.20	49	0.50
DUP	0.001	0.03	<0.05	3.7	<0.2	0.5	56.0	<0.01	0.01	3.2	0.098	0.19	0.19	50	0.56
Target Range - Lower Bound	<0.001	0.02	<0.05	3.4	<0.2	0.3	53.3	<0.01	<0.01	2.7	0.088	0.15	0.14	46	0.44
Upper Bound	0.002	0.04	0.10	3.9	0.4	0.7	59.4	0.02	0.02	3.5	0.108	0.22	0.25	53	0.62
L2041640-1 146693															
DUP															
Target Range - Lower Bound															
Upper Bound															

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA18001253

Sample Description	**Method** **Analyte** **Units** **LOR**	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
			DUPLICATES	
L2039797-9 146689		7.61	65	0.7
DUP		7.50	65	0.7
Target Range - Lower Bound		7.13	60	<0.5
Upper Bound		7.98	70	1.0
L2041640-1 146693				
DUP				
Target Range - Lower Bound				
Upper Bound				

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA18001253

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05 C-IR07 LOG-22 ME-MS41
OA-ELE07 OA-VOL08m PUL-31 S-CAL06a
S-GRA06 S-GRA06a S-IR08 SPL-21
WEI-21

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2039797-COFC

COC Number: 15 - 17 - 38

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days)			EMERGENCY		
	4 day [P4]	☐		**1 Business day [E1]**	☐
	3 day [P3]	☐		**Same Day, Weekend or Statutory holiday [E0]**	☐
	2 day [P2]	☐			

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	**Sample Identification and/or Coordinates** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)									Number of Containers
	~~146~~			Composite	R	R	R	R	R	R									
	146698	17-DEC-17		WASTE	X	X	X	X	X	X									
	146699	17-Dec-17		WASTE	X	X	X	X	X	X									
	146700	17-DEC-17		WASTE	X	X	X	X	X	X									
	146685	08-DEC-17		WASTE	X	X	X	X	X	X									
	146684	06-DEC-17		WASTE	X	X	X	X	X	X									
	146686	11-DEC-17		WASTE	X	X	X	X	X	X									
	146687	11-DEC-17		WASTE	X	X	X	X	X	X									
	146688	10-DEC-17		WASTE	X	X	X	X	X	X									
	146689	10-DEC-17		WASTE	X	X	X	X	X	X									

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?

☐ YES ☑ NO

Are samples for human drinking water use?

☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INIITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
-2°C			7.9		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Kala Joe	Date: Dec 22. 2017	Time:	Received by:	Date: DEC 28/17.	Time: 13:35	Received by: PAUL	Date: DEC 29	Time: 13:10

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

OCTOBER 2015 FRONT

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 28-DEC-17
Report Date: 30-JAN-18 16:08 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2040080
Project P.O. #: PO#228594
Job Reference:
C of C Numbers: 17-37
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

	Sample ID	L2040080-1	L2040080-2	L2040080-3	L2040080-4	L2040080-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	03-DEC-17	03-DEC-17	05-DEC-17	05-DEC-17	13-DEC-17
	Sampled Time					
	Client ID	146680	146681	146682	146683	146690
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.3	8.6	8.7	8.5	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	<0.05	<0.05	<0.05	0.09	0.11
Acid Base Accounting	FIZZ RATING (Unity)	1	1	1	1	1
	MPA (tCaCO3/1Kt)	<0.3	0.6	<0.3	<0.3	<0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	8	6	14	16
	NNP (tCaCO3/1Kt)	8	7	6	14	16
	Ratio (NP/MPA) (Unity)	51.20	12.80	38.40	89.60	102.40
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.01	0.02	0.02	0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	0.01	0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	<0.01	0.01	<0.01	<0.01	<0.01
	Total Sulfur (combustion) (%)	<0.01	0.02	<0.01	<0.01	<0.01
Total Metals	Aluminum (Al) (%)	1.11	0.91	1.05	1.21	1.32
	Antimony (Sb) (ppm)	0.05	<0.05	<0.05	0.18	<0.05
	Arsenic (As) (ppm)	1.1	0.6	0.7	3.2	0.7
	Barium (Ba) (ppm)	290	240	360	280	240
	Beryllium (Be) (ppm)	0.34	0.27	0.21	0.36	0.29
	Bismuth (Bi) (ppm)	0.01	0.22	0.09	0.03	0.02
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.10	0.22	0.21	0.14	0.05
	Calcium (Ca) (%)	0.37	0.30	0.22	0.65	0.71
	Cerium (Ce) (ppm)	29.8	22.4	10.95	27.6	31.7
	Cesium (Cs) (ppm)	0.33	0.40	0.43	0.46	0.36
	Chromium (Cr) (ppm)	5	5	4	9	5
	Cobalt (Co) (ppm)	6.2	5.1	7.5	6.3	5.8
	Copper (Cu) (ppm)	114.5	3010	2710	444	111.5
	Gallium (Ga) (ppm)	5.48	4.33	5.04	5.76	6.22
	Germanium (Ge) (ppm)	0.06	<0.05	<0.05	0.05	0.05
	Gold (Au) (ppm)	<0.02	0.03	0.03	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.08	0.06	0.08	0.13	0.06
	Indium (In) (ppm)	0.034	0.040	0.039	0.031	0.017
	Iron (Fe) (%)	2.46	2.05	2.00	2.42	2.24
	Lanthanum (La) (ppm)	16.1	12.2	5.9	14.0	16.7
	Lead (Pb) (ppm)	3.3	3.5	3.1	4.1	3.2
	Lithium (Li) (ppm)	6.9	3.6	4.8	9.0	7.8
	Magnesium (Mg) (%)	0.46	0.36	0.42	0.53	0.66
	Manganese (Mn) (ppm)	718	462	417	516	601

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2040080-6	L2040080-7	L2040080-8	L2040080-9	
	Description	WASTE	WASTE	WASTE	WASTE	
	Sampled Date	13-DEC-17	13-DEC-17	16-DEC-17	16-DEC-17	
	Sampled Time					
	Client ID	146691	146692	146696	146697	
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.6	8.6	8.7	8.7	
Organic / Inorganic Carbon	Carbon (C) (%)	0.43	0.26	0.05	0.11	
Acid Base Accounting	FIZZ RATING (Unity)	2	2	1	1	
	MPA (tCaCO3/1Kt)	3.8	2.2	<0.3	<0.3	
	Neutralization Potential (NP) (tCaCO3/1Kt)	35	27	9	15	
	NNP (tCaCO3/1Kt)	31	25	9	15	
	Ratio (NP/MPA) (Unity)	9.33	12.34	57.60	96.00	
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.03	0.01	0.01	
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	0.02	0.02	
	Sulfide Sulfur (T minus HCl leach) (%)	0.12	0.07	<0.01	<0.01	
	Total Sulfur (combustion) (%)	0.12	0.07	<0.01	<0.01	
Total Metals	Aluminum (Al) (%)	0.76	1.04	1.03	1.14	
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	
	Arsenic (As) (ppm)	0.6	0.8	0.8	0.8	
	Barium (Ba) (ppm)	180	150	260	270	
	Beryllium (Be) (ppm)	0.24	0.28	0.19	0.26	
	Bismuth (Bi) (ppm)	0.24	0.06	0.15	0.34	
	Boron (B) (ppm)	<10	<10	<10	<10	
	Cadmium (Cd) (ppm)	0.18	0.19	0.15	0.15	
	Calcium (Ca) (%)	1.35	1.05	0.36	0.58	
	Cerium (Ce) (ppm)	14.65	47.6	23.6	21.7	
	Cesium (Cs) (ppm)	0.28	0.29	0.46	0.40	
	Chromium (Cr) (ppm)	4	4	5	5	
	Cobalt (Co) (ppm)	5.1	5.7	5.1	5.7	
	Copper (Cu) (ppm)	2050	1355	2420	2630	
	Gallium (Ga) (ppm)	4.21	5.68	5.03	6.10	
	Germanium (Ge) (ppm)	<0.05	0.05	0.06	0.06	
	Gold (Au) (ppm)	0.04	<0.02	0.04	0.06	
	Hafnium (Hf) (ppm)	0.06	0.05	0.08	0.08	
	Indium (In) (ppm)	0.061	0.061	0.051	0.054	
	Iron (Fe) (%)	2.05	2.12	2.38	2.79	
	Lanthanum (La) (ppm)	7.6	25.6	12.6	11.2	
	Lead (Pb) (ppm)	4.3	5.3	3.1	2.7	
	Lithium (Li) (ppm)	3.8	6.1	4.2	5.2	
	Magnesium (Mg) (%)	0.35	0.47	0.43	0.53	
	Manganese (Mn) (ppm)	521	660	521	618	

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2040080-1	L2040080-2	L2040080-3	L2040080-4	L2040080-5
	Description	WASTE	WASTE	WASTE	WASTE	WASTE
	Sampled Date	03-DEC-17	03-DEC-17	05-DEC-17	05-DEC-17	13-DEC-17
	Sampled Time					
	Client ID	146680	146681	146682	146683	146690
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	0.01	0.02	0.01
	Molybdenum (Mo) (ppm)	1.11	3.87	1.95	0.63	1.09
	Nickel (Ni) (ppm)	3.3	2.9	3.6	6.3	4.2
	Niobium (Nb) (ppm)	0.10	0.13	0.20	0.18	0.15
	Phosphorus (P) (ppm)	740	640	690	760	630
	Potassium (K) (%)	0.53	0.52	0.64	0.42	0.54
	Rhenium (Re) (ppm)	<0.001	0.001	0.001	<0.001	<0.001
	Rubidium (Rb) (ppm)	27.4	25.1	32.4	21.7	25.6
	Scandium (Sc) (ppm)	5.0	3.4	2.5	4.6	3.5
	Selenium (Se) (ppm)	0.3	0.8	0.5	0.4	0.3
	Silver (Ag) (ppm)	0.07	0.49	0.36	0.09	0.03
	Sodium (Na) (%)	0.07	0.08	0.07	0.07	0.08
	Strontium (Sr) (ppm)	33.8	29.6	28.9	47.0	49.9
	Sulfur (S) (%)	0.02	0.03	0.02	0.02	0.02
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.02	0.14	0.13	0.03	0.02
	Thallium (Tl) (ppm)	0.16	0.16	0.19	0.13	0.17
	Thorium (Th) (ppm)	3.2	2.4	0.6	3.4	4.2
	Tin (Sn) (ppm)	0.6	0.6	0.6	0.6	0.6
	Titanium (Ti) (%)	0.084	0.082	0.122	0.074	0.084
	Tungsten (W) (ppm)	0.40	1.16	1.29	0.31	0.52
	Uranium (U) (ppm)	0.22	0.34	0.24	0.31	0.21
	Vanadium (V) (ppm)	54	49	57	52	48
	Yttrium (Y) (ppm)	12.15	6.89	5.82	10.25	6.69
	Zinc (Zn) (ppm)	86	65	75	77	62
	Zirconium (Zr) (ppm)	1.3	1.1	1.6	2.9	0.8
Permanent Gases	Carbon Dioxide (CO2) (%)	<0.2	0.2	<0.2	0.3	0.4
Miscellaneous	Carbon (C) (%)	0.04	0.07	0.05	0.17	0.17

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2040080-6	L2040080-7	L2040080-8	L2040080-9	
	Description	WASTE	WASTE	WASTE	WASTE	
	Sampled Date	13-DEC-17	13-DEC-17	16-DEC-17	16-DEC-17	
	Sampled Time					
	Client ID	146691	146692	146696	146697	
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	0.02	0.01	
	Molybdenum (Mo) (ppm)	4.51	5.75	1.67	1.20	
	Nickel (Ni) (ppm)	2.3	2.5	3.3	4.6	
	Niobium (Nb) (ppm)	0.11	0.09	0.19	0.16	
	Phosphorus (P) (ppm)	570	690	590	540	
	Potassium (K) (%)	0.26	0.29	0.59	0.59	
	Rhenium (Re) (ppm)	0.011	0.002	<0.001	0.001	
	Rubidium (Rb) (ppm)	13.1	16.0	30.2	28.6	
	Scandium (Sc) (ppm)	2.6	5.5	3.9	4.2	
	Selenium (Se) (ppm)	1.9	1.1	0.9	0.7	
	Silver (Ag) (ppm)	0.67	0.23	1.23	0.72	
	Sodium (Na) (%)	0.05	0.06	0.08	0.08	
	Strontium (Sr) (ppm)	52.9	41.6	32.3	46.3	
	Sulfur (S) (%)	0.15	0.10	0.02	0.02	
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	
	Tellurium (Te) (ppm)	0.11	0.04	0.14	0.23	
	Thallium (Tl) (ppm)	0.09	0.11	0.18	0.17	
	Thorium (Th) (ppm)	1.4	5.6	2.6	2.1	
	Tin (Sn) (ppm)	0.6	0.9	0.7	0.7	
	Titanium (Ti) (%)	0.029	0.037	0.101	0.100	
	Tungsten (W) (ppm)	0.38	0.15	0.48	0.57	
	Uranium (U) (ppm)	0.30	0.43	0.23	0.27	
	Vanadium (V) (ppm)	38	46	55	63	
	Yttrium (Y) (ppm)	5.06	8.31	8.01	9.24	
	Zinc (Zn) (ppm)	58	71	74	88	
	Zirconium (Zr) (ppm)	1.1	0.9	1.3	1.2	
Permanent Gases	Carbon Dioxide (CO2) (%)	1.6	1.0	0.2	0.4	
Miscellaneous	Carbon (C) (%)	0.52	0.33	0.08	0.15	

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-37

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

CERTIFICATE VA18001254

Project: L2040080

P.O. No.: ALSM-CW16-102-APN

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 2-JAN-2018.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2040080

CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
	Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
	Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
	LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L2040080-1 146680		1.12	1	<0.3	8	8	51.20	8.3	<0.01	<0.01	<0.05	<0.2	<0.01	0.04	0.02	0.07
L2040080-2 146681		1.10	1	0.6	7	8	12.80	8.6	0.02	0.01	<0.05	0.2	0.01	0.07	0.01	0.49
L2040080-3 146682		1.12	1	<0.3	6	6	38.40	8.7	<0.01	<0.01	<0.05	<0.2	0.01	0.05	0.02	0.36
L2040080-4 146683		1.16	1	<0.3	14	14	89.60	8.5	<0.01	<0.01	0.09	0.3	<0.01	0.17	0.02	0.09
L2040080-5 146690		1.12	1	<0.3	16	16	102.40	8.9	<0.01	<0.01	0.11	0.4	<0.01	0.17	0.01	0.03
L2040080-6 146691		1.12	2	3.8	31	35	9.33	8.6	0.12	0.12	0.43	1.6	<0.01	0.52	0.02	0.67
L2040080-7 146692		1.18	2	2.2	25	27	12.34	8.6	0.07	0.07	0.26	1.0	<0.01	0.33	0.03	0.23
L2040080-8 146696		1.18	1	<0.3	9	9	57.60	8.7	<0.01	<0.01	0.05	0.2	0.02	0.08	0.01	1.23
L2040080-9 146697		1.18	1	<0.3	15	15	96.00	8.7	<0.01	<0.01	0.11	0.4	0.02	0.15	0.01	0.72

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOR	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L2040080-1 146680		1.11	1.1	<0.02	<10	290	0.34	0.01	0.37	0.10	29.8	6.2	5	0.33	114.5	2.46
L2040080-2 146681		0.91	0.6	0.03	<10	240	0.27	0.22	0.30	0.22	22.4	5.1	5	0.40	3010	2.05
L2040080-3 146682		1.05	0.7	0.03	<10	360	0.21	0.09	0.22	0.21	10.95	7.5	4	0.43	2710	2.00
L2040080-4 146683		1.21	3.2	<0.02	<10	280	0.36	0.03	0.65	0.14	27.6	6.3	9	0.46	444	2.42
L2040080-5 146690		1.32	0.7	<0.02	<10	240	0.29	0.02	0.71	0.05	31.7	5.8	5	0.36	111.5	2.24
L2040080-6 146691		0.76	0.6	0.04	<10	180	0.24	0.24	1.35	0.18	14.65	5.1	4	0.28	2050	2.05
L2040080-7 146692		1.04	0.8	<0.02	<10	150	0.28	0.06	1.05	0.19	47.6	5.7	4	0.29	1355	2.12
L2040080-8 146696		1.03	0.8	0.04	<10	260	0.19	0.15	0.36	0.15	23.6	5.1	5	0.46	2420	2.38
L2040080-9 146697		1.14	0.8	0.06	<10	270	0.26	0.34	0.58	0.15	21.7	5.7	5	0.40	2630	2.79

Project: L2040080

CERTIFICATE OF ANALYSIS VA18001254

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
Sample Description	**LOR**	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2040080-1 146680		5.48	0.06	0.08	0.01	0.034	0.53	16.1	6.9	0.46	718	1.11	0.07	0.10	3.3	740
L2040080-2 146681		4.33	<0.05	0.06	0.01	0.040	0.52	12.2	3.6	0.36	462	3.87	0.08	0.13	2.9	640
L2040080-3 146682		5.04	<0.05	0.08	0.01	0.039	0.64	5.9	4.8	0.42	417	1.95	0.07	0.20	3.6	690
L2040080-4 146683		5.76	0.05	0.13	0.02	0.031	0.42	14.0	9.0	0.53	516	0.63	0.07	0.18	6.3	760
L2040080-5 146690		6.22	0.05	0.06	0.01	0.017	0.54	16.7	7.8	0.66	601	1.09	0.08	0.15	4.2	630
L2040080-6 146691		4.21	<0.05	0.06	0.01	0.061	0.26	7.6	3.8	0.35	521	4.51	0.05	0.11	2.3	570
L2040080-7 146692		5.68	0.05	0.05	0.01	0.061	0.29	25.6	6.1	0.47	660	5.75	0.06	0.09	2.5	690
L2040080-8 146696		5.03	0.06	0.08	0.02	0.051	0.59	12.6	4.2	0.43	521	1.67	0.08	0.19	3.3	590
L2040080-9 146697		6.10	0.06	0.08	0.01	0.054	0.59	11.2	5.2	0.53	618	1.20	0.08	0.16	4.6	540

Project: L2040080

CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2040080-1 146680		3.3	27.4	<0.001	0.02	0.05	5.0	0.3	0.6	33.8	<0.01	0.02	3.2	0.084	0.16	0.22
L2040080-2 146681		3.5	25.1	0.001	0.03	<0.05	3.4	0.8	0.6	29.6	<0.01	0.14	2.4	0.082	0.16	0.34
L2040080-3 146682		3.1	32.4	0.001	0.02	<0.05	2.5	0.5	0.6	28.9	<0.01	0.13	0.6	0.122	0.19	0.24
L2040080-4 146683		4.1	21.7	<0.001	0.02	0.18	4.6	0.4	0.6	47.0	<0.01	0.03	3.4	0.074	0.13	0.31
L2040080-5 146690		3.2	25.6	<0.001	0.02	<0.05	3.5	0.3	0.6	49.9	<0.01	0.02	4.2	0.084	0.17	0.21
L2040080-6 146691		4.3	13.1	0.011	0.15	<0.05	2.6	1.9	0.6	52.9	<0.01	0.11	1.4	0.029	0.09	0.30
L2040080-7 146692		5.3	16.0	0.002	0.10	<0.05	5.5	1.1	0.9	41.6	<0.01	0.04	5.6	0.037	0.11	0.43
L2040080-8 146696		3.1	30.2	<0.001	0.02	<0.05	3.9	0.9	0.7	32.3	<0.01	0.14	2.6	0.101	0.18	0.23
L2040080-9 146697		2.7	28.6	0.001	0.02	<0.05	4.2	0.7	0.7	46.3	<0.01	0.23	2.1	0.100	0.17	0.27

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-JAN-2018
Account: APN

Project: L2040080

CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
L2040080-1 146680		54	0.40	12.15	86	1.3
L2040080-2 146681		49	1.16	6.89	65	1.1
L2040080-3 146682		57	1.29	5.82	75	1.6
L2040080-4 146683		52	0.31	10.25	77	2.9
L2040080-5 146690		48	0.52	6.69	62	0.8
L2040080-6 146691		38	0.38	5.06	58	1.1
L2040080-7 146692		46	0.15	8.31	71	0.9
L2040080-8 146696		55	0.48	8.01	74	1.3
L2040080-9 146697		63	0.57	9.24	88	1.2

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: Appendix 1
Total # Appendix Pages: 1
Finalized Date: 23-JAN-2018
Account: APN

Project: L2040080

CERTIFICATE OF ANALYSIS VA18001254

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221   Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-JAN-2018
Account: APN

QC CERTIFICATE VA18001254

Project: L2040080

P.O. No.: ALSM-CW16-102-APN

This report is for 9 Other samples submitted to our lab in Vancouver, BC, Canada on 2-JAN-2018.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Method	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
Sample Description LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
STANDARDS															
Buffer pH6						6.0									
Buffer pH6						6.0									
Target Range - Lower Bound						5.3									
Upper Bound						6.7									
CO-ASSAY								0.50	1.8						
Target Range - Lower Bound								0.42	1.5						
Upper Bound								0.64	2.4						
DS-1							2.56				3.14				
Target Range - Lower Bound							2.51				3.01				
Upper Bound							2.71				3.25				
GS313-8							1.21				0.93				
Target Range - Lower Bound							1.19				0.90				
Upper Bound							1.29				0.98				
KZK-1	2	25.0	32	57	2.28										
KZK-1	2	25.0	32	57	2.28										
Target Range - Lower Bound	<1	22.9	30	54	2.18										
Upper Bound	>4	27.1	38	64	2.53										
MA-2c								1.54	5.7						
Target Range - Lower Bound								1.50	5.5						
Upper Bound								1.84	6.8						
MRGeo08													4.29	2.63	31.6
Target Range - Lower Bound													4.00	2.44	29.6
Upper Bound													4.92	3.00	36.4
OREAS 905													0.51	0.80	32.5
Target Range - Lower Bound													0.45	0.73	28.4
Upper Bound													0.58	0.91	35.0
UTS-1												0.88			
Target Range - Lower Bound												0.83			
Upper Bound												0.93			
UTS-1										0.87					
Target Range - Lower Bound										0.81					
Upper Bound										0.95					
UTS-4												1.74			
Target Range - Lower Bound												1.64			
Upper Bound												1.84			
UTS-4										1.72					
Target Range - Lower Bound										1.61					
Upper Bound										1.87					

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
LOR	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01	0.05	0.05
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	<0.02	10	440	0.74	0.61	1.08	2.20	74.5	17.7	91	10.70	624	3.55	9.14	0.10
Target Range - Lower Bound	<0.02	<10	370	0.67	0.60	1.00	2.01	66.2	17.0	81	9.40	587	3.22	8.73	0.07
Upper Bound	0.04	20	530	0.95	0.76	1.24	2.47	81.0	21.0	102	11.60	675	3.96	10.80	0.29
OREAS 905	0.40	<10	240	1.13	5.49	0.35	0.34	79.9	13.8	16	1.23	1525	3.39	6.16	0.07
Target Range - Lower Bound	0.33	<10	200	0.78	5.16	0.29	0.30	72.0	12.4	15	1.14	1450	3.14	5.74	<0.05
Upper Bound	0.45	20	300	1.08	6.32	0.38	0.38	88.0	15.4	20	1.50	1670	3.86	7.12	0.22
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
STANDARDS															
Buffer pH6															
Buffer pH6															
Target Range - Lower Bound															
Upper Bound															
CO-ASSAY															
Target Range - Lower Bound															
Upper Bound															
DS-1															
Target Range - Lower Bound															
Upper Bound															
GS313-8															
Target Range - Lower Bound															
Upper Bound															
KZK-1															
KZK-1															
Target Range - Lower Bound															
Upper Bound															
MA-2c															
Target Range - Lower Bound															
Upper Bound															
MRGeo08	0.71	0.06	0.149	1.22	36.7	29.6	1.13	416	13.35	0.33	1.05	694	1020	1080	138.0
Target Range - Lower Bound	0.64	0.04	0.137	1.12	33.2	29.6	1.03	378	13.10	0.30	0.79	622	900	959	132.0
Upper Bound	0.83	0.10	0.179	1.40	41.0	36.4	1.29	473	16.10	0.39	1.09	760	1130	1175	162.0
OREAS 905	0.98	0.02	0.571	0.31	39.7	6.1	0.14	338	2.74	0.09	0.32	8.8	230	16.3	18.6
Target Range - Lower Bound	1.08	<0.01	0.517	0.28	35.6	4.3	0.13	310	2.65	0.07	0.19	7.8		15.2	17.3
Upper Bound	1.36	0.04	0.643	0.36	44.0	5.5	0.19	390	3.35	0.12	0.43	10.0		19.0	21.3
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-1															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															
UTS-4															
Target Range - Lower Bound															
Upper Bound															

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

	Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
Sample Description	**LOR**	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
		STANDARDS														
Buffer pH6																
Buffer pH6																
Target Range - Lower Bound																
Upper Bound																
CO-ASSAY																
Target Range - Lower Bound																
Upper Bound																
DS-1																
Target Range - Lower Bound																
Upper Bound																
GS313-8																
Target Range - Lower Bound																
Upper Bound																
KZK-1																
KZK-1																
Target Range - Lower Bound																
Upper Bound																
MA-2c																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		0.007	0.32	3.15	6.1	1.1	3.2	77.7	0.01	0.04	20.5	0.379	0.75	5.18	100	2.71
Target Range - Lower Bound		0.006	0.27	2.80	6.7	0.9	2.8	72.1	<0.01	<0.01	19.1	0.338	0.64	4.93	90	2.44
Upper Bound		0.010	0.35	3.90	8.4	1.9	4.0	88.5	0.03	0.04	23.7	0.424	0.92	6.13	112	3.42
OREAS 905		<0.001	0.07	0.96	1.6	2.2	1.2	12.6	0.01	0.07	8.8	0.019	0.11	2.22	5	0.53
Target Range - Lower Bound		<0.001	0.04	0.90	1.6	1.8	0.8	10.9	<0.01	0.04	7.8	0.008	0.06	2.08	4	0.44
Upper Bound		0.002	0.09	1.34	2.2	2.8	1.7	13.7	0.02	0.09	10.0	0.030	0.16	2.66	8	0.76
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-1																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																
UTS-4																
Target Range - Lower Bound																
Upper Bound																

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-JAN-2018
Account: APN

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
STANDARDS				
Buffer pH6				
Buffer pH6				
Target Range - Lower Bound				
Upper Bound				
CO-ASSAY				
Target Range - Lower Bound				
Upper Bound				
DS-1				
Target Range - Lower Bound				
Upper Bound				
GS313-8				
Target Range - Lower Bound				
Upper Bound				
KZK-1				
KZK-1				
Target Range - Lower Bound				
Upper Bound				
MA-2c				
Target Range - Lower Bound				
Upper Bound				
MRGeo08		18.35	791	23.3
Target Range - Lower Bound		17.50	708	18.1
Upper Bound		21.5	870	25.7
OREAS 905		7.03	65	41.2
Target Range - Lower Bound		6.32	58	39.9
Upper Bound		7.84	76	55.1
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-1				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				
UTS-4				
Target Range - Lower Bound				
Upper Bound				

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description / **Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
BLANKS															
BLANK								<0.05	<0.2						
Target Range - Lower Bound								<0.05	<0.2						
Upper Bound								0.10	0.4						
BLANK													<0.01	<0.01	<0.1
Target Range - Lower Bound													<0.01	<0.01	<0.1
Upper Bound													0.02	0.02	0.2
BLANK						6.0									
Target Range - Lower Bound						5.5									
Upper Bound						6.9									
BLANK												<0.01			
Target Range - Lower Bound												<0.01			
Upper Bound												0.02			
BLANK										<0.01					
Target Range - Lower Bound										<0.01					
Upper Bound										0.02					
BLANK							<0.01				<0.01				
Target Range - Lower Bound							<0.01				<0.01				
Upper Bound							0.02				0.02				
DUPLICATES															
ORIGINAL													0.02	0.17	200
DUP													0.02	0.17	203
Target Range - Lower Bound													<0.01	0.15	191.5
Upper Bound													0.03	0.19	212
ORIGINAL							0.13				2.51				
DUP							0.14				2.58				
Target Range - Lower Bound							0.12				2.47				
Upper Bound							0.15				2.62				
L2040080-9 146697	1	<0.3	15	15	96.00	8.7		0.11	0.4	0.02					
DUP	1	<0.3	15	15	96.00	8.6		0.11	0.4	0.01					
Target Range - Lower Bound	<1	<0.3	13	13	91.19	8.1		<0.05	<0.2	<0.01					
Upper Bound	2	0.6	17	17	100.81	9.2		0.17	0.6	0.02					

***** See Appendix Page for comments regarding this certificate *****

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description / Method / Analyte / Units / LOR	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Target Range - Lower Bound	<0.02	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2	<0.01	<0.05	<0.05
Upper Bound	0.04	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4	0.02	0.10	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	<0.02	<10	30	0.36	0.02	>25.0	0.10	16.95	1.3	11	0.64	15.0	0.59	0.59	<0.05
DUP	<0.02	10	30	0.32	0.02	>25.0	0.11	17.60	1.3	12	0.66	15.0	0.61	0.58	<0.05
Target Range - Lower Bound	<0.02	<10	20	0.27	<0.01	23.7	0.09	16.40	1.1	10	0.57	14.3	0.56	0.51	<0.05
Upper Bound	0.04	20	40	0.41	0.03	>25.0	0.12	18.15	1.5	13	0.73	15.7	0.64	0.66	0.10
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2040080-9 146697															
DUP															
Target Range - Lower Bound															
Upper Bound															

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb
Units	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
LOR	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10	0.2	0.1
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	0.02	<0.01	<0.005	<0.01	<0.2	0.2	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Target Range - Lower Bound	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2	<10	<0.2	<0.1
Upper Bound	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4	20	0.4	0.2
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.09	0.22	0.009	0.07	16.1	1.7	0.94	131	2.10	0.01	0.06	8.1	510	4.5	3.5
DUP	0.09	0.21	0.009	0.07	16.4	1.4	0.95	135	2.10	0.02	<0.05	8.1	500	4.7	3.4
Target Range - Lower Bound	0.07	0.19	<0.005	0.06	15.2	1.4	0.89	121	1.95	<0.01	<0.05	7.5	470	4.2	3.2
Upper Bound	0.11	0.24	0.010	0.08	17.3	1.7	1.00	145	2.26	0.02	0.10	8.7	540	5.0	3.7
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2040080-9 146697															
DUP															
Target Range - Lower Bound															
Upper Bound															

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U	V	W
Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
LOR	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05	1	0.05
BLANKS															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK	<0.001	0.01	<0.05	<0.1	0.2	<0.2	<0.2	<0.01	0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Target Range - Lower Bound	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02	<0.05	<1	<0.05
Upper Bound	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04	0.10	2	0.10
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
BLANK															
Target Range - Lower Bound															
Upper Bound															
DUPLICATES															
ORIGINAL	0.001	0.03	17.10	1.6	0.9	<0.2	251	<0.01	0.02	1.9	<0.005	1.26	2.29	7	0.65
DUP	<0.001	0.03	17.85	1.5	1.1	<0.2	251	<0.01	0.02	2.0	<0.005	1.41	2.33	7	0.67
Target Range - Lower Bound	<0.001	0.02	16.10	1.4	0.8	<0.2	238	<0.01	<0.01	1.7	<0.005	1.21	2.14	6	0.56
Upper Bound	0.002	0.04	18.85	1.7	1.3	0.4	264	0.02	0.03	2.2	0.010	1.46	2.48	8	0.76
ORIGINAL															
DUP															
Target Range - Lower Bound															
Upper Bound															
L2040080-9 146697															
DUP															
Target Range - Lower Bound															
Upper Bound															

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
		BLANKS		
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK		<0.05	<2	<0.5
Target Range - Lower Bound		<0.05	<2	<0.5
Upper Bound		0.10	4	1.0
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
BLANK				
Target Range - Lower Bound				
Upper Bound				
		DUPLICATES		
ORIGINAL		13.85	31	2.9
DUP		13.85	31	2.8
Target Range - Lower Bound		13.10	27	2.1
Upper Bound		14.60	35	3.6
ORIGINAL				
DUP				
Target Range - Lower Bound				
Upper Bound				
L2040080-9 146697				
DUP				
Target Range - Lower Bound				
Upper Bound				

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	**Method**	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41	ME-MS41	ME-MS41
	Analyte	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	C	CO2	S	C	S	Ag	Al	As
	Units	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	ppm	%	ppm
	LOR	1	0.3	1	1	0.01	0.1	0.01	0.05	0.2	0.01	0.01	0.01	0.01	0.01	0.1
								DUPLICATES								
L2035058-11													0.05			
DUP													0.04			
Target Range - Lower Bound													0.03			
Upper Bound													0.06			

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 Au ppm 0.02	ME-MS41 B ppm 10	ME-MS41 Ba ppm 10	ME-MS41 Be ppm 0.05	ME-MS41 Bi ppm 0.01	ME-MS41 Ca % 0.01	ME-MS41 Cd ppm 0.01	ME-MS41 Ce ppm 0.02	ME-MS41 Co ppm 0.1	ME-MS41 Cr ppm 1	ME-MS41 Cs ppm 0.05	ME-MS41 Cu ppm 0.2	ME-MS41 Fe % 0.01	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05
							DUPLICATES									
L2035058-11																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	**Method Analyte Units LOR**	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1
		DUPLICATES														
L2035058-11																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05	ME-MS41 V ppm 1	ME-MS41 W ppm 0.05
								DUPLICATES								
L2035058-11																
DUP																
Target Range - Lower Bound																
Upper Bound																

***** See Appendix Page for comments regarding this certificate *****

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 23-JAN-2018
Account: APN

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

Sample Description	Method Analyte Units LOR	ME-MS41 Y ppm 0.05	ME-MS41 Zn ppm 2	ME-MS41 Zr ppm 0.5
		DUPLICATES		
L2035058-11				
DUP				
Target Range - Lower Bound				
Upper Bound				

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2040080

QC CERTIFICATE OF ANALYSIS VA18001254

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05
OA-ELE07
S-CAL06a
SPL-21
C-IR07
OA-VOL08m
S-GRA06
WEI-21
LOG-22
PUL-31
S-GRA06a
ME-MS41
PUL-QC
S-IR08

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2040080-COFC

COC Number: ~~5~~ - 17-37

Page of

Report To	Contact and company name below will appear on the final report	
Company:	Minto Explorations Ltd.	
Contact:	Minto Environment - Coordinator	
Phone:	1-604-759-4659	
	Company address below will appear on the final report	
Street:	2100-510 West Georgia St.	
City/Province:	Vancouver, British Columbia	
Postal Code:	V6B 0M3	
Invoice To	Same as Report To	☐ YES ☑ NO
	Copy of Invoice with Report	☐ YES ☑ NO
Company:	Minto Explorations Ltd.	
Contact:	Ruth Cayetano	

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ YES ☐ NO
☑ Compare Results to Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax minto_environment@mintomine.com
Email 2
Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax ap@mintomine.com
Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days):
4 day [P4] ☐
3 day [P3] ☐
2 day [P2] ☐

EMERGENCY:
1 Business day [E1] ☐
Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:
Job #:
PO / AFE: TBD
LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#
Major/Minor Code: Routing Code:
Requisitioner:
Location:

ALS Lab Work Order # (lab use only)

ALS Contact: **Sampler:**

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	146680	03-DEC-2017		WASTE	X	X	X	X	X	X	
	146681	03-DEC-2017		WASTE	X	X	X	X	X	X	
	146682	05-DEC-2017		WASTE	X	X	X	X	X	X	
	146683	05-Dec-2017		WASTE	X	X	X	X	X	X	
	146690	13-Dec-2017		WASTE	X	X	X	X	X	X	
	146691	13-Dec-17		WASTE	X	X	X	X	X	X	
	146692	13-Dec-17		WASTE	X	X	X	X	X	X	
	146696	16-Dec-17		WASTE	X	X	X	X	X	X	
	146697	16-Dec-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System?
☐ YES ☑ NO
Are samples for human drinking water use?
☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐
Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
-2			6.6		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Jutta	Date: Dec 22.2017	Time:	Received by: ?	Date: DEC 28/17	Time: 13:55	Received by: PAUL	Date: DEC 29	Time: 13:10

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Minto Explorations Ltd.
ATTN: Minto Environment - Coordinator
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 04-JAN-18
Report Date: 08-FEB-18 16:54 (MT)
Version: FINAL

Client Phone: 604-759-4659

Certificate of Analysis

Lab Work Order #: L2041640
Project P.O. #: 228594
Job Reference:
C of C Numbers: 17-39
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

Shane Stack
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L2041640-1	L2041640-2	L2041640-3	L2041640-4	L2041640-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	15-DEC-17	15-DEC-17	15-DEC-17	21-DEC-17	22-DEC-17
	Sampled Time					
	Client ID	146693	146694	146695	146726	146728
SOIL						
Physical Tests	pH (Unity)	8.8	9.0	8.3	9.0	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.17	0.56	0.61	0.18	0.09
Acid Base Accounting	FIZZ RATING (Unity)	2	2	2	2	1
	MPA (tCaCO3/1Kt)	0.9	12.5	0.3	0.3	0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	16	37	55	21	10
	NNP (tCaCO3/1Kt)	15	25	55	21	10
	Ratio (NP/MPA) (Unity)	17.07	2.96	176.00	67.20	32.00
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.03	0.40	0.01	<0.01	0.01
	Total Sulfur (combustion) (%)	0.03	0.40	0.01	0.01	0.01
Total Metals	Aluminum (Al) (%)	1.00	0.88	0.96	1.21	0.93
	Antimony (Sb) (ppm)	0.08	0.06	0.09	0.05	0.05
	Arsenic (As) (ppm)	1.9	0.6	3.0	0.4	0.9
	Barium (Ba) (ppm)	200	210	140	240	250
	Beryllium (Be) (ppm)	0.30	0.24	0.94	0.31	0.24
	Bismuth (Bi) (ppm)	0.32	0.09	0.05	0.04	0.26
	Boron (B) (ppm)	<10	10	10	<10	<10
	Cadmium (Cd) (ppm)	0.21	0.13	0.43	0.06	0.23
	Calcium (Ca) (%)	0.63	1.09	2.33	0.91	0.42
	Cerium (Ce) (ppm)	21.1	27.0	29.0	28.3	25.6
	Cesium (Cs) (ppm)	0.50	0.55	0.40	0.34	0.44
	Chromium (Cr) (ppm)	5	4	3	6	5
	Cobalt (Co) (ppm)	6.2	8.1	5.7	6.2	5.6
	Copper (Cu) (ppm)	2630	2160	502	283	1950
	Gallium (Ga) (ppm)	5.19	4.76	5.66	5.77	4.72
	Germanium (Ge) (ppm)	0.06	0.06	0.05	0.07	0.07
	Gold (Au) (ppm)	0.08	<0.02	<0.02	<0.02	0.04
	Hafnium (Hf) (ppm)	0.04	0.07	0.04	0.06	0.03
	Indium (In) (ppm)	0.063	0.080	0.026	0.022	0.047
	Iron (Fe) (%)	2.53	2.63	2.17	2.31	2.40
	Lanthanum (La) (ppm)	10.7	14.4	15.7	15.0	13.1
	Lead (Pb) (ppm)	3.9	3.7	5.4	2.7	2.8
	Lithium (Li) (ppm)	4.6	3.9	4.7	6.8	4.2
	Magnesium (Mg) (%)	0.46	0.71	0.31	0.64	0.38
	Manganese (Mn) (ppm)	598	767	621	544	441

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L2041640-6	L2041640-7	L2041640-8	L2041640-9	L2041640-10
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	23-DEC-17	26-DEC-17	21-DEC-17	23-DEC-17	26-DEC-17
	Sampled Time					
	Client ID	146729	146733	146727	146730	146732
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	9.0	8.8	8.4	9.0	8.9
Organic / Inorganic Carbon	Carbon (C) (%)	0.29	0.62	0.07	0.41	0.65
Acid Base Accounting	FIZZ RATING (Unity)	2	2	1	2	2
	MPA (tCaCO3/1Kt)	0.3	1.9	3.8	4.4	<0.3
	Neutralization Potential (NP) (tCaCO3/1Kt)	24	46	11	29	41
	NNP (tCaCO3/1Kt)	24	44	7	25	41
	Ratio (NP/MPA) (Unity)	76.80	24.53	2.93	6.63	262.40
	Sulfate Sulfur (carbonate leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	0.01	0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.01	0.06	0.12	0.13	<0.01
	Total Sulfur (combustion) (%)	0.01	0.06	0.12	0.14	<0.01
Total Metals	Aluminum (Al) (%)	1.14	0.94	1.23	0.97	0.77
	Antimony (Sb) (ppm)	<0.05	0.06	<0.05	0.05	0.07
	Arsenic (As) (ppm)	0.3	1.1	0.5	1.2	0.9
	Barium (Ba) (ppm)	310	190	210	300	160
	Beryllium (Be) (ppm)	0.25	0.44	0.27	0.26	0.33
	Bismuth (Bi) (ppm)	0.03	0.04	0.25	0.06	0.03
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.02	0.06	0.12	0.14	0.05
	Calcium (Ca) (%)	0.95	1.60	0.44	0.96	1.39
	Cerium (Ce) (ppm)	28.5	28.0	22.2	24.9	30.4
	Cesium (Cs) (ppm)	0.91	0.42	0.31	0.55	0.38
	Chromium (Cr) (ppm)	6	5	4	5	5
	Cobalt (Co) (ppm)	6.0	6.4	6.0	7.3	5.4
	Copper (Cu) (ppm)	163.0	454	3220	1170	44.7
	Gallium (Ga) (ppm)	5.48	4.80	7.15	4.80	4.17
	Germanium (Ge) (ppm)	0.08	0.08	0.06	0.06	0.05
	Gold (Au) (ppm)	<0.02	<0.02	0.09	<0.02	<0.02
	Hafnium (Hf) (ppm)	0.06	0.06	0.04	0.05	0.04
	Indium (In) (ppm)	0.024	0.036	0.110	0.058	0.030
	Iron (Fe) (%)	2.41	2.49	2.76	2.41	2.29
	Lanthanum (La) (ppm)	14.7	14.5	10.9	13.4	15.9
	Lead (Pb) (ppm)	1.9	3.3	3.6	2.7	3.3
	Lithium (Li) (ppm)	4.8	4.8	8.2	3.9	3.4
	Magnesium (Mg) (%)	0.60	0.71	0.62	0.59	0.53
	Manganese (Mn) (ppm)	526	696	437	537	603

	Sample ID	L2041640-1	L2041640-2	L2041640-3	L2041640-4	L2041640-5
	Description	Waste	Waste	Waste	Waste	Waste
	Sampled Date	15-DEC-17	15-DEC-17	15-DEC-17	21-DEC-17	22-DEC-17
	Sampled Time					
	Client ID	146693	146694	146695	146726	146728
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	<0.01	0.01	<0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	1.62	36.1	1.79	1.78	4.19
	Nickel (Ni) (ppm)	2.8	2.6	1.9	3.4	2.7
	Niobium (Nb) (ppm)	0.14	0.23	<0.05	0.10	0.20
	Phosphorus (P) (ppm)	680	800	650	640	580
	Potassium (K) (%)	0.56	0.57	0.19	0.47	0.57
	Rhenium (Re) (ppm)	<0.001	0.105	0.002	0.001	0.003
	Rubidium (Rb) (ppm)	28.4	33.6	9.2	22.0	30.0
	Scandium (Sc) (ppm)	4.4	5.6	3.6	3.7	3.9
	Selenium (Se) (ppm)	1.3	1.2	0.5	<0.2	0.7
	Silver (Ag) (ppm)	0.68	0.43	0.10	0.10	0.48
	Sodium (Na) (%)	0.06	0.06	0.03	0.08	0.07
	Strontium (Sr) (ppm)	41.5	79.8	77.4	66.2	34.0
	Sulfur (S) (%)	0.05	0.44	0.02	0.02	0.03
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.15	0.05	0.02	0.01	0.11
	Thallium (Tl) (ppm)	0.20	0.30	0.05	0.14	0.19
	Thorium (Th) (ppm)	4.3	4.7	2.8	3.5	3.3
	Tin (Sn) (ppm)	0.6	1.7	0.5	0.6	0.6
	Titanium (Ti) (%)	0.084	0.090	0.008	0.079	0.092
	Tungsten (W) (ppm)	0.50	0.51	0.11	0.42	0.45
	Uranium (U) (ppm)	0.22	0.62	0.24	0.37	0.21
	Vanadium (V) (ppm)	55	72	41	50	52
	Yttrium (Y) (ppm)	6.50	9.44	7.68	6.99	5.95
	Zinc (Zn) (ppm)	67	65	63	66	71
	Zirconium (Zr) (ppm)	1.1	1.8	1.3	1.1	0.9
Permanent Gases	Carbon Dioxide (CO2) (%)	0.6	2.1	2.2	0.7	0.3
Miscellaneous	Carbon (C) (%)	0.23	0.66	0.72	0.23	0.12

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L2041640-6 Waste 23-DEC-17 146729	L2041640-7 Waste 26-DEC-17 146733	L2041640-8 Waste 21-DEC-17 146727	L2041640-9 Waste 23-DEC-17 146730	L2041640-10 Waste 26-DEC-17 146732
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	<0.01	0.01	<0.01	<0.01
	Molybdenum (Mo) (ppm)	2.86	1.14	6.81	5.71	0.59
	Nickel (Ni) (ppm)	3.4	2.4	2.6	2.5	2.3
	Niobium (Nb) (ppm)	0.13	0.14	0.12	0.19	0.07
	Phosphorus (P) (ppm)	620	690	800	820	530
	Potassium (K) (%)	0.67	0.43	0.38	0.63	0.34
	Rhenium (Re) (ppm)	0.005	0.003	0.002	0.016	0.001
	Rubidium (Rb) (ppm)	33.9	21.3	20.0	31.6	17.3
	Scandium (Sc) (ppm)	4.8	5.1	3.1	5.3	4.8
	Selenium (Se) (ppm)	<0.2	0.2	2.7	0.5	0.2
	Silver (Ag) (ppm)	0.05	0.17	0.73	0.25	0.05
	Sodium (Na) (%)	0.09	0.07	0.05	0.07	0.07
	Strontium (Sr) (ppm)	61.2	136.0	35.3	81.4	98.9
	Sulfur (S) (%)	0.03	0.09	0.15	0.18	0.01
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.01	0.03	0.09	0.03	0.01
	Thallium (Tl) (ppm)	0.21	0.13	0.17	0.25	0.11
	Thorium (Th) (ppm)	3.3	3.6	2.9	3.2	3.5
	Tin (Sn) (ppm)	0.6	0.7	1.8	1.0	0.5
	Titanium (Ti) (%)	0.112	0.069	0.057	0.100	0.043
	Tungsten (W) (ppm)	0.79	0.50	0.34	0.44	0.23
	Uranium (U) (ppm)	0.43	1.11	0.28	0.38	0.30
	Vanadium (V) (ppm)	52	50	55	65	41
	Yttrium (Y) (ppm)	8.35	9.35	6.19	7.28	8.51
	Zinc (Zn) (ppm)	63	71	74	62	56
	Zirconium (Zr) (ppm)	1.1	1.3	1.3	1.5	0.7
Permanent Gases	Carbon Dioxide (CO2) (%)	1.1	2.3	0.3	1.5	2.4
Miscellaneous	Carbon (C) (%)	0.37	0.73	0.11	0.48	0.74

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-39

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Page: 1
Total # Pages: 2 (A - E)
Plus Appendix Pages
Finalized Date: 30-JAN-2018
Account: APN

CERTIFICATE VA18005872

Project: L2041640

This report is for 10 Other samples submitted to our lab in Vancouver, BC, Canada on 8-JAN-2018.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
PUL-QC	Pulverizing QC Test
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

Project: L2041640

CERTIFICATE OF ANALYSIS VA18005872

Sample Description	Method Analyte Units LOR	WEI-21 Recvd Wt. kg 0.02	OA-VOL08m FIZZ RAT Unity 1	OA-VOL08m MPA tCaCO3/1Kt 0.3	OA-VOL08m NNP tCaCO3/1Kt 1	OA-VOL08m NP tCaCO3/1Kt 1	OA-VOL08m Ratio (N Unity 0.01	OA-ELE07 pH Unity 0.1	S-IR08 S % 0.01	S-CAL06a S % 0.01	C-GAS05 C % 0.05	C-GAS05 CO2 % 0.2	S-GRA06a S % 0.01	C-IR07 C % 0.01	S-GRA06 S % 0.01	ME-MS41 Ag ppm 0.01
L2041640-1 146693		1.06	2	0.9	15	16	17.07	8.8	0.03	0.03	0.17	0.6	<0.01	0.23	<0.01	0.68
L2041640-2 146694		1.06	2	12.5	25	37	2.96	9.0	0.40	0.40	0.56	2.1	<0.01	0.66	<0.01	0.43
L2041640-3 146695		0.94	2	0.3	55	55	176.00	8.3	0.01	0.01	0.61	2.2	<0.01	0.72	<0.01	0.10
L2041640-4 146726		1.08	2	0.3	21	21	67.20	9.0	0.01	<0.01	0.18	0.7	0.01	0.23	<0.01	0.10
L2041640-5 146728		1.12	1	0.3	10	10	32.00	8.9	0.01	0.01	0.09	0.3	<0.01	0.12	<0.01	0.48
L2041640-6 146729		1.04	2	0.3	24	24	76.80	9.0	0.01	0.01	0.29	1.1	<0.01	0.37	<0.01	0.05
L2041640-7 146733		1.10	2	1.9	44	46	24.53	8.8	0.06	0.06	0.62	2.3	<0.01	0.73	<0.01	0.17
L2041640-8 146727		0.90	1	3.8	7	11	2.93	8.4	0.12	0.12	0.07	0.3	<0.01	0.11	<0.01	0.73
L2041640-9 146730		1.34	2	4.4	25	29	6.63	9.0	0.14	0.13	0.41	1.5	0.01	0.48	<0.01	0.25
L2041640-10 146732		1.10	2	<0.3	41	41	262.40	8.9	<0.01	<0.01	0.65	2.4	0.01	0.74	<0.01	0.05

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE OF ANALYSIS VA18005872

Sample Description	**Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
	Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
	Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOR	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L2041640-1 146693		1.00	1.9	0.08	<10	200	0.30	0.32	0.63	0.21	21.1	6.2	5	0.50	2630	2.53
L2041640-2 146694		0.88	0.6	<0.02	10	210	0.24	0.09	1.09	0.13	27.0	8.1	4	0.55	2160	2.63
L2041640-3 146695		0.96	3.0	<0.02	10	140	0.94	0.05	2.33	0.43	29.0	5.7	3	0.40	502	2.17
L2041640-4 146726		1.21	0.4	<0.02	<10	240	0.31	0.04	0.91	0.06	28.3	6.2	6	0.34	283	2.31
L2041640-5 146728		0.93	0.9	0.04	<10	250	0.24	0.26	0.42	0.23	25.6	5.6	5	0.44	1950	2.40
L2041640-6 146729		1.14	0.3	<0.02	<10	310	0.25	0.03	0.95	0.02	28.5	6.0	6	0.91	163.0	2.41
L2041640-7 146733		0.94	1.1	<0.02	<10	190	0.44	0.04	1.60	0.06	28.0	6.4	5	0.42	454	2.49
L2041640-8 146727		1.23	0.5	0.09	<10	210	0.27	0.25	0.44	0.12	22.2	6.0	4	0.31	3220	2.76
L2041640-9 146730		0.97	1.2	<0.02	<10	300	0.26	0.06	0.96	0.14	24.9	7.3	5	0.55	1170	2.41
L2041640-10 146732		0.77	0.9	<0.02	<10	160	0.33	0.03	1.39	0.05	30.4	5.4	5	0.38	44.7	2.29

Project: L2041640

CERTIFICATE OF ANALYSIS VA18005872

Sample Description	Method Analyte Units LOR	ME-MS41 Ga ppm 0.05	ME-MS41 Ge ppm 0.05	ME-MS41 Hf ppm 0.02	ME-MS41 Hg ppm 0.01	ME-MS41 In ppm 0.005	ME-MS41 K % 0.01	ME-MS41 La ppm 0.2	ME-MS41 Li ppm 0.1	ME-MS41 Mg % 0.01	ME-MS41 Mn ppm 5	ME-MS41 Mo ppm 0.05	ME-MS41 Na % 0.01	ME-MS41 Nb ppm 0.05	ME-MS41 Ni ppm 0.2	ME-MS41 P ppm 10
L2041640-1 146693		5.19	0.06	0.04	<0.01	0.063	0.56	10.7	4.6	0.46	598	1.62	0.06	0.14	2.8	680
L2041640-2 146694		4.76	0.06	0.07	0.01	0.080	0.57	14.4	3.9	0.71	767	36.1	0.06	0.23	2.6	800
L2041640-3 146695		5.66	0.05	0.04	<0.01	0.026	0.19	15.7	4.7	0.31	621	1.79	0.03	<0.05	1.9	650
L2041640-4 146726		5.77	0.07	0.06	<0.01	0.022	0.47	15.0	6.8	0.64	544	1.78	0.08	0.10	3.4	640
L2041640-5 146728		4.72	0.07	0.03	<0.01	0.047	0.57	13.1	4.2	0.38	441	4.19	0.07	0.20	2.7	580
L2041640-6 146729		5.48	0.08	0.06	0.01	0.024	0.67	14.7	4.8	0.60	526	2.86	0.09	0.13	3.4	620
L2041640-7 146733		4.80	0.08	0.06	<0.01	0.036	0.43	14.5	4.8	0.71	696	1.14	0.07	0.14	2.4	690
L2041640-8 146727		7.15	0.06	0.04	0.01	0.110	0.38	10.9	8.2	0.62	437	6.81	0.05	0.12	2.6	800
L2041640-9 146730		4.80	0.06	0.05	<0.01	0.058	0.63	13.4	3.9	0.59	537	5.71	0.07	0.19	2.5	820
L2041640-10 146732		4.17	0.05	0.04	<0.01	0.030	0.34	15.9	3.4	0.53	603	0.59	0.07	0.07	2.3	530

CERTIFICATE OF ANALYSIS VA18005872

Sample Description	Method Analyte Units LOR	ME-MS41 Pb ppm 0.2	ME-MS41 Rb ppm 0.1	ME-MS41 Re ppm 0.001	ME-MS41 S % 0.01	ME-MS41 Sb ppm 0.05	ME-MS41 Sc ppm 0.1	ME-MS41 Se ppm 0.2	ME-MS41 Sn ppm 0.2	ME-MS41 Sr ppm 0.2	ME-MS41 Ta ppm 0.01	ME-MS41 Te ppm 0.01	ME-MS41 Th ppm 0.2	ME-MS41 Ti % 0.005	ME-MS41 Tl ppm 0.02	ME-MS41 U ppm 0.05
L2041640-1 146693		3.9	28.4	<0.001	0.05	0.08	4.4	1.3	0.6	41.5	<0.01	0.15	4.3	0.084	0.20	0.22
L2041640-2 146694		3.7	33.6	0.105	0.44	0.06	5.6	1.2	1.7	79.8	<0.01	0.05	4.7	0.090	0.30	0.62
L2041640-3 146695		5.4	9.2	0.002	0.02	0.09	3.6	0.5	0.5	77.4	<0.01	0.02	2.8	0.008	0.05	0.24
L2041640-4 146726		2.7	22.0	0.001	0.02	0.05	3.7	<0.2	0.6	66.2	<0.01	0.01	3.5	0.079	0.14	0.37
L2041640-5 146728		2.8	30.0	0.003	0.03	0.05	3.9	0.7	0.6	34.0	<0.01	0.11	3.3	0.092	0.19	0.21
L2041640-6 146729		1.9	33.9	0.005	0.03	<0.05	4.8	<0.2	0.6	61.2	<0.01	0.01	3.3	0.112	0.21	0.43
L2041640-7 146733		3.3	21.3	0.003	0.09	0.06	5.1	0.2	0.7	136.0	<0.01	0.03	3.6	0.069	0.13	1.11
L2041640-8 146727		3.6	20.0	0.002	0.15	<0.05	3.1	2.7	1.8	35.3	<0.01	0.09	2.9	0.057	0.17	0.28
L2041640-9 146730		2.7	31.6	0.016	0.18	0.05	5.3	0.5	1.0	81.4	<0.01	0.03	3.2	0.100	0.25	0.38
L2041640-10 146732		3.3	17.3	0.001	0.01	0.07	4.8	0.2	0.5	98.9	<0.01	0.01	3.5	0.043	0.11	0.30

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2041640

CERTIFICATE OF ANALYSIS VA18005872

Sample Description / **Method**	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	V	W	Y	Zn	Zr
Units	ppm	ppm	ppm	ppm	ppm
LOR	1	0.05	0.05	2	0.5
L2041640-1 146693	55	0.50	6.50	67	1.1
L2041640-2 146694	72	0.51	9.44	65	1.8
L2041640-3 146695	41	0.11	7.68	63	1.3
L2041640-4 146726	50	0.42	6.99	66	1.1
L2041640-5 146728	52	0.45	5.95	71	0.9
L2041640-6 146729	52	0.79	8.35	63	1.1
L2041640-7 146733	50	0.50	9.35	71	1.3
L2041640-8 146727	55	0.34	6.19	74	1.3
L2041640-9 146730	65	0.44	7.28	62	1.5
L2041640-10 146732	41	0.23	8.51	56	0.7

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2041640

CERTIFICATE OF ANALYSIS VA18005872

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:

C-GAS05	C-IR07	LOG-22	ME-MS41
OA-ELE07	OA-VOL08m	PUL-31	PUL-QC
S-CAL06a	S-GRA06	S-GRA06a	S-IR08
SPL-21	WEI-21		

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2041640-COFC

COC Number: ~~15~~ 17-39

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ 3 day [P3] ☐ 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aquaregia digestion (ICP)	Paste pH	% Inorganic Carbonate	Total Carbon/Sulphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
				Composite	R	R	R	R	R	R	
	146693	15-DEC-17		WASTE	X	X	X	X	X	X	
	146694	15-DEC-17		WASTE	X	X	X	X	X	X	
	146695	15-DEC-17		WASTE	X	X	X	X	X	X	
	146726	21-Dec-17		WASTE	X	X	X	X	X	X	
	146728	22-Dec-17		WASTE	X	X	X	X	X	X	
	146729	23-Dec-17		WASTE	X	X	X	X	X	X	
	146733	26 Dec 17		WASTE	X	X	X	X	X	X	
	146727	21-Dec 17		WASTE	X	X	X	X	X	X	
	146730	23-Dec-17		WASTE	X	X	X	X	X	X	
	146732	26-Dec-17		WASTE	X	X	X	X	X	X	

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C: 6°C.

FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)

Released by: Date: Dec 28 2017 Time:

INITIAL SHIPMENT RECEPTION (lab use only)

Received by: Date: JAN 4/18 Time: 15:55

FINAL SHIPMENT RECEPTION (lab use only)

Received by: JC Date: JAN - 5 2018 Time: 13:25

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

1 If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

OCTOBER 2015 FRONT

Minto Explorations Ltd.
ATTN: Minto Environment
Suite 2100- 510 West Georgia St
Vancouver BC V6B 0M3

Date Received: 10-JAN-18
Report Date: 09-FEB-18 15:07 (MT)
Version: FINAL REV. 2

Client Phone: 604-759-0860

Certificate of Analysis

Lab Work Order #: L2043509
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers: 17-40
Legal Site Desc:

Comments: Please note, the ALS Minerals version of the finalized report and QC can be found at the end of the attachment.

The PO for this submission is 229099

Shane Stack
Account Manager

	Sample ID	L2043509-1	L2043509-2	L2043509-3	L2043509-4	L2043509-5
	Description	Waste	Waste	Waste	Waste	Tails
	Sampled Date	24-DEC-17	28-DEC-17	28-DEC-17	30-DEC-17	01-DEC-17
	Sampled Time					
	Client ID	146731	146735	146734	146736	DEC TAILS 2017
Grouping	**Analyte**					
SOIL						
Physical Tests	pH (Unity)	8.5	8.9	9.0	9.1	8.0
Organic / Inorganic Carbon	Carbon (C) (%)	0.05	0.49	0.27	0.19	0.33
Acid Base Accounting	FIZZ RATING (Unity)	1	2	2	2	2
	MPA (tCaCO3/1Kt)	1.9	7.5	3.1	0.6	4.4
	Neutralization Potential (NP) (tCaCO3/1Kt)	8	32	23	21	25
	NNP (tCaCO3/1Kt)	6	25	20	20	21
	Ratio (NP/MPA) (Unity)	4.27	4.27	7.36	33.60	5.71
	Sulfate Sulfur (carbonate leach) (%)	0.02	0.01	<0.01	0.01	0.04
	Sulfate Sulfur (HCl leach) (%)	<0.01	<0.01	<0.01	<0.01	<0.01
	Sulfide Sulfur (T minus HCl leach) (%)	0.06	0.24	0.10	0.02	0.14
	Total Sulfur (combustion) (%)	0.06	0.24	0.10	0.02	0.14
Total Metals	Aluminum (Al) (%)	1.14	1.01	1.01	1.07	1.17
	Antimony (Sb) (ppm)	<0.05	<0.05	<0.05	<0.05	<0.05
	Arsenic (As) (ppm)	1.6	1.4	1.1	0.5	1.4
	Barium (Ba) (ppm)	300	310	240	140	280
	Beryllium (Be) (ppm)	0.25	0.25	0.19	0.31	0.18
	Bismuth (Bi) (ppm)	0.13	0.05	0.50	0.02	0.20
	Boron (B) (ppm)	<10	<10	<10	<10	<10
	Cadmium (Cd) (ppm)	0.27	0.15	0.09	0.04	0.26
	Calcium (Ca) (%)	0.35	1.18	1.02	1.01	1.10
	Cerium (Ce) (ppm)	29.7	26.9	23.1	20.0	21.5
	Cesium (Cs) (ppm)	0.56	0.46	0.44	0.29	0.43
	Chromium (Cr) (ppm)	5	5	5	6	7
	Cobalt (Co) (ppm)	12.0	8.8	5.4	5.0	6.3
	Copper (Cu) (ppm)	3140	1720	2310	48.9	1965
	Gallium (Ga) (ppm)	5.86	5.38	5.20	5.47	6.34
	Germanium (Ge) (ppm)	0.07	0.06	0.08	0.05	0.06
	Gold (Au) (ppm)	0.04	<0.02	0.06	<0.02	0.07
	Hafnium (Hf) (ppm)	0.06	0.05	0.06	0.06	0.05
	Indium (In) (ppm)	0.099	0.080	0.040	0.019	0.066
	Iron (Fe) (%)	3.45	3.00	2.65	2.05	3.70
	Lanthanum (La) (ppm)	15.6	14.7	11.3	9.0	10.6
	Lead (Pb) (ppm)	4.2	4.4	3.7	3.0	3.6
	Lithium (Li) (ppm)	4.4	3.9	4.5	6.2	4.5
	Magnesium (Mg) (%)	0.49	0.68	0.60	0.64	0.68
	Manganese (Mn) (ppm)	683	720	667	529	653

	Sample ID	L2043509-1	L2043509-2	L2043509-3	L2043509-4	L2043509-5
	Description	Waste	Waste	Waste	Waste	Tails
	Sampled Date	24-DEC-17	28-DEC-17	28-DEC-17	30-DEC-17	01-DEC-17
	Sampled Time					
	Client ID	146731	146735	146734	146736	DEC TAILS 2017
Grouping	**Analyte**					
SOIL						
Total Metals	Mercury (Hg) (ppm)	0.01	0.01	0.01	<0.01	0.01
	Molybdenum (Mo) (ppm)	24.9	19.20	4.41	1.28	6.69
	Nickel (Ni) (ppm)	3.7	3.2	2.7	4.9	2.5
	Niobium (Nb) (ppm)	0.16	0.22	0.14	0.10	0.19
	Phosphorus (P) (ppm)	780	850	610	680	800
	Potassium (K) (%)	0.65	0.60	0.59	0.26	0.61
	Rhenium (Re) (ppm)	0.007	0.040	0.007	0.003	0.010
	Rubidium (Rb) (ppm)	32.7	30.6	27.1	11.0	27.4
	Scandium (Sc) (ppm)	7.0	5.5	4.2	4.1	4.1
	Selenium (Se) (ppm)	1.5	1.4	1.8	<0.2	1.1
	Silver (Ag) (ppm)	0.50	0.35	0.67	0.02	0.50
	Sodium (Na) (%)	0.05	0.06	0.06	0.09	0.06
	Strontium (Sr) (ppm)	44.8	78.2	64.1	60.5	73.2
	Sulfur (S) (%)	0.06	0.25	0.10	0.01	0.16
	Tantalum (Ta) (ppm)	<0.01	<0.01	<0.01	<0.01	<0.01
	Tellurium (Te) (ppm)	0.11	0.03	0.09	0.01	0.11
	Thallium (Tl) (ppm)	0.27	0.21	0.16	0.07	0.20
	Thorium (Th) (ppm)	1.9	2.8	3.2	2.0	3.1
	Tin (Sn) (ppm)	1.8	1.4	0.5	0.5	1.1
	Titanium (Ti) (%)	0.101	0.098	0.095	0.053	0.110
	Tungsten (W) (ppm)	0.46	0.60	0.52	0.84	0.09
	Uranium (U) (ppm)	0.55	0.46	0.27	0.44	0.49
	Vanadium (V) (ppm)	95	72	52	42	75
	Yttrium (Y) (ppm)	12.35	9.31	7.39	7.72	6.96
	Zinc (Zn) (ppm)	80	76	71	53	99
	Zirconium (Zr) (ppm)	2.1	1.4	1.2	1.0	1.3
Permanent Gases	Carbon Dioxide (CO2) (%)	0.2	1.8	1.0	0.7	1.2
Miscellaneous	Carbon (C) (%)	0.09	0.54	0.33	0.24	0.36

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ABA-OA-VOL08-AX	Soil	Acid Base Accounting	OA-VOL08
CARBON-C-GAS05-AX	Soil	Carbon, TOC and CO2	C-GAS05
CARBON-C-IR07-AX	Soil	Carbon (C) using LECO analyzer	Total Carbon - Method Code C-IR07

Total Carbon & Sulfur - Method Codes C-IR07 & S-IR08

A 0.1g sample is heated to approximately 1350°C in an induction furnace while passing a stream of oxygen through the sample. Carbon dioxide & sulfur dioxide released from the sample are measured by an IR detection system (Leco analyzer) and the total carbon & sulfur results are provided.
.

ALS Test Code	Matrix	Test Description	Method Reference**
ME-MS41-AX	Soil	Aqua Regia ICPMS	Aqua Regia ICPMS

A prepared sample (0.50 g) is digested with aqua regia in a graphite heating block. After cooling, the resulting solution is diluted to with deionized water, mixed and analyzed by inductively coupled plasma-atomic emission spectrometry. Following this analysis, the results are reviewed for high concentrations of bismuth, mercury, molybdenum, silver and tungsten and diluted accordingly. Samples are then analysed by ICP-MS for the remaining suite of elements. The analytical results are corrected for inter-element spectral interferences.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-OA-ELE07-AX	Soil	pH	OA-ELE07
SULPHUR-S-CAL06A-AX	Soil	Sulfide Sulfur Calc from HCl Leach	ALS Minerals S-CAL06A

Sulfide Sulfur (as S) is calculated by subtracting the HCl Leachable Sulfate Sulfur (as S) from the Total Sulfur (as S) obtained from combustion.

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06-AX	Soil	Sulfate Sulfur in Soil (Carbonate Leach)	ALS Minerals S-GRA06

A prepared sample is boiled with a sodium carbonate solution for 30 minutes. Any insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-GRA06A-AX	Soil	Sulfate Sulfur in Soil (HCl Leach)	ALS Minerals S-GRA06A

A prepared sample is heated with dilute hydrochloric acid for 30 minutes. Silica and any acid-insoluble materials are removed by filtration and ferric iron is reduced to ferrous iron by the addition of hydroxylamine hydrochloride. The sulfate in the resulting filtrate is then precipitated with barium chloride in a dilute hydrochloric acid medium. The barium sulfate precipitate is filtered, ignited, weighed and the Sulfate Sulfur is calculated (as S).

ALS Test Code	Matrix	Test Description	Method Reference**
SULPHUR-S-IR08-AX	Soil	Total Sulfur in Soil by Combustion	ALS Minerals S-IR08

The sample is heated to approximately 1350 °C in an induction furnace while passing a stream of oxygen through the sample. Sulfur dioxide released from the sample is measured by an IR detection system and the Total Sulfur result is provided.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
AX	ALS MINERALS - VANCOUVER, B.C., CANADA

Chain of Custody Numbers:

17-40

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

CERTIFICATE VA18008409

Project: L2043509

This report is for 5 Other samples submitted to our lab in Vancouver, BC, Canada on 12-JAN-2018.

The following have access to data associated with this certificate:

ALSEV DATASUBLET	SHANE STACK	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI-21	Received Sample Weight
SPL-21	Split sample - riffle splitter
LOG-22	Sample login - Rcd w/o BarCode
PUL-31	Pulverize split to 85% <75 um

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	
C-GAS05	Inorganic Carbon (CO2)	
C-IR07	Total Carbon (Leco)	LECO
S-GRA06	Sulfate Sulfur-carbonate leach	WST-SEQ
ME-MS41	Ultra Trace Aqua Regia ICP-MS	
OA-VOL08m	Modified NP	
S-IR08	Total Sulphur (Leco)	LECO
OA-ELE07	Paste pH	
S-CAL06a	Sulfide Sulfur (calculated*)	
S-GRA06a	Sulfate Sulfur (HCl leachable)	WST-SEQ

To: **ALS ENVIRONMENTAL**
ATTN: SHANE STACK
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:
Colin Ramshaw, Vancouver Laboratory Manager

CERTIFICATE OF ANALYSIS VA18008409

Method	WEI-21	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-VOL08m	OA-ELE07	S-IR08	S-CAL06a	C-GAS05	C-GAS05	S-GRA06a	C-IR07	S-GRA06	ME-MS41
Analyte	Recvd Wt.	FIZZ RAT	MPA	NNP	NP	Ratio (N	pH	S	S	C	CO2	S	C	S	Ag
Units	kg	Unity	tCaCO3/1Kt	tCaCO3/1Kt	tCaCO3/1Kt	Unity	Unity	%	%	%	%	%	%	%	ppm
Sample Description LOR	0.02	1	0.3	1	1	0.01	0.1	0.01	0.01	0.05	0.2	0.01	0.01	0.01	0.01
L2043509-1 146731	1.06	1	1.9	6	8	4.27	8.5	0.06	0.06	0.05	0.2	<0.01	0.09	0.02	0.50
L2043509-2 146735	1.04	2	7.5	25	32	4.27	8.9	0.24	0.24	0.49	1.8	<0.01	0.54	0.01	0.35
L2043509-3 146734	1.26	2	3.1	20	23	7.36	9.0	0.10	0.10	0.27	1.0	<0.01	0.33	<0.01	0.67
L2043509-4 146736	1.06	2	0.6	20	21	33.60	9.1	0.02	0.02	0.19	0.7	<0.01	0.24	0.01	0.02
L2043509-5 DEC TAILS 2017	1.02	2	4.4	21	25	5.71	8.0	0.14	0.14	0.33	1.2	<0.01	0.36	0.04	0.50

CERTIFICATE OF ANALYSIS VA18008409

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe
Units	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%
Sample Description **LOR**	0.01	0.1	0.02	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2	0.01
L2043509-1 146731	1.14	1.6	0.04	<10	300	0.25	0.13	0.35	0.27	29.7	12.0	5	0.56	3140	3.45
L2043509-2 146735	1.01	1.4	<0.02	<10	310	0.25	0.05	1.18	0.15	26.9	8.8	5	0.46	1720	3.00
L2043509-3 146734	1.01	1.1	0.06	<10	240	0.19	0.50	1.02	0.09	23.1	5.4	5	0.44	2310	2.65
L2043509-4 146736	1.07	0.5	<0.02	<10	140	0.31	0.02	1.01	0.04	20.0	5.0	6	0.29	48.9	2.05
L2043509-5 DEC TAILS 2017	1.17	1.4	0.07	<10	280	0.18	0.20	1.10	0.26	21.5	6.3	7	0.43	1965	3.70

***** See Appendix Page for comments regarding this certificate *****

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Project: L2043509

CERTIFICATE OF ANALYSIS VA18008409

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P
Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm
Sample Description / **LOR**	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2	10
L2043509-1 146731	5.86	0.07	0.06	0.01	0.099	0.65	15.6	4.4	0.49	683	24.9	0.05	0.16	3.7	780
L2043509-2 146735	5.38	0.06	0.05	0.01	0.080	0.60	14.7	3.9	0.68	720	19.20	0.06	0.22	3.2	850
L2043509-3 146734	5.20	0.08	0.06	0.01	0.040	0.59	11.3	4.5	0.60	667	4.41	0.06	0.14	2.7	610
L2043509-4 146736	5.47	0.05	0.06	<0.01	0.019	0.26	9.0	6.2	0.64	529	1.28	0.09	0.10	4.9	680
L2043509-5 DEC TAILS 2017	6.34	0.06	0.05	0.01	0.066	0.61	10.6	4.5	0.68	653	6.69	0.06	0.19	2.5	800

Project: L2043509

CERTIFICATE OF ANALYSIS VA18008409

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl	U
Units	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm
Sample Description LOR	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02	0.05
L2043509-1 146731	4.2	32.7	0.007	0.06	<0.05	7.0	1.5	1.8	44.8	<0.01	0.11	1.9	0.101	0.27	0.55
L2043509-2 146735	4.4	30.6	0.040	0.25	<0.05	5.5	1.4	1.4	78.2	<0.01	0.03	2.8	0.098	0.21	0.46
L2043509-3 146734	3.7	27.1	0.007	0.10	<0.05	4.2	1.8	0.5	64.1	<0.01	0.09	3.2	0.095	0.16	0.27
L2043509-4 146736	3.0	11.0	0.003	0.01	<0.05	4.1	<0.2	0.5	60.5	<0.01	0.01	2.0	0.053	0.07	0.44
L2043509-5 DEC TAILS 2017	3.6	27.4	0.010	0.16	<0.05	4.1	1.1	1.1	73.2	<0.01	0.11	3.1	0.110	0.20	0.49

ALS Canada Ltd.

2103 Dollarton Hwy
North Vancouver BC V7H 0A7
Phone: +1 (604) 984 0221 Fax: +1 (604) 984 0218
www.alsglobal.com/geochemistry

To: **ALS ENVIRONMENTAL**
100 - 8081 LOUGHEED HWY.
BURNABY BC V5A 1W9

Finalized Date: 30-JAN-2018
Account: APN

Project: L2043509

CERTIFICATE OF ANALYSIS VA18008409

Method	ME-MS41	ME-MS41	ME-MS41	ME-MS41	ME-MS41
Analyte	V	W	Y	Zn	Zr
Units	ppm	ppm	ppm	ppm	ppm
Sample Description / **LOR**	1	0.05	0.05	2	0.5
L2043509-1 146731	95	0.46	12.35	80	2.1
L2043509-2 146735	72	0.60	9.31	76	1.4
L2043509-3 146734	52	0.52	7.39	71	1.2
L2043509-4 146736	42	0.84	7.72	53	1.0
L2043509-5 DEC TAILS 2017	75	0.09	6.96	99	1.3

***** See Appendix Page for comments regarding this certificate *****

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Gold determinations by this method are semi-quantitative due to the small sample weight used (0.5g).

Applies to Method: ME-MS41

LABORATORY ADDRESSES

Processed at ALS Vancouver located at 2103 Dollarton Hwy, North Vancouver, BC, Canada.

Applies to Method:
C-GAS05 C-IR07 LOG-22 ME-MS41
OA-ELE07 OA-VOL08m PUL-31 S-CAL06a
S-GRA06 S-GRA06a S-IR08 SPL-21
WEI-21

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

L2043509-COFC

COC Number: 15-17-40

Page of

Report To	Contact and company name below will appear on the final report
Company:	Minto Explorations Ltd.
Contact:	Minto Environment - Coordinator
Phone:	1-604-759-4659
	Company address below will appear on the final report
Street:	2100-510 West Georgia St.
City/Province:	Vancouver, British Columbia
Postal Code:	V6B 0M3
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☑ NO
Company:	Minto Explorations Ltd.
Contact:	Ruth Cayetano

Report Format / Distribution

Select Report Format: ☑ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☑ YES ☐ NO

☑ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax minto_environment@mintomine.com

Email 2

Email 3

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax ap@mintomine.com

Email 2

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ · 3 day [P3] ☐ · 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ · Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

Project Information

ALS Account # / Quote #:

Job #:

PO / AFE: TBD

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only)

ALS Contact:

Sampler:

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Total Metals- Aqua regia disgestion (ICP)	Paste pH	% Inorganic Carbonate	Total Corbon/Sukphur (Leco)	AP - determination by % sulphide sulphur	Modified NP - (MEND 1991)	Number of Containers
	[illegible]			Composite	R	R	R	R	R	R	
	146731	24-Dec-17		WASTE	x	x	x	x	x	x	
	146735	28-Dec-17		WASTE	x	x	x	x	x	x	
	146734	28-Dec-17		WASTE	x	x	x	x	x	x	
	146736	30-Dec-17		WASTE	x	x	x	x	x	x	
	DEC TAILS 2017	Dec-17		TAILS	x	x	x	x	x	x	

Drinking Water (DW) Samples [1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☑ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☑ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☑

INITIAL COOLER TEMPERATURES °C: 1.0

FINAL COOLER TEMPERATURES °C: 4

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 04 Jan 14	Time:	Received by: EHF	Date: 10 Jan 2018	Time: 12:20	Received by: JC	Date: JAN 11 2018	Time: 1205pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2013 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

[1] If any water samples are taken from a Regulated Drinking Water (DW) System please submit using an Authorized DW COC form

Appendix D: 2017 Modified NP Method (MEND 1991) ABA Results for Tailings

Appendix D. 2017 Summary Tailings Analysis Results from ALS Minerals

Monthly Tails Sample ID	Paste pH	TIC	S(T)	S(SO_4)	S(S^{-2})	AP	Net NP	NP:AP Ratio (NP/AP)	NP Modified
		%	%	%	%	$CaCO_3$kg / tonne		(NP/AP)	NP
FEBTAL2017	8.2	0.26	0.06	0.02	0.04	1.25	23	20.0	25
MARTAL2017	8	0.19	0.09	0.05	0.04	1.25	18	16.8	21
APRTAL2017	8	0.23	0.06	0.03	0.03	0.94	23	26.7	25
APR10TAL2017	8	0.19	0.09	0.02	0.07	2.19	20	10.5	23
MAY8TAL2017	8	0.18	0.09	0.03	0.06	1.88	16	10.1	19
MAY29TAL2017	7.9	0.21	0.16	0.07	0.09	2.81	14	6.8	19
JUN5TAL2017	7.8	0.2	0.09	0.04	0.05	1.56	18	13.4	21
JUN12TAL2017	7.9	0.25	0.12	0.06	0.06	1.88	19	12.3	23
JUN21TAL2017	7.8	0.25	0.11	0.05	0.06	1.88	20	12.3	23
JULTAL2017	8.1	0.19	0.15	0.08	0.07	2.19	13	8.2	18
AUGTAL2017	8.2	0.33	0.1	<0.01	0.1	3.13	20	7.4	23
SEPTAL2017	8.2	0.3	0.08	0.05	0.03	0.94	22	25.6	24
OCTTAL2017	8	0.26	0.1	<0.01	0.1	3.13	18	6.7	21
NOVTAL2017	7.9	0.22	0.11	0.05	0.06	1.88	24	14.4	27
DECTAL2017	8	0.33	0.14	<0.01	0.14	4.38	5.71	4.8	21

Appendix P – Wildlife and Hazing Tracking Report

Date	Time	Type of Animal	Number of Animals	Location	Description: Size/Color/Markings and Additional Notes
5-Jan-17	11:30	Fox	1	Airport Road near the core shack	Red
5-Jan-17	13:30	Fox	1	Minto North	Red/Orange
8-Jan-17	10:30	Fox	1	Surface Magazine	
8-Jan-17	10:00	Fox	1	bicycle shack	ran away
15-Jan-17	12:40	Fox	1	Burn Pit	Red
18-Jan-17	10:45	Moose	1	Airstrip	Bull moose, walking around
19-Jan-17	16:00	Fox	1	Portal	
20-Jan-17	13:00	Fox	1	Surface Magazine	
10-Feb-17	17:30	Fox	1	A2S3 Pit	
11-Feb-17	9:40	Moose	2	Jump ramp A2S3	Large moose
17-Feb-17	5:00	Lynx	1	km 6	good shape, running for hills
24-Feb-17	9:00	Fox	1	Access Rd. Km 0.8	
24-Feb-17	17:35	Fox	2	KM 0.75	Red
24-Feb-17	21:30	Fox	1	Pit, 823 Bench	
25-Feb-17	14:25	Lynx	5	W3 area	momma and four kittens
11-Mar-17	13:45	Fox	1	Dry Stack	Healthy, red
22-Mar-17	10:00	Lynx	1	km 16	
23-Mar-17	9:00	Fox	1	Selkirk Towers	
25-Mar-17	16:15	Bald Eagle	1	km 22	Healthy adult in tree
25-Mar-17	15:30	Otter	1	Big Creek Bridge	Tracks in snow on river
31-Mar-17	15:45	Deer	8	KM 24	on side of road
1-Apr-17	10:00	Rabbit	1	Airstrip SS course	white
1-Apr-17	11:00	Rabbit	1	Dyno SS course	white
8-Apr-17	5:30	Rabbit	1	warehouse	
15-Apr-17	6:30	Porcupine	1	walking along berm by W15	great big sucker
17-Apr-17	17:30	Bear	1	0.5 km	Cinnamon Black Bear
17-Apr-17	17:20	Bear	1	km 0.5	walking around
19-Apr-17	14:38	Bear	1	3.5Km	Cinnamon Black Bear
19-Apr-17	16:45	Lynx	1	Landfill/LTF entrance	Adult
22-Apr-17	17:05	Bear	1	WMA	checking out pallet of buckets
1-May-17	19:00	Bear	2	near km2	Sow and Cub (black bear)
3-May-17	10:00	Bear	1	airport road	passing through going north
3-May-17	10:15	Bear	1	below air strip	Black Bear
5-May-17	11:00	Bear	1	Airport Road (top of Dumas)	Light brown, healthy (Black Bear)
5-May-17	11:30	Bear	3	KM 9 hill	Sow and 2 cubs
5-May-17	2:00	Wolf	1	Pelly	Grey Wolf
6-May-17	12:20	Lynx	1	W2	Light grey
6-May-17	11:50	Bear	1	Airport Road behind Dumas	Light brown, healthy (Black Bear)
7-May-17	18:30	Bear	1	Behind Selkirk Tower	Dark Brown (Black Bear)
8-May-17	19:00	Bear	1	Sewage Lagoon Road	Light brown, healthy (Black Bear)
9-May-17	13:00	Moose	2	Km 2.5	Healthy Cow moose and year old calf. Both healthy and grazing
14-May-17	12:30	Bear	1	access road between 0.5 and 1.0	just chilling
16-May-17	19:30	Bear	1	km 3.5	headed south
18-May-17	20:30	Bear	1	km 3	
19-May-17	13:30	Bear	1	Dyno road	Large Cinnamon Black bear
19-May-17	9:00	Bear	1	airport road	small black bear w/ tan on nose
20-May-17	10:15	Bear	2	Dyno	one was larger cinnamon, the other was slightly smaller and all black with tan on the muzzle.

Date	Time	Type of Animal	Number of Animals	Location	Description: Size/Color/Markings and Additional Notes
20-May-17	11:00	Bear	2	Km 1.5 on the hill	Black Bear
24-May-17	16:30	Bear	1	Willows behind Dumas Shop	Small Black Bear ~250 lbs
24-May-17	22:15	Bear	1	Willows behind Dumas Shop	black bear - approx 300-350 lb, light brown with silver/grey
26-May-17	14:00	Wolf	1	km 18	white, scruffy
27-May-17	8:10	Mule deer	1	0.5	healthy looking doe
28-May-17	23:00	Bear	1	Willows behind Dumas Shop	small black bear w/ tan on nose
1-Jun-17	14:00	Bear	1	Km 0.75	Dark Brown (Black Bear)
1-Jun-17	14:15	Fox	1	WSP	cross-fox, dark colouring with white-ended tail
3-Jun-17	15:00	Ermine	1	top of WSP dam	small weasal, approx. 15 cm.long, brown back and head, white belly, dark tipped tail
3-Jun-17	11:30	Bear	1	km 0.8	
3-Jun-17	14:00	Bear	2	airport road	left towards the bush opposite side of dumas, Black bear
13-Jun-17	2:30	Fox	1	haul road by buttress	ran down towards buttress
23-Jun-17	13:00	Seagull	1	barge	seagull ate 5 ducklings
24-Jun-17	7:45	Bear	1	Dumas shop (behind)	Light brown, healthy (Black Bear)
25-Jun-17	19:30	Bear	1	Km 1.7	Young, tall/lanky very aggressive and predatory male.
25-Jun-17	11:00	Deer	1	crusher pad	walking around
25-Jun-17	7:58	Bear	1	km 1.7	
25-Jun-17	8:00	Porcupine	1	Dyno gate	
26-Jun-17	21:15	Deer	1	in camp	skittish
27-Jun-17	8:00	Fox	1	Km 10	Dark grey fox, with a rabbit in its mouth
27-Jun-17	16:00	Porcupine	1	SWD	
30-Jun-17	8:30	Bear	1	Portal Road	Beautiful cinnamon coloured, big black bear
30-Jun-17	8:35	Fox	1	Dumas shop (behind)	Dark grey fos with a mouse/rodent in its mouth
1-Jul-17	5:45	Deer	1	Offices	
1-Jul-17	9:00	Black Bear	1	km 1	Skinny
2-Jul-17	6:30	Fox	1	near A2 radar	
3-Jul-17	17:00	Deer	1	between mine tech office and warehouse	
4-Jul-17	13:20	Ravens	3	Warehouse Yard	3 Ravens were picking in the calcium chloride bag
6-Jul-17	15:00	Deer	1	between mine tech office and bunk house	Adult in healthy condition
7-Jul-17	11:00	Ravens	3	Warehouse Laydown	Resting and pecking at small calcium bags
8-Jul-17	15:45	Bear	2	KM9	Black bear
9-Jul-17	9:15	Bear	2	Access Road 7km	Sow & Cub, Black Bears
9-Jul-17	8:30	Bear	1	Access Road 15km	black bear
12-Jul-17	21:30	Bear	1	In front of camp, DSTF and Dumas	Large brown coloured black bear
12-Jul-17	21:30	Bear	1	In big field in back of camp	
19-Jul-17	9:15	Wolf	1	km 12	adult
20-Jul-17	8:45	Bear	1	Behind Selkirk Tower	black bear
21-Jul-17	2:00	Porcupine	1	by green tents	
21-Jul-17	2:30	Black Bear	1	km 7	
22-Jul-17	10:00	Black Bear	1	smoking area beside the rink	
22-Jul-17	13:30	Black Bear	2	river landing	healthy and young
22-Jul-17	10:00	Black Bear	3	Dumas Corner	mother and two cubs
22-Jul-17	10:30	Black Bear	1	near ice rink by camp	single small black bear
24-Jul-17	20:30	Bear	1	Trails above camp	Tall thin Black bear (young)
27-Jul-17	8:15	Bear	1	Access Road 18.75km	black bear
27-Jul-17	15:00	Frog	1	Tailings Pond	Body ~7cm long
28-Jul-17	6:30	Bear	1	Dumas shop (behind)	Black Bear
29-Jul-17	10:35	Bear	3	Landfill	Sow and 2 cubs (Black Bear)
29-Jul-17	11:00	Bear	1	Dumas shop (behind)	Black bear

Date	Time	Type of Animal	Number of Animals	Location	Description: Size/Color/Markings and Additional Notes
1-Aug-17	10:30	Bear	1	Corner between Driftwood and Airstrip	Smaller bear, possibly young, sandy coloured body with darker legs (Black Bear)
1-Aug-17	16:30	Bear	1	Main Waste Dump Expansion	black bear
1-Aug-17	10:50	Bear	1	Airstrip/WMA intersection	Healthy Condition. Cinnamon colour. Medium size
2-Aug-17	14:05	Bear	1	W33	Light body with dark legs (Black Bear)
4-Aug-17	8:00	Bear	1	Core Shack	Light body with dark legs (Black Bear)
4-Aug-17	16:00	Bear	1	Portal	no description provided
4-Aug-17	16:15	Black Bear	1	km 17	healthy and young
6-Aug-17	5:50	Fox	2	OB dump behind Pelly	red foxes
6-Aug-17	13:30	Deer	1	WMA	Small adult deer
12-Aug-17	18:35	Black Bear	2	Pelly laydown	Sow and cub
13-Aug-17	12:00	Bear	1	between 11 & 12 km	Black bear
13-Aug-17	13:45	Deer	1	WMA	small adult deer
14-Aug-17	24:00	Deer	1	WMA	Doe Deer. Eating not timid but alert
15-Aug-17	13:00	Bear	1	Airport	Black bear
19-Aug-17	10:30	Fox	1	Main Waste Dump east of Pelly	Friendly Red Fox
21-Aug-17	8:00	Bear	1	Dumas Corner	unknown
21-Aug-17	6:30	Fox	1	A253 Access road	
22-Aug-17	8:00	Bear	1	WMA	black throughout, 250-300lbs (Black Bear)
22-Aug-17	17:00	Bear	1	WMA	black throughout, 250-300lbs (Black Bear)
22-Aug-17	16:45	Bear	2	WMA	Black bears
23-Aug-17	15:00	Bear	1	STP	Black throughout (Black Bear)
23-Aug-17	17:25	Bear	1	STP/Camp	Dark brown with a light chest patch (Black Bear)
23-Aug-17	19:00	Bear	2	STP/Camp	Dark brown with a light chest patch (Black Bear)
24-Aug-17	18:45	Bear	1	behind camp (sherwood)	Large healthy black (Black Bear)
24-Aug-17	23:00	Bear	1	behind camp (sherwood), in camp by main parking (gym)	Large healthy black bear
25-Aug-17	18:45	Bear	2	Behind camp	2 black bears: 1 black in colour and one brown in colour
25-Aug-17	19:45	Bear	2	Behind camp	2 black bears: 1 black in colour and one brown in colour
25-Aug-17	20:30	Bear	1	In camp, by the ice rink	The brown coloured bear in the dynamic duo (black bear)
25-Aug-17	22:20	Bear	1	In camp by the bicycle shack	The brown coloured bear in the dynamic duo
25-Aug-17	6:45	Porcupine	1	Portal pad	"large for a porcupine"
25-Aug-17	13:00	Black Bear	1	Km 1.5 on the hill	large
26-Aug-17	0:00	Bear	1	In camp , by the STP road	Not clear which one as it was dark, but most likely one of our pair
26-Aug-17	0:25	Bear	1	By the Dumas shop	Black throughout (Black Bear)
26-Aug-17	6:45	Bear	1	STP/Selkirk towers	Large healthy black bear
26-Aug-17	7:30	Fox	1	Nuway corner where we store the drill	Red in colour, pretty srawny
26-Aug-17	9:30	Bear	2	At the underground fuel farm	Black sow, with a brown young cub
26-Aug-17	9:00	Black Bear	2	UG fuel tanks	one sow and one cub healthy and brown in colour
27-Aug-17	7:00	Fox	1		
28-Aug-17	10:30	Bear	1	Up the hill at KM1.5	All black
29-Aug-17	10:00	Bear	1	At the emergency pullout at KM9.5	All black
29-Aug-17	15:00	Bear	1	Up on the ridge behind camp	All Black
29-Aug-17	19:45	Bear	1	At the fuel farm	All black
30-Aug-17	8:30	Bear	1	Up on the ridge behind camp-behind the Selkirk Tower Corridor	Small (brown) black bear
1-Sep-17	17:00	Bear	1	Km 1.5 on the hill	Black
1-Sep-17	15:50	Bear	1	Site Service shop	Black bear
3-Sep-17	7:10	Fox	1	airport	healthy
20-Sep-17	12:15	Deers	2	On the walkway behind Mine Tech	Light brown, one doe and her offspring
20-Sep-17	11:45	Deer	2	Warehouse Laydown	Doe and Calf
21-Sep-17	12:40	Wolf	1	between 4 & 5km	Grey with some black, medium size

Date	Time	Type of Animal	Number of Animals	Location	Description: Size/Color/Markings and Additional Notes
21-Sep-17	14:00	Bear	1	Km 3 access road	Black bear
22-Sep-17	8:00	Bear	1	between 11 & 12 km	Black bear
23-Sep-17	8:00	Black Bear	1	Km 1	Large black
23-Sep-17	16:00	Fox	1	minto north road	
25-Sep-17	18:10	Deer	5	A2 ramp	mule
25-Sep-17	5:00	Wolves	2	haul road behind dumas	one grey, one black
26-Sep-17	9:20	Deer	1	Nuway	small, possibly female
26-Sep-17	10:30	Deer	1	nuway	young and skinny
28-Sep-17	4:45	Porcupine	1	In front of 840 dump	Porcupine colour
28-Sep-17	22:00	Wolf	1	Between Nuway and the Mill	Small, black
6-Oct-17	14:30	Wolf	1	KM 9 hill	Healthy
15-Oct-17	6:30	Wolf	1	Road to the green tents	Grey. Ran into the bush by the vent raise road
18-Oct-17	18:30	Fox	1	West wall above A2S3	moved away when the vehicle approached and parked in the area
22-Oct-17	12:15	Black Bear	1	Camp	Adult in healthy condition
22-Oct-17	12:20	Fox	1	Site Service shop	red fox
13-Nov-17	16:00	Fox	1	A2S4/MVF22 Intersection	Running back and forth across the road
23-Nov-17	14:00	Coyote	1	KM 10	running along road
14-Dec-17	13:15	Rabbit	1	Road to the mags	Carcass
31-Dec-17	14:15	Wolf	1	Fresh Tracks by W33	
31-Dec-17	7:50	Fox	1	Capstone East entrance	Red

Appendix Q – 2017 Update Minto Mine Constructed Wetland Treatment Research Program

Forward looking. Lateral thinking.

Minto Mine Constructed Wetland Treatment Research Program – Demonstration-Scale 2017

Document # 011_1117_10C

Prepared for:
Minto Explorations Ltd.
Capstone Mining Corp.
#13 Calcite Business Centre
151 Industrial Road
Whitehorse, Yukon
Y1A 2V3

Prepared by:
Contango Strategies Limited
104-411 Downey Road
Saskatoon, SK
S7N 4L8

Date: November 2017

Executive Summary

The Minto Mine is an open pit and subsurface copper mine located 240 km northwest of Whitehorse in the Yukon Territory. As a result of mining activities, cadmium, copper, molybdenum, selenium, and zinc are slightly elevated beyond background concentrations and have been identified as constituents of concern in the Reclamation and Closure Plan for the Minto Mine. As part of the Reclamation and Closure Plan, a constructed wetland treatment system (CWTS) was designed by Contango with the objective of attaining suitable passive treatment of water quality at mine closure.

A phased approach is being followed to guide the site-specific design and implementation of a constructed wetland treatment system at closure. The phased approach for Minto Mine was initiated with a site assessment in 2013 that identified plants suitable for a CWTS as well as natural treatment processes that were already occurring on-site. Following the site assessment, pilot-scale testing was undertaken to confirm and provide proof-of-concept before constructing the on-site demonstration-scale wetland.

The demonstration-scale constructed wetland treatment system was constructed at Minto in 2014 and commissioned from 2015 through mid-2017 during which time the system matured and operational adjustments were made. Commissioning successfully established plant and microbial populations and achieved conditions conducive for treatment of constituents of concern. The demonstration-scale CWTS operational period ran for a month from mid-August to mid-September 2017. Various aspects of the system were measured in 2017 and are detailed in this report including operating conditions, water treatment performance, fate and distribution of treated metals, evapotranspiration, detritus decomposition rates, microbial community characterization (catalyzing treatment reactions), and pest control.

Throughout the operational period, the demonstration-scale CWTS successfully achieved an average decrease in concentrations of 0.0169 µg/L for cadmium (from 0.0261 µg/L to 0.0092 µg/L), 31.8 µg/L for copper (from 49.1 µg/L to 17.3 µg/L), 3.6 µg/L for molybdenum (from 6.3 µg/L to 2.7 µg/L), 3.5 µg/L for selenium (from 4.0 µg/L to 0.5 µg/L), and 47.3 µg/L for zinc (from 49.2 µg/L to 1.9 µg/L). Leaching of copper and other constituents from the mineralized soils used in the construction decreased by the end of 2017 with constituents showing a shift into stable reduced mineral forms in the soil (as the CWTS was designed to do for constituents from the water, but also has now done for the elements in the soil). Additional positive results were also documented; plant uptake of constituents remained minimal throughout operation and high abundance of beneficial sulphide-producing bacteria for treatment of Cu, Cd, Zn, as well as nitrate- and selenium-treating bacteria associated with plant roots.

The operational period of the demonstration CWTS confirmed that the predicted water quality for the Minto Mine at closure is amenable to treatment by these methods. Results from ongoing monitoring of the system in future years will be used to optimize performance and inform the designs for the full-scale constructed wetland treatment system.

Table of Contents

List of Tables

List of Figures

List of Equations

List of Appendices

Abbreviations and definitions

Acid volatile sulphides (AVS) – Sulphide complexed with Fe (FeS) where the sulphide can preferentially exchange Fe for heavy metals (e.g., Ni, Zn, Cd, Pb, Cu, Hg) which are then more stably bound.

Amendment – A chemical or organic material added to encourage specific conditions (e.g., aerobic/anaerobic, pH, ORP) or as a source of something that is needed for passive treatment (e.g., nutrients, alkalinity, binding sites, etc).

Carbon source – A source of carbon (energy/electrons) for microbes (see electron donors). Examples include ethanol, methanol, acetate, sugar (glucose), molasses, wood chips, detritus (dead plant matter).

Carex aquatilis – A plant (emergent macrophyte) commonly known as water sedge.

Contango – Contango Strategies Ltd.

Constructed wetland treatment system (CWTS) – Wetlands that are designed and constructed to remove compounds from water, using natural processes to sequester them into the soils rendering them less bioavailable. They are different from wetlands that provide habitat for wildlife.

Constituent of Concern (COC) – Specific elements that have been identified for evaluation, including cadmium, copper, molybdenum, selenium, and zinc.

Denitrification – Where nitrate (NO_3^-) is reduced by microorganisms to form nitrite (NO_2^-), nitric oxide (NO), or nitrous oxide (N_2O), or nitrogen gas (N_2) (see nitrate reduction).

Dissolved oxygen (DO) – Diatomic oxygen (O_2) dissolved in water; oxygen can dissolve in water by diffusion from surrounding air, as a product of photosynthesis, or through forced aeration.

Electron donor(s) – A chemical compound that donates electrons to another compound (see carbon source). An electron donor is a reducing agent, which that by virtue of it donating electrons, is itself oxidized (see oxidation and reduction).

Explanatory parameters – Quantifiable parameters that indicate the type of water treatment reactions that are likely to take place (i.e., dissolved oxygen, pH, soil redox).

Evapotranspiration – The combined effects of open water evaporation and plant transpiration (Beebe *et al*, 2014).

Genetic analysis – Analysis to assess the presence, identity, and diversity of different microbes in a sample.

ICP-MS – Inductively coupled plasma mass spectrometry.

Macrophytes – An aquatic plant, large enough to be seen by eye. Can be emergent, submergent, or floating.

Microbes – Microscopic organisms that can be uni- or multi-cellular. This includes algae, bacteria, fungi, viruses, and yeast.

Most probable number (MPN) – A statistical value representing the viable population of microbes in a sample through use of dilution and multiple inoculations.

Oxidation – The loss of electrons, or increase in valence state, by a molecule, atom, or ion. Can be driven by microbes. Process is complementary to chemical reduction.

Oxidation-reduction potential (ORP) – A measure of the tendency of a chemical species to acquire or donate electrons, thus becoming reduced or oxidized, respectively, measured in millivolts.

Passive or semi-passive treatment system(s) (PTS) – General term used to refer to both passive and semi-passive treatment systems that use processes coupling transformations (e.g., chemical and biogeochemical reactions) with physical transfers (e.g., sorption, filtration) to remove constituents from water, often operationally passive with little long-term management required.

Redox – Oxidation-reduction potential (in sediment), a measure of the tendency of a chemical species acquire or donate electrons, thus becoming reduced or oxidized, measured in millivolts. This measurement is relative to the water ORP.

Reduction – The gain of electrons, or a decrease in valence state, by a molecule, atom, or ion. Can be catalyzed by microbes. Process is complementary to chemical oxidation.

Simultaneously extracted metals (SEM) – Amounts of heavy metals such as Ni, Zn, Cd, Pb, Cu, Hg in sediment, assessed in the context of AVS for excess sulphide. (also see acid volatile sulphide)

Sorption – The physical and/or chemical process by which one substance becomes attached to another substance.

Specific conductivity (SPC) – A measurement of electrical conductivity in water that is typically expressed in µs/cm, which has been adjusted for temperature (25°C).

Species (sp.) – One of the basic units of biological classification and a taxonomic rank. Rank in the classification of organisms below genus and above strain. Also can be used to refer to the oxidation state of a mineral (e.g., selenate and selenite are species of selenium).

SPLP – Synthetic precipitation leachate procedure.

Sulphide – An inorganic anion of sulphur that can form stable complexes with metals and make them insoluble in water (remove them from the water).

Sulphide producing bacteria (SPB) – Microbial reduction of sulphur compounds, such as sulphate, sulphite, thiosulphate, and sulphur, which produces sulphides and alkalinity. (see also SRB).

Sulphate reducing bacteria (SRB) – A form of sulphide producing bacteria that specifically uses sulphate for reduction (see sulphide producing bacteria).

Sulphide production – Microbial reduction of sulphur compounds, such as sulphate, sulphite, thiosulphate, and sulphur, which produces sulphides and alkalinity.

Thermodynamic minimum – The minimum concentration of a contaminant of concern that is consistently achievable.

Total dissolved solids (TDS) – A measure of the combined organic and inorganic salts dissolved in water.

Total organic carbon (TOC) – A measurement of the total organic carbons present in water.

Transfer – Processes that treat water by transferring a constituent to another location without changing its form. For example: absorption, adsorption, dilution, dispersion, filtration, precipitation (aqueous to solid), and volatilization.

Transform – Processes that change the chemical form or state of a constituent. For example: biodegradation, biotransformation, hydrolysis, ionization, oxidation, photolysis, and reduction.

1. Introduction

The Minto Mine, owned and operated by Capstone Mining Corp., is located 240 km northwest of Whitehorse on the west side of the Yukon River. The Minto property lies within the eastern part of the Dawson Range, with elevations from 700 to 1,000 m above mean sea level. The landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed.

The Minto Mine has been in commercial operation since October 2007 and the deposits being mined are copper sulphide mineralized zones. Surface and groundwater water quality is a key consideration in the evaluation of potential effects of mining and mineral development projects and changes to water quality parameters have the potential to affect aquatic and human use of water resources. A Reclamation and Closure Plan (RCP) is required under both the Water License and the Quartz Mining License. The RCP is intended to address the long-term physical and chemical stability of the site and closure of the proposed features and disturbances associated with the mine. As a part of the RCP, a Constructed Wetland Treatment System (CWTS) is being designed, evaluated, and optimized for water treatment at closure through a phased program approved during the Minto Phase V/VI Expansion Project (Yukon Online Registry Project Number 2013-0100). Constituents of concern that are being evaluated through the CWTS program include cadmium, copper, molybdenum, selenium, and zinc.

1.1. Purpose and Objectives

The primary objective for operation of the demonstration-scale CWTS in 2017 was to complete commissioning and progress into operational performance. Once operational performance is achieved, the removal rate coefficients (RRC; *k*) can be assessed to evaluate and refine full-scale designs. To achieve the operational performance, it was recognized that the remaining copper in the soils used in construction needed to be converted into metal-sulphide form; therefore, this was addressed in the early months of 2017 and paired with evapotranspiration trials to make best use of this time.

In 2017, the monitoring program shifted focus from commissioning to testing of operational performance. Activities carried out in 2017 to achieve these objectives were:

- Monitor explanatory parameters and performance to determine when commissioning is complete and the operational period has begun;
- Assess removal of constituents from the water;
- Determine the hydraulic retention time (HRT) by tracer trial and associated correction factor to apply to the nominal (calculated) HRT;
- Evaluate CWTS performance, and determine achievable concentrations of contaminants of concern (thermodynamic minimums);
- Update site-specific removal rate coefficients (from commissioning period) with data from operational period;
- Determine amount of water loss due to evapotranspiration and effect on outflow concentrations;
- Monitor metals leaching from mineralized soils used in construction;

- Assess stability of constituents of concern in soils;
- Determine the rate and extent of detritus decomposition (*C. aquatilis* leaves) in the CWTS over time;
- Assess treatment mechanisms (including microbes); and
- Determine an appropriate method for insect pest control (aphids) in the CWTS.

1.2. Overall CWTS Project Approach

For a CWTS to be effective, it must be designed, piloted (tested), optimized, implemented, and maintained in a site-specific manner. A phased approach allows for improvements and optimization at each step. The phases used at the Minto Mine include:

1) site assessment and information gathering;
2) technology selection and conceptual design;
3) pilot-scale testing and optimization (controlled environment, off-site);
4) demonstration-scale confirmation and optimization (on-site); and
5) full-scale implementation.

Phases 1 to 3 are complete at Minto. This work is summarized in the Research Program, Pilot Plant and Demonstration reports completed by Contango (2014a and 2014b). Phase 4 of the project is underway, with the on-site demonstration CWTS constructed at the Minto Mine during fall 2014 (Contango, 2015). Commissioning of the CWTS occurred from 2015-2017 with operations beginning in late 2017. Performance results of the demonstration CWTS indicate that the CWTS is maturing as expected (Contango, 2015; 2016; 2017). This document reports on the 2017 on site demonstration-scale CWTS data, with focus on results from the operational period from August 18 – September 22, 2017.

2. Demonstration-Scale Constructed Wetland Treatment System Design

2.1. CWTS Layout and Dimensions

The demonstration-scale CWTS is located on the northeast side of the mine site, perched on the MVFE area as shown in Figure 1.

Construction of the demonstration-scale CWTS was completed in 2014 and includes two series in parallel with two cells in each series and a final catchment basin (Figure 1). Water flows from the feed tank through the A cells, through the B cells and into the final combined catchment basin. Water from the catchment basin of the demonstration-scale CWTS is not discharged off-site, rather it is collected in a sump at the toe of the Mill Valley Fill Extension (MVFE). Series 1 and series 2 flow independently of each other and are intended as replicates for analytical testing and operation confirmation. Additional details can be found in the Minto Demonstration-Scale Report (Contango, 2015) and Appendix A of this report.

Figure 1 – Picture of demonstration-scale CWTS at Minto Mine.
Demonstration-scale CWTS location in relation to its surroundings. To the far right is the mine camp while below is the tree line. This photo was taken on September 24, 2017.

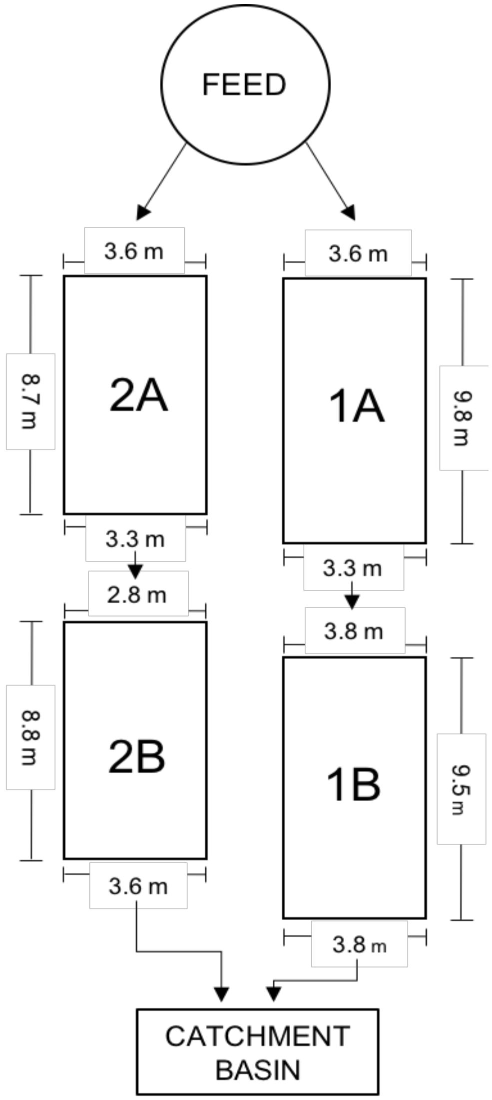


Figure 2 – Diagram of demonstration-scale CWTS.
Dimension measurements are indicated at soil surface. Water flows are indicated with black arrows. Water flows from the feed tank into the A cells, into the B cells then into the final catchment basin. Series 1 and series 2 flow independently of each other, and serve as replicates.

2.2. Soils

Soils used to construct the CWTS are described in Appendix A of this report and in the initial report that outlines construction (Contango, 2015). In brief, the recommended soil for the CWTS was sand, with 2-7% by volume organic material (e.g., woodchips, peat). The material used in the construction of the demonstration-scale CWTS was an organic peat, and analyses received after construction indicated an elevated concentration of leachable copper (Appendix A, Table A2). This leachable copper has affected the CWTS performance results. Therefore, this has been a focus of efforts through the commissioning period to transition these leachable copper minerals into stable sulphide minerals which will not leach from the CWTS.

2.3. Vegetation

The demonstration-scale CWTS was planted with *Carex aquatilis* (aquatic sedge) and aquatic mosses (bryophytes) from the W10 area of the Minto Site. The plant selection and borrow source were identified during the site assessment in 2014 (Contango, 2014a) and pilot-scale testing (Contango, 2014b).

2.4. Water Source

The water source for the demonstration-scale CWTS is seepage from the toe of the Mill Valley Fill Extension (MVFE) and was selected for the demonstration-scale CWTS as the seepage is similar to that expected upon closure in the MVFE area. Zinc concentrations were elevated in the water being used in the CWTS in 2016, and it was uncertain if this was due to a culvert used for water collection in the area or seasonal variation. However, zinc concentrations remained elevated in 2017, suggesting that the culvert is contributing to elevated zinc concentrations. Further details can be found in Appendix A and Contango’s 2016 update report (Contango, 2017).

3. Commissioning and Operations

The period between the construction of the CWTS and achieving the expected treatment performance is referred to as the commissioning period. During this period, several criteria are monitored to determine when the commissioning period has been successfully completed. Criteria that were achieved that indicated the end of the commissioning period and the beginning of the operational period for the Minto Mine demonstration-scale CWTS include the following and are further discussed in the sections listed:

- Plant establishment and maturation such that the plants have grown in to densities visually similar to natural wetlands in the area, but in monoculture (Section 3.2),
- Establishment of reducing conditions within the CWTS (i.e., average soil redox was below -100 mV consistently in 2017; Section 5.1),
- No increase in aqueous copper concentrations through the CWTS (due to copper containing soils used in construction; Sections 5.2.1 and 5.6), and
- Microbial population establishment and maturation to levels similar or better to pilot-scale (Section 5.9).

Once the above criteria were met, the CWTS was deemed to be in the operational period. The same criteria, other than the copper leaching, could be used for the full-scale CWTS. The on-site demonstration-scale CWTS was commissioned from 2015 to 2017, comprising of 135 days in 2015, 150 days in 2016 and 82 days in 2017 (Table 1). The CWTS then proceeded to the operational period and operated for 35 days in 2017 (Table 1).

Table 1 – Days of operation of demonstration-scale CWTS.

Scale	Year	Period (days)	Date	
			Start	End
Commissioning-A[2]	2014[1]	23	Aug 27	Sept 19
	2015	135	May 16	Sept 29
	2016	87	May 2	Jul 28
Commissioning-B[3]	2016	63	Jul 29	Sept 30
	2017	82	May 27	Aug 17
Operational Period	2017	35	Aug 18	Sept 22

[1] The CWTS was constructed in 2014, but no water testing occurred during this first month of commissioning-A.
[2] The end of the commissioning-A period and the beginning of the commissioning-B period was marked by the addition of organics on July 28, 2016.
[3] The end of the commissioning-B period and the beginning of the operational period was marked by stabilization of flow rates and resolution of feed water delivery complications.

For the demonstration-scale CWTS the commissioning period was divided into two periods, commissioning-A, and commissioning-B. The end of the commissioning-A period and the beginning of the commissioning-B period was marked by the addition of organics on July 28, 2016. These organics (straw and wood chips) were added to further aid the copper in the soils to transition into sulphide mineral forms, and represents an amount of organic material similar to what would be produced by the CWTS once fully established with *Carex aquatilis*.

The end of the commissioning-B period was expected to be between July 16 and August 2, 2017. However, due to issues with feed-water pumps and flow meters, the end of the commissioning-B period was extended to August 17, 2017 and was marked by stabilization of flow rates and resolution of feed water delivery complications. Additionally, sandbags were added at the end of each cell on August 11, 2017 to increase the water depth and further promote reducing conditions. Therefore, the operational period began on August 18, 2017 and ran until September 22, 2017. Flow was turned off to prepare for winter freeze-up on September 30, 2017, and the last sampling date used was September 22, 2017. Discussions in this document are focused on the operational period and further details on commissioning in 2015 and 2016 can be found in Contango's past reports (2015 and 2016).

3.1. Flow Rates

The targeted flow rates were varied during commissioning of the demonstration-scale CWTS to target desirable conditions for establishment of the CWTS. Since the cells in series 2 are smaller than cells in series 1, a faster flow rate is used for series 2 to obtain an equal HRT to series 1.

In 2017, a long HRT was selected to aid in generating reducing conditions in the CWTS and, therefore, flow rates were set to as slow as they could operate. The nominal HRT was targeted to be 5 days. The operational ranges of the flow meters used in the CWTS were 0.3 to 3 gallons per minute (GPM). To obtain this long HRT, the targeted flow rates used during the commissioning and operational periods of the CWTS in 2017 were 0.37 and 0.31 GPM for series 1 and series 2, respectively. Due to pump and flow meter issues, the actual flow rates varied from the target flow rates throughout 2017 commissioning and operational periods. Table 2 summarizes known pump and flow meter issues that occurred in 2017. The average flow rate for the 2017 operational period was a calculated flow rate of 0.38 GPM and 0.29 GPM for series 1 and series 2, respectively. Additional information on flow rates and associated HRT calculations are provided in Appendix A.

3.2. Health and Establishment of CWTS Vegetation

3.2.1. *Carex aquatilis*

During the commissioning period, plants establish and mature, with density expected to increase over time. From planting in 2014 to the last site visit in 2017 *C. aquatilis* thrived in the CWTS creating a dense emergent macrophyte monoculture, supplemented with aquatic mosses (Figure 3). This suggests that *C. aquatilis* are very robust and reaffirms that they are a good candidate for use in the full-scale CWTS at Minto. In July 2017, an aphid infestation occurred in the CWTS which affected the *C. aquatilis*. The biomass above water appeared to partially die off, however the plants continued to send out new shoots suggesting the *C. aquatilis* were resilient to the infestation. Further discussion about the aphids and the control measures in 2017 is presented in Section 6.

3.2.2. Moss

Aquatic mosses have continued to mature and expand in size from 2014 through 2017. The mature mosses are beginning to show characteristics of the desired coupled transfer (sorption, filtration) and transformation (mineralization, reduction) processes. The top of the moss is growing and producing new green biomass that provides transfer sites, and the older, bottom of the moss is turning black and beginning to decompose which creates sulphide reducing zones that allow for transformation (Figure 4 and Figure 5).

Figure 3 – Maturation of the CWTS from construction through operations.
2015 pictures show cell 2A.

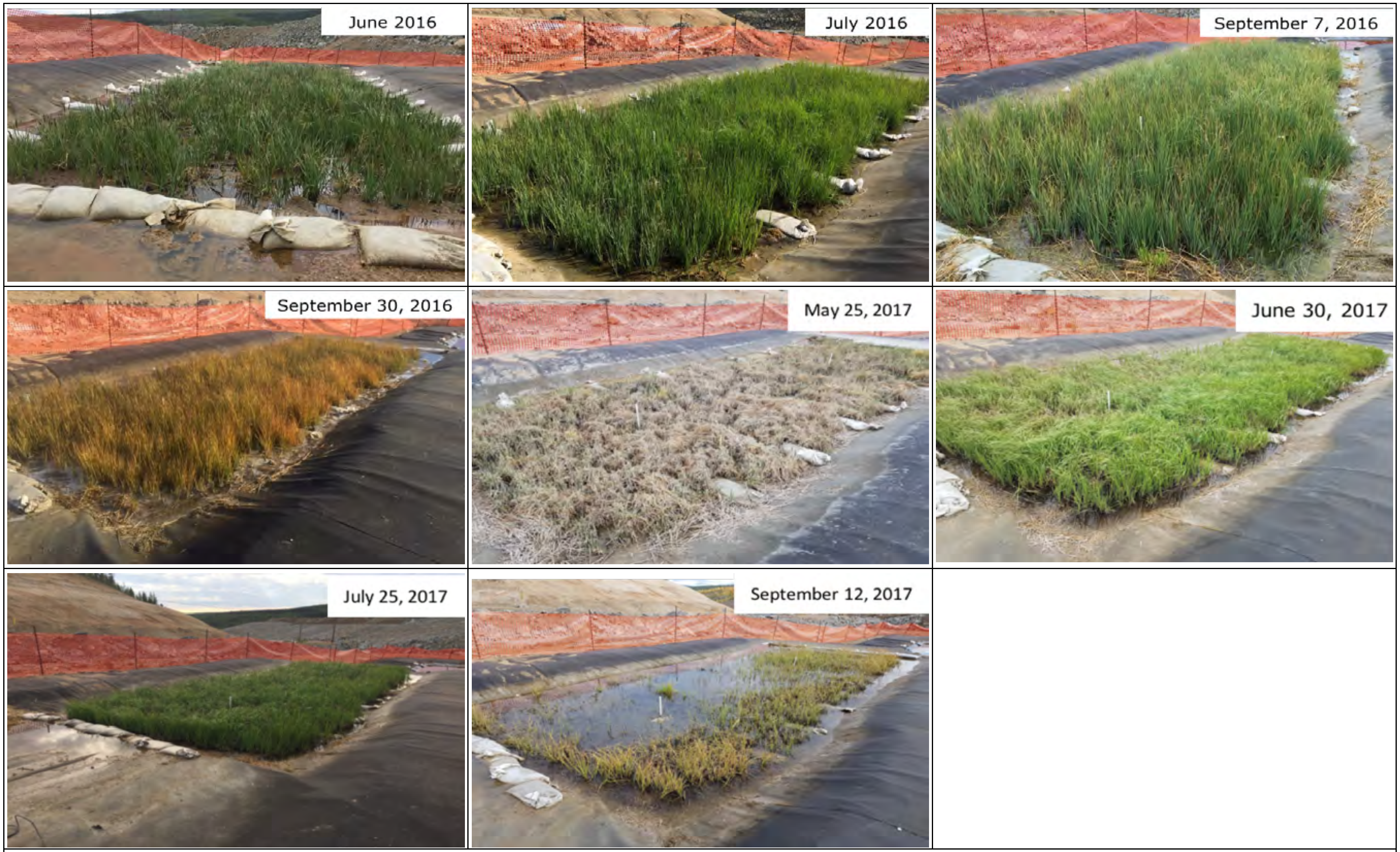


Figure 3 continued – Maturation of the CWTS from construction through operations.
2016 and 2017 pictures show cell 1B. September 12, 2017 shows increased yellowing and die off in cell 1B due to aphid infestation.

Figure 4 – Moss maturation in CWTS through 2016.

Figure 5 – Moss top and bottom view in June 2016 and September 2017.

4. Timeline and Sampling Schedule

Major events and operational adjustments or amendments for 2017 are listed in Table 2. Details for events up to 2017 can be found in the Minto Demonstration-scale 2016 Update Report (Contango, 2017). The actual dates as well as effective days of operation are provided, which adjusts for time that the CWTS was not receiving water when it was frozen. The effective days of operation allows for comparison to expected timelines from the pilot-scale testing, and for planning and scheduling to be done for full-scale construction and commissioning. The sampling schedule for 2017 was conceptually developed prior to beginning construction of the demonstration-scale CWTS (Appendix A). Actual dates of sampling were adjusted for timing of spring thaw and winter freeze-up, and the associated ability to have the pumps operating at the W62 sump to supply water to the demonstration-scale CWTS.

Table 2 – Events and sampling activities since construction.

Event	Key Activity	Flow Rate Setting m^3/day (gal/min)		Dates	Effective Days of Operation
		CWTS Series 1	CWTS Series 2		
CWTS constructed and planted	First sampling, water started.	*	*	August 27 – 31, 2014	0-4
Freeze up for winter	Feed water pumps turned off.	*	*	September 19, 2014	23
Winter 2014/2015					
Commissioning-A[2]				May 16 – September 29, 2015	136
Winter 2015/2016					
Commissioning-A[2]				May 2 – July 27, 2016	86
Commissioning-B[2]				July 28 – September 30, 2016	64
Winter 2016/2017					
Flow started	Flow started.	2.18 (0.40)	1.85 (0.34)	May 27, 2017	312
Evaporation Study	Flow stopped.	-	-	June 8, 2017	324
End of Evaporation Study	Flow re-started.	4.80 (0.88)	4.58 (0.84)	June 15, 2017	331
Flush CWTS	Flow increased.	5.07 (0.93)	4.20 (0.77)	June 15 – 19, 2017	331-335
Contango Site Visit #7 (Spring Sampling)	Microbiology, soils, and water tested.	2.07 (0.38)	1.42 (0.26)	June 20-22, 2017	336-338
	Detritus decomposition trial started.			June 21, 2017	337
Saline Tracer Study	Salt added to cells for tracer study.	1.74 (0.32)	0.55 (0.10)	June 21 – July 2, 2017	337-348
Flow interruptions	Flow rates increased causing feed tank to collapse, and flow stoppage.	*	*	July 16, 2017	362
Contango Site Visit #8 (Summer Sampling)	Microbiology and soils tested. Detritus bags collected.[3]	*	*	July 25 – 26, 2017	371-372
Flow interruptions	Pump issues. Repairs required and new totalizer installed on CWTS 1.	*	*	July 25 - August 16, 2017[1]	371-393
Sprayed for aphids	Insecticide applied 7 times to CWTS.	N/A	N/A	July 25 – September 13, 2017	371-421
Water level raised	Sand bags were added to the ends of each cell.	*	*	August 11, 2017	388
Beginning of operational period				August 18, 2017	395
Summer Water Sampling	Not completed during Contango Site Visit #8 due to flow interruptions.	2.40 (0.44)	1.64 (0.30)		
Fall Sampling	Completed by Minto. Microbiology, soils, water, and plants tested. Detritus bags collected.	2.02 (0.37)	1.42 (0.26)	September 11, 2017	419
Freeze up for winter	Flow stopped.	-	-	September 30, 2017	438

* This indicates no flow rate was given, flow rate was unmeasurable or variable; however, cells remained flooded throughout.

[1] Resolution of the flow interruptions marked the end of commissioning-B and the beginning of the operational period.

[2] Detailed information for Commissioning-A and Commissioning-B in 2015 and 2016 can be found in the Minto Demonstration-Scale 2016 Update Report (Contango, 2017).

[3] Due to flow interruptions during the Contango site visit, the summer seasonal water sampling occurred on August 18, 2017 when flows had re-started.

5. Performance

5.1. Monitoring Explanatory Parameters

The following are key findings regarding explanatory parameters, which are detailed further below:

- Dissolved oxygen (DO) decreased from an average of 8.4 mg/L during commissioning-B in 2016, to an average of 5.3 mg/L during operations in 2017. This elevated DO in the water column is likely the result of photosynthesis of algae and mosses. Despite this DO level in the water column being in oxidizing ranges, stable reducing conditions were achieved in CWTS soils within the targeted soil redox range (-100 to -250 mV).

Average water temperature of the demonstration-scale CWTS in 2017 were similar to those in 2015 (12.9°C) and 2016 (10.2°C). The average water temperature during the operational period in 2017 was 9.7°C, ranging from 5.3°C to 14.9°C. As expected, conductivity did not change from previous years and pH remained circumneutral.

DO concentrations in the CWTS cells were on average 5.3 mg/L, which is lower than commissioning-A and slightly higher than commissioning–B (Table 3). Reducing conditions are needed for nitrate and selenium treatment processes, and for creating metal sulphides that remove copper and cadmium from the water. Water oxidation-reduction potential (ORP) also decreased compared to 2016 by 73 mV, which is also indicative of reducing conditions in the CWTS.

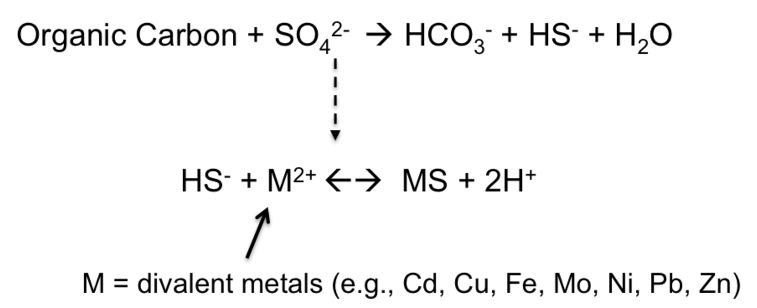
Table 3 – Average in situ measurements from the pilot scale and demonstration-scale CWTS.

Testing Period		DO (mg/L)	Conductivity (µS/cm)	pH	ORP (mV)	Soil redox (mV)
Demonstration-scale 2015		10.0	817.9	8.11	147.9	-52
Demonstration-scale 2016	Commissioning-A[1]	15.9	890.9	7.79	143.7	-85
	Commissioning-B[2]	8.4	1020	7.59	157.6	-89
Demonstration-scale 2017	Commissioning-B[3]	4.3	795.9	7.43	18.7	-162
	Operational period[4]	5.3	879.7	7.36	124.9	-152

[1] Data for commissioning-A period is from May 2-July 28, 2016.
[2] Data for commissioning-B period is from July 29-September 30, 2016.
[3] Data for commissioning-B period is from May 27-August 17, 2017.
[4] Data for operational period is from August 18-September 22, 2017.

A key explanatory parameter used to monitor maturation of the CWTS during the commissioning period is the soil redox potential, which is measured using platinum tip probes (in soil) and Calomel electrodes (in water). This measurement offers insight into the direction of electron flux between the sediment/soil/pore water and overlying water column (Faulkner et al., 1989; Huddleston & Rodgers, 2008), and can be used to confirm reducing conditions in the soil. Based on the information gathered in pilot-scale testing, the targeted soil redox for the demonstration-scale CWTS is between -100 and -250 mV. In these redox ranges, bacterial sulphide-production through reduction of sulphur compounds (e.g., sulphate) is expected. Sulphide production directly results in metals and metalloid treatment for constituents such as cadmium, copper, molybdenum, nickel, lead, and zinc by precipitation as metal sulphides (Figure 6).

This maturation period is necessary for sufficient quantities of microbes to populate the CWTS and become active in decomposing organic material. It is the electrons produced by the decomposition of organic material that is reported by the soil redox measurements. The decomposition of organic material then feeds the sulphate-reducing bacteria the type of energy they need to produce the sulphides that remove the copper, cadmium, molybdenum, and zinc from the water. The microbial activity of the CWTS is discussed further in Section 5.3.2.



$$\text{Organic Carbon} + SO_4^{2-} \rightarrow HCO_3^- + HS^- + H_2O$$

$$HS^- + M^{2+} \leftrightarrow MS + 2H^+$$

M = divalent metals (e.g., Cd, Cu, Fe, Mo, Ni, Pb, Zn)

Figure 6 – Example equation of sulphate reduction and resultant metals mineralization and treatment.

Equation is not balanced; demonstrates sulphate reduction with creation of alkalinity and sulphides, which can then form metal sulphide complexes.

As expected from the pilot-scale testing, the soil redox in all the demonstration-scale CWTS cells has decreased and stabilized over time, indicating maturation of the CWTS (Figure 7). At the end of 2016, the demonstration-scale CWTS had begun achieving soil redox values that are conducive to sulphide production due to the decomposition of the organics that were added on July 28, 2016 (Contango, 2017). By the end of 2017, soil redox values had decreased to within the targeted range, even without additional organics added to the CWTS. It is therefore evident that the commissioning period was successful and the CWTS has matured and become self-sufficient in producing organic matter to provide electrons to generate reducing conditions upon decomposition. Soil redox will continue to be monitored throughout operation in 2018.

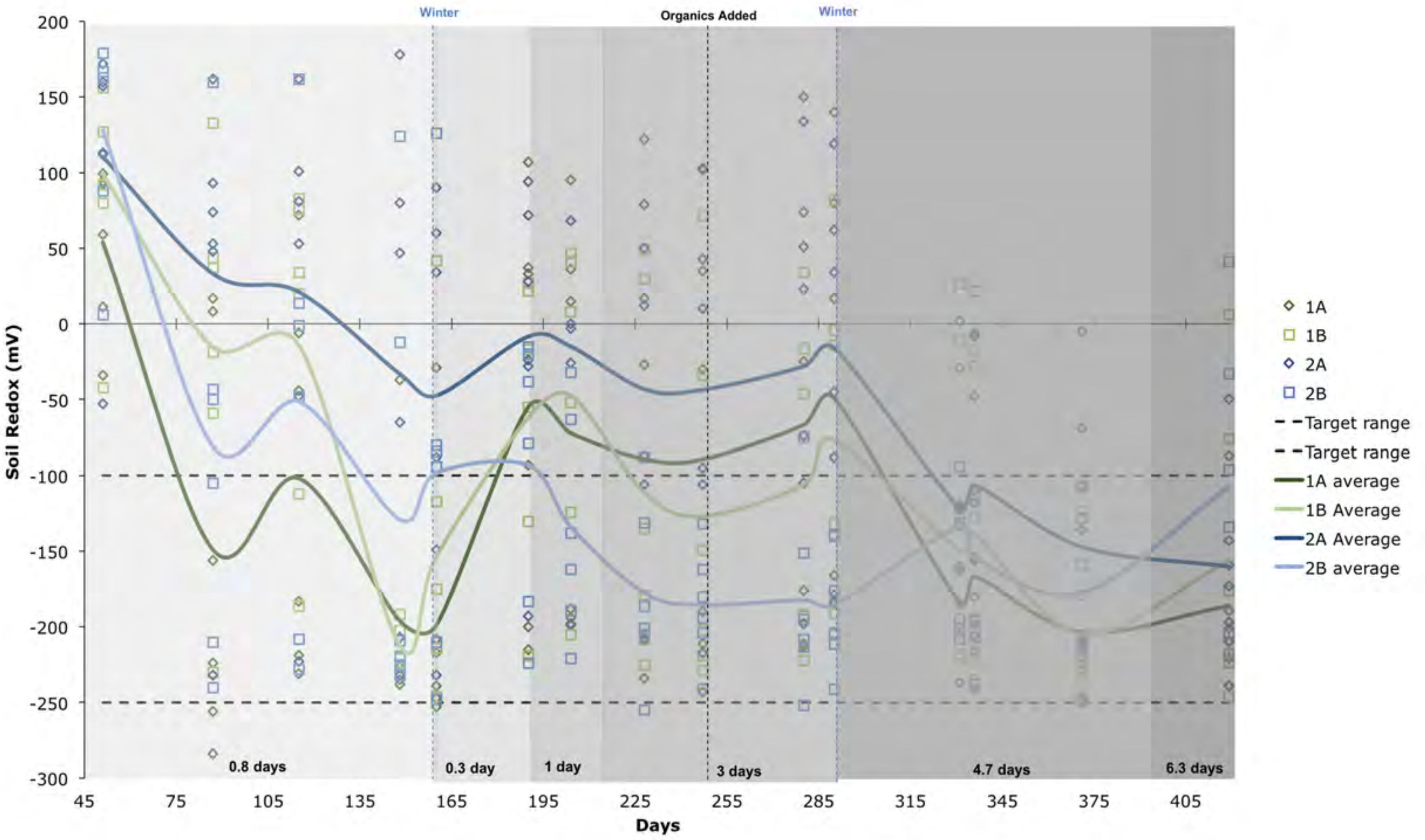


Figure 7 – Soil redox potential of each CWTS cell over time.
All demonstration-scale CWTS soil redox measurements are plotted. Targeted soil redox values based on pilot-scale testing are indicated with dotted lines. The blue dotted line indicates break in measurements for winter 2015 and 2016. Days and associated grey shading in 2015 and 2016 indicate the nominal HRT. Days and associated grey shading in 2017 indicate the actual HRT (average of series 1 and 2) using recorded water depths and flow rates during those time periods.

5.2. Water

The following are key findings regarding constituents in the water, which are detailed further below:

- Copper treatment in the CWTS was masked by leaching from the soils used in construction of the CWTS into the water, but this has mostly been remedied now by the wetland treating this copper and turning it into more stable sulphide forms in the soil.
- During the operational period the demonstration-scale CWTS successfully achieved an average decrease in concentrations of 0.0169 µg/L for cadmium (from 0.0261 µg/L to 0.0092 µg/L), 31.8 µg/L for copper (from 49.1 µg/L to 17.3 µg/L), 3.6 µg/L for molybdenum (from 6.3 µg/L to 2.7 µg/L), 3.5 µg/L for selenium (from 4.0 µg/L to 0.5 µg/L), and 47.3 µg/L for zinc (from 49.2 µg/L to 1.9 µg/L).
- Molybdenum and selenium treatment in the operational period is notable as the removal rates were negligible within the margins of error of the testing method in the commissioning-A period.

5.2.1. Metal Leaching from Soils into Overlaying Water

Although treatment improved through commissioning as the CWTS matured, copper and aluminum leaching from the soils into the overlaying water, masking the effects of treatment (Contango, 2017). Therefore, additional sampling was performed through the CWTS to identify these fluctuations. Details of the sampling methods can be found in Appendix A of this document and Figure A4 in Appendix A shows the sampling locations in series 2 of the demonstration-scale CWTS. Graphs showing concentrations of copper and selenium throughout the CWTS are presented below (Figure 8 and Figure 9, respectively) while graphs for the remaining constituents can be found in Appendix B (Figures B1 to B4).

Since the beginning of operations of the demonstration-scale CWTS, significant concentrations of copper have been leaching from the CWTS soils used in construction (Contango, 2016 and 2017; Section 5.6). Moreover, aluminum (which could not be accounted for by the influent water chemistry) was elevated in the CWTS. Because of metals leaching from the soils, the treatment occurring within the CWTS was far greater than what was being observed by simply measuring the inflow and outflow points (Contango, 2017). These soils first needed to be treated, before significant treatment could occur for the influent waters.

In early 2017 (June 20, 2017 sampling date), copper was still leaching from the soils into the water (Figure 8). However, at later sampling dates in 2017 copper was no longer leaching at a rate that the treatment wetland could not keep up with for treatment. Copper concentrations decreased by the end of the A cells and stabilized through B cells, indicating that treatment of copper is occurring and that copper leaching from the soils has subsided. Leaching of constituents from the soils is further described in Section 5.6.

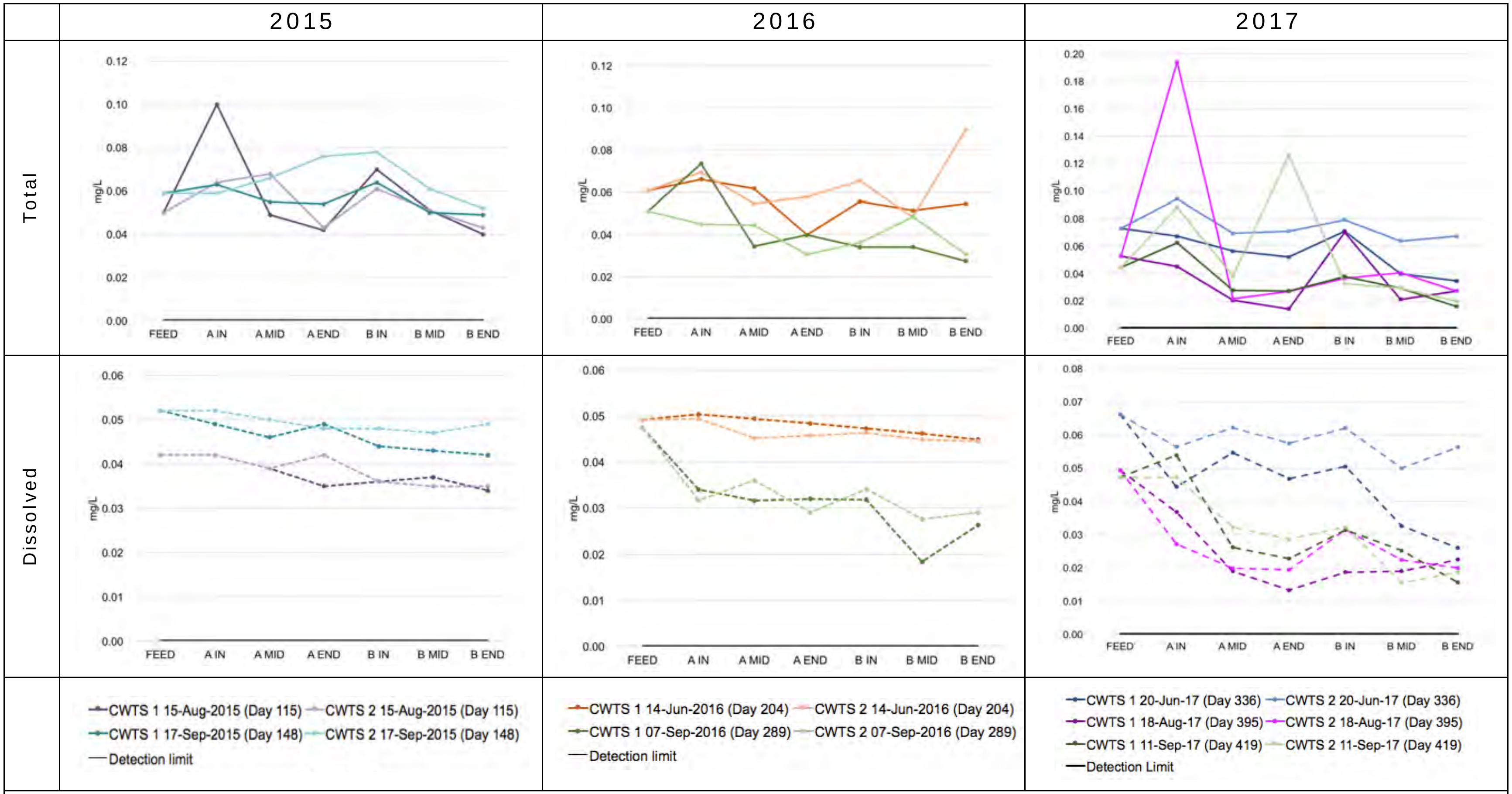


Figure 8 – Copper concentrations through the CWTS.
2015 (left), 2016 (middle), and 2017 (right) total (top) and dissolved (bottom) copper concentrations. Data shown for seven timepoints, where water was sampled at 7 locations through the flow path of the CWTS to assess for treatment fronts within the CWTS, or possible leaching of constituents from the soils into the CWTS. The Maxxam (2015 results) detection limit (DL; black line) for copper is 0.0002 mg/L. The ALS (2016 and 2017 results) DL for copper is 0.0005 mg/L. Spikes in copper concentrations were observed in early sampling points in the CWTS indicating leaching from the soils is occurring; however, later sampling points do not show any copper spikes and, therefore, leaching has subsided. The 2017 graphs are on different y-axes than previous graphs due to one data point from 18-Aug-17 for total copper and two data points from 20-Jun-17 for dissolved copper that are higher than previous axes.

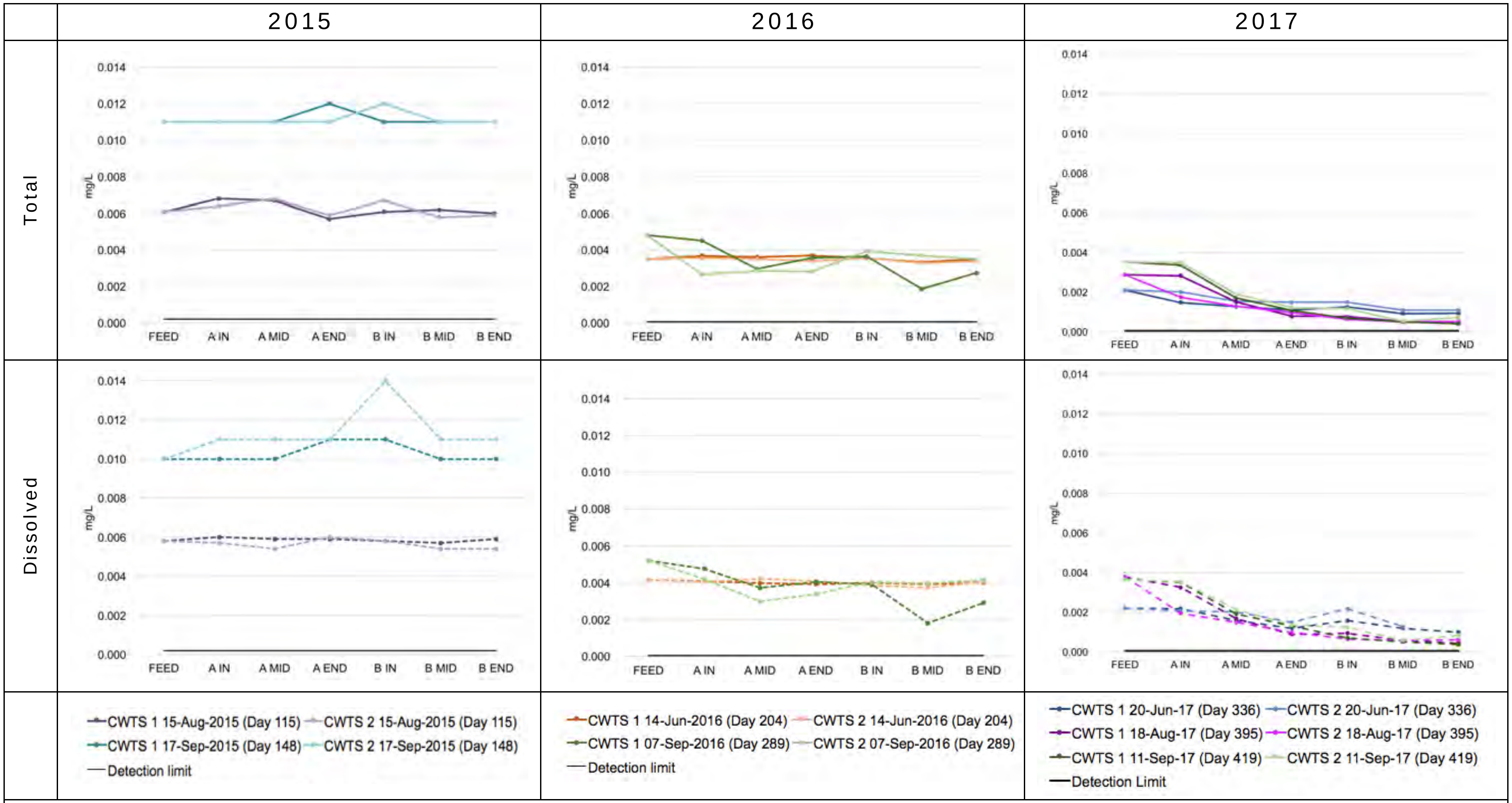


Figure 9 – Selenium concentrations through the CWTS.
2015 (left), 2016 (middle), and 2017 (right) total (top) and dissolved (bottom) copper concentrations. Data shown for seven timepoints, where water was sampled at 7 locations through the flow path of the CWTS to assess for treatment fronts within the CWTS, or possible leaching of constituents from the soils into the CWTS. Y-axes are set to be the same for total and dissolved. The Maxxam (2015 results) detection limit (DL; black line) for selenium is 0.0002 mg/L. The ALS (2016 and 2017 results) DL is 0.000050 mg/L. This graph indicates that leaching is not occurring as there are no spikes in selenium concentrations throughout the CWTS.

5.2.2. *Performance during Commissioning-A*

The commissioning-A period occurred from May 16 to September 29 in 2015 and May 2 to July 28 in 2016. Details regarding the results of the commissioning-A period can be found in Demonstration-Scale 2016 Update Report (Contango, 2017).

5.2.3. *Performance during Commissioning-B*

The beginning of commissioning-B was marked by the addition of organics to the CWTS and ran from July 29 to September 30 in 2016 and from May 27 to August 17 in 2017. These organics (straw and wood chips) were added to further aid the copper in the soils to transition into sulphide mineral forms, and represents an amount of organic material similar to what would be produced by the CWTS once fully established with *Carex*. Treatment of constituents was similar through 2016 and 2017 for commissioning-B. An evapotranspiration trial was also completed during commissioning-B to allow water to stagnate and provide time for copper in the soils to convert to sulphide mineral forms more readily.

5.2.4. *Performance during Operations*

Figures showing performance of the demonstration-scale CWTS in 2017 (commissioning-B and operational period) can be found in Appendix B (Figures B5 to B12). In the operational period from August 18 to September 22, 2017, dissolved cadmium, copper, selenium, and zinc treatment improved from the 2017 commissioning-B period. Dissolved metals concentrations were used for the discussion in this report instead of total metals concentrations, as total values were highly variable and not representative of the metals concentrations in the CWTS. The variability of the total metals concentrations is likely owing to particulate material containing metals being part of the grab sample collection method. During the operational period the CWTS achieved an average decrease of 0.0169 µg/L for cadmium (from 0.0261 µg/L to 0.0092 µg/L), 31.8 µg/L for copper (from 49.1 µg/L to 17.3 µg/L), 3.5 µg/L for selenium (from 4.0 µg/L to 0.5 µg/L), and 47.3 µg/L for zinc (from 49.2 µg/L to 1.9 µg/L; Table 4, Figure 10, Figure 11, Figure 12, and Figure 13, respectively). In contrast, molybdenum removal was fairly constant through 2017 (both commissioning-B and operations) with a decrease of 3.9 µg/L (5.7 µg/L to 1.8 µg/L) during commissioning-B and a decrease of 3.6 µg/L (from 6.3 µg/L to 2.7 µg/L) during operations (Table 4). The percent removal of molybdenum and selenium in 2017 is notable, as it has increased from 0% removal during commissioning-A in 2015 and 2016 (Contango, 2016 and 2017) (Table 4). Furthermore, nitrite and nitrate outflow concentrations also decreased from feed water concentrations throughout the demonstration-scale CWTS. Nitrite and nitrate are therefore being removed through treatment in the CWTS (Figure 15 and Figure 16). These results indicate that the commissioning periods were successful in establishing beneficial conditions for the removal of constituents in the CWTS and treatment of these constituents should continue through 2018.

Table 4 – Percent removal of dissolved constituents in the demonstration-scale CWTS.

COC (µg/L)		Commissioning period				Operational period
		2015[1]	2016[2]	2016[3]	2017[4]	2017[5]
Cd	In	0.0505	0.0240	0.0185	0.0163	0.0261
	Out	0.0248	0.0142	0.0066	0.0093	0.0092
	%	49	40	64	41	66
Cu	In	54.5	61.6	46.1	59.5	49.1
	Out	45.0	56.7	28.8	35.5	17.3
	%	17	8	37	36	65
Mo	In	11.0	7.6	7.3	5.7	6.3
	Out	11.3	7.6	5.7	1.8	2.7
	%	0	0	21	62	57
Se	In	11.0	3.7	5.7	2.5	4.0
	Out	11.3	3.4	3.3	0.9	0.5
	%	0	8	41	61	87
Zn	In	12.3	92.8	37.6	135.3	49.2
	Out	6.8	49.0	11.6	4.9	1.9
	%	42	47	69	95	96

[1] Values calculated from end of last two sampling event in 2015 before the addition of EDTA (September 9 and 17, 2015; during commissioning-A).
[2] Commissioning-A (May 2, 2016 to July 28, 2016).
[3] Commissioning-B (July 29, 2016 to September 30, 2016).
[4] Commissioning-B (May 27, 2017 to August 17, 2017).
[5] Operational period (August 18, 2017 to September 22, 2017).

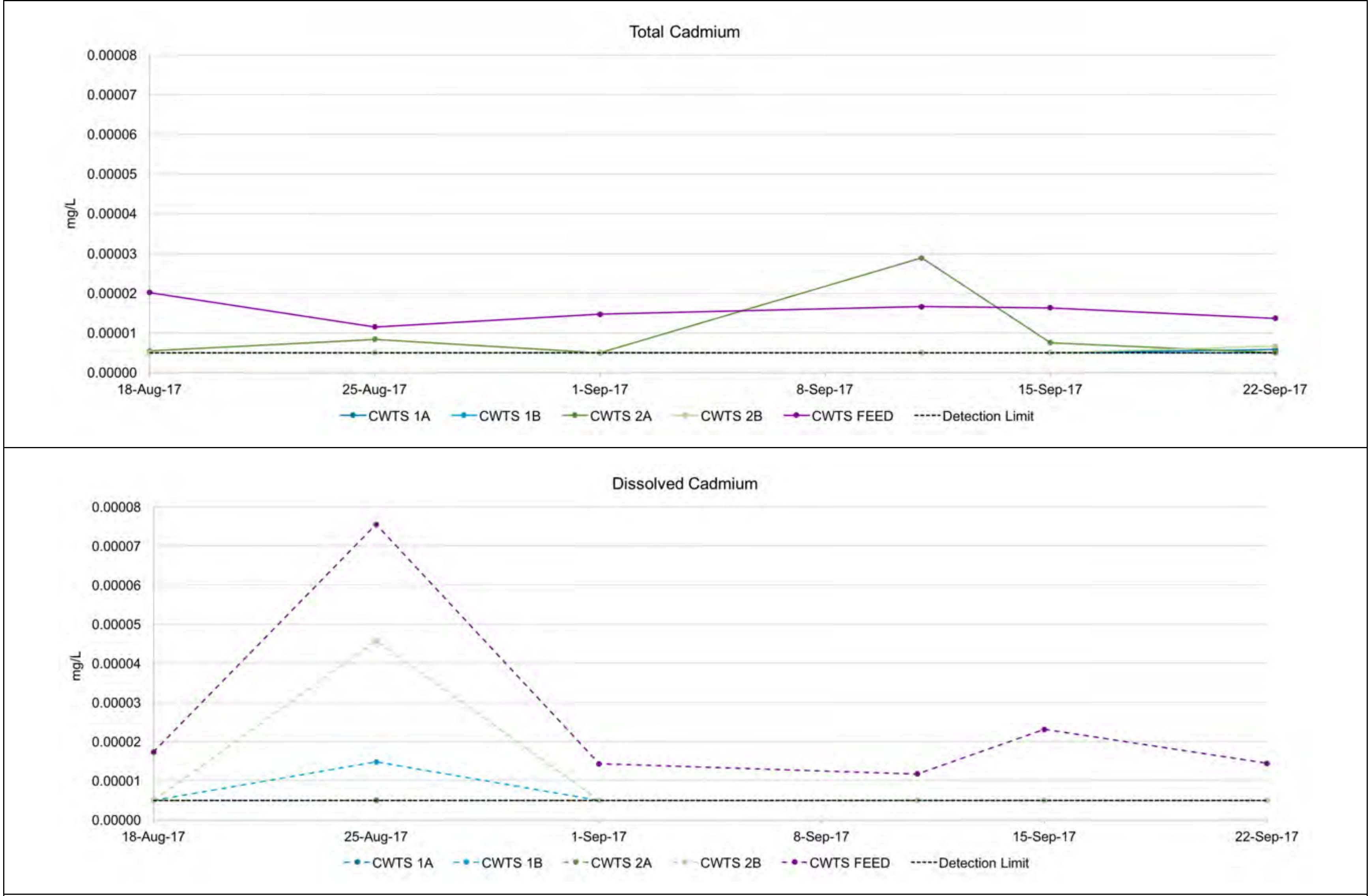


Figure 10 – Cadmium concentrations in operational period of the demonstration-scale CWTS.
The ALS detection limit for cadmium is 0.000005 mg/L.

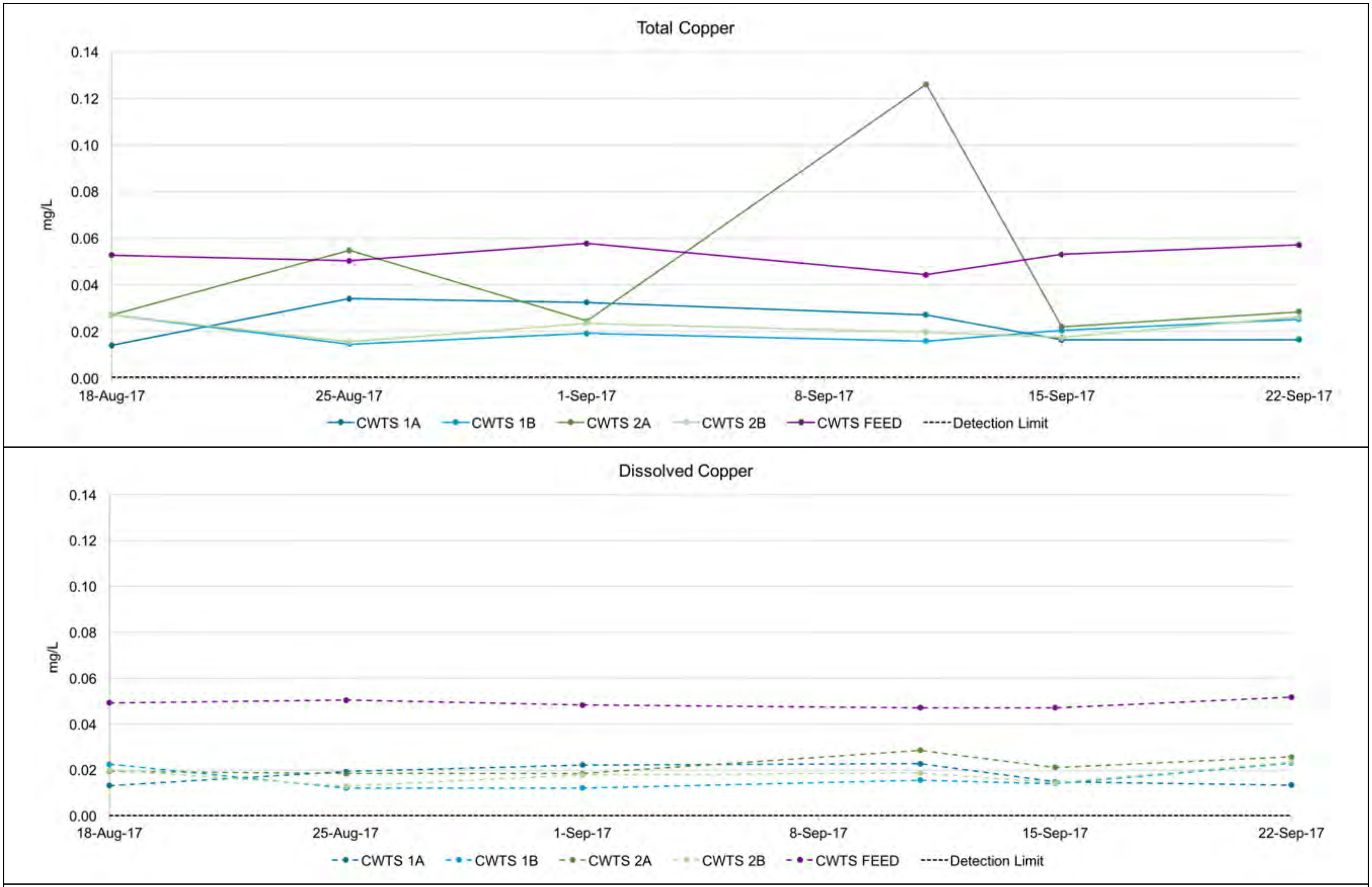
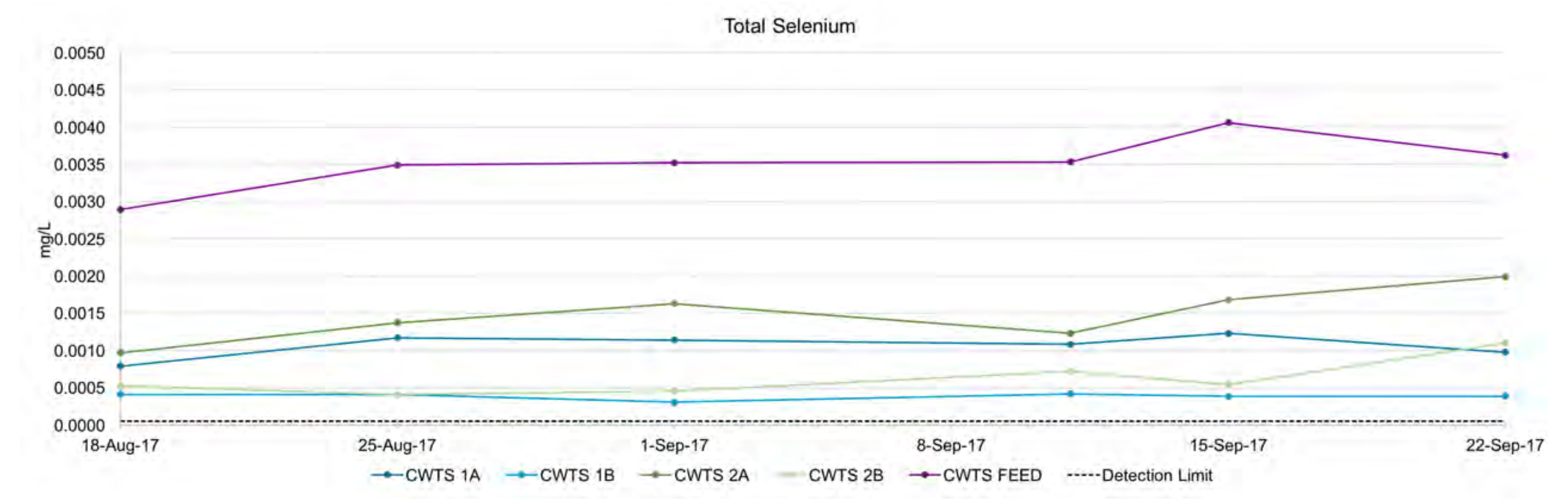


Figure 11 – Copper concentrations in operational period of the demonstration-scale CWTS.
The ALS detection limit for dissolved and total copper is 0.0002 mg/L and 0.0005 mg/L, respectively.



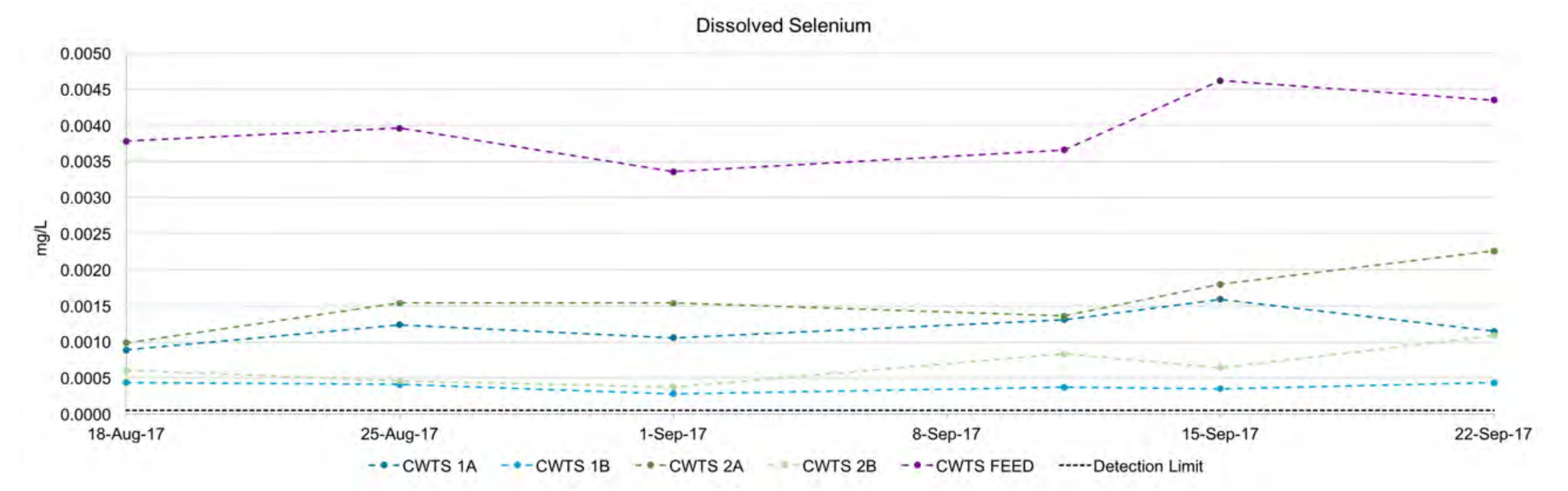


Figure 12 – Selenium concentrations in operational period of the demonstration-scale CWTS.
The ALS detection limit for selenium is 0.000050 mg/L.

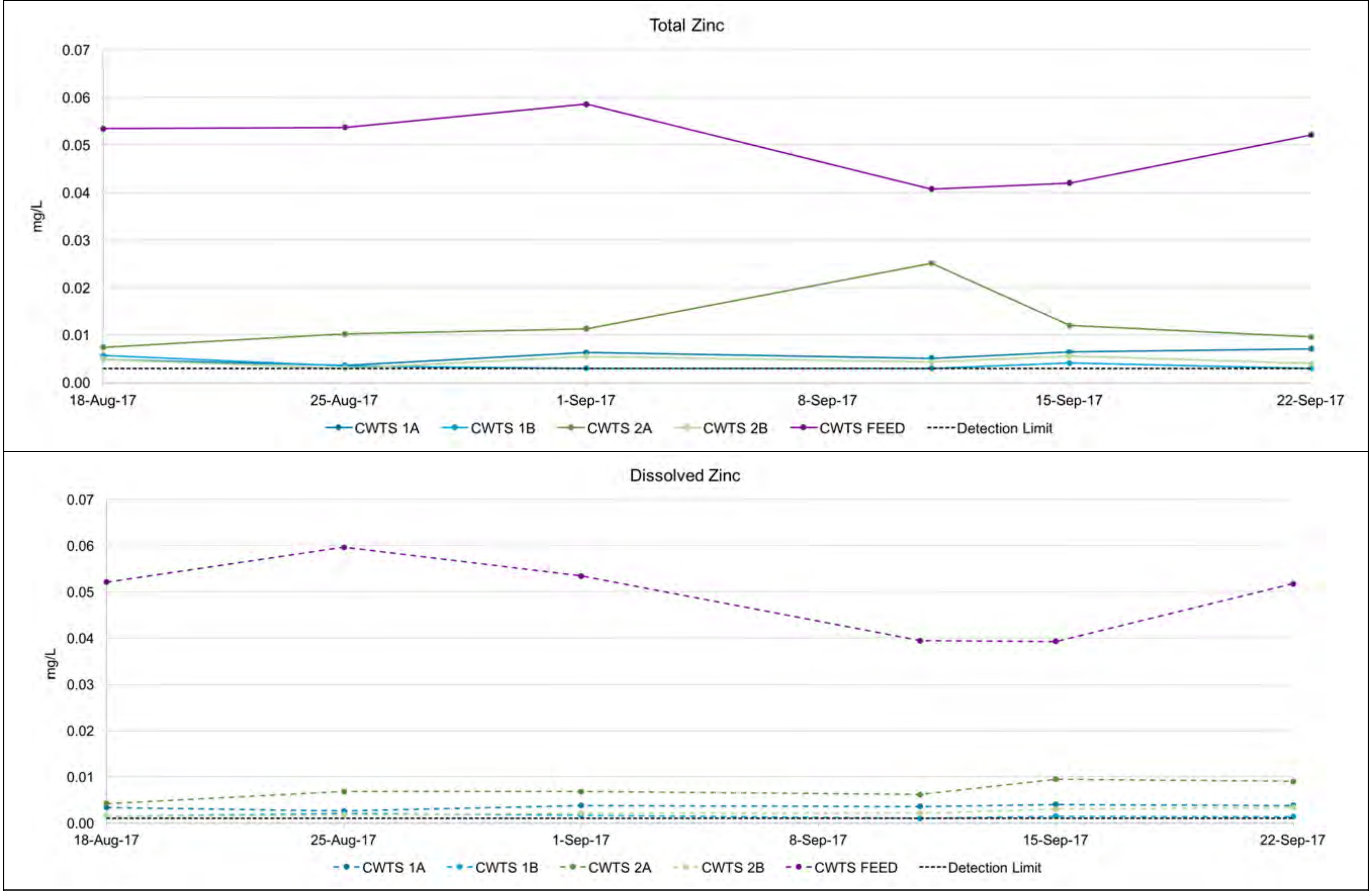


Figure 13 – Zinc concentrations in operational period of the demonstration-scale CWTS.

The ALS detection limit for dissolved and total zinc is 0.001 mg/L and 0.003 mg/L, respectively.

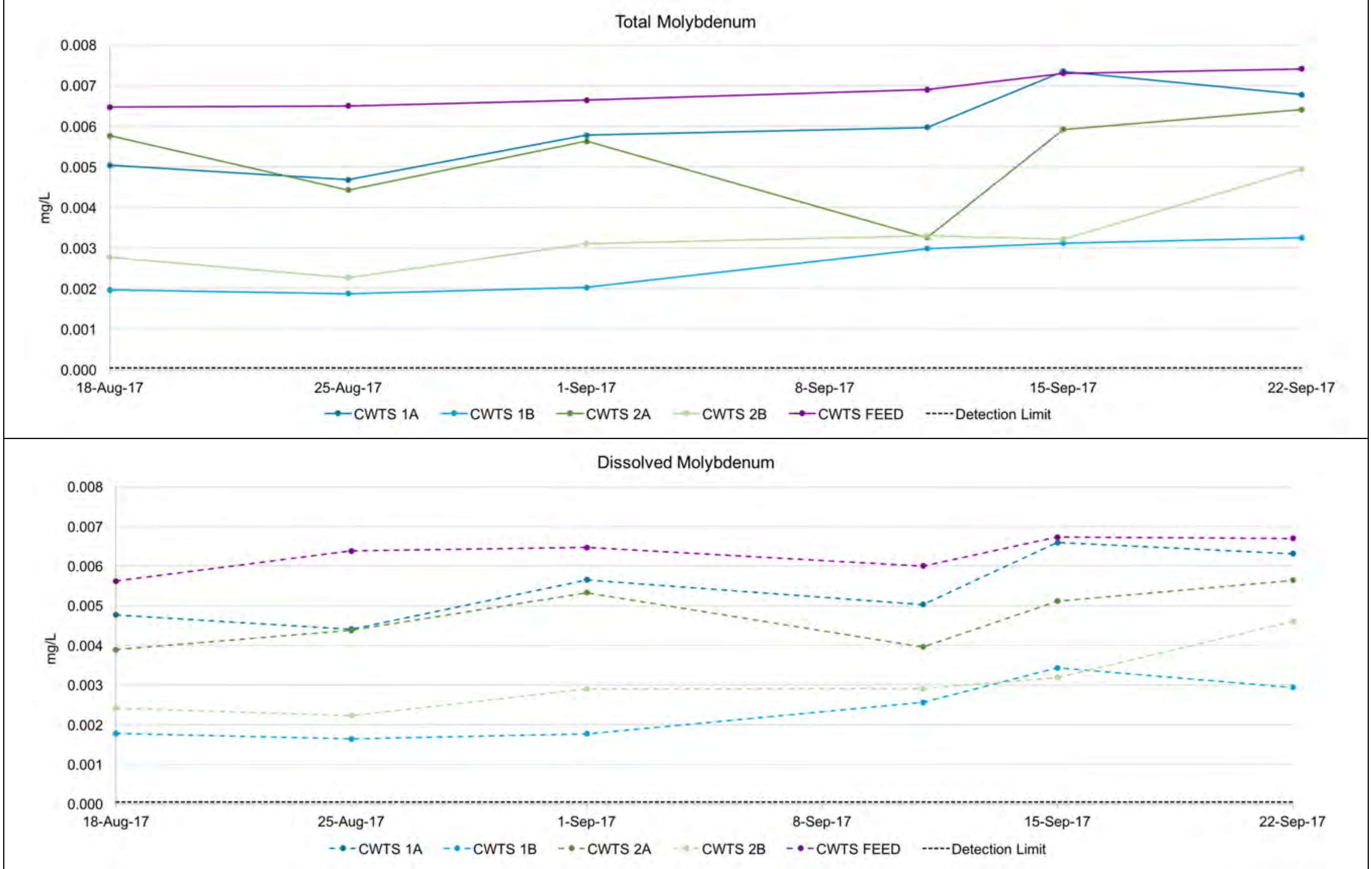


Figure 14 – Molybdenum concentrations in operational period of the demonstration-scale CWTS.
The ALS detection limit for molybdenum is 0.000050 mg/L.

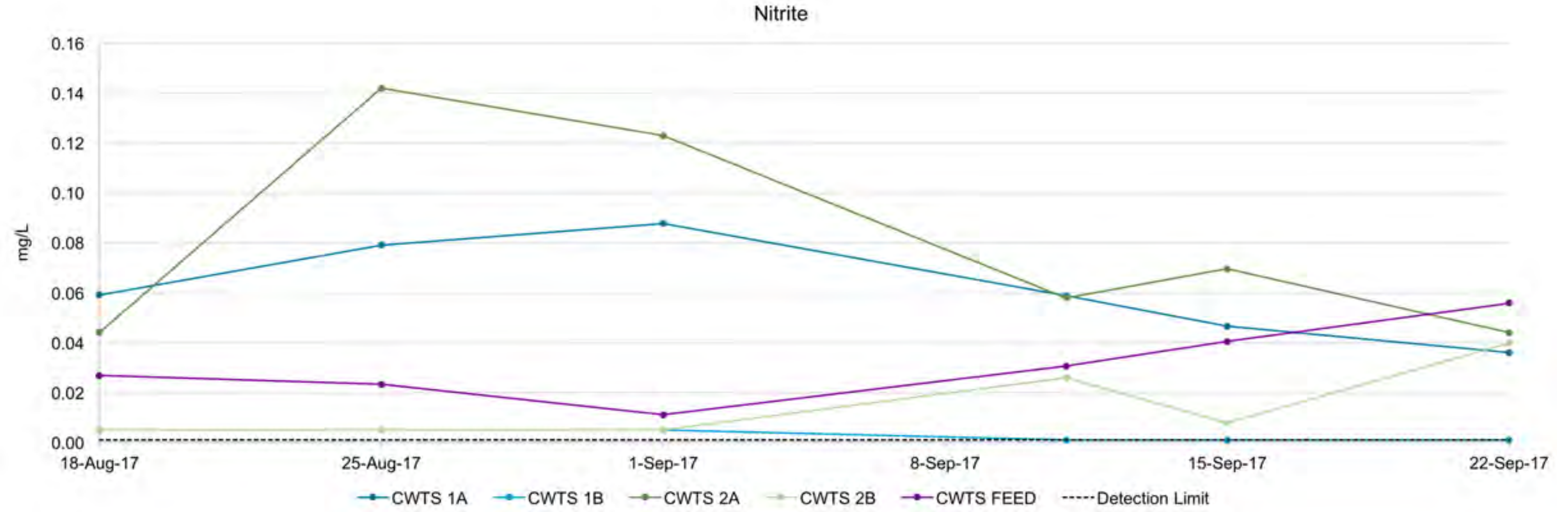


Figure 15 – Nitrite as N (NO_2) concentrations in operational period of the demonstration-scale CWTS.
The ALS detection limit for nitrite is 0.0050 mg/L.

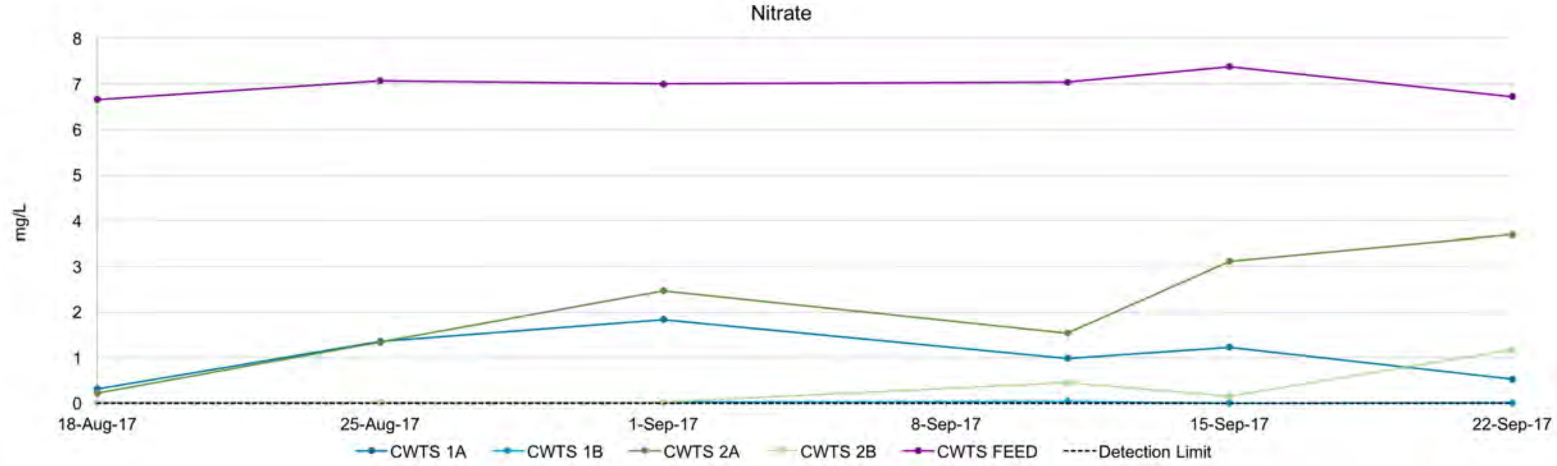


Figure 16 - Nitrate as N (NO_3) concentrations in operational period of the demonstration-scale CWTS.
The ALS detection limit for nitrate is 0.025 mg/L.

5.3.Hydraulic Retention Time

The following are key findings regarding the hydraulic retention time, which are detailed further below:

- The tracer study effectively demonstrated the HRT and flow symmetry through the CWTS.
- There was a single flow path in the CWTS (shown by a single peak in the tracer study)
- Water is incorporating in to the CWTS soils (shown by the long tail for depletion of the tracer).
- The nominal HRT is calculated from the area of the CWTS and the depth at the in situ measuring points. This nominal HRT does not account for depth variations, embankment slopes, vegetation (using space in the water), or substrate pore space involvement. It was found that once all of these factors are in play, the correction factor from nominal to actual is only 0.01 added to the depth of the CWTS, which is incorporated into the HRT calculation as expressed in Equation 3.

5.3.1. Tracer Study

A tracer study was conducted in cell 1A of the CWTS in 2016 (June 13-15, 2016) and in 2017 (June 21-July 2, 2017). Results from the 2016 tracer study can be found in the 2016 demonstration-scale CWTS report (Contango, 2017). The methods of the 2017 tracer study were refined from the 2016 tracer study methods and are further discussed in Appendix A. The nominal HRT is calculated from the area of the CWTS and the depth at the in situ measuring points. This nominal HRT does not account for depth variations, embankment slopes, vegetation (using space in the water), or substrate pore space involvement. The purpose of the tracer studies was to determine the actual hydraulic retention time (HRT) that occurs in the CWTS with a known inflow rate and depth measurement. Then, using this actual HRT form the tracer study, a correction factor can be developed for future CWTS HRT calculations.

Salt (NaCl) was used as the tracer in these tracer studies. By adding a salt solution at the inflow of the CWTS, and placing a YSI meter at the outflow of the CWTS, it could be determined how long it took for the salt to pass through the CWTS by monitoring the specific conductance (SPC) in situ (as salt raises the SPC). The actual HRT of the CWTS was determined by calculating the amount of time that passed between the addition of the salt tracer at the inflow of the CWTS and the peak in SPC at the outflow.

The nominal HRT at the time of the tracer study was calculated based on the flow rate at the time of the tracer study, the known area of cell 1A, and measured depth of cell 1A obtained from the depth sticks that were installed in the CWTS in June 2016 (Appendix A, Figure A5). The results from the 2017 HRT tracer study suggests that the actual HRT of cell 1A is 2.25 days while the nominal HRT of cell 1A is 2.05 days. Therefore, the actual HRT was approximately 10% slower than the nominal HRT. The actual HRT of 2.25 days obtained from the 2017 tracer study was used to solve Equation 1, implying 0.14 m of water involvement as the "depth", which was 0.01 m greater than the measured depth of 0.13 m of water. This results in a correction factor of 0.01 (Equation 2). Therefore, the correction factor can be applied to the operational HRT as shown in Equation 3 in order to more accurately estimate HRT of the CWTS.

This HRT correction factor has been incorporated into calculations for the operational HRT for the demonstration-scale CWTS in 2017. The correction factor was incorporated into the operational HRT calculations in Section 5.3.2 and used to determine the 2017 removal rate coefficients in Section 5.4.2.

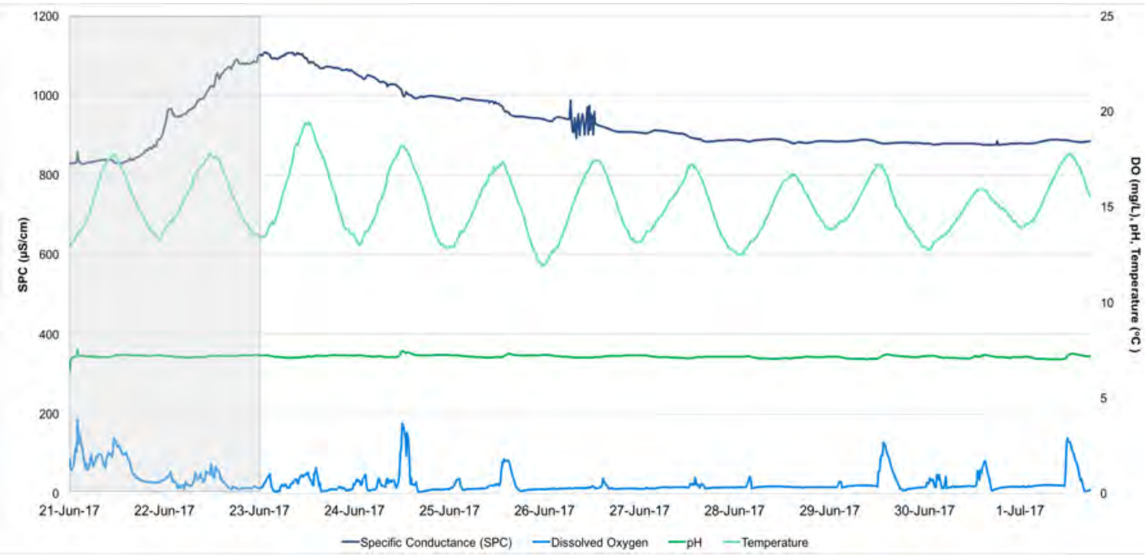


Figure 17 – Hydraulic retention time tracer study results.
Specific Conductance (SPC; µS/cm) on primary y-axis. Dissolved oxygen (mg/L), pH, and temperature (ºC) on secondary y-axis. Grey shading indicates time from when CWTS was dosed to the peak of tracer breakthrough, which was used as the actual HRT. The fluctuation in temperature correspond to day (peaks) and night (lows). The dates on the x-axis are at 24 hr intervals, beginning from 7:52 am on June 21, 2017.

$$\text{Actual depth} = \frac{(Q \times \text{actual HRT})}{A}$$

Equation 1 – Equation for calculation of the actual CWTS depth including the correction factor.
Q is the flow rate; actual HRT is the HRT obtained from the tracer study (2.25 days); *A* is the area of cell 1A.

$$\text{Correction factor} = \text{Actual depth} - \text{measured depth}$$

Equation 2 – Equation for calculation of the correction factor.
The actual depth was calculated via Equation 1 (0.14 m); measured depth is the depth of cell 1A during the tracer study (0.13 m).

5.3.2. *Operational Hydraulic Retention Time*

The operational HRTs of the demonstration-scale CWTS for 2017 were calculated for each series using Equation 3. Equation 3 uses the volume of a CWTS series including a correction factor (calculated from the results of the tracer study in Equation 2; Section 5.3) and the flow rate from the operational period under consideration. For the operating period in 2017, the average HRT was calculated for August 17 – September 22, 2017 as the flows and depths were relatively stable during this time. The operational HRTs calculated were 5.85 days and 6.82 days for series 1 and series 2, respectively. The operational HRTs were then averaged and used in the calculation of removal rate coefficients in Section 5.4.2.

$$\text{Operational HRT} = \frac{A \times \text{actual depth}}{Q}$$

Equation 3 – Equation for calculation of hydraulic retention time.

Operational HRT is the confirmed hydraulic retention time; A is the area of the CWTS; actual depth was calculated using Equation 1 (0.14 m); Q is the flow rate.

5.4. Treatment Effectiveness

The following are key findings regarding treatment effectiveness of the CWTS, which are detailed further below:

- All targeted constituents are being treated by mineralization and sequestered to the soils (minimal plant uptake).
- The lowest concentrations consistently achievable for the treatment design (thermodynamic minimums) were reached by the end of the A cells for cadmium and copper.
- RRCs for cadmium and zinc in the 2017 demonstration-scale CWTS were artificially low because low flow rates did not provide the resolution needed to determine a RRC.
- Removal rate coefficients (RRCs, *k*) have been developed that can be used for full-scale sizing.
- Copper leaching from soils has decreased but is still likely making the RRC artificially low in this CWTS; however, the RRC is expected to improve once copper leaching has subsided.

5.4.1. Thermodynamic Minimums

The thermodynamic minimum is the lowest concentration consistently achievable for a given treatment design and water chemistry. Once reached, making the CWTS bigger will not result in further decrease of outflow concentration (although outflow load may continue to decrease). Therefore, thermodynamic minimums are useful parameters to aid in developing appropriate RRCs and determining appropriate sizing and outflow water quality objectives of a CWTS. The thermodynamic minimum was determined for each constituent in the demonstration-scale CWTS. The thermodynamic minimum was calculated by comparing the A cell and the B cell concentrations in a series to determine if the concentrations were significantly different or not. If a concentration had stabilized between the A and B cell in a series, the thermodynamic minimum was considered to have been met. To determine when concentrations had stabilized, statistical analyses were done (paired t-test, one-tailed, $\alpha=0.05$) to determine if the concentrations were significantly different or not. These analyses were then also visually compared to the concentrations of constituents at seven sampling locations throughout the CWTS from two time points, to further evaluate and confirm whether concentrations appeared to have leveled off (Figure 8 and Figure 9 for copper and selenium, respectively; Figures B1 to B4 in Appendix B for remaining constituents). However, there was not enough time points in the operational period for this data to be used in the statistical analyses to further refine the expected HRT for the thermodynamic minimums. This can be refined in 2018, by varying flow rates.

Based on the results of the t-test for the A cell and B cell concentrations, it was determined that the thermodynamic minimum was achieved for cadmium and copper by the end of the A cells in the demonstration-scale CWTS. The detection limit was reached for cadmium prior to the outflow of cell A, suggesting that faster flows would be needed to accurately determine the HRT at which the thermodynamic minimum was met (Figure 18). The thermodynamic minimum for molybdenum, nitrate, and selenium were not yet statistically achieved, suggesting that a larger CWTS would achieve lower concentrations of these constituents (Appendix B, Figures B13 to B17). The thermodynamic minimum for zinc was not statistically achieved, however, the majority of zinc load was removed within the beginning of cell A, with minimal load removal in the remainder of the CWTS (Figure 18). Furthermore, outflow concentrations of both cell A and B for zinc are at or near detection limit (Figure B17), so it is not necessarily beneficial to build a larger CWTS for zinc.

As shown by the graphs previously mentioned, concentrations in A cells and B cells were very similar for cadmium and copper. This shows that treatment is occurring in the A cells and has reached a thermodynamic minimum which does not decrease further for the B cells. However, these results for copper should be taken with consideration that there is still some residual copper in the soils from construction that is being treated, and therefore, there is more copper treatment ongoing that can be noted by just the water concentrations.

Interestingly, once cadmium, copper and nitrate are treated, zinc and molybdenum begin to have an increase in treatment. This phenomenon is referred to as a treatment front, which generally abides by reaction orders (i.e., nitrate treatment before sulphate, etc.; Murray-Gulde, 2008).

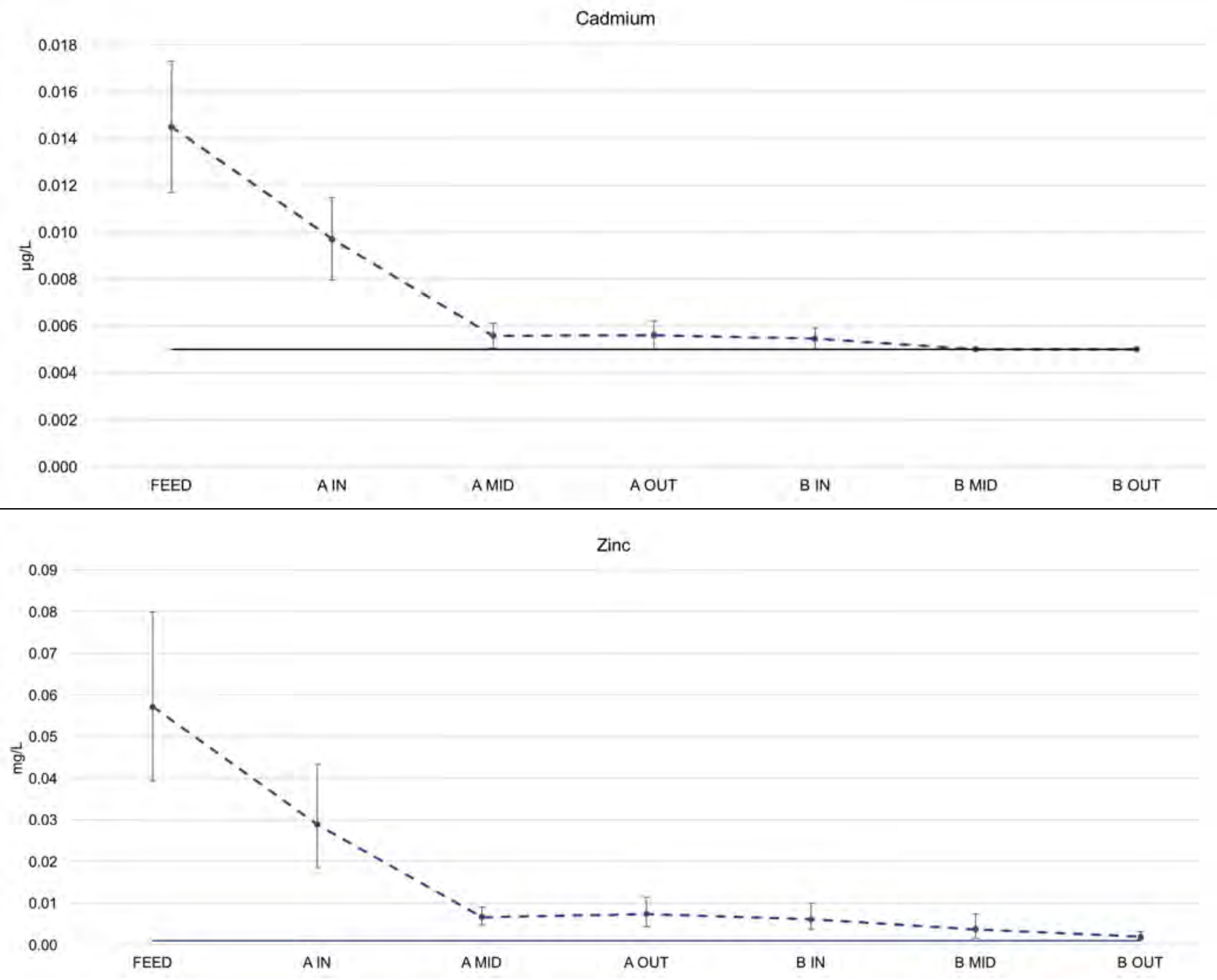


Figure 18 – Average dissolved cadmium and zinc concentrations through the CWTS during the operational period. Data shows the average of series 1 and series 2 for two sampling points during the operational period (August 18 and September 11, 2017). Error bars show minimum and maximum concentrations at each sampling point. The black horizontal line shows the detection limit of 0.005 µg/L for cadmium and 0.001 mg/L for zinc.

5.4.2. *Removal Rate Coefficients*

An important factor for CWTS design is the rate of treatment, also known as the removal rate coefficient (RRC; *k*). The RRC is based on the treatability of a specific compound and the hydraulic retention time of the CWTS, both of which are site-specific based on water chemistry, CWTS designs, and characteristics of the CWTS. A RRC was calculated and applied for cadmium, copper, molybdenum, selenium, zinc, and nitrate which can be used to refine future sizing and performance estimations of a full-scale CWTS (Table 5). In pilot-scale testing specific for the Minto CWTS, the RRC for selenium was a zero-order reaction kinetic, however, optimizations of the operation of the system through the demonstration-scale commissioning have enabled a first-order RRC to be maintained. Therefore, cadmium, copper, selenium, zinc, and nitrate are calculated as first-order kinetics, but molybdenum followed a zero-order kinetic. In other words, the reaction rate for molybdenum is a constant rate and does not depend on concentration, whereas the reaction rates for cadmium, copper, selenium, zinc, and nitrate are proportional to concentration (a half-life type of reaction).

In Equation 4 and Equation 5, *Cf* is the final concentration, *Ci* is the initial concentration, and *HRT* is the operational hydraulic retention time calculated in Equation 3 (Section 5.3.2) using the CWTS depth and correction factor calculated from the tracer study (Equation 1 and Equation 2; Section 5.3).

$$k = \frac{-\ln\left(\frac{Cf}{Ci}\right)}{HRT}$$

Equation 4 – Equation for calculation of first-order removal rate coefficient.
k is the removal rate coefficient; *Cf* is the final concentration; *Ci* is the initial concentration; *HRT* is the operational hydraulic retention time.

$$k = \frac{(Ci - Cf)}{HRT}$$

Equation 5 – Equation for calculation of zero-order removal rate coefficient.
k is the removal rate coefficient; *Cf* is the final concentration; *Ci* is the initial concentration; *HRT* is the operational hydraulic retention time.

RRCs were calculated for each constituent (dissolved and total) and series 1 and series 2 were averaged for the operational period in 2017 and compared to RRCs calculated to the commissioning period of 2016, and pilot-scale RRCs (Table 6). In 2016, all RRCs were calculated using outflow concentrations from the B cells while in 2017, cadmium and copper RRCs were calculated using outflow concentrations and HRTs from the A cells as they had reached their thermodynamic minimum at the end of cells 1A and 2A (Section 5.4.1). The RRCs for the remaining constituents did not reach their thermodynamic minimum in the A cells and, therefore, outflow concentrations and HRTs from the B cells were used. RRCs for cadmium and zinc in the 2017 demonstration-scale CWTS were artificially low because low flow rates did not provide the resolution needed to determine a RRC. Additionally, RRCs for copper in demonstration-scale CWTS are also artificially low due to copper leaching from soils used in construction of the system. Therefore, the RRCs for copper are expected to improve once leaching has subsided. In general, RRCs improved from those calculated in 2016 (Table 5; Contango, 2017).

Applying the removal rate coefficients (*k*) from Table 5 to Equation 3 above, parameters can be rearranged to solve for those of interest, such as the volume needed, that in turn determines the area of CWTS required which is dependent upon the design. Analytical results from August 17 – September 22, 2017 were chosen to calculate *k* because this is the operational period after commissioning-B was completed and flow rates were stable and at targeted values. The treatment rate coefficients applied here are intended to be conservative estimates for conceptual sizing purposes and will need to be refined through further demonstration-scale (on site) testing.

Table 5 – Removal rate coefficients (k) for constituents of concern.

COC	Pilot[1] k*day^{-1}	2016 Demonstration[2] (Commissioning) k*day^{-1}		2017 Demonstration[3] (Operational) k*day^{-1}		Recommended[4] k*day^{-1}
	Total	Dissolved	Total	Dissolved	Total	Dissolved
First order removal rate coefficients						
Cd	1.142	0.172	0.174	>0.521[5]	>0.226[5]	1.142
Cu[6]	1.171	0.0778[6]	0.0740[6]	>0.3100[6]	>0.1356[6]	1.171
Mo	0.1010	0.0416	0.0468	N/A	N/A	N/A
Se	N/A	N/A	N/A	0.3186	0.3069	0.3186
Zn	1.144	0.195	0.183	0.512[5]	0.394[5]	1.144
Nitrate	0.559	0.0914	N/A	0.591	N/A	0.591
Zero order removal rate coefficients						
Mo	N/A	N/A	N/A	0.0006	0.0006	0.0006
Se	0.00181	0.000357	0.000316	N/A	N/A	N/A

[1] Values calculated from data in Contango, 2014b (pilot-scale report) for *Carex aquatilis* + moss with low nitrogen scenario.

[2] Analytical results from August 10 – September 17, 2016 were used.

[3] Analytical results from August 18 – September 22, 2017 were used.

[4] Cadmium, copper, and zinc recommended RRCs are developed from total concentrations in pilot-scale testing and are conservative proxies for dissolved concentrations.

[5] RRCs for cadmium and zinc in the 2017 demonstration-scale CWTS were artificially low because low flow rates did not provide the resolution needed to determine a RRC, so the lowest potential k value based on available data is reported here.

[6] RRC's for copper in demonstration-scale CWTS are artificially lowered due to copper leaching from soils used in construction of the system and are therefore expected to improve once leaching has subsided.

N/A = an RRC is not available. All RRCs are for first-order reaction kinetics except for selenium in the 2016 demonstration-scale CWTS and molybdenum in the 2017 demonstration-scale CWTS, which are zero-order reaction rate kinetics. All RRCs in 2016 and 2017 used outflow concentrations for the B cells in the CWTS.

5.5.Evapotranspiration in the Demonstration-Scale CWTS

The following are key findings regarding the evapotranspiration studies, which are detailed further below:

- The evapotranspiration studies revealed a significant loss of water, which will impact calculations of loads to the receiving environment (making them lower than previously estimated).
- In May and June, an average water loss of 5.3 L/day/m^2 was observed, which is equivalent to 18-20% of water (~700 L/day lost in the demonstration CWTS).
- During the evapotranspiration trials, copper leached into the water as it was transformed from an oxide mineral to a sulphide mineral (because of the copper in the soils used for construction). This is not representative of what would occur during periods with no flow in a full-scale CWTS, where soils with minimal leachable copper are used and copper is deposited in sulphide form (fraction 4) by the biogeochemical activity of the CWTS (Section 5.6).

Total evapotranspiration from a CWTS is measured as the combined effects of open water evaporation and plant transpiration (Beebe et al., 2014). The purpose of calculating the evapotranspiration of a CWTS is to understand the amount of water lost per day over the surface area of a wetland, which in turn concentrates constituents, and should be considered in the context of the decrease in outflow concentration (or not) and outflow load reduction. It should also be noted that evapotranspiration will vary depending on temperature, humidity, and wind on-site and, therefore, will fluctuate over time. This should be considered when interpreting evapotranspiration rates, however, for conceptual calculation purposes, a set rate is applied here.

The off-site evapotranspiration study conducted in 2016 suggested that approximately 15.5 L/day/m^2 could be lost due to evapotranspiration (Contango, 2017). The results of the 2017 on-site evapotranspiration studies were intended to provide more accurate estimates at the CWTS than the off-site study and had an average water loss of 5.3 L/day/m^2 (Table 6). These results are consistent with pilot-scale results from another CWTS planted with *Carex* where 5.1 L/day/m^2 were lost through evapotranspiration. Although the off-site study can be informative, the on-site study is more representative of what would occur during operation of the full-scale CWTS in the spring. The difference in the two rates is expected to be due to temperature difference of the trial. The on-site during the evapotranspiration study were on average 9.6°C in May and 13.7°C in June while temperatures in the off-site study were on average 22°C during the day (12 hr) and 16°C during the night (12 hr) which is less representative of site conditions. Temperatures in July and August at Minto were only slightly higher than June temperatures and were on average 15.8°C and 13.9°C, respectively. Therefore, we would expect marginally higher rates of evapotranspiration in these months.

Table 7 shows the amount of water lost to evapotranspiration during the operational period (August 18 – September 22, 2017) in each cell of the demonstration-scale CWTS. The amount of water lost in the CWTS during each flow rate period tested is calculated using Equation 6.

$$Water\ loss\ (\%) = \frac{ET}{Q} \times 100$$

Equation 6 – Equation for the calculation of the water loss due to evapotranspiration.

Q is the flow rate (L/day); ET is the evapotranspiration rate (L/day).

Table 6– Water loss through evapotranspiration in the CWTS.

Study	Cell	Water loss[1] (L/day)	Water loss[2] (L/day/m^2)
Trial 1: May 16 – 24, 2017	1A	575.0	8.3
	1B	143.7	2.1
	2A	509.0	8.8
	2B	152.7	2.6
		L/day/m^2 Average	5.4
Trial 2: June 8 – 11, 2017	1A	580.8	8.3
	1B	116.2	1.7
	2A	775.7	13.3
	2B	339.4	5.8
		L/day/m^2 Average	7.3
Trial 3: June 11 – 15, 2017	1A	292.7	4.2
	1B	27.9[3]	0.4
	2A	273.4	4.7
	2B	203.6	3.5
		L/day/m^2 Average	3.2
		L/day/m^2 Overall Average	5.3

[1] Water loss (L/day) = (initial depth (m) – final depth (m)) * area of CWTS (m^2) * 1000 L/m^3/days.

[2] Water loss (L/day/m^2) = Water loss (L/day) / area of CWTS (m^2).

Total days of study in trials 1, 2, and 3 were 8, 3, and 5 days, respectively. The area of series 1 is 69.7 m^2 and the area of series 2 is 58.2 m^2.

[3] Depths in this cell had minimal change throughout trial 3.

Table 7 shows how this water loss likely affected the load leaving the wetland. The average ambient temperature on-site for this time period was 9.9°C, and so the evapotranspiration rates from the trials are expected to be relevant to the operational period. The information in Table 7 is calculated based on Equation 7 and Equation 8.

Evapotranspiration has a significant effect on the calculation of constituent load to the receiving environment. Therefore, future models for assimilative capacity in the downstream receiving environment should take into account not only the predicted outflow concentrations from the CWTS using removal rate coefficients (Section 5.4.2), but also adjust the load accounting for evapotranspiration.

Concentrations of copper (and other metals) were measured in the water during the evapotranspiration studies to determine if any leaching occurred during periods of no flow because the soils used in construction contained oxidized copper minerals. In the 2017 study, this is noted by an average decrease of 63.3 µg/L copper after flow was restarted and treatment of copper resumed. This is not representative of what would occur during periods with no flow in a full-scale CWTS, where soils with minimal leachable copper are used and copper is deposited in sulphide form (fraction 4) by the biogeochemical activity of the CWTS (Section 5.6). In a full-scale CWTS, lower flows and stagnation will result in greater treatment of constituents into sulphide mineral forms.

The demonstration-scale evapotranspiration studies were conducted to inform evapotranspiration rate estimates for full-scale CWTS design. However, these results are fortuitous because the study was conducted during the commissioning-B period, rather than the operational period when the CWTS was running optimally. Additionally, since the studies were conducted in the spring, they do not capture the seasonality of evapotranspiration rates and are therefore conservative numbers. Thus, it is recommended that another evapotranspiration study be conducted on-site in 2018.

$$Load_{in} = C_i \times V$$

Equation 7 – Equation for the calculation of load of a constituent into a CWTS over a period of time.

$Load_{in}$ is the mass of a constituent that enters a CWTS over a period of time; C_i is the inflow concentration of the constituent; V is the volume of water that enters a CWTS over a period of time.

$$Load_{out(ET)} = Water\ Out_{ET} \times C_f$$

Equation 8 – Equation for the calculation of the load out of a constituent over a period of time, adjusted for evapotranspiration.

$Load_{out(ET)}$ is load out of a constituent over a period of time, adjusted for evapotranspiration; $Water\ Out_{ET}$ is the outflow water volume over a period of time, adjusted for evapotranspiration; C_f is the outflow concentration of the constituent.

Table 7 – Average constituent load in, load out, load out adjusted for evapotranspiration and load removed adjusted for evapotranspiration in the demonstration-scale CWTS.

COC	Form	Load in (mg/day)	Load out[1] (mg/day)	Load out Adjusted for evapotranspiration[2] (mg/day)	Load removed adjusted for evapotranspiration (mg/day)	Load removed[3] (%)
Cd	D	0.0476	0.0162	0.0131	0.0345	71
	T	0.0283	0.0094	0.0076	0.0207	73
Cu	D	89.7	31.4	25.4	64.3	72
	T	96.2	38.4	31.1	65.1	67
Mo	D	11.5	4.8	3.9	7.6	65
	T	12.6	5.2	4.2	8.3	66
Se	D	7.2	0.9	0.7	6.5	89
	T	6.4	0.9	0.7	5.7	88
Zn	D	90.0	3.4	2.8	87.2	97
	T	91.6	7.5	6.0	85.5	93

[1] Inflow volume was used for the calculation of load out using outflow concentrations without adjusting for evapotranspiration (Appendix A, Equation A2).

[2] Outflow volume adjusted for evapotranspiration was used for the calculation of load out adjusted for evapotranspiration.

[3] Load Removed (%) = (Load out adjusted for evapotranspiration)/(Load in) * 100

Water loss for each flow period is an average of all time points and is calculated using Equation 7. Average water loss in series 1 and 2 is 377.9 L/day/m2 (18%) and 315.4 L/day/m2 (20%), respectively. D = dissolved, T = total. Results in the table are from the operational period only (August 18 – September 22, 2017) and are therefore not representative of what would occur year-round. Ambient temperature on-site for this period was on average 9.9°C.

5.6. Soils

The following are key findings regarding constituents in the soil, which are detailed further below:

- In 2017, leachable copper concentrations in soils decreased in the top 0-10cm while total copper concentrations increased.
- Most constituents, including copper, have shifted primarily into stable reduced and residual minerals fractions in the soil.
- Acid volatile sulphides (AVS) were non-detectable in the CWTS in 2016. In 2017 small amounts of AVS were detected in cells 1A and 2A which indicates that residual sulphides are starting to become available for metal treatment and that copper in the soils are becoming rendered inert through sulphide mineralization.

Although unintentional, the high initial leachable copper concentrations in the CWTS soils (Appendix A, Table A2) allowed for additional testing to be carried out on these CWTSs. Because the soil substrates used for construction of the CWTS were from overburden sources, the copper was in oxidized form rather than in a mineral form that would typically be found in a reducing CWTS (i.e., soils with negative redox). Therefore, there was some initial leaching of copper from the soils into the water.

To assess the effect of the elevated metals in the soils used in construction on CWTS functionality, four soil analytical test methods were used and are described in Appendix A. Analytical methods tested for total metals, leachable metals, and metal speciation. Results of these test methods during the operational period are discussed in the following sections. Table 8 shows the definitions of extractable fractions from the sequential extraction procedure for the speciation of metals (Tessier et al., 1979).

Table 8 - Summary of extractable fractions from sequential extraction procedure for the speciation of metals[1].

Fraction	Description	When COCs Become Unstable and Release to the Water Column
1	Exchangeable fraction for adsorbed minerals	Readily released (i.e., soluble and exchangeable)
2	Mineral fraction bound to carbonates or solubilized at pH 5	Decreased pH
3	Oxidized mineral fraction bound to Fe-Mn oxides	Reducing conditions
4	Reduced mineral fraction and sulphides	Oxidizing conditions
5	Residual mineral fraction (primary and secondary minerals)	Not expected to be released in solution over time under conditions normally encountered in nature

[1] Method based on Tessier et al., 1979.

Analysis of leachable metals in 2017 used the same leach method as in 2016 and results can be found in Appendix B, Table B2. When compared to early 2016 results, leachable copper concentrations in 2017 soils decreased throughout the CWTS (Figure 19) while total copper concentrations increased overall as copper shifted from its leachable to mineral form (Figure 20). In general, soils in the demonstration-scale CWTS appear to be reaching a steady-state with concentrations of leachable copper changing little throughout 2017. We expect leachable copper decrease further in 2018.

Sequential extraction procedure for the speciation of particulate trace metals was conducted for all constituents of concern and results and figures can be found in Appendix B (Tessier et al., 1979). The analysis shows that despite elevated initial leachable copper concentrations, the soils have become more stable (less leachable) over time in the CWTS setting as the soils have aged, shifting from oxidized to reduced, mineral forms (Figure 21; Figures B18 and B19). This beneficial aging of soils to a less soluble mineralized form of sulphide is expected for this type of treatment CWTS design. It should also be noted that copper leached from the original substrate into the water put additional treatment demands on the CWTSs.

For the CWTS to treat the copper from the soils, additional organic carbon is needed beyond that necessary for the waters alone. Organic carbon is contributed to the CWTS through decomposition of plant material as the CWTS matures. Organic carbon is used as food by the microbes, which in turn produce sulphides which drive metals treatment through mineralization that is helped by biogeochemical processes. Presently, as there is excess copper in the soils in oxidized forms transitioning to reduced forms, these will bind to and consume the sulphides produced, transforming them to the sulphide-bound fraction 4 (Table 7). This in turn impacts the ability to treat water, as it uses the available sulphides that would otherwise treat metals in the water. When the mineral fractions of the soils have completed their transformation into sulphide-bound minerals, the soils will no longer be “sulphide hungry”, allowing for the soil-produced sulphides to be utilized for metals treatment in the water. This progress can be tracked in results from the sequential extraction tests, the appearance of acid volatile sulphides (AVS) in the soils (iron sulphates, which will only occur after the copper is transformed), and the change of sulphate concentrations in the water.

Additional reserve treatment capacity can be stored in a CWTS through creation of a reserve of AVS (newly formed amorphous iron sulphides). AVS are referred to as such because of the testing method, which is also done alongside simultaneously extracted metals (AVS:SEM; at Minto, cadmium, copper, and zinc were tested for) to determine the ratio of iron sulphides to free metals. An excess of AVS suggests the metals would be non-bioavailable and not likely to leach. In the case of Minto, where the soils used in construction had excess copper, the appearance of measurable AVS would also indicate that the copper in the soils is nearing an endpoint of transformation to sulphide forms.

AVS was tested for in 2016 prior to adding the straw and wood chips and was non-detectable (hence, the decision to add the straw and wood chips). The appearance of small amounts of measurable AVS over time (cell 1A in June and cell 2A in September, 2017) indicates that the amount of sulphide produced in the soils is beginning to exceed the total amount of copper placed with the original soils and the CWTS should eventually start performing the way it should have if substrates with high leachable copper had not been used. However, the AVS:SEM ratio is indicating there is significant copper in the soils still consuming the sulphides, and treatment performance is expected to improve as that continues to be remedied over time. An AVS:SEM ratio greater than one indicates excess copper in the soils has been reduced to sulphide form and is no longer consuming excess sulphides, allowing for AVS to form. Once the AVS:SEM ratio of all cells is consistently greater than one, we do not expect any further copper leaching to occur, and copper treatment within the CWTS should improve until this time.

Zinc (Figures B20 and B21) mineral forms have become stable over time, with most of these constituents found in the reduced or mineral form (fraction 4 and 5) by the end of 2017. Cadmium concentrations are at or near detection limits for all fractions (Figures B22 and B23). Molybdenum was mostly found in the most stable residual mineral fraction 5, which contained around 40% of the total molybdenum in the samples (Figures B24 and B25). Selenium was at or near the detection limit for all fractions at the end of 2017, and was barely detectable for the stable fractions 4 and 5 (Figures B26 and B27).

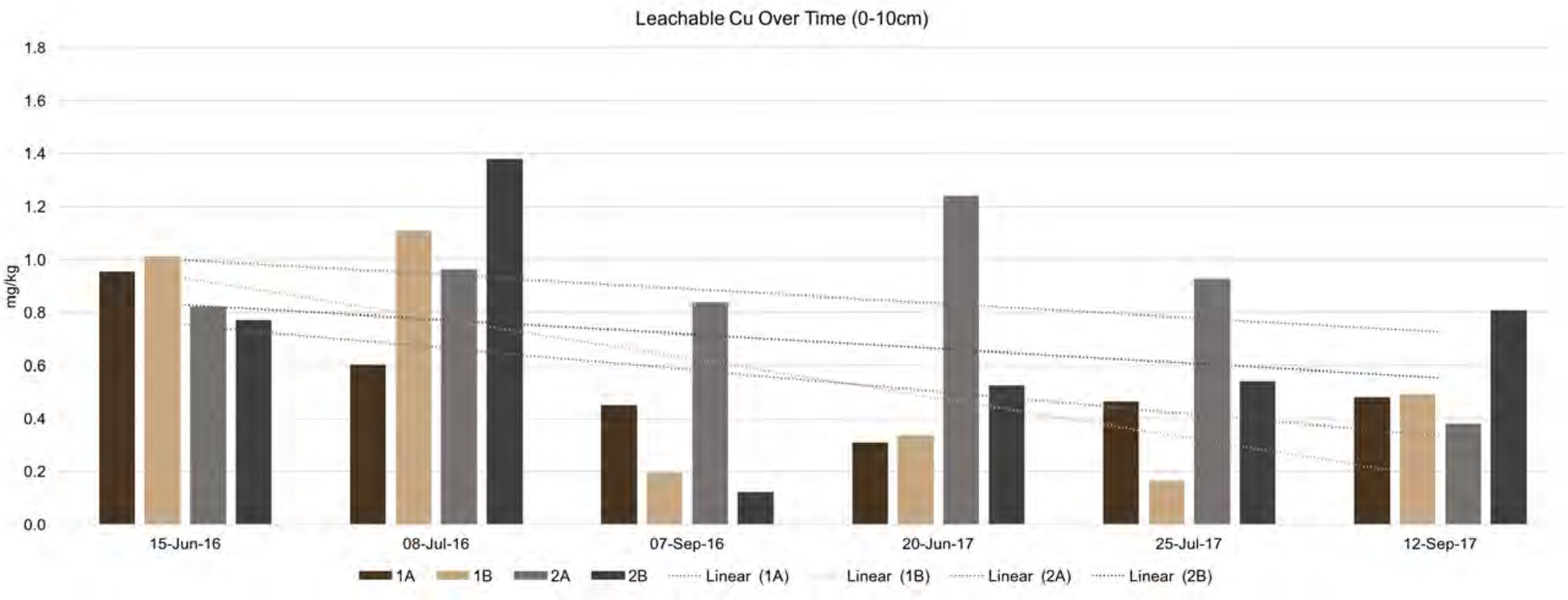


Figure 19 – Leachable copper concentrations in soils over time in the demonstration-scale CWTS.
Figure shows concentrations in shallow soil (0-10 cm). Trendlines (dotted lines) show a general decrease in leachable copper over time.

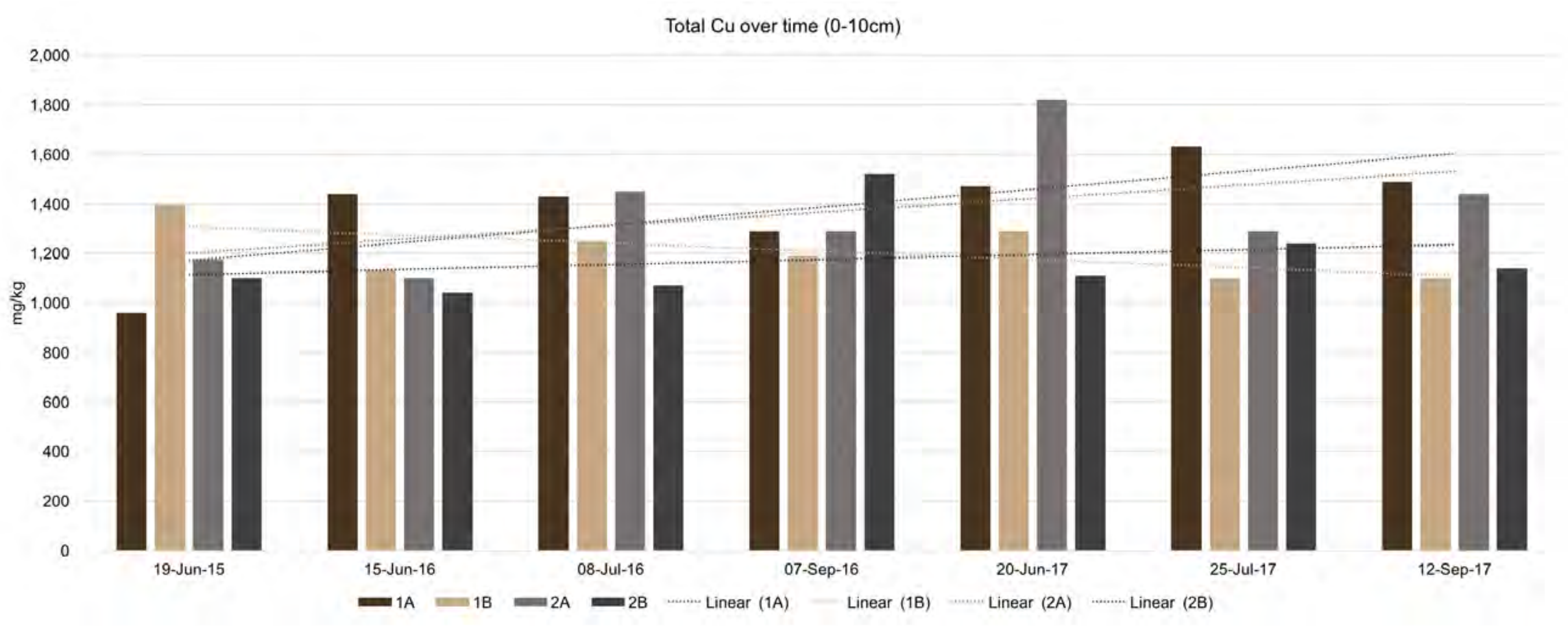


Figure 20 – Total copper concentrations in soils over time in the demonstration-scale CWTS.
Figure shows concentrations in shallow soil (0-10 cm). Trendlines (dotted lines) show a general increase in total copper over time.

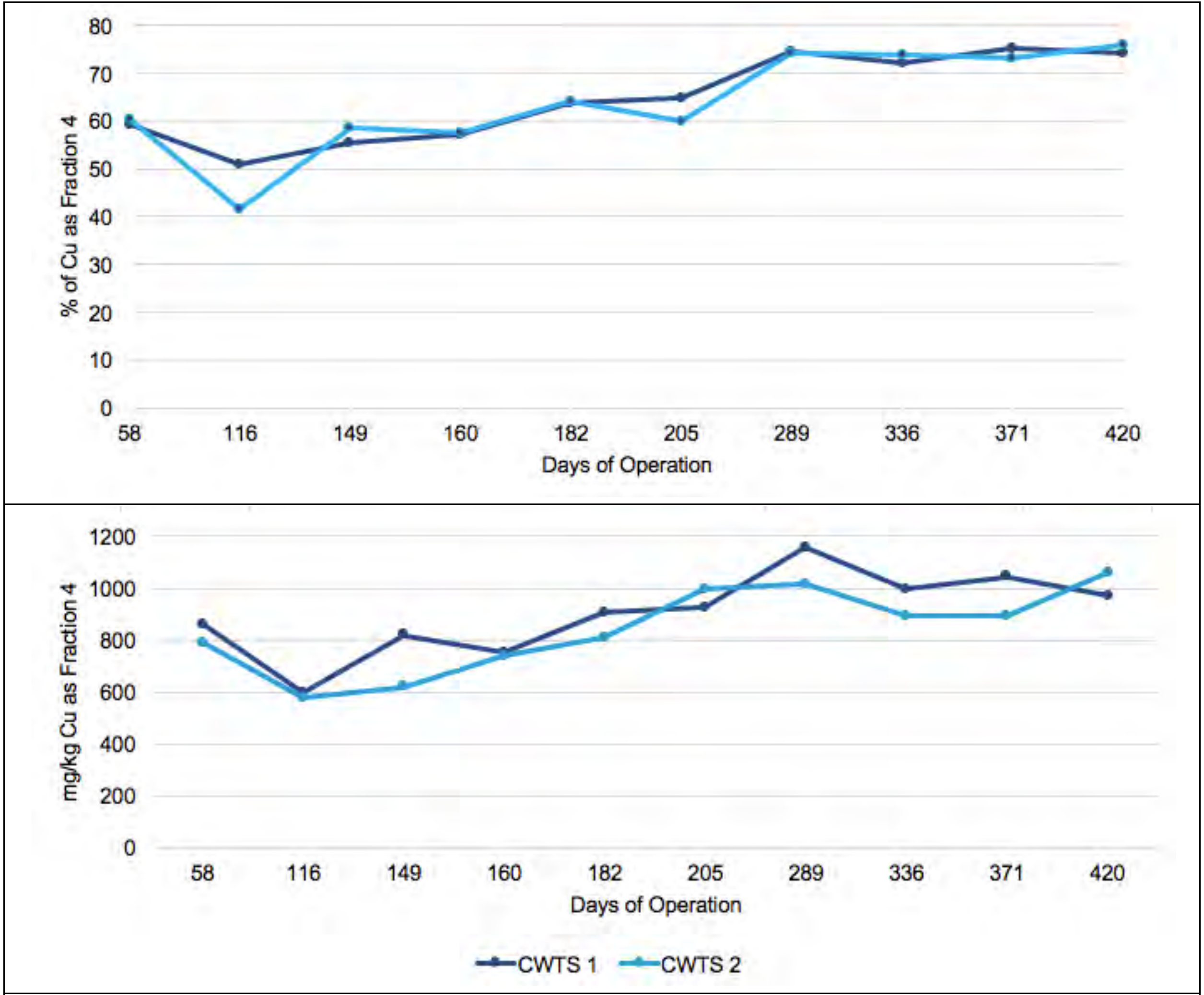


Figure 21 – Copper as sequential leach fraction 4 over time.
Copper in the form of the targeted Fraction 4 (sulphide mineral form and bound to organics), increased in the CWTS over time as the soils matured. Additional information can be found in Appendix B.

5.7. Metals Uptake

The following are key findings regarding metals uptake, which are detailed further below:

- Overall, uptake of metals in *C. aquatilis* was low and generally lower in 2017 than in 2016 demonstration-scale CWTS results.
- Targeted treatment mechanisms are becoming more robust, rendering elements non-bioavailable.

Concentrations of the constituents of concern in *C. aquatilis* and moss from the demonstration-scale CWTS in 2017 were compared to those from 2016. *C. aquatilis* and moss in the demonstration-scale CWTS had greater copper concentrations than the pilot CWTSs, likely reflecting the bioavailable copper that was in the soils used for construction. Concentrations of copper in the *C. aquatilis* at the end of 2017 were similar or lower than 2016 concentrations (Figure 22). The moss had higher copper concentrations in the A cells than in 2016, but lower concentrations in B cells, indicating more treatment earlier in the CWTS as it matures (Figure 22). Over time, constituents sorbed to mosses will form reduced minerals, rendering them less bioavailable.

Cadmium concentrations in *C. aquatilis* and moss were similar in 2017 and 2016, except for higher concentrations in cell 1B where concentrations were higher for *C. aquatilis*, (Figure 23). Similar selenium concentrations were observed in both plant types in 2017 as in 2016, (Figure 24; Contango, 2016 and 2017). Concentrations of molybdenum in moss generally decreased from 2016 to 2017, while concentrations of molybdenum in *C. aquatilis* decreased significantly and now remain around the detection limit (Figure 25). In 2017, overall concentrations of zinc decreased in *C. aquatilis* and moss from 2016, except for cell 1B in *C. aquatilis* and cell 2A in moss where concentrations of zinc remained the same (Figure 26).

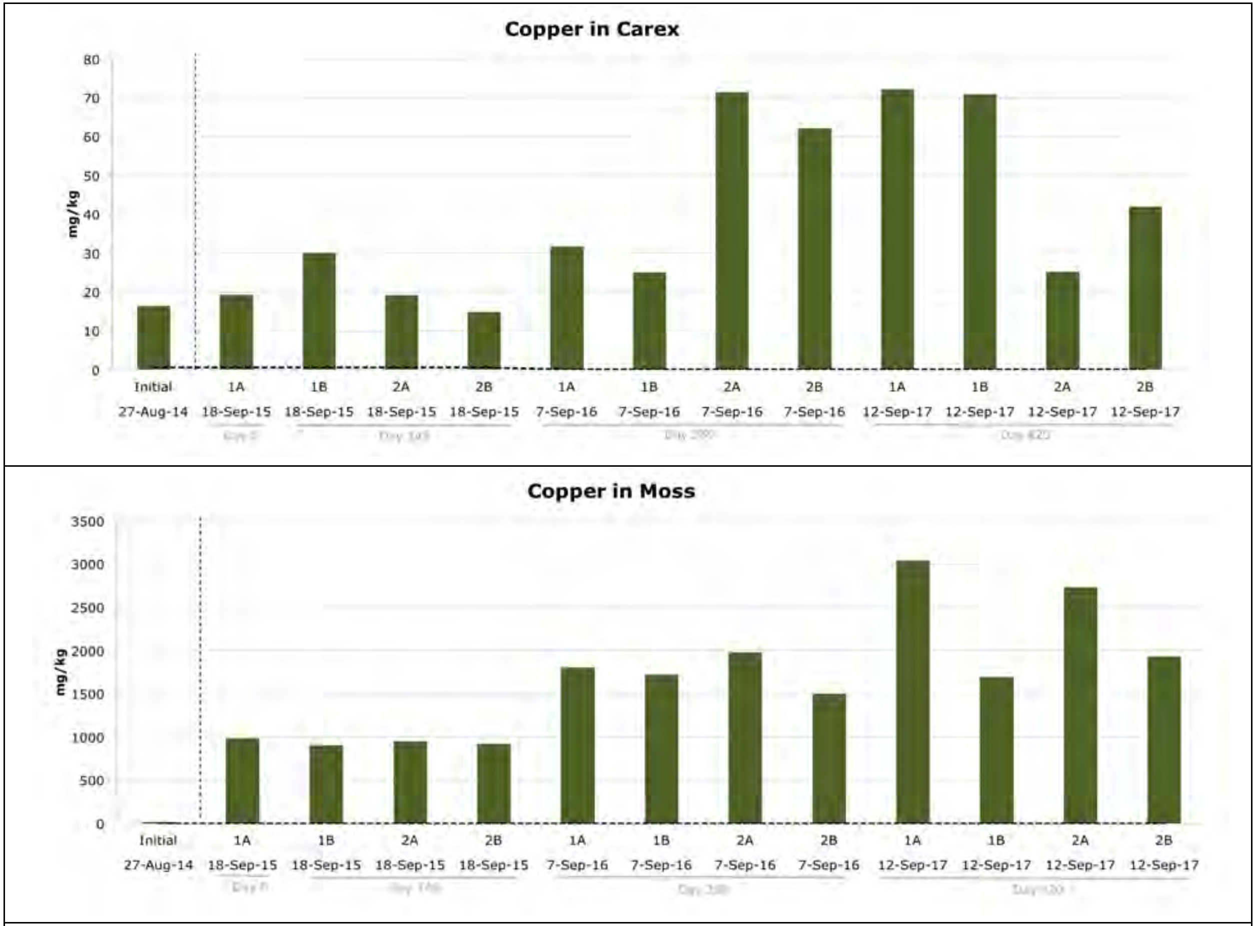


Figure 22 – Copper concentrations in plants.
The 2014 detection limit (DL; horizontal dotted line) for copper is 0.5 mg/kg, the 2015 DL is 0.1 mg/kg, and the 2016 and 2017 DL is 0.05 mg/kg. The initial data set is the average of three *Carex* replicates at construction.

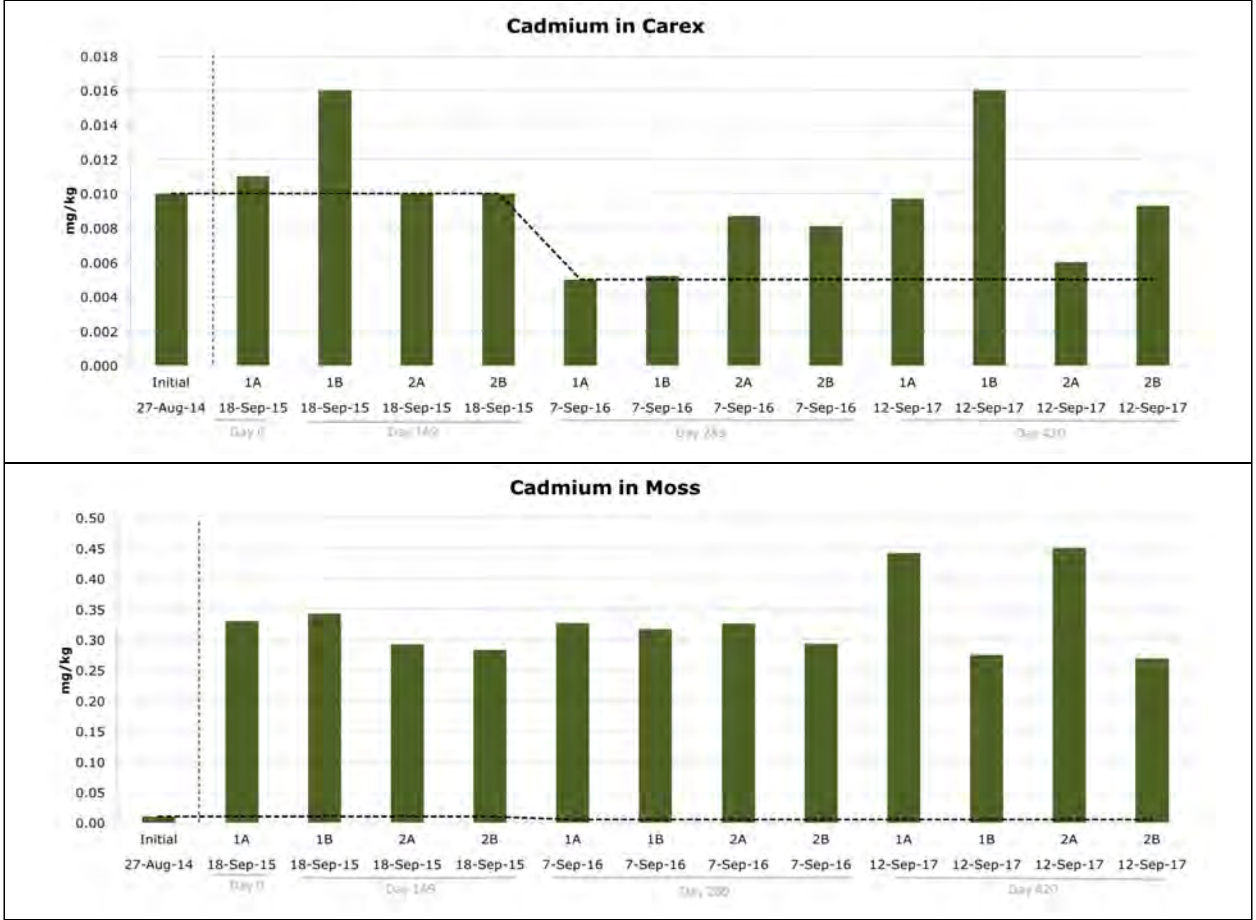


Figure 23 – Cadmium concentrations in plants.

The 2014 and 2015 detection limit (DL; horizontal dotted line) for cadmium is 0.10 mg/kg. The initial data set is the average of three *Carex* replicates at construction.

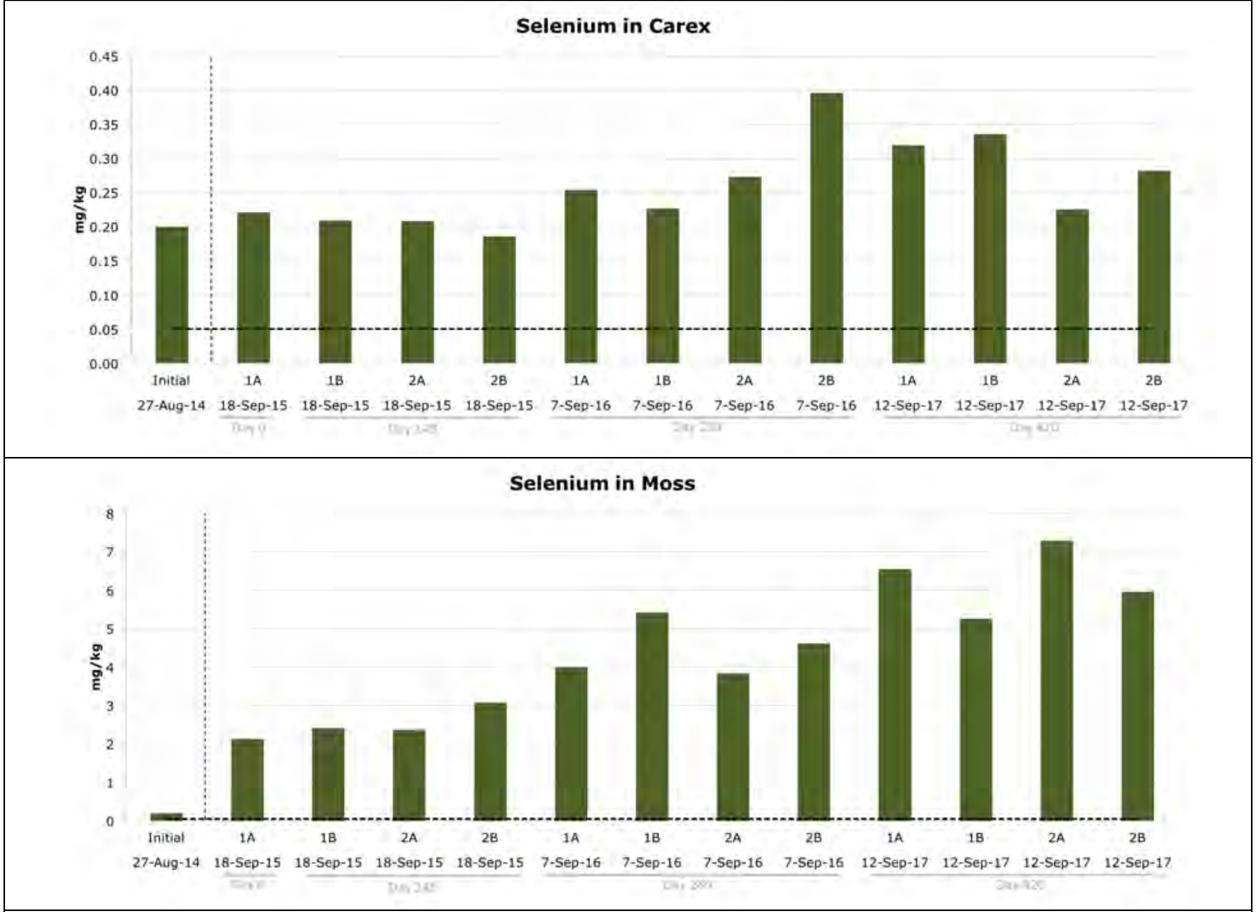


Figure 24 – Selenium concentrations in plants.
The method detection limit (DL; horizontal dotted line) for selenium is 0.2 mg/kg. The initial data set is the average of three *Carex* replicates at construction.

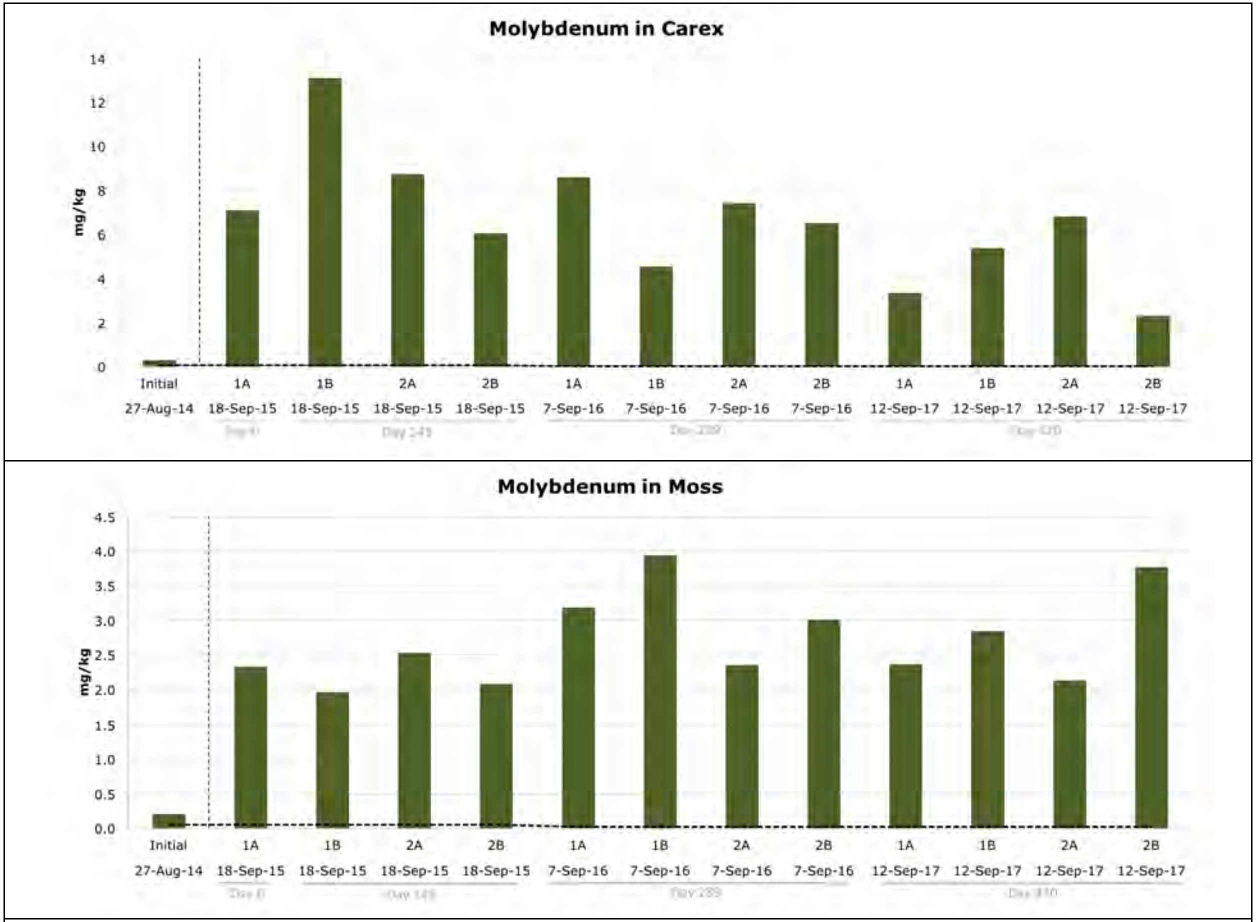


Figure 25 – Molybdenum concentrations in plants.

The 2014 and 2015 detection limit (DL; horizontal dotted line) for molybdenum is 0.05 mg/kg, the 2016 and 2017 DL is 0.020 mg/kg. The initial data set is the average of three *Carex* replicates at construction.

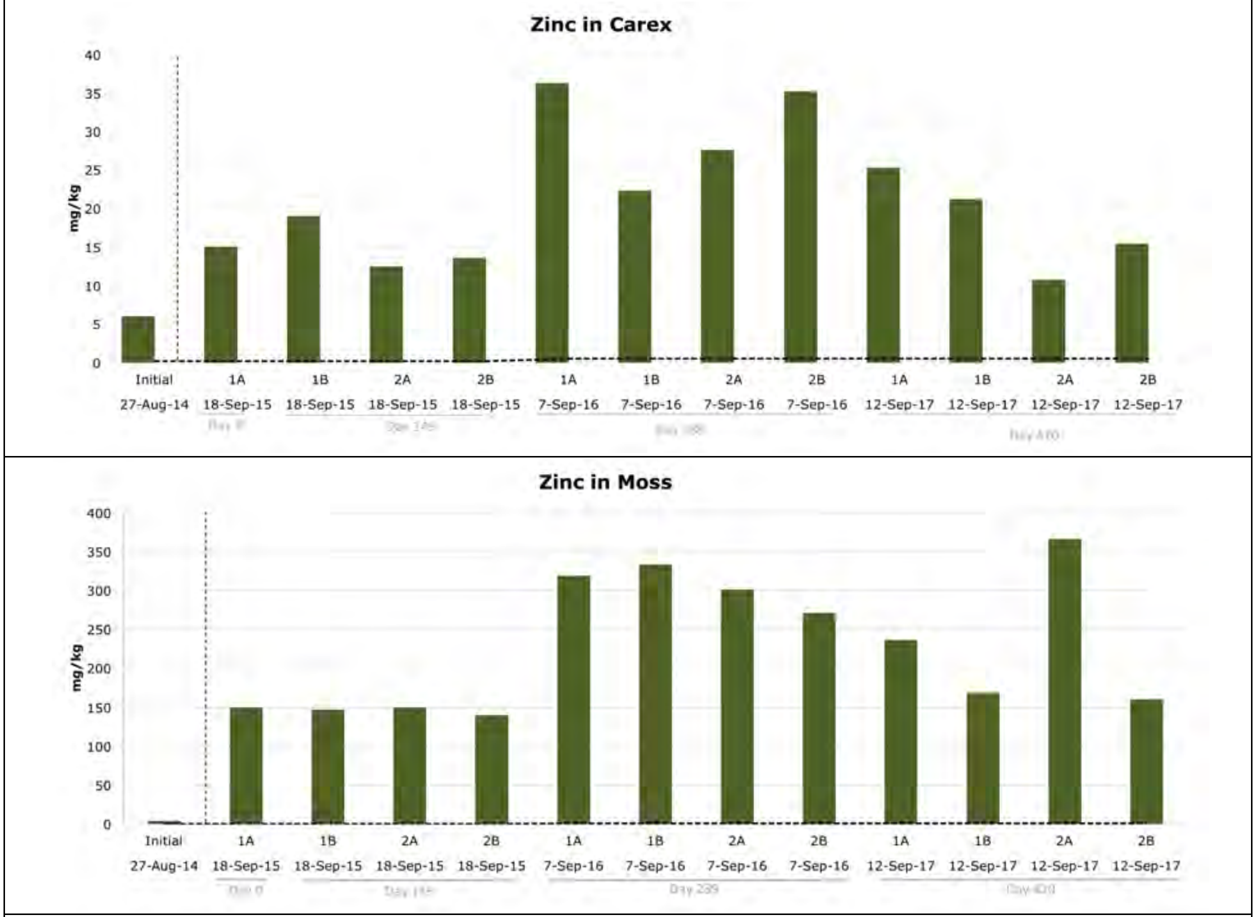


Figure 26 – Zinc concentrations in plants.
The 2014 detection limit (DL; horizontal dotted line) for zinc is 2.0 mg/kg, the 2015 DL is 0.002 mg/kg, and the 2016 and 2017 DL is 0.5 mg/kg. The initial data set is the average of three *Carex* replicates at construction.

5.8. Detritus Study

The following are key findings regarding the detritus study, which are detailed further below:

- The detritus study suggested that algae growth on the assay devices had reached a steady state (growth vs decomposition) by ~23 days of the study.
- After 83 days submerged in the CWTS, *C. aquatilis* decomposed on average 64%.

A detritus study was conducted in 2017 to assess decomposition rates of *C. aquatilis* in the CWTS over time as well as to determine the steady state of carbon contribution from algae growth on CWTS materials (Chimney and Pietro, 2006; Hammerly et al., 1989). Additional details describing the methods can be found in Appendix A. The study began on June 21, 2017 when six bags filled with 5g of oven dried *C. aquatilis* were submerged into each CWTS cell to determine the decomposition rate of *C. aquatilis* (Figure 27). Variability between samples are indicated by error bars (minimum and maximum values) in Figure 28. Six additional bags filled with 3.8 g of polyester filter fiber material were submerged into each cell of the CWTS to determine the algae growth rate. On July 25, 2017 and September 11, 2017 (after 34 and 83 days of submersion in the CWTS, respectively) one bag filled with *C. aquatilis* and one bag with the polyester fiber were sacrificed from each CWTS cell and the dried weights compared to initial sample weights (Table 9). This resulted in four replicates for each treatment and sampling date.

The weight of the polyester fiber bags increased by an average 23% after 34 days, and by 21% after 83 days, suggesting that the algae growth had reached a steady state prior to 34 days. After being submerged for 34 days in the CWTS, *C. aquatilis* decomposed on average 56% from the initial weight (decreasing from 5 g to 2.2 g) and continued to decompose to an average of 64% (decreasing from 5 g to 1.8 g) after submersion for 83 days in the CWTS (Table 9). There was little variability between cells. These detritus decomposition rates have been adjusted for by subtracting the weights of algal growth of the corresponding polyester fiber filled bag (Appendix A).

Four bags of each material remain in each cell for future sampling. The detritus study will continue in 2018 to enable monitoring and calculation of decomposition and accretion rates.

Figure 27 – Detritus study bags.

Left are mesh bags filled with sedges and polyester fiber fill stuffing. Left are mesh bags with *C. aquatilis* and control polyester prior to addition to the CWTS, middle are bags submerged in a CWTS cell and attached to depth stick, and right is a mesh bag with decomposed sedges and polyester fiber fill stuffing.

Table 9 – Results of the *C. aquatilis* detritus study.

	Initial weight of *C. aquatilis* (g)	Dry weight after 34 days (g) [2]	Decrease in weight after 34 days (%)	Dry weight after 82 days (g) [2]	Decrease in weight after 83 days (%)
1A	5.0[1]	2.1	57%	1.7	65%
1B		2.1	59%	1.7	67%
2A		2.3	54%	2.0	61%
2B		2.4	52%	1.9	63%
Average		2.2	56%	1.8	64%

[1] Initial weight prior to bags being placed in CWTS.

[2] Weights of *C. aquatilis* corrected by subtracting the increase in weight from the polyester fiber fil to account for algae growth.

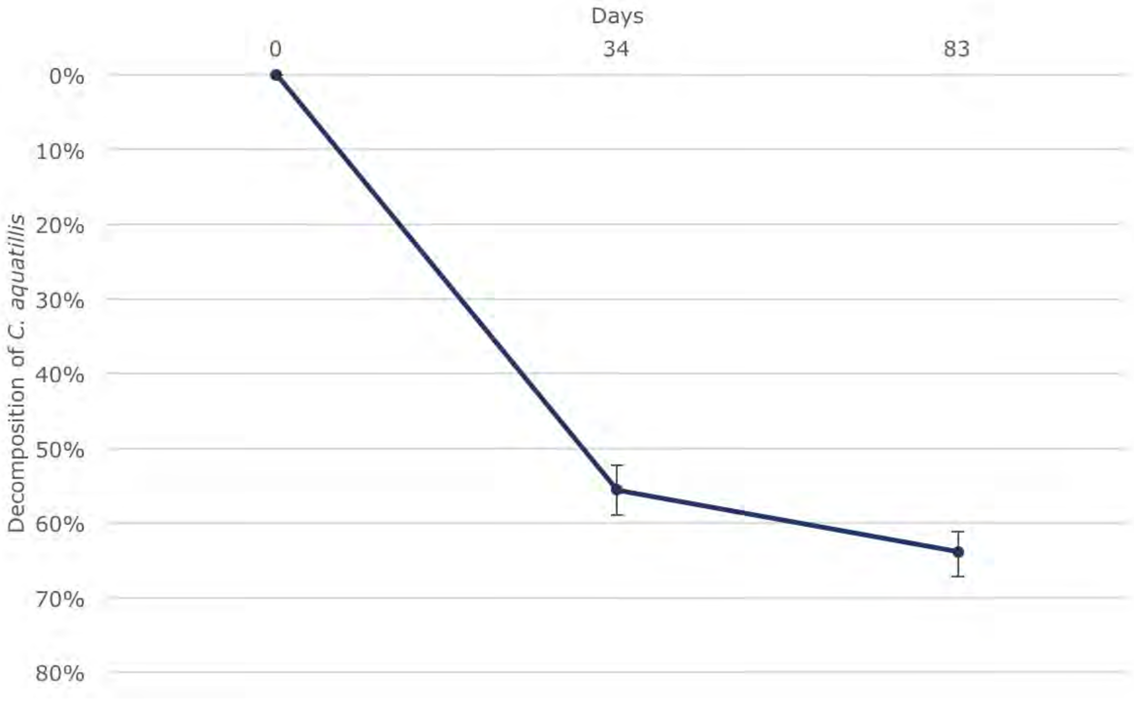


Figure 28 – *C. aquatilis* decomposition over time.

Decomposition was measured by the decrease in weight over time of the *C. aquatilis* samples compared to the initial weight. The decomposition rate was corrected for algae growth by subtracting the increase in weight of the polyester filter foam from the dry weight of the *C. aquatilis* samples over time. Error bars indicate the variation in results for each time point.

5.9. Beneficial Microbes

The following are key findings regarding beneficial microbe establishment in the CWTS, which are detailed further below:

- Establishment of sulphide-producing bacteria (SPB) increased throughout 2017 and was highest after commissioning was completed.
- SPB were found in highest abundance in root and soil samples.
- The average number of different types of sulphide-producing bacteria increased over time in all sample types tested (root, soil, detritus, and moss).
- Selenium-reducing and nitrate-reducing bacteria increased over time with the highest abundances found in *C. aquatilis* roots.

Microbes are the driving force of many treatment pathways that are targeted in CWTSs. The beneficial microbes in these CWTSs catalyze biogeochemical processes that remove specific constituents of concern from the water column. Careful design of CWTSs can create the environmental conditions needed to enhance the abundance and metabolic activity of these beneficial microbes. Accordingly, complimentary methods of genetic and growth-based testing were used to characterize the microbial populations associated with a range of microbial habitats in the demonstration-scale CWTS (e.g., soils, sediment, biofilms, aquatic mosses, and plant roots).

In the context of the Minto Mine CWTS, beneficial microbes include those that are involved in the reduction of selenium (i.e., selenate and selenite), nitrate, and sulphur compounds. Reduced sulphur can in turn treat copper, cadmium, molybdenum, and zinc through geochemical interactions. Information on each of these mechanisms and the associated microbial populations in the demonstration-scale CWTS is outlined in the following sections.

5.9.1. Sulphide-producing Bacteria

Treatment of metals and metalloids can be achieved by targeting the lithic biogeochemical sequestration of divalent metals through sulfide (i.e., S^{2-}, HS^{-}) precipitation as mineralized species (e.g., covellite [CuS], chalcocite [Cu_2S]). These sulfide-bound species are relatively insoluble (CuS; $K_{sp} = 10^{-16}$; Stumm and Morgan 1996) and are transferred from the water column into the CWTS soil as non-bioavailable fractions (Murray-Gulde et al., 2003; Huddleston et al., 2008). Moreover, similar reactions occur with cadmium and zinc, rendering them non-bioavailable. As such, sulphide production is a key biogeochemical mechanism for water treatment at Minto Mine. Sulphides can be created by beneficial microorganisms through the reduction of sulphur-containing compounds, such as sulphate, sulphite, thiosulphate, and elemental sulphur.

Based on the information gathered in pilot-scale testing, the targeted soil redox for the demonstration-scale CWTS is between -100 and -250 mV to facilitate these reactions. This is in agreement with literature that indicates anaerobic conditions with relatively low ORP (-250 to -100 mV) are necessary to promote anaerobic metabolism in bacteria which oxidizes organic matter and produces electrons, which in turn reduces sulfate to hydrogen sulfide (H_2S) and other sulfide species (i.e., bisulfide ion (HS^-), sulfide ion [S^{2-}]; Mitsch and Gosselink 2007). In these redox ranges, bacterial sulphide-production through reduction of sulphur compounds is expected, alongside increases in the proportion (percentage) and abundance of these microbes.

As expected, diversity (Table 10), proportion, and inferred abundance of sulphide-producing bacteria (SPB) increased as the soil redox decreased in the demonstration-scale CWTS with the highest proportions observed in 2017 compared to 2016, as the CWTS has matured (Figure 29, Figure 30, Figures B28 and B29 in Appendix B; Contango, 2017). Proportions of SPB increased in all sample types (soil, roots, moss, and detritus) over time through 2017 (Table 10). As observed in 2016, the *C. aquatilis* roots were again found to harbour the highest proportions and abundances of beneficial SPB, followed by the soil, detritus, and moss. Furthermore, the highest proportions were observed in the operational period for both soil and root samples. Root, detritus, and soil samples harboured the highest average number of different SPB types, followed by moss (Table 10). However, the average number of different types of SPB increased over time in every sample type tested.

The microbial analysis of various sample types in the CWTS has therefore confirmed that the commissioning period proceeded as expected and was successful in establishing beneficial SPB populations alongside reducing conditions. Monitoring of soil redox as well as microbial populations will continue to be monitored for stability or further improvement in 2018.

Table 10 – Average number of different types of sulphide-producing bacteria in 2014/2015, 2016, and 2017.

Sample Type	2014 & 2015	2016	2017
detritus	NT	6	9
moss	3	4	8
root	6	8	9
soil	4	8	9

NT – not tested. The number of different types is based on counting the number of operational taxonomic units (clustered at 97% identity) that are classified as known sulphide-producing bacteria.

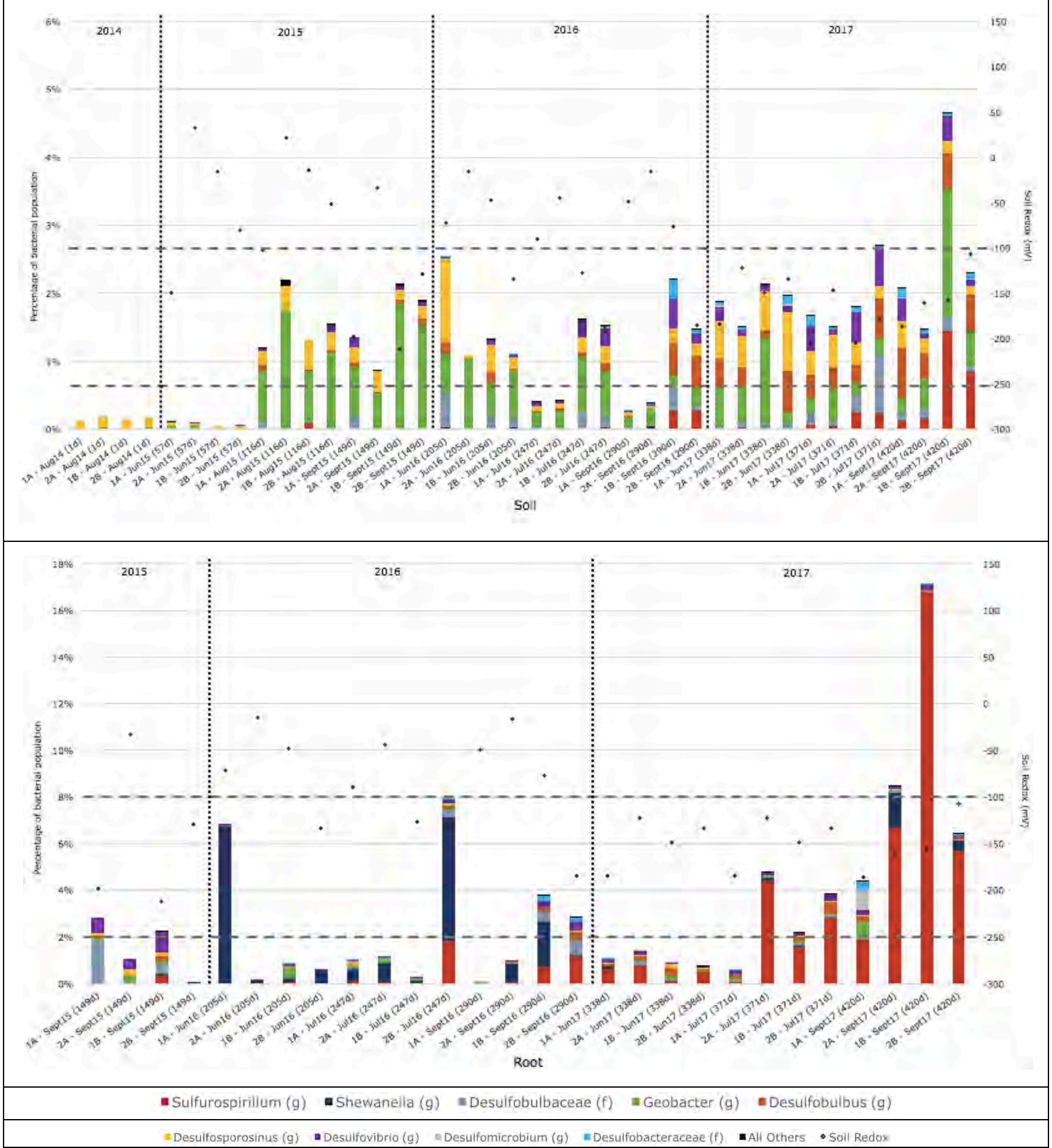


Figure 29 – Percentage and identity of sulphide-producing bacteria in soil (top) and roots (bottom) demonstration-scale CWTS.

The horizontal dashed lines indicate the targeted soil redox range. Organism classifications and data analysis methods have been updated from Contango (March 2016). The y-axis provides the percentage of the bacterial community (relative abundance) that corresponds to sulphide-producing bacteria through the reduction of sulphate, sulphite, thiosulphate, and sulphur. Percentage is based on identification via genetic sequencing. Organisms are either classified to the genus (g) or family level (f). The root y-axis is different from the soil y-axis as the % SPBs is much higher in one sample of root (1B – Sept17 (420d)).

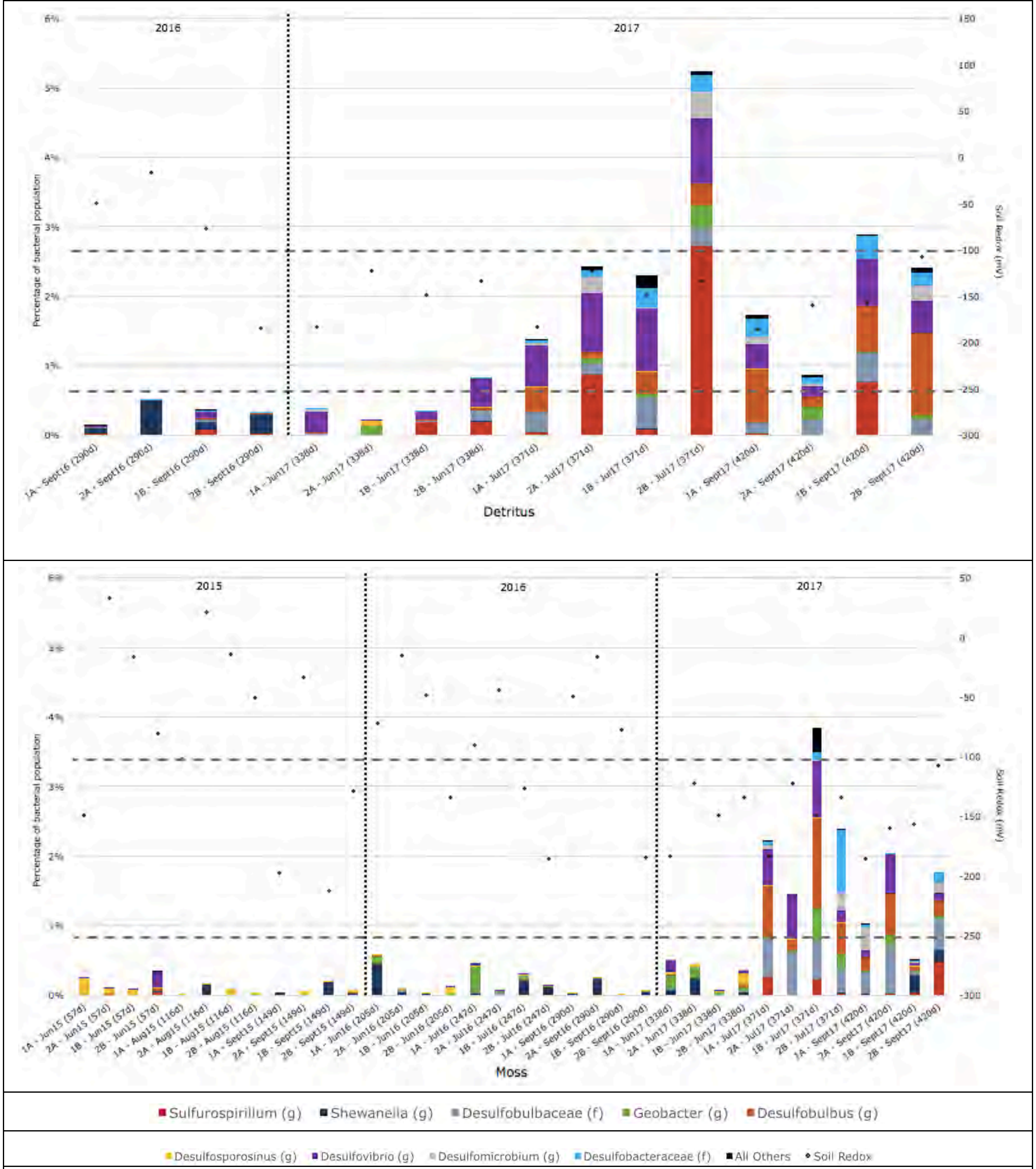


Figure 30 – Percentage and identity of sulphide-producing bacteria in detritus (top) and moss (bottom) demonstration-scale CWTS.

The horizontal dashed lines indicate the targeted soil redox range. Organism classifications and data analysis methods have been updated from Contango (March 2016). The y-axis provides the percentage of the bacterial community (relative abundance) that corresponds to sulphide-producing bacteria through the reduction of sulphate, sulphite, thiosulphate, and sulphur. Percentage is based on identification via genetic sequencing. Organisms are either classified to the genus (g) or family level (f).

5.9.2. Selenium-reducing Bacteria

The targeted selenium treatment pathways in the Minto CWTS include sorption to moss and soils, and subsequent microbial reduction of soluble (sorbed) selenate (Se(VI)) and selenite (Se(IV)) to insoluble elemental selenium (Se (0)). This reductive process can also be achieved directly in the water column, but is more effective when associated with mosses and biofilms due to their sorptive properties that bring the selenium in contact with beneficial selenium-reducing bacteria. Selenium reduction biogeochemical processes are achieved within the range of soil redox conditions targeted for sulphate-reduction as suggested by pilot-scale testing and literature (Contango, 2014).

Selenite-reducing organisms are ubiquitous in nature and as expected, were detected in all sample types, including algae, biofilm, moss, soil, sediment, roots, and detritus. Although organisms that reduce selenate to elemental selenium (rather than intermediary selenium compounds) are generally less abundant in the environment, they were found associated with all sample types, indicating that the conditions conducive to their proliferation have been created within the CWTS. Moreover, the abundance of selenite- and selenate-reducing organisms generally increased or remained stable over time in the demonstration-scale CWTS through the commissioning and operational periods in (Figure B30 in Appendix B). Aquatic mosses were found to initially host the highest abundance of both selenate- and selenite-reducing organisms, affirming the importance of the inclusion of moss in the CWTS. Over time, as the vegetation has established, selenium-reducing bacteria have increased in abundance on the roots of *C. aquatilis* (Figure B30 in Appendix B).

These findings indicate the commissioning period was successful and the demonstration-scale CWTS has established and maintained beneficial selenium-reducing microbes. Selenium is removed as it is sorbed to moss or detritus or by interacting directly with selenium in water that has been drawn into the root zone by plants. Abundance of selenium-reducing bacteria is similar to that found through 2016 and during pilot-scale soil testing, suggesting they have established as expected. Selenium-reducing microorganisms will continue to be monitored in 2018, alongside performance testing.

5.9.3. Nitrate-reducing Bacteria

Nitrate is sometimes a constituent of concern during operations and early closure owing to residuals from blasting activities. Even if not in exceedance of water quality guidelines in terms of receiving environment objectives, nitrate often requires treatment in order to subsequently achieve treatment of other constituents such as selenium and metals through sulphide production. Nitrate can be removed from water through denitrification by different types of microbes, including nitrate reducing bacteria which can reduce nitrate (NO_3) to nitrite (NO_2), and also denitrifying organisms that are capable of fully reducing nitrate to nitric oxide (NO), nitrous oxide (N_2O), and dinitrogen gas (N_2, which is the most abundant gas in air). Most-probable number (MPN) analysis was therefore used to quantify these organisms.

As observed in 2016, nitrate-reducing and denitrifying organisms were found associated with all sample types in the demonstration-scale CWTS (Figure 31; Contango, 2017). Roots and detritus had a high abundance of both nitrate and denitrifying organisms, with soil being similar to or slightly less than what was found during pilot-scale testing. These results indicate nitrate reducers have established in the CWTS during the commissioning period as expected. Nitrate-reducing microorganisms will continue to be monitored in 2018, alongside performance testing.

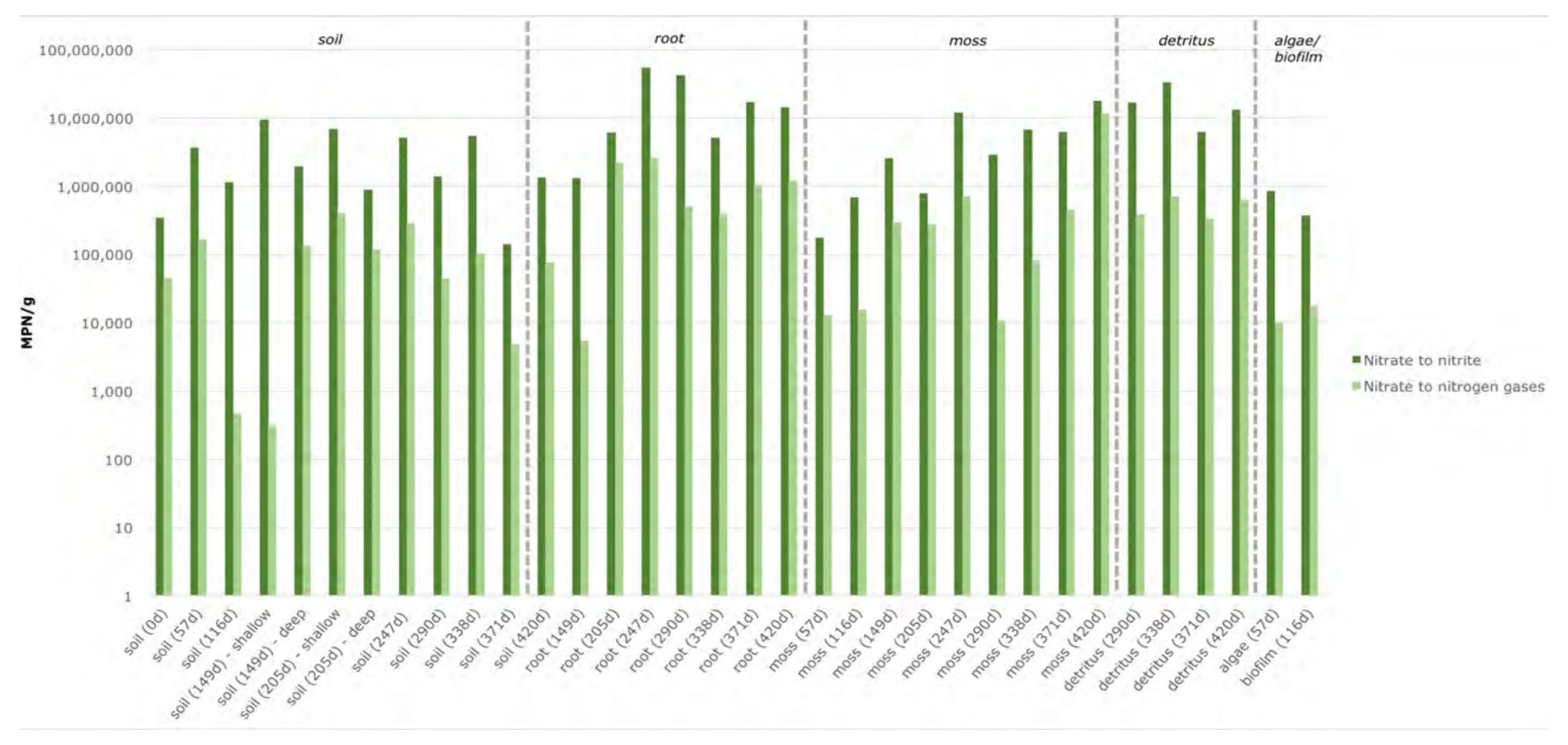


Figure 31 – Abundance of nitrate-reducing and denitrifying organisms in various CWTS sample types over time.
Nitrate-reducing = reduction of nitrate to nitrite; denitrifying = reduction of nitrate to nitrogen gases.
Shallow soil (0-5 cm); deep soil (10-20 cm); soil at 0d was that used for construction of CWTS.

6. Operational Challenges

The following are key findings regarding operational challenges, which are detailed further below:

- Aphids were again found in abundance on *C. aquatilis* in 2017.
- Efforts to control the aphid population on-site were made but an ongoing spraying regiment was not maintained and, therefore, aphids remained. However, no short-term detrimental effect on *C. aquatilis* viability was observed, despite the persistence of aphids.
- Damage to the above water vegetation was observed however new shoots were emerging in the CWTS and treatment COCs was not impacted by damage to the above water vegetation.
- Effects of aphids on *C. aquatilis* did not affect treatment.
- These issues with aphids are likely owing to the isolated nature of the demonstration-scale CWTS and not expected to affect the full-scale CWTS.

The Minto Mine's demonstration-scale CWTS, which is constructed of an emergent macrophyte monoculture of *Carex aquatilis*, experienced an aphid infestation in 2016 and 2017. The demonstration-scale CWTS is located in a relatively isolated area, away from other vegetation and potential sources of insects. It is known that aphids can migrate on air currents (Dixon, 1971), possibly over great distances (Riley et. al., 1995), which may be how they reached the demonstration-scale CWTS. Aphids are often monophagous, meaning they feed on one species of plant (Foottit and Maw, 1997) and it is likely that having additional vegetation available will not reduce the level of infestation on the *Carex* species planted in the CWTS. However, if additional surrounding vegetation is available, it could provide habitat for natural predators of aphids. With the demonstration CWTS currently located 50 m away from trees or other vegetation, there is little to no opportunity for natural predators to inhabit the area or incentive to travel the distance to the CWTS. The large buffer area (MVFE) around the demonstration-scale CWTS allows the aphids to colonize more robustly than anticipated in the full-scale CWTS onsite, which would not have the same buffer zone. This would not be an issue in the full-scale CWTS.

Aphids can be controlled, naturally, by predatory insects such as ladybugs, lacewings, and parasitic wasps (Flint, 2001). Ladybugs were observed in very small numbers on the *Carex* plants but in insufficient numbers to control the aphid population. Lacewings are found throughout North America and would be expected to be present in the Minto Mine region (Russel and Diaz, 2015). Several types of parasitic wasps that prey on aphids are known to be present in the Yukon (Finnamore, 1997). Other control methods involve the use of insecticidal soaps, which are recommended as they are non-toxic to most other insects and kill aphids through contact (the soft bodies are suffocated by the fatty acids in the soap; Ubl and Munnerlyn, 2009).

To quantify the aphid population on-site, sticky, yellow insect traps were installed at W10 and W15 as well as eight (two per cell) in the CWTS in 2017 (Figure 32). However, none of the traps at any of the locations were successful in trapping aphids and instead trapped numerous other insects. It was observed that the sticky traps at W10 and W15 trapped a larger quantity and diversity of insects compared to the traps installed in the CWTS. This suggests that the larger population and diversity at the W10 and W15 areas assisted with keeping aphid populations under control in these areas. Due to the isolated area of the CWTS, away from other vegetated areas, the CWTS hosted a smaller quantity and diversity of insects which were not able to keep the aphid population under control.

Efforts were made in 2017 to control the aphid population by applying a mild insecticidal soap (Scott's EcoSense Bug B Gone Insecticidal Soap concentrate mixed with water) or a soap solution using a hand-held sprayer. Although the insecticidal soap was more effective than the soap solution, an ongoing spraying regiment was not maintained long enough to decimate the population. Care must be taken when using insecticidal soap to spray all surfaces of plant leaves, as aphids frequently inhabit the underside of leaves. Applications should be repeated every 4-7 days (follow label instructions) until pests are eliminated (Ubl and Munnerlyn, 2009). A stronger insecticidal soap (Trounce's Yard and Garden Insecticide) was applied on September 13, 2017 in another effort to reduce aphid populations; however, no discernable change was noticed, perhaps due to the lateness in the season. Insecticidal soaps with natural plant-based pyrethrins may provide control with fewer negative impacts than insecticides like malathion, permethrin, and acephate because pyrethrins break down quickly (Flint, 2001).

Series 1 of the CWTS appeared to have a larger aphid infestation and resulted in more damage to the above water vegetation. Regrowth will be monitored in 2018 and replanting of Series 1 may be required. The aphids will continue to be monitored in 2018 and compared with other background areas (e.g., W10 and W15) to see if increases in aphid populations are specific to the CWTS, or general to the area. In 2018, it is recommended that a stronger insecticide be applied early in the season and on a frequent, predetermined schedule.

Figure 32 - Insect traps.
Insect traps installed in CWTS cells (left and right), insect trap installed at W15 (center) in 2017.

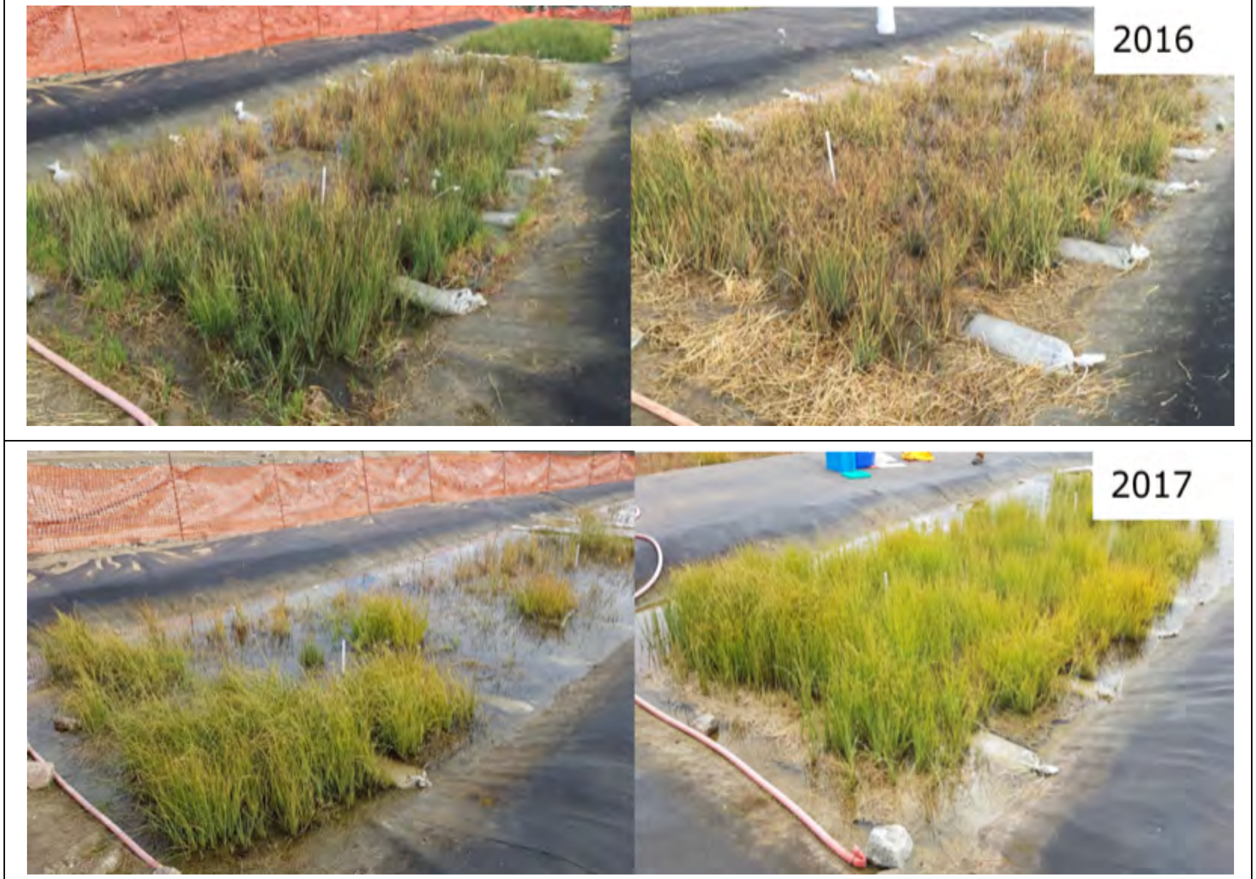


Figure 33 – Aphids observed in cell 1A and 2A in 2016 (top) and 2017 (bottom). Left pictures are of cell 1A. Right pictures are of cell 2A. Note the increased yellowing in cell 1A (2017) and cell 2A (2016, 2017) due to a denser aphid population.

Figure 34 – Aphids observed on *C. aquatilis.*
The left picture was taken in 2016 and the right picture was taken in 2017. Note the small green and black aphids on *C. aquatilis* leaves.

7. Summary of Results

When designed and implemented in a strategic and scientifically guided manner, CWTS can mitigate risks posed by many constituents. A treatment plan including processes to precipitate insoluble species of these constituents for sequestration into the soils of the wetland are very desirable as this mechanism captures the constituents and stores them in stable form in the soil, rather than transferring the constituents to an indeterminate fate (e.g., through plant uptake that can potentially bio accumulate in wildlife or be re-released in plant decomposition). This study addressed several important design considerations regarding implementation of a CWTS at full-scale for the treatment of metals and metalloids to meet the overriding objective of completing commissioning of the CWTS and progress through operational performance. A summary of key findings from the 2017 studies and recommendations to meet the objectives are listed below.

Monitor explanatory parameters and performance to determine when commissioning is complete, and the operational period has begun:

- Dissolved oxygen (DO) decreased from an average of 8.4 mg/L during commissioning-B in 2016, to an average of 5.3 mg/L during operations in 2017. The DO in the water column is likely the result of photosynthesis of algae and mosses.
- Despite this DO level in the water column being in oxidizing ranges, stable reducing conditions were achieved in the CWTS soils within the targeted soil redox range (-100 to -250 mV).

Assess removal of constituents from the water:

- Copper treatment in the CWTS was masked by leaching from the soils used in construction of the CWTS into the water, but this has mostly been remedied now by the wetland treating this copper and turning it into more stable sulphide forms in the soil.
- During the operational period the demonstration-scale CWTS successfully achieved an average decrease in concentrations of 0.0169 µg/L for cadmium (from 0.0261 µg/L to 0.0092 µg/L), 31.8 µg/L for copper (from 49.1 µg/L to 17.3 µg/L), 3.6 µg/L for molybdenum (from 6.3 µg/L to 2.7 µg/L), 3.5 µg/L for selenium (from 4.0 µg/L to 0.5 µg/L), and 47.3 µg/L for zinc (from 49.2 µg/L to 1.9 µg/L).
- Molybdenum and selenium treatment in the operational period is notable as the removal rates were negligible within the margins of error of the testing method in the commissioning-A period.

Determine the hydraulic residence time (HRT) by tracer study and associated correction factor to apply to the nominal (calculated) HRT:

- The tracer study effectively demonstrated the HRT (2.25 days) and flow symmetry through the CWTS.
- There was a single flow path in the CWTS (shown by a single peak in the tracer study)
- Water is incorporating into the CWTS soils (shown by the long tail for depletion of the tracer).

- The nominal HRT is calculated from the area of the CWTS and the depth at the in-situ measuring points. This nominal HRT does not account for depth variations, embankment slopes, vegetation (using space in the water), or substrate pore space involvement. It was found that once all of these factors are in play, the correction factor from nominal to actual is only 0.01 added to the depth of the CWTS, which is incorporated into the HRT calculation as expressed in Equation 3.

Evaluate CWTS performance, and determine achievable concentrations of contaminants of concern (thermodynamic minimums):

- All targeted constituents are being treated by mineralization and sequestered to the soils (minimal plant uptake).
- The lowest concentrations consistently achievable for the treatment design (thermodynamic minimums) were reached by the end of the A cells for cadmium and copper.
- RRCs for cadmium and zinc in the 2017 demonstration-scale CWTS were artificially low because low flow rates did not provide the resolution needed to determine a RRC.
- Removal rate coefficients (RRCs, *k*) have been developed that can be used for full-scale sizing.
- Copper leaching from soils has decreased but is still likely making the RRC artificially low in this CWTS; however, the RRC is expected to improve once copper leaching has subsided.

Update site-specific removal rate coefficients (from commissioning period) with data from operational period:

- Removal rate coefficients (RRCs, *k*) have been developed that can be used for full-scale sizing.
- Copper leaching from soils has decreased but is still likely making the RRC artificially low in this CWTS.

Determine amount of water loss due to evapotranspiration and effect on outflow concentrations:

- The evapotranspiration studies revealed a significant loss of water, which will impact calculations of loads to the receiving environment (making them lower than previously estimated).
- In May and June, an average water loss of 5.3 L/day/m^2 was observed, which is equivalent to 18-20% of water (~700 L/day lost in the demonstration CWTS).
- During the evapotranspiration trials, copper leached into the water as it was transformed from an oxide mineral to a sulphide mineral (because of the copper in the soils used for construction). This is not representative of what would occur during periods with no flow in a full-scale CWTS, where soils with minimal leachable copper are used and copper is deposited in sulphide form (fraction 4) by the biogeochemical activity of the CWTS (Section 5.6).

Monitor metals leaching from mineralized soils used in construction:

- In 2017, leachable copper concentrations in soils decreased in the top 0-10cm while total copper concentrations increased.

Assess stability of constituents of concern in soils:

- Most constituents, including copper, have shifted primarily into stable reduced and residual minerals fractions in the soil.
- Acid volatile sulphides (AVS) were non-detectable in the CWTS in 2016. In 2017, small amounts of AVS were detected in cells 1A and 2A which indicates that residual sulphides are starting to become available for metal treatment and that copper in the soils are becoming rendered inert through sulphide mineralization.

Determine the rate and extent of detritus decomposition (*C. aquatilis* leaves) in the CWTS over time:

- The detritus study suggested that algae growth on the assay devices had reached a steady state (growth vs decomposition) by ~23 days of the study.
- After 83 days submerged in the CWTS, *C. aquatilis* decomposed on average 64%.

Assess treatment mechanisms (including microbes):

- Establishment of sulphide-producing bacteria (SPB) increased throughout 2017 and was highest after commissioning was completed.
- SPB were found in highest abundance in root and soil samples.
- The average number of different types of sulphide-producing bacteria increased over time in all sample types tested (root, soil, detritus, and moss).
- Selenium-reducing and nitrate-reducing bacteria increased over time with the highest abundances found in *C. aquatilis* roots.

Determine an appropriate method for insect pest control (aphids) in the CWTS:

- Aphids were again found in abundance on *C. aquatilis* in 2017.
- Efforts to control the aphid population on-site were made but an ongoing spraying regiment was not maintained and, therefore, aphids remained. However, no short-term detrimental effect on *C. aquatilis* viability was observed, despite the persistence of aphids.
- Damage to the above water vegetation was observed however new shoots were emerging in the CWTS and treatment COCs was not impacted by damage to the above water vegetation.
- Effects of aphids on *C. aquatilis* did not affect treatment.
- These issues with aphids are likely owing to the isolated nature of the demonstration-scale CWTS and not expected to affect the full-scale CWTS.

9. Closure

We trust the information herein satisfies your present requirements. Should you have any questions, please contact the persons listed below. We appreciate the opportunity to provide the services detailed in this report and look forward to discussing any comments you may have.

Respectfully submitted,

Contango Strategies Ltd
Prepared by:

Monique Simair (Haakensen), PhD, RPBio, PBiol, EP
President & Principal Scientist

Rachel Martz, BSc
Environmental Scientist

COLLEGE OF APPLIED BIOLOGY
Monique
Haakensen
R.P. Bio
2671
CAB

B Eisner

Bryanna Eisner, BSc
Junior Scientist

With contributions from:
Vanessa Friesen, PhD, EP
Christie Brizinski, dip BT

10.References

Beebe, D.A., Castle J., Molz, F.J., and Rodgers, J. (2014). Effects of evapotranspiration on treatment performance in constructed wetlands: Experimental studies and modelling. Journal of ecological engineering vol 71 pp. 394-400.

Chimney, M.J., and Pietro, K.C. (2006). Decomposition of macrophyte litter in a subtropical constructed wetland in south Florida (USA). Ecol. Eng. *27*, 301–321.

Contango Strategies. (2014a). Minto Mine Constructed Wetland Treatment Research Program - Site Assessment. YESAB Registry documents number 2013-0100-256 and 2013-0100-257. March 24, 2014. Available at http://www.yesabregistry.ca/wfm/lamps/yesab/lowspeed/projectdetails.jsp;time=1510008082247.

Contango Strategies. (2014b). Minto Mine Constructed Wetland Treatment Research Program – Pilot Scale Report. November 3, 2014.

Contango Strategies. (2015). Minto Mine Constructed Wetland Treatment Research Program – Demonstration Scale. March 22, 2015. Document #011_0315_01A.

Contango Strategies. (2016). Minto Constructed Wetland Treatment Research Program – Demonstration Scale 2015 Update. March 2016. Document #011_0316_03B.

Contango Strategies. (2017). Minto Mine Constructed Wetland Treatment Research – Demonstration Scale 2016 Update. February, 2017. Document #011_0217_05B.

Dixon, A.F.G. (1971). Migration in aphids. Sci. Prog. 59:41-53.

Faulkner, S.P., Patrick, W.H. Jr. and Gambrell, R.P. (1989). Field techniques for measuring wetland soil parameters. Soil Science Society of America Journal, Vol. 53, pp. 883-890.

Finnamore, A.T. (1997). Aculeate wasps of the Yukon (Hymenoptera: Aculeata), other than Formicidae. Insects of the Yukon pp. 867-900.

Flint, M.L. (2001). Aphids: Integrated pest management for home gardeners and landscape professionals. University of California Davis, Integrated Pest Management Program. Accessed on August 16, 2017: http://ipm.ucanr.edu/PMG/PESTNOTES/pn7404.html.

Foottit, R. and Maw, E. (1997). Aphids of the Yukon. Biological Resources Program, Research Branch, Agriculture and Agri-Food Canada. Ottawa, ON.

Haines, W.P., Renwick, J.A.A. (2009). Bryophytes as food: comparative consumption and utilization of mosses by a generalist insect herbivore. Entomologia Experimentalis et Applicata 133(3): 296-306.

Hammerly, J., Leguizamon, M., Maine, M.A., Schiver, D., and Pizarro, M.J. (1989). Decomposition rate of plant material in the Parana Medio River (Argentina). Hydrobiologia *183*, 179–184.

Huddleston, G.M. III, Rodgers, J.H. Jr., (2008). Design of a constructed wetland for treatment of copper-contaminated wastewater. Environmental Geosciences 15, 9-19.

Longton, R.E. (1997). The role of bryophytes and lichens in polar ecosystems. In: Woodin, S.J., Marquiss, M. (eds). Ecology of Arctic Environments. Blackwell, Oxford, pp 69-96.

Mitsch, W.J. and J.G. Gosselink. (2007). Wetlands, 5th ed., John Wiley & Sons, Inc., New York

Murray-Gulde, C.L., Heatley, J.E., Karanfil, T., Rodgers, J.H. Jr., Myers, J.E., (2003). Performance of a hybrid reverse osmosis-constructed wetland treatment system for brackish water. Water Research 37, 705-713.

Murray-Gulde, C.L., Bridges, W.C., and Rodgers, J.H. (2008). Evaluating performance of a constructed wetland treatment system designed to decrease bioavailable copper in a waste stream. Env. Geosci *15*, 21–38.

Oakton Instruments. (1997). Tech Tip #8: Practical Considerations for Conductivity and Total Dissolved Solids Measurement. Oakton Reg. TM #1,692,543. Retrieved December 20, 2016 from: www.4oakton.com/TechTips/OAK_TT08.pdf

Riley, J.R., Reynolds, D.R., Mukhopadhyay, S., Ghosh, M.R., and Sarkar, T.K. (1995). Long-distance migration of aphids and other small insects in northeast India. Eur. J. Entomol. 92:639-653.

Russell, A. and Diaz, R. (2015). LSU AgCenter, Department of Entomology, Pub. 3483. Accessed on August 30, 2017: http://entomology.lsu.edu/assets/greenlacewings.pdf.

Stumm W & Morgan JJ. (1996). Aquatic chemistry, chemical equilibria and rates in natural waters. John Wiley & Sons, Inc. New York, NY, USA.

Suren, A.M., and Winterbourn, M.J. (1991). Consumption of aquatic bryophytes by alpine stream invertebrates in New Zealand. New Zealand Journal of Marine and Freshwater Research 25(3): 331-343.

Tessier, A., Campbell, P.G.C., and Bisson, M. (1979). Sequential Extraction Procedure for the Speciation of Particulate Trace Metals. Analytical Chemistry, Vol. 51, pp. 844-851.

Ubl, J.D. and Munnerlyn, C. (2009). HGIC 2771: Insecticidal soaps for garden pest control. Clemson University Cooperative Extension. Accessed on August 16, 2017: http://www.clemson.edu/extension/hgic/pests/pesticide/hgic2771.html.

Appendix R - 2017 Annual Socio-Economic Monitoring Report

capstone
MINTO MINE

Minto Mine
2017 Annual Socio Economic Monitoring Report

Prepared by:
Minto Explorations Ltd.
Minto Mine
March 2018

Contents

1 Introduction

This report has been prepared by Minto Explorations Ltd., a subsidiary of Capstone Mining Corp., in regards to the Minto Mine property (Minto), located in central Yukon. The following report summarizes the results of the socio economic available data at Minto for 2017, as required by the Socio Economic Monitoring Program framework.

The Minto Mine Socio-economic Monitoring Program (Minto Explorations, Yukon Government, Selkirk First Nation, 2014) is a program that has been developed in conjunction with Selkirk First Nation and the Yukon Government to monitor the socio economic effects of Minto Mine on SFN. The primary components of the program include; the mine providing information relating to SFN (e.g. employment data, training information etc.), a community based survey (conducted by SFN and YG), and information from SFN and YG relating to Pelly Crossing or SFN. The information from all of those components is then used in the preparation of an annual report produced by a third party consultant.

Not all of the data that has been requested from historical records is available. Going forward Minto will collect the required and necessary data in order to provide more accurate information for the bi-annual reports. Minto has given best efforts to collect and obtain historical data and going forward accuracy of information and data collection will continue to be further refined.

1.1 Factors at Minto that may have a socio-economic impact

The Minto Mine is an open pit and underground copper mine located 240 kilometres north of Whitehorse in central Yukon, Canada. Minto is located on Selkirk First Nation Category "A" land.

An initial cooperation agreement (CA) between Selkirk First Nation and Minto was agreed upon and signed in 1997, and was later amended in 2009. The agreement serves as a formal document that covers governance, business partnerships, training and employment, and royalties of the Minto Mine on Selkirk First Nations land.

The community of Pelly Crossing is located along the Klondike Highway on the banks of the Pelly River, 282 kilometers northwest of Whitehorse. Pelly Crossing is home to SFN people which includes 336 people (2011 census) 305 which are first nation. The average income of population aged 15 years and over in Pelly Crossing is $26,585 with the average house price being $274,106 (2011 National Household Survey). The median population age of Pelly Crossing is 38 years of age (2011 census).

The city of Whitehorse is the capital of Yukon and is the largest community in the territory with a population of 27,889 (Yukon government website) or 76% of the total Territorial population.

The remote location and access to Minto dictates a fly in fly out (FIFO) camp operation. In Yukon, there is a general shortage of available professional and skilled workers. The location is also impacted by low amounts of locally manufactured goods and materials.

The advanced and post-secondary education and training opportunities available in Yukon, is generally lower than opportunities further south. This impacts the local labour pool resulting in a shortage of potential workers with mining career related experience, and educational backgrounds. Recruitment of local candidates is also impacted by lower overall literacy rates in the North, and a shortage of local candidates possessing a valid driver's license.

Other factors that may have impacted socio-economic indicators include:

- Implementation of socio-economic monitoring program
- Permitting and Regulatory delays
- Declining copper prices
- Mine life uncertainty

2 Minto and Contractors Safety Statistics

The below table (Table 2-1) summarises the safety statistics for Minto Employees and site contractors for 2017. The total incidents include minor first aids treated at the site, any property damage, near-misses that could have resulted in an incident, medical aids (where treatment is required off site) and lost-time accidents where a worker would be unable to return to their duties and had to miss work. In 2017, there were 3 lost time accidents, all 3 were contactor employees.

2017 Total incidents	Minto	Contractors
57	22	35

3 Employment

Minto utilizes a preferential hiring recruitment approach as outlined in our Cooperation Agreement, with Selkirk First Nation. Our preferential hiring involves the following: Positions are first advertised and offered in the following order of priority: SFN, NTC (Northern Tutchone) Pelly Crossing Resident, OFN, Yukon, and Western Canada.

3.1 Employment Income and Distribution

The following sections outline information and figures that demonstrate salaries are higher for those who are in major centres and/or employed outside of Yukon. Potential reasons for this for Minto include:

- 7 out of 8 Managerial staff live outside Yukon.
- The majority of professional, supervisory and designated staff are residents of the rest of Canada (Non-Yukon residents)

Other factors for this could potentially be linked to a lack of potential candidate pools in Yukon of professional and managerial experienced staff. Further, the post-secondary education requirements for these roles cannot be obtained in Yukon.

The Company operates a fly in fly out (FIFO) camp model which is attractive to employees who can stay in their current hometowns and not have to move North. This approach has become somewhat standard practice for the mining industry in Western Canada, our peer group, and Minto operates in a fashion to be competitive in this market. Employees expect a FIFO in a remote mining location.

Major centres of Whitehorse and Rest of Canada have the highest income. One of the possible reasons for this is that those areas have a larger qualified candidate pool? Outlying areas including Pelly Crossing and Rest of Yukon have less availability of qualified candidates for skilled, professional and managerial positions.

3.1.1 Minto - Average employment income by Residency

	Pelly	Whitehorse	Yukon	Rest of Canada
Minto	29.86	$34.17	$33.08	$42.61

3.1.2 Contractors - Average employment income by Residency

	Pelly	Whitehorse	Yukon	Rest of Canada
Pelly	$27.85	$29.15	$28.34	$31.13
Dumas	18.50	$20.67	$20.75	$21.82
Sodexo	$16.27	$17.83	$16.09	$16.43

Potential contributing factors include:

- Dumas Contracting is located in eastern Canada indicating hiring from a preferred talent pool in this location
- Most Sodexo employees are entry-level non-skilled workers. Sodexo, like many Remote Site Service providers, has a high turnover rate. However, this number was approximately 106% in 2017, it could be due to the uncertain future mine plans, however, we've noticed that a change in on-site management has made a positive difference and lessened turnover. Sodexo's voluntary turnover at Minto for 2017 was 40%. In total there were 35 new hires in 2017 and 30 exits (including voluntary and involuntary).

3.1.3 Minto and Contractors – Annual and cumulative total employee income by Group

	Pelly Crossing	Whitehorse	Yukon	Rest of Canada
Minto	$512,458.5	$4,257,665.43	$1,468,130.90	$9,285,929.74
Pelly	$403,310.08	$2,771,763.42	$467,939.54	$1,587,027.14
Dumas	-	$149,558	$157,267	$6,131,670
Sodexo	$121,708.92	$608,544.60	$81,139.28	$243,417.84

3.1.4 Minto – Northern Employment by Group

	SFN	Yukon FN	OFN	Other Yukon	Other Canadians	Total
Minto	17	16	1	37	75	146

3.1.5 Minto - Employment by Residency

	Pelly Crossing	Whitehorse	Other Yukon	Canada	Total
Minto	8	49	13	76	146

3.1.6 Contractor - Employment by Residency

	Pelly Crossing	Yukon	Canada	Total
Pelly	6	41	15	62
Dumas	0	7	43	50
Sodexo	3	13	13	29

3.1.7 Minto – 2017 New Hires by Group

	SFN	Yukon FN	OFN	Other Yukon	Other Canadians	Total
Minto	8	0	1	13	27	49

3.1.8 Minto - Employment by Job Categories and Group

	SFN	Yukon FN	Other Yukon	OFN	Other Canadians	Total
Management	0	0	1	0	10	11
Professional	1	4	13	0	38	56
Skilled	3	4	10	1	22	40
Semi-skilled	10	8	13	0	3	34
Entry Level	3	0	2	0	0	5
TOTAL	17	16	39	1	73	146

3.1.9 Minto and Contractors – Annual and cumulative total employees by group

	Aboriginal	Yukon (Non-FN)	Total Yukon	Male	Female	Other Canadian	Total
Minto	30	37	70	128	18	76	146
Pelly	23	28	47	48	14	15	62
Dumas	5	2	7	49	1	43	50
Sodexo	12	4	16	17	12	13	29

3.2 Voluntary Exits

In 2017, Minto had a slight increase in our voluntary turnover rate from the 2016 rate of 23.8%. A total of 40 employees voluntarily left Minto, which represents a voluntary turnover rate of 27.6%.

The results of voluntary exit surveys indicate the following main reasons for resignations:

- Most of the voluntary turnover was at the beginning of the year was a result in the Company announcing a shut down at the end of the year. This decision was abandoned mid-year.
- Enhanced opportunity at other Mines coming on line, as commodity prices picked up.

4 Business

As part of Minto and SFN's cooperation agreement there is a requirement for the company to provide preferred opportunity notification to SFN to negotiate and potentially be awarded a contract to supply the requirement. SFN has developed partnerships with a number of Minto's vendors for which the details of financial benefit Minto is not privy to. As such, this section summarizes expenditures by the company that is the primary vendor and does not account for any SFN proportional expenditures as a result of those partnerships.

In 2015, Minto and SFN worked jointly to establish new or maintained contracts to ensure involvement from SFN and support our First Nations partners. The contractual arrangements highlighted below represent the majority of the opportunities that SFN and Minto share with service providers. As well as financial gain, SFN also does benefit from employment opportunities on some contracts.

- Borealis Shuttle – Pelly Crossing Shuttle Service-SFN Summer Students
- Capital Helicopters- Helicopter Support
- Driftwood Drilling- Exploration Drilling
- Dumas- UG Mining
- Dyno Nobel Canada- Blasting supplies and services
- Glacier Water Services- Water Hauling
- Manitoulin Transport- Freight Hauling
- Northern Vacuum Services- Vacuum Truck Rental
- Nuway Crushing- Crushing Services
- Parkland Fuel- Fuel Supply
- Pelly Construction- 988 loader rental
- Pelly Construction- Mining Services
- Selkirk Development Corp- Office Lease
- Sodexo- Catering Services
- Standard Bus- Bussing of Staff/Contractors
- Tintina Air- Secondary Air Support
- Yukon Inn- Employee lodging

The six rights of procurement must be met in selection of such vendor relationships.

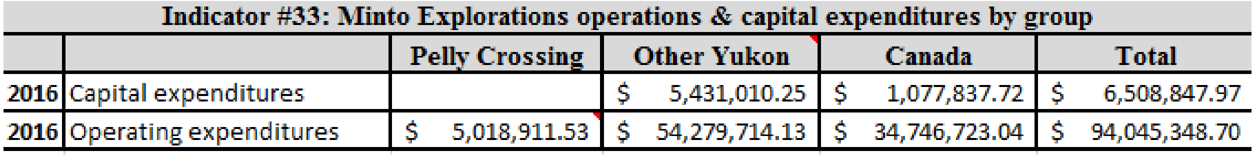
- Right Materials (to fill need)
- Right Place (Yukon preference)
- Right Quantity and Quality (High quality and ability to supply)
- Right Supplier (Service, technical and aftermarket support, value added service)
- Right moment (product available when needed)
- Right price (competitive commercial price)

In total Minto spent $64,729,636 on Yukon vendors in 2016 [i]. This represented 59% of total spend that stayed in the Yukon, supporting local business and developing partnerships for long term mutual benefit. Minto selects the appropriate local vendors based on vendors that meet selection criteria that support Minto's corporate social responsibility. Such partnerships are built on transparency, human rights and labor compliance, supplier status, financial, geographical, and environmental compliancy. The framework for successful local suppliers is based on common shared goals, continuous improvement, and vendors that support Minto's policies and procedures.

In addition to support of our First Nations partners, Minto also strives to support Yukon based companies and service providers based on ability to service our needs and meets commercial acceptance criteria. In analyzing a business for suitability Minto follows best practice guidelines and the six rights of procurement in selecting potential suppliers.

Minto will continue to maintain and increase its spend with local suppliers as they invest in supporting the mining industry and Minto is committed to sustainability in developing the relationships for long term mutual benefit.

1. Mine Capital and Operating Expenditures [i]



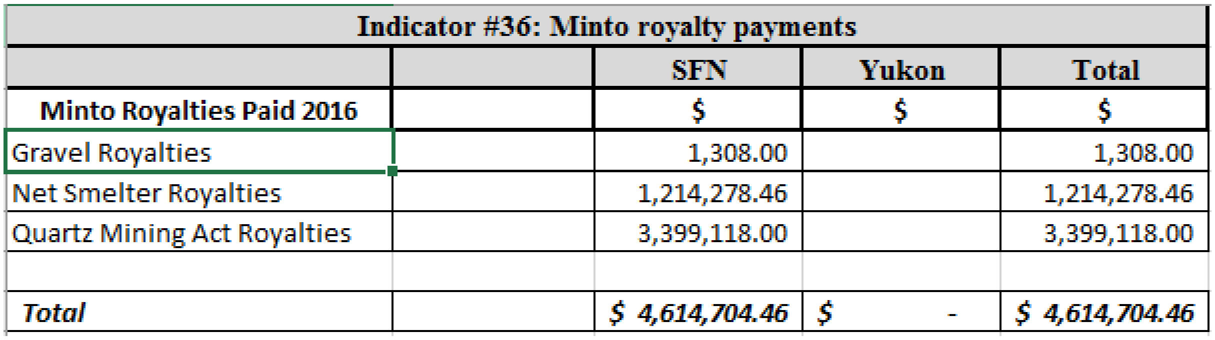
Indicator #33: Minto Explorations operations & capital expenditures by group

		Pelly Crossing	Other Yukon	Canada	Total
2016	Capital expenditures		$ 5,431,010.25	$ 1,077,837.72	$ 6,508,847.97
2016	Operating expenditures	$ 5,018,911.53	$ 54,279,714.13	$ 34,746,723.04	$ 94,045,348.70

4.1 Yukon business names by group

See attached **Appendix "A"** noting all Yukon Business Names by group. Note that not all business are captured due to some expenditure by employees and reimbursed through expenses and all contractor purchased items.

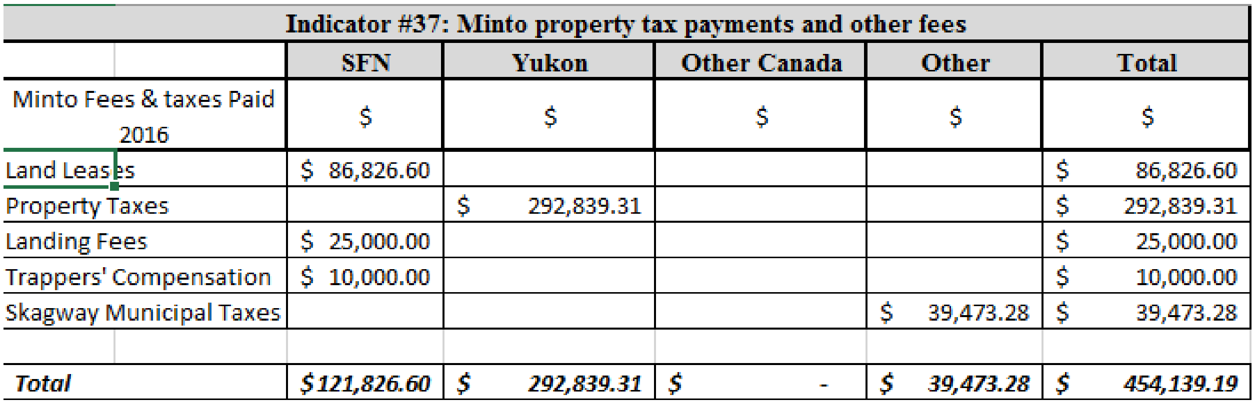
4.2 Minto Royalty Payments [i]



Indicator #36: Minto royalty payments

		SFN	Yukon	Total
Minto Royalties Paid 2016		**$**	**$**	**$**
Gravel Royalties		1,308.00		1,308.00
Net Smelter Royalties		1,214,278.46		1,214,278.46
Quartz Mining Act Royalties		3,399,118.00		3,399,118.00
Total		***$ 4,614,704.46***	***$ -***	***$ 4,614,704.46***

4.3 Minto property tax payments and other fees [i]



Indicator #37: Minto property tax payments and other fees

	SFN	Yukon	Other Canada	Other	Total
Minto Fees & taxes Paid 2016	$	$	$	$	$
Land Leases	$ 86,826.60				$ 86,826.60
Property Taxes		$ 292,839.31			$ 292,839.31
Landing Fees	$ 25,000.00				$ 25,000.00
Trappers' Compensation	$ 10,000.00				$ 10,000.00
Skagway Municipal Taxes				$ 39,473.28	$ 39,473.28
Total	***$121,826.60***	***$ 292,839.31***	***$ -***	***$ 39,473.28***	***$ 454,139.19***

---

[i] Please note that data presented in this section is for 2016 year. 2017 data was unavailable at the time of completion of this report.

5 Capacity, Training and Education

Minto, working with our major contractor partners, supported many different capacity building, training and educational initiatives in 2017. Through a combination of “on-the- job” training and mentoring, combined with sponsoring apprenticeships, pre-apprenticeships and other educational initiatives, we continued to build upon work done starting in past years - to create a workplace that enhances our current employees skills and also supports the ongoing development towards a more advanced local labour force.

5.1.1 Selkirk First Nation and Other First Nation specific training in 2017

Mill Competency Program

- Minto continued with the Mill Operator Competency Program in 2017, specifically targeting, local entry-level workers.

Apprenticeship training

- Minto continued sponsoring One SFN student in apprenticeship training (Warehouse Partsperson) however this employee failed the exam levels and is in the process of rewriting his level 1 training within that program of study.
- Additionally Minto is currently sponsoring another OFN within the Millwright Apprenticeship program, and this employee has now successfully completed his program, and is a Certified Red Seal journeyperson Millwright.

SFN Summer Student

- In 2017, Minto employed an SFN Summer Student over a 6-week period. During that time the student developed a number of transferable skills by working with Site Services, Environmental and Warehouse Departments.

Environmental Monitor-in-Training

- Minto offered an Environmental Monitor-in-Training program to local SFN citizens. We hoped to have two candidates go through the program; we ended up with one.
- The Trainee learned specific skills, such as how to: inspect and coordinate site waste management; monitor wildlife activity and determent on site; participate in small scale reclamation activities; proper chain-of-command for water and soil samples leaving site for testing; assist and conduct routine environmental monitoring activities according to Environmental Monitoring Plan and established protocols, including:
    - Surface water, groundwater and soil sampling;
    - Flow measurements;
    - Fisheries and other biological monitoring
- The training went very well and we were able to provide the candidate with full-time employment over a 1-year term.

6 Cultural Well-being

Minto’s approach to community investment is based upon opportunities to further build and maintain our social license, maintain good relationships with our partners and maintain a local presence and good reputation in the communities where we operate and where our employees live and work. The goal of this is to strengthen accountability and working partnerships with stakeholders while providing a foundation to understand and consider the needs, opinions and interests of the community.

Minto employs several methods of community engagement with different levels of involvement from the community and other stakeholders. These methods include formal and informal ways that are best suited for the various stakeholders. While Minto currently employs many different engagement methods, they are largely utilized in an ad hoc way. In the absence of signed, guiding document the current general strategy is that management reviews ways we engage and uses management best efforts and discretion for methods of engagement.

A community engagement plan was prepared and signed off by Minto management in 2015. A method of engagement and frequency table was prepared and presented to Selkirk First Nation Chief and Council.

Examples of community and cultural engagement initiatives include the following:

- Fort Selkirk educational tours with Selkirk citizens and Minto employees and contractors
- Sports Sponsorship
- Christmas Turkey Distribution
- High school Bursaries, and attendance by Senior Minto Management at Graduation ceremonies.
- Selkirk First Nation Elder's workshops held at the Mine site, whereby Minto employees and Contractors get to participate in traditional cultural activities, such as beading workshops, birch bark crafts and traditional sewing.

In 2017 Capstone spending included the following designed to enhance and protect SFN cultural and community wellbeing;

- $500 provided to each of the 3 SFN graduating students in 2017
- $9,350 worth of turkeys, delivered to each home in Pelly Crossing for Christmas
- $2,500 to support Yukon sports
- $2,500 in contributions to SFN events, including the Selkirk Bears Hockey team.

Minto also continued to support the primary industry event in the territory - the 2017 Geoscience Forum and Trade Show which is the territory's largest conference and industry event. We also continued to support the supported the Yukon Chamber of Commerce, and the Yukon Chapter of the Special Olympics.

Appendix A – Yukon Businesses used by Minto in 2017

Acklands Grainger
ALBERTA FUEL DISTRIBUTORS INC.
Air North
Ajax Steel Limited (Steel Only)
Ajax Steel Limited
Alkan Air Ltd.
All-West Glass Whitehorse Limited
ALX Exploration Services
Aon Reed Stenhouse Inc.
Aqua Tech Supplies & Services
Arctic Star Printing
Boring Guy Equipment Repair
The Brick
Bud's Industrial Installations (Yukon) Ltd.
Carmacks Hotel
Canada Games Centre
CHALLENGER GEOMATICS LTD.
The Chocolate Claim
City Of Whitehorse
Clean Choices
Clayton Johns
Cobalt Construction Ltd
Dimok Timber Ltd
Dog Powered Sports Association of the Yukon
Duncan's Limited
Dynamic Systems
Dyno Nobel
The Edgewater Hotel (2009) Ltd.
Eecol Electric Corp.
Finning
Fountain Tire
General Waste Management
General Enterprise Ltd.
Tom Gill
Government Of The Yukon
GP Distributing
Bluewave Energy
GRIFFITHS HEATING & SHEET METAL
High Country Inn
Hi Tech Fluid Power
Marcel McGinty
Mercer Contracting
Mile 918 Driver Development
MIC MAC TOYOTA (YUKON) LTD.
Mobile Maintenance Services
Napa Whitehorse (0331) Div of Uap Inc
Northern Fusion Welding Fabrication
Northern Industrial Sales (Whitehorse)
North 60 Petro Ltd
Northerm Windows & Doors
NUWAY CRUSHING LTD.
Northwestel Inc.
Office Supply Centre
Pacific Northwest Freight Systems
Patricia Halladay Graphic Design
Peacock Sales Limited
Pelly Construction
PolarCom Certified Personal Computers ML & Associates
Quality Bearing Supply Ltd
R.C. Crane and Construction
Reactive Design
Sandvik
Selkirk Development Corporation
39539 Yukon Inc.
Selkirk First Nation
Secure Mobile Shredding
Stephane Gingras
Shoppers Drug Mart
Small's Expediting Services
Larry Smith
Staples#251 Whitehorse
Superior Propane
Territorial Auto Parts
Tahyah Van Bibber
The Whitehorse Star Ltd.
Tintina Air Inc.
Total North Communications Ltd.
Total Fire Protection Services Ltd.
Totaltrac Yukon Inc.
TransNorth Helicopters

Home Hardware
INTEGRAPHICS LIMITED
Inkspirationz Graphix
Integraphics Ltd.
JACOBS INDUSTRIES LIMITED
Java Connection
Dywidag Systems
Kathleen Burke Cleaning Service
Kilrich Industries Ltd
Kindra Stewart
Klondike Motors
Lamarche & Lang
Listers Motor Sports
Locksmith Services Ltd.
MacPherson Rentals
Mac's Fireweed Books (Maximillians Corporation)
Maintenance Enforcement Program
Marsh Lake Tents & Events
Marj Eschak
Research Northwest
George McGinty
Kenny McGinty
Kevin McGinty
True K9 Security Detection Inc.
Underhill Geomatics Ltd.
Whitehorse Chamber of Commerce
Westmark Whitehorse Hotel & Conf. Center
Whitehorse Beverages
Whitehorse Motors Ltd.
Woodland Heating and Sheetmetal
Yukon Energy Corporation
Yukon Hospital Foundation
Yukon Mine Training Association
Yukon Chamber of Commerce
Yukon Chamber Of Mines
Yukon Government
Yukon Honda
Yukon Inn
Yukon Pump Limited
Yukon Radiator Shop
Yukon Service Supply Company
Yukon College
YUKON YAMAHA
Yukon Workers' Comp Health & Safety Bd
Yukon Women in Mining Association