Minto Mine

Water Licence QZ96-006

Quartz Mining Licence QML-0001

2014 Annual Report

Prepared by:
Minto Explorations Ltd.
Minto Mine

March 2015

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List of Acronyms

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

QA/QC	Quality Assurance and Quality Control
QML	Quartz Mining Licence QZ-0001
ROD	Reclamation Overburden Dump
SAT	Waste material destined for subaqueous long term storage
SECP	Sediment and Erosion Control Plan
SDD	South Diversion Ditch
SMP	Seepage Monitoring Plan
SOP	Standard Operating Procedure
SWD	Southwest Dump
TDD	Tailings Diversion Ditch
TDS	Total dissolved solids
TSS	Total suspended solids
UG	Underground
UTM	Universal Transverse Mercator
WGS 84	World Geodetic System 1984
WSP	Water Storage Pond
WUL	Water Use Licence QZ96-006
YWB	Yukon Water Board

List of Units

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

1 Introduction

This Annual Report has been prepared by Minto Explorations Ltd. (Minto) for the 2014 calendar year, as required by Type A Water Use Licence (WUL) QZ96-006 and Quartz Mining Licence (QML) QML-0001. Specific requirements for the Annual Report, as outlined in the respective licences, are summarized in Table 1-1.

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

An aerial photo taken in September 2014, with site infrastructure labeled, is presented in Figure 1-1. For comparison, the preceding year's aerial photo is shown in Figure 1-2.

Table 1-1: Reporting Requirements as per WUL and QML (2014)

Licence	Section	Clause	Requirement
WUL QZ96-006			
	6		Summary of the review of the *Spill Contingency Plan* including any changes needed.
	8		Summary list of all spills for 2014.
	18	a	Summary of all data generated as a result of the monitoring requirements of the WUL, including analysis and interpretation by a qualified individual or firm and a discussion of any variance from baseline conditions, from previous year's data, or from expected performance.
		b	A detailed record of any major maintenance work carried out on any physical works where that maintenance may have a direct or indirect impact on water quality or water quantity, either as a result of the maintenance activity itself or as a result of the changed operation or performance of the physical works following the completion of the maintenance activity.
		c	Updated descriptions and UTM coordinates for the surveillance monitoring sites listed in Appendix 1 of this licence.
		d	Details of results, including data collected during freshet for the Yukon River Monitoring Program.
		e	Detailed data on the volume of water used during the year including water withdrawal from each water source, water routed around and through the site as part of the water conveyance system, water diverted around the site, water routed for storage in the pits, water deposited with mine wastes in waste storage facilities, water routed to the Water Storage Pond, water routed to the treatment plant and water discharged to Minto Creek.
		f	Details of results, including data collected, for the Groundwater Monitoring Program.

Licence	Section	Clause	Requirement
		g	Details of the review of the Adaptive Monitoring and Management Plan (AMMP), including the resulting updated AMMP.
		h	Detailed data on tailings deposition in the Main Pit and Area 2 Pit, including volume and tonnage of tailings slurry deposited, cumulative volume of tailings solids stored in the pits, tailings solids surface elevation and pit water elevation.
		i	Details of results, including data collected, for the Seepage Monitoring Program.
		j	Details and findings of the Physical Monitoring Program, including monitoring of the Dry Stack Tailings Storage Facility (DSTSF).
		k	Details of the review of the water balance/water quality model, including the resulting updated water model and results.
		l	Results and interpretations of the QA/QC Program.
		m	Meteorological data compiled, including evaporation and evapo-transpiration data.
		n	Results of the Annual Biological Monitoring Program.
		o	Results of the Minto Creek Detention Structure (MCDS) Seepage Monitoring Program.
		p	Any other reports which are required by this licence.
	28		Results and interpretations of the QA/QC Program.
	77		Seepage monitoring results report.
	78		Updated water balance and water quality model and submit the updated model as part of the Annual Report.
		a	Updated model input parameters based on the most current climatic, environmental and operational conditions and data.
		b	An update of the basic climatic input parameters and the frequency analysis for the regional stations based on current climatic data.
		c	Technical information deficiencies that are identified in Water Use Register QZ09-094, exhibit 5.4, Appendix A.
	79		Meteorological data compiled, including evaporation and evapo-transpiration data and snow pack.
	82	e	A list of each of the annual physical inspection recommendations and an explanation of how each recommendation has been addressed.
	85		Results of the MCDS Seepage Monitoring Program.
	86		Annual Biological Monitoring Report.
	89		Results from the full depth dry stack tailings samples.
	93		Review and update the AMMP.
	95		Results of the Waste Rock Management Verification Program.
		a	Detailed records on the types and quantity of waste rock placed at each location.
		b	Monitoring and verification of the characteristics of the waste rock in accordance with the grades required by Clause 43 of this licence, stored at each location.

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

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

Aerial imagery obtained from Challenger Geomatics. Imagery acquired September 9th 2014.

Datum: NAD 83 Projection: UTM Zone 8N

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Figure 1-1: Site Layout (2014)

Figure 1-2: Site ortho-photo (2013)

2 Site Activities

Operation of the Minto Mine continued in 2014, with the production of 40.6 million pounds (Mlb) of copper from the milling of 1.40 million tonnes (Mt) of ore. Surface mining for the year totaled 1.25 M bank cubic meters (BCM) which was a reduction over 2013 mining.

General site activities included surface mining of Area 2 and Area 118 open pits and underground mining of the Minto South (Area 118 Underground (UG)) and M-Zone targets. Milling was a combination of run of mine ore as well as ore stockpiled from previous mining. Tailings produced from the milling process were deposited into the completed Main Pit as per the *Phase IV Tailings Management Plan*. Waste rock produced from mining activities was hauled to various waste rock dumps as per the *Waste Rock and Overburden Management Plan*. Maintenance and repair work were also completed on various structures around the mine site such as access roads.

2.1 Exploration

No exploration drilling occurred at Minto in 2014, however a program of in-fill drilling aimed at upgrading some of Minto's probable reserves to proven reserves began in late 2014. The two areas targeted were the Area 2 Stage 3 pit footprint (Phase V/VI target) and the Area 118 UG ore zone. A total of 3,026 metres (m) of core drilling in nineteen holes were completed in 2014.

2.2 Infrastructure and Construction Projects

A number of construction projects were undertaken in 2014, including completion of the new camp facilities (Selkirk Towers), South Diversion Ditch (SDD), Tailings Diversion Ditch (TDD); construction of a warehouse, propane tank farm, reagent storage building, Land Treatment Facility (LTF), wash bay, M-Zone infrastructure and demonstration scale Constructed Wetland Treatment System (CWTS).

2.2.1 Camp Expansion

The camp expansion project was completed in October 2014, with employees beginning occupancy shortly thereafter. The new camp is composed of steel modular shipping container sized units arranged in a three-storey configuration containing 120 sleeping rooms with private washrooms. Each floor also contains two common rooms, laundry facilities, and storage rooms. With the completion of the camp extension, older and rented bunkhouses that were no longer necessary were removed from site. An arctic corridor was constructed to join the new camp buildings (named Selkirk Towers) to the remainder of camp. The final room count at Minto is currently 258.

2.2.2 Warehouse

Construction of a new warehouse building began in 2013 with engineering, steel building purchase and concrete foundation being poured. In 2014, the building was erected (February through March) and a concrete floor poured in June. Work on the interior including shelving, office space, washroom, environmental preparation laboratory, issue counter and a mezzanine were completed in late October with the warehouse opening for business in November. The new warehouse provides secure temperature-controlled storage for mechanical parts and consumables with a size of approximately 24 m by 30 m (80 by 100 feet).

2.2.3 Propane Tank Farm Pad

The construction of a propane tank farm pad was initiated in 2013 and completed in 2014. The propane tank farm pad was constructed in order to supply the Minto South UG with propane to power ventilation and heat from the fresh air raise. The pad was completed in the summer of 2014 and was built out of run of the mine construction grade waste rock with a cap of fine gravel (residuum) on top for final grading. Currently, there are four 386,000 litre (L) propane tanks located on the pad that will feed the fresh air vent raise west of Area 2 Pit. In addition to the construction of the propane tank farm pad, the road connecting the pad to the Minto South UG fresh air raise pad was widened and graded to support the gas line.

The tanks will be linked via common manifold and pump that will deliver propane to a mine ventilation heater system (dual heaters) situated at the fresh air vent raise. The gas line is buried and surrounded by soft aggregate to protect against punctures. The gas line has been pressure tested and will be part of 2015 fresh air vent system commissioning.

The fresh air vent system is comprised of thirty million British Thermal Unit (BTU) heaters, a 400 horsepower fan capable of supplying 315,000 cubic feet per minute of fresh air and plenum which is mounted over the vertical excavation (vent raise). The vent raise serves as both a conduit for fresh air for underground mining and as well as a second egress for the mine as required by the mine's *Emergency Response Plan.*

2.2.4 Power Line

In 2014, the site's power grid was extended to the Minto South UG fresh air vent raise. A 4,160 volt (V) surface cable was used; however, no new power poles were installed.

2.2.5 Reagent Storage Building

In 2014, a reagent storage building was constructed on the Mill Valley Fill (MVF) to store all bulk mill reagents from the outside environment. The building was constructed on a geomembrane lined dirt floor. The building is comprised of a tent like structure with a twenty-three ounce gauge water proof fabric overlaying a heavy gauge galvanized pipe building frame. The building was erected on concrete key block footing. The building was constructed in October 2014 with all reagents that required shelter being moved in by the end of November 2014.

2.2.6 M-Zone Infrastructure

M-Zone infrastructure construction began in late January as the bottom of the Area 2 Pit was backfilled for a level working area and a dewatering sump developed. Once the ground was prepared and dewatering was established, four forty foot sea containers were used as walls and base for a plastic tent over truss roof shelter. The interior of the sea containers provided storage; the tent building which was equipped with roll up doors was used as a maintenance repair area for the mobile fleet working nearby in the underground M-Zone headings. Another wood framed shelter was constructed adjacent to the shop building and was covered with insulated tarps to provide shelter for equipment during the colder winter months.

Ventilation to the underground workings was provided by a dual duct vent tube system with air supplied by two, 150 horsepower fans. A six million BTU heater connected in series to the fans provided heat to the air flow to ensure underground headings did not freeze. Propane was provided to the workings by positioning a smaller mobile tank in the bottom of the Area 2 Pit.

Feed lines for propane and compressed air were buried underground in trenches to connect the propane tank to the heater and supply compressed air to the underground works. Also buried were all of the electrical cables that provided power to surface air compressors.

A mobile trailer was fitted with a large water tank with immersion heaters in a separated section which was insulated and heated. The heated section of the trailer was also used to house all electrical panels and starters required for various electrical distribution circuits. The large water tank was used to supply water to the underground for drilling.

In late November, 2014 all supporting infrastructure was decommissioned and de-mobilized from the bottom of the Area 2 Pit.

2.2.7 South Diversion Ditch

Final construction of the South Diversion Ditch (SDD) was completed in August 2014 with minor adjustments made to ensure it met the design requirement. The modifications included brushing out vegetation, removing boulders that may have impeded flow and widening the spillway. The as-built construction report was completed and submitted to the Yukon Water Board (YWB) in September 2014 and is attached as a reference in Appendix A.

2.2.8 Tailings Diversion Ditch

The Tailings Diversion Ditch (TDD) designed by EBA Engineering and referenced in the Technical Memo: Minto Project – Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility (dated October 25, 2011) was completed in September 2014. The work completed in 2014 included: installation of embankment fill (construction grade waste rock) along Segment C (EBA Figure 6 in the aforementioned report); grading of the ditch overall and sloping all ditch walls to 2:1; installing a Bentofix geosynthetic clay liner (GCL) to line the embankment fill with Segment C and part of Segment B; installation of a bucket packed 0.6 m nominal thickness layer of silt/clay fines over the GCL; installation of 12 ounce (oz) Geotextile within Segment A and a portion of Segment B up to a transition location where

GCL was used; and installing zero grade rip rap to line the full length of ditch within the work area. The as-built report is provided in Appendix B for further details on the construction of the TDD.

2.2.9 Land Treatment Facility

In 2014, construction of a new LTF was completed to replace the previous LTF which was undersized and challenging to operate given the location and local topography. The new LTF is comprised of a treatment area, two access ramps, exterior containment berms and a runoff collection sump. The treatment area and inside berm are lined with EL4040 (40 mil) geomembrane sandwiched between layers of 12 oz geotextile. The collection sump was lined with EL6060 (60 mil) geomembrane overlaid on a layer of 12 oz geotextile. The final as-built specification of the facility are: a 2350 m^2 treatment area which is able to treat 2350 m^3 of contaminated soil and a collection sump capable of holding up to 770 m^3 of water. The inside berm height is 1.5 m. Please note that all measurements referring to the size of the LTF are approximations.

2.2.10 Wash Bay

A light vehicle wash bay was constructed in 2014 and equipped with an electric pressure washer, concrete floor and sump, and oil water separator. The building (M-Zone shop) was taken from the M-Zone infrastructure upon completion of mining in the M-Zone and setup up over the concrete floor near the water treatment plant. The water from washing is collected in sumps and routed through an oil water separator before getting pumped over to the tailings building where it is sent to the Main Pit. The oil water separator is emptied as required and sent offsite for final disposal.

2.2.11 Demonstration Scale Constructed Wetland Treatment System

In August 2014, Minto completed the construction of a demonstration scale CWTS. See Section 6.3.3 for full details on the construction of the CWTS.

2.2.12 Liner Project

As part of the *Spill and Contamination Prevention Plan*, a number of sites were identified where there was a high risk of contaminant spills and leaks from vehicles and heavy equipment. These included equipment staging, maintenance areas and fuelling areas. Liners (40 mil high density polyethylene (HDPE) geomembrane) were installed in these locations and backfilled with native soil. The aim of lining these areas is to facilitate clean-up and prevent cumulative drips and spills from penetrating underlying soil.

Additionally, a lined wash pad with containment sumps was constructed for Pelly Construction's heavy equipment. The purpose was to facilitate the cleaning of heavy equipment in order to identify minor oil leaks at an early stage, before major seal and hose failures occur.

The locations are indicated in Figure 2-1, below.

Liner Locations

1.	Pelly equipment wash pad.	440m²
2.	Pelly main shop.	375m²
3.	Pelly lubrication bay.	250 m²
4.	821 bench laydown.	900m²
5.	Chemical reagent shed.	223m²
6.	Dumas equipment line-up.	200m²
7.	New Land Treatment Facility.	3,800m²
8.	Area 118 equipment fuelling area.	50m²

Figure 2-1: Liner Projects (2014)

2.3 Mining Activities

Section 2.3 discusses the mining activities for 2014 including, but not limited to: open pit and underground mining; Main Pit buttress construction; waste rock and tailings management; ore stockpiles; operating results; and concentrate shipments.

2.3.1 Open Pit Mining

The year began with mining in the Stage 2 pushback of the Area 2 Pit, which was completed on January 30, 2014. Subsequently, a portion of the pit bottom was backfilled to serve as a staging area for the M-Zone underground project.

Mining in the Area 118 Pit began on January 2 and was completed on October 14, 2014. Shortly before the completion of the pit, most of the surface mining fleet was idled and the workforce laid off, with a small number of equipment operators retained to haul ore from stockpiles and to complete construction and reclamation work around the site.

On November 19, 2014 after the completion of the M-Zone underground mining project, a small fleet of contractor equipment and personnel began a project to recover remnant ore underneath the main haulage ramp in the Area 2 Pit; this work continued through the end of the year and into 2015.

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

Table 2-1: Open Pit Mined Quantities: Mining Waste Volume and Ore Volume (2014)

	Waste / Overburden (BCM)	Ore (BCM)	Ore (t)
Area 2 Pit	58,310	54,701	149,552
Area 118 Pit	1,006,739	129,926	351,488
Totals	**1,065,049**	**184,627**	**501,040**

2.3.2 Underground Mining

After completing Stage 2 of the Area 2 Pit, Minto identified an opportunity to extract a portion of the Phase IV underground reserve by accessing it from a portal collared at the bottom of the pit, rather than through underground workings connected to the Minto South Portal, as was initially planned.

This specific area was previously a stope within the Area 2 portion of the Phase IV Minto South UG, where it was scheduled to be one of the last mined. It was given the name “M-Zone” to distinguish it from other parts of the *Phase IV Underground Plan*.

The M-zone project allowed earlier access to a high-grade ore zone, avoided the risk of mining in close proximity to the tailings and water deposit slated for Area 2, and eliminated the costly development that would have been required to access the zone from the Minto South Underground complex. The M-Zone portal was collared near the bottom of the pit at the 691 m elevation along the west wall, directly into the ore. After a short development campaign along the footwall of the ore zone, 283,000 tonnes of ore were extracted at an average grade of 2.07% Copper (Cu).

The M-Zone project was completed by the end of November 2014. All surface infrastructure has been removed and the underground workings will be flooded as part of future plans to use the Area 2 Pit for tailings and water storage.

After completion of the M-Zone, mining activities resumed in the Minto South Underground complex. After a short campaign of rehabilitation work and development, production began in the 118 UG zone.

2.3.3 Main Pit Buttress Construction

Construction of the Main Pit Buttress to the limits of EBA's 2011 design is essentially complete. An as-built report for the buttress is attached as Appendix C. Ground movement monitoring data are summarized in Section 5.21.

2.3.4 Waste Rock Management

Waste rock dump development continued in 2014, as per the *Minto Mine Waste Rock and Overburden Management Plan*. Table 2-2, below, summarizes the waste materials and ultimate destinations, and the volumes deposited in BCM. Current waste rock inventory in the various waste rock and overburden dumps at the Minto Mine site are summarized in Table 2-3.

Table 2-2: Waste Destination and Volumes (2014)

Material Type	Destination	BCM
Waste Rock - Low-grade	Southwest Dump North	511,878
Waste Rock - Mid-grade	Southwest Dump South	326,025
Waste Rock - SAT	Main Pit South Wall Buttress	130,928
Waste Rock - Construction-spec	Projects / Roads / Road Crush	53,048
Waste Rock - Mixed	Area 2 Pit Backfill	49,750
Waste Rock - Mixed	Main Pit South Wall Buttress	19,405
Waste Rock - Low-grade	Main Waste Dump Access Rehab	18,182
Overburden	DSTSF	11,040
Overburden	Reclamation Overburden Dump	4,347
Total		**1,124,603**

Table 2-3: Waste Dump Location and Storage Volumes (2014)

Dump Location	Quantity Stored as of December 31, 2014 (m3)
Main Pit Buttress	3,990,333
Southwest Dump	12,117,903
Mill Valley Fill Extension	1,441,040
Reclamation Overburden Dump	4,304,347
Main Waste Dump	8,168,182
Total Waste Dumped	**30,021,805**

2.3.5 Tailings Management

Deposition of slurry tailings into the Main Pit Tailings Management Facility (MPTMF) began on November 1, 2012 and continued uninterrupted throughout 2014; no tailings were deposited to the Area 2 Pit. The filter press plant, previously used to prepare tailings for deposition to the Dry Stack Tailings Storage Facility (DSTSF), has been deactivated and did not operate in 2014. While the filter press plant equipment is still in place, a substantial portion of the building's electrical supply has been re-routed to the Minto South UG portal.

Deposition in the MPTMF was initially from the north corner of the pit from a pipe at 784 m elevation. As the tailings level began to reach the water surface at that location, the discharge point was moved to a location closer to the middle of the pit by floating the line on the water surface.

The water level in the pit remained above the tailings surface elevation. As a result, no ice formation was seen around the discharge point and tailings were not observed to remain ponded on the ice surface. The relatively high end-of-pipe temperature, combined with the erosive effect of the tailings stream, melts through the ice at the discharge point.

A total of 1,388,000 dry metric tonnes (dmt) of tailings were discharged to the pit in 2014. Since November 2012, the Main Pit has received 2,941,000 tonnes of tailings. At year-end, the water level was measured at 787 m, as compared to the reading one year prior at 781 m.

As per the terms of the *Tailings Management Plan*, a bathymetric survey of the pit was completed in summer 2014, with the goal of mapping the tailings surface. As in 2013, the 2014 bathymetric mapping technique used did not produce an image of the true depth of the tailings / water interface.

2.3.6 Ore Stockpiles

Minto currently maintains six stockpiles, which are listed below and shown in Figure 2-2.

- North stockpile – setup location for Minto's secondary crushing contractor. Storage location for ore grading more than 2.0% Cu.
- West stockpile – sulfide ore grading 1.0% - 2.0% Cu.
- East stockpile – partially oxidized ore from Area 2 and Stage 5 of the Main Pit.
- South stockpile – sulfide ore grading 0.5% - 1.0% Cu.
- Oxide stockpile – partially oxidized ore from the Main Pit.
- Blue stockpile – sulfide ore grading 0.5% - 1.0% Cu.

In addition to the above, which are used for temporary storage of ore, Minto maintains a stockpile of several ore types at the crusher, a live pile of crushed ore, and a portal ore pad for short-term storage of ore trucked out of the Minto South UG.

In order to provide predictable head grades to the mill and maximize revenue, Minto segregates ore into six categories, as defined below, with the stored quantities summarized in Table 2-4:

- Red: sulfide ore grading > 4.0% Cu.
- Yellow: sulfide ore grading 2.0 to 4.0% Cu.
- Green: sulfide ore grading 1.0% to 2.0% Cu.
- Blue: sulfide ore grading 0.50% to 1.0% Cu.
- POX: partially oxidized ore grading > 1.0% Cu.
- LGPOX: partially oxidized ore grading 0.50% to 1.0% Cu.

Table 2-4: Stockpile Inventory (2014)

	December 31, 2013			December 31, 2014		
	Mass (tonnes)	Cu (%)	Ag (g/t)	Mass (tonnes)	Cu (%)	Ag (g/t)
Red	1,364	3.99	16.36	0	-	-
Yellow	23,541	2.35	7.03	0	-	-
Green	633,076	1.31	4.41	2,554	1.32	4.26
Blue	591,134	0.66	1.92	326,297	0.66	2.08
POX	188,626	1.34	4.51	345,646	1.11	3.03
LG POX	55,389	0.65	1.11	55,389	0.65	1.11
Portal Ore Pad	4,518	2.16	8.29	390	2.36	6.82
Live Pile	24,377	2.25	7.62	19,728	0.89	2.70
Total Ore	**1,522,025**	**1.07**	**3.45**	**750,004**	**0.88**	**2.47**

Figure 2-2: Minto Ore Stockpiles (2014)

2.3.7 Operating Results

Ore processing and metal production results for the 2014 calendar year are summarized in Table 2-5, below.

Table 2-5: Operating Results (2014)

Metal Production	Quantity
Copper (t)	18,411
Gold (kg)	619
Silver (kg)	5,317
Ore Milled	
Ore processed (t)	1,439,000
Copper grade (%)	1.37
Gold grade (g/t)	0.56
Silver grade (g/t)	4.71
Recoveries	
Copper (%)	93.3
Gold (%)	77.5
Silver (%)	78.5
Concentrates Produced	
Copper concentrate (dmt)	50,246
Copper (%)	36.6
Gold (g/t)	12.32
Silver (g/t)	105.8

2.3.8 Concentrate Shipments

Minto produced 54,623 metric tonnes of concentrate at 8.0% moisture content, which corresponds to 50,246 dmt. The average concentrate grades are listed in Table 2-5, above. 1,348 truckloads of concentrate were shipped from Minto in 2014: 685 via the winter ice bridge and 663 during the summer barge season.

2.4 Mine Access Road

Section 2.4 discusses the 2014 operation of the Mine Access Road.

2.4.1 Traffic

From January 1 to April 15, 2014 access across the Yukon River was over an ice bridge, during this period 1,866 heavy and 1,025 light vehicles travelled across the ice bridge. There was no land access to the mine site until June 5, 2015 when the summer tug and barge operation began. During the barge operating season, 2,425 heavy and 867 light vehicles accessed the Minto Mine via the Mine Access Road. The final day of barge operation for the 2014 operating season was November 9; after which mine access was once again by air only for the remainder of the year.

2.4.2 Access Control Issues

No access control issues were experienced in 2014.

2.4.3 Planned Access Road Maintenance for 2015

Beyond routine maintenance work, no major projects or upgrades are planned for 2015 with regard to the access road.

2.5 Accidents and Incidents

Section 2.5 discusses the 2014 accidents and incidents at the Minto Mine.

2.5.1 Incidents

In 2014, three lost time accidents occurred at Minto Mine; all rendered by contractors working at the mine. In addition, there were sixteen medical aids and five serious incidents reported to the Yukon Workers Compensation Health and Safety Board for the 2014 reporting period. In order to respond to incidents on site, Minto maintains a current *Emergency Response Plan* supported by a compliment of emergency response personnel trained and certified in advanced first aid, firefighting and mine rescue along with equipment required for all response types. In addition, reporting and investigation of incidents is standard practice at the site.

2.5.2 Wildlife Incidents

There were no wildlife incidents at Minto Mine in 2014.

2.5.3 Reportable Spills

In 2014, five reportable spills occurred at Minto Mine, summarized in Table 2-6, below.

Table 2-6: Reportable Spills (2014)

Date	Volume (L)	Substance	Cause
March 15, 2014	40	Antifreeze	The Sandvik DR 560 drill had recently been commissioned and assembled on site, with the previous day being the machine's first day of operation. The drill was being moved when an engine cooling line failed. The failure was thought to be the result of a manufacturing defect.
April 14, 2014	1,000	Diesel	A new operator allowed a diesel bulk storage tank at the fuel farm to overflow during filling. An investigation has shown the employee had not received adequate instruction prior to having been assigned the task.
July 29, 2014	2	Diesel	A truck driver forgot to replace the filler cap on the diesel tank of his truck before coming to site. Some fuel spilled from the tank while driving off the barge landing.
August 4, 2014	100	Antifreeze	The operator of a Bomega water buggy reversed over a drum of waste antifreeze. Though there was someone spotting for him, the drum was hidden from the spotter's view during the manoeuvre.
December 17, 2014	800	Diesel	An excavator was working in the Area 2 Pit when it slid on loose rock and rolled over. It had recently been re-fuelled and the force of the fuel moving in the full tank caused the filler cap to blow off, allowing the fuel to drain from the tank.

The spills in Table 2-6, above, were reported as per the *Spills Regulations* of the Yukon Environment Act. Additionally, non-reportable spills were tracked internally as per the WUL. Spills on site were cleaned up with a variety of methods including, but not limited to, utilizing spills pads, soil excavation, soil treatment in the LTF, and in-situ remediation treatment aided by a bioremediation product (Gator).

A site goal was set to reduce spills (both reportable and non-reportable) by at least 15% over the 2013 spills; this target was achieved in 2014.

2.5.4 Spill Contingency Plan Review

An update to the Minto Mine Spill Contingency Plan is required annually as part of the Annual Report and the updated 2015 Minto Mine Spill Contingency Plan is provided in Appendix D.

3 Proposed Mining for 2015

Section 3 discusses the proposed mining for 2015 at the Minto Mine, including open pit and underground mining.

3.1 Proposed Open Pit Mining for 2015

Remnant ore recovery in the Area 2 Pit will continue with a small workforce until April 2015. Execution of the Phase V/VI mine plan will begin with the mining of the Minto North Pit, upon issuance of the necessary licences.

3.2 Proposed Underground Mining for 2015

Mining will continue in the 118 UG zone of the Minto South UG.

4 Mineral Reserves and Mine Life

Minto Mine's 2014 updated mineral resources and reserves were not published at the time of writing this report and as such there is no update from the 2013 reserves and therefore not included in this report.

5 Environmental Monitoring

Environmental monitoring programs are outlined in the *Environmental Monitoring, Surveillance and Reporting Plan* (EMSRP) and the results for the monitoring conducted in 2014 are provided in this section. These programs include the water monitoring program, geochemical monitoring program, meteorological monitoring program, physical monitoring program, aquatic environmental monitoring program, terrestrial environmental monitoring program, and quality assurance and quality control program. Where possible, the 2014 results have been compared to historical results to identify trends and compare 2014 values with previous values

5.1 Surface Water Surveillance Program

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

The WUL non-freshet water quality standards were compared to the water quality result statistic summaries at stations W2, W16, W16a, and W50.

As water quality stations may be adjusted from year-to-year as a result of environmental changes or modifications to infrastructure, an update to the water quality station locations listed in the WUL is provided in Table 5-1 and Figure 5-1, below. All surveillance monitoring sites in use in 2014 are confirmed with a Global Positioning System (GPS) unit to determine current UTM coordinates. Coordinates presented in Table 5-1 are associated with the World Geodetic System 1984 (WGS 84) coordinate system.

Table 5-1: Water Quality Monitoring Site Descriptions and UTM Coordinates (2014)

Site Name	Description	UTM Location (m) Zone 8 (WGS 84)	
		Easting	Northing
W1	Lower reach of Minto Creek.	392445	6948251
W2	Minto Creek, upstream of the Minto Creek/Yukon River confluence where the Mine Access Road crosses Minto Creek.	392584	6948402
W3	Minto Creek, (at the Metal Mining Effluent Regulations compliance point).	387000	6945778
W4	Yukon River, upstream of the confluence with Minto Creek.	394070	6948203
W5	Yukon River, downstream of the confluence with Minto Creek.	392583	6949119
W7	Mouth of the tributary on the south side of Minto Creek, approximately 0.8 km downstream of W50.	387546	6946034
W8	Western collection sump from the DSTSF.	385629	6945076
W8a	Eastern collection sump from DSTSF.	385716	6945012
W10	Headwaters of Minto Creek (southwest fork at headwaters).	383855	6943364
W12 W12a	Main Pit water. W12 and W12a are called W12 internally and represent the same sampling location.	384544	6945137
W13	Mill Water Storage Pond (if not discharging).	385081	6945038
W13a	Discharge from the Mill Water Storage Pond.	385295	6945164
W14	Tailings Thickener Overflow.	385223	6945089
W15	Upper Minto Creek Storm Water Collection Sump, downstream of the overburden dump, and upstream of Main Pit.	384181	6944708
W16	Water Storage Pond.	386402	6945559
W16a	Discharge from the Water Storage Pond.	386679	6945664
W17	Water Storage Pond Dam Seepage.	386679	6945664
W30	Headwaters of Minto Creek (northwest fork).	383693	6945026
W32	At toe of Southwest Dump (southwest fork).	383952	6944564
W33	Above Tailings Diversion Ditches.	385351	6944072
W35a W35b	Storm Water Collection Point - South Diversion Ditch. W35a and W35b are called W35 internally and are the same sampling location.	385223	6944427
W36	Minto Creek Detention Structure.	385892	6945191
W37	100 m downstream of Minto Creek Detention Structure (W36) and upstream of the Water Storage Pond.	385958	6945213
W38	Original Ground near Southwest Dump; approximately 90 m ENE of W15.	384120	6944764
W39	Original Ground near Southwest Dump; approximately 165 m ESE of W15.	384068	6944698
W40	Original Ground near Southwest Dump; approximately 290 m SE of W15.	384008	6944618
W41	Original Ground near Southwest Dump; 130 m NE of W15. This site has been destroyed and is no longer available.	n/a	n/a
W42	Storm Water Collection Sump; north side of Mine Access Road at approximately 0.5 km.	385602	6945241
W43	Storm Water Collection Sump - north side of Mine Access Road at Water Storage Pond; approximately 1.5 km on access road.	386371	6945614
W44	Area 2 Underground.	384975	6944546
W45	Area 2 Pit.	384912	6944068
W46	Minto Creek downstream of W7 and W6 tributaries.	387873	6946301
W47	Area 118 Pit Water.	384804	6944180
W50	Minto Creek, approximately 50 m downstream of the toe of the Water Storage Pond Dam and downstream of the inflow of the treated water.	386747	6945682
MC1	Minto Creek upstream of Minto Canyon near Km 8 on Mine Access Road.	390967	6947528
WC	Convergence point for W15 and W35 inflows.	384947	6944954
WTP	Treated Water from Water Treatment Plant.	385126	6945154

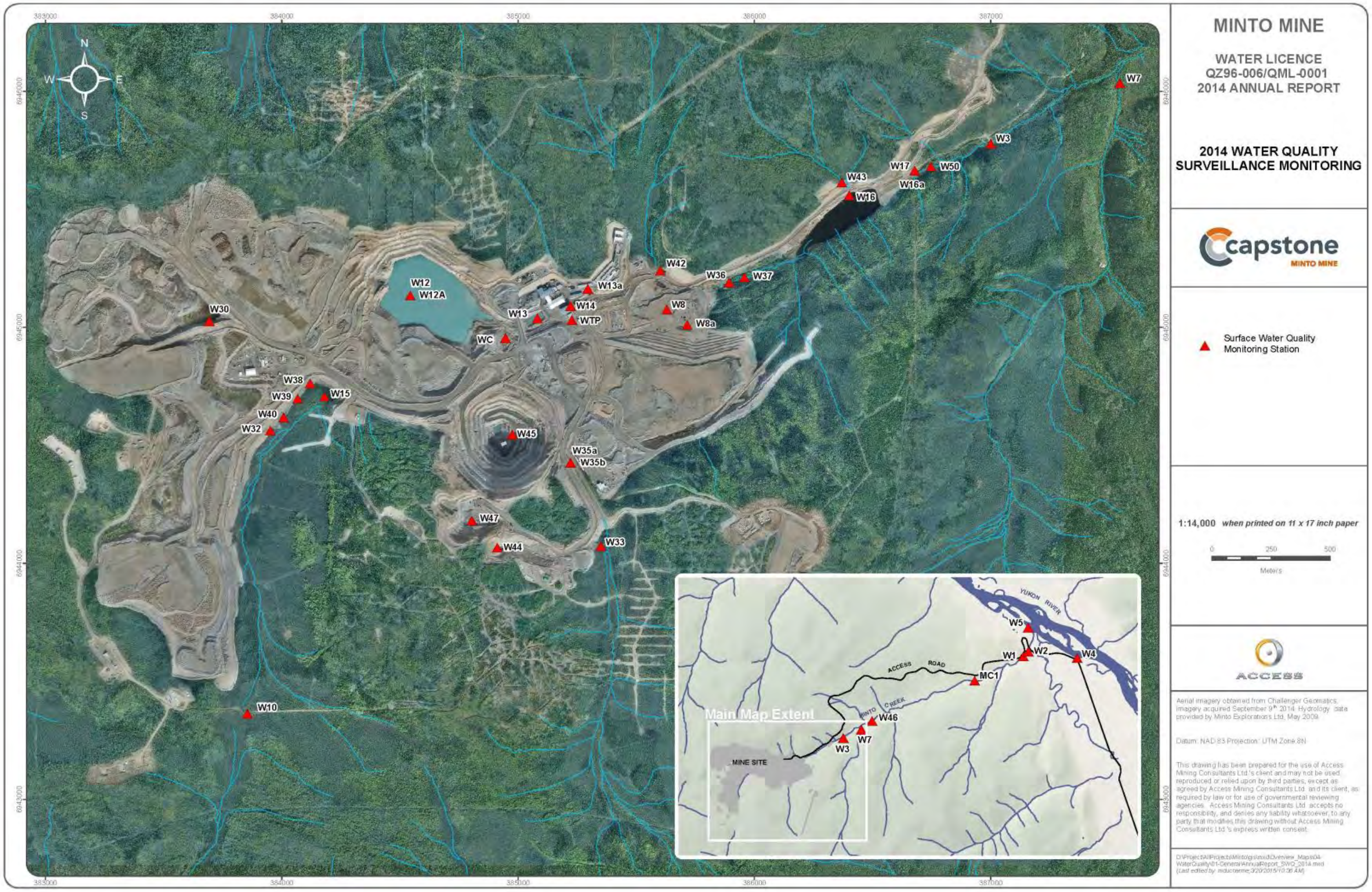

Figure 5-1: Water Quality Surveillance Monitoring Locations (2014)

5.1.1 Monitoring Conformance

2014 conformance with the external and internal water sampling requirements is summarized in Table 5-2, below. Flow monitoring at water quality surveillance sites is highly variable as a result of site and seasonal conditions and is not presented in Table 5-2, however, full details were provided in the Monthly Reports submitted to the YWB. Additionally, the specifics of non-conformance in relation to external and internal water sampling requirements are included in the Monthly Reports. Quality Assurance and Quality Control (QA/QC) sampling is not included in sampling events described in Table 5-2, but is provided in Section 5.16.

Table 5-2: Water Quality Sampling Monitoring Conformance Summary (2014)

Site Name	2014 WQ sampling events*	2014 Reason(s) for non-conformance events
W1	N/A	N/A
W2	39	Seasonal conditions (site dry and / or frozen).
W3	58	Sampled as per schedule.
W4	49	Seasonal conditions (site frozen and / or unsafe) and human error.
W5	45	Seasonal conditions (site frozen and / or unsafe).
W7	11	Seasonal conditions (site dry and / or frozen).
W8	0	Site dry for all of 2014.
W8a	52	Sampled as per schedule.
W10	7	Seasonal conditions (site dry and / or frozen).
W12	15	W12 and W12A are internally referred to as W12 and sampled as one site. Sampled as per schedule.
W12A		
W13	2	Seasonal conditions (site frozen and / or unsafe) and site conditions (no through-flow from April - December 2014).
W13A	0	No water was observed at W13A during 2014.
W14	12	Sampled as per schedule.
W15	28	Seasonal conditions (site dry and / or frozen).
W16	48	Seasonal conditions (site frozen and / or unsafe) and human error.
W16a	14	Sampled as per schedule.
W17	59	Sampled as per schedule.
W30	6	Seasonal conditions (site dry and / or frozen).
W32	1	Seasonal conditions (site dry and / or frozen).
W33	6	Seasonal conditions (site dry and / or frozen).
W35a	10	W35a and W35b are internally referred to as W35 and sampled as one site. Seasonal conditions (site dry and / or frozen).
W35b		
W36	12	Sampled as per schedule.
W37	5	Site conditions (site dry).
W38	4	Site conditions (site dry).
W39	0	Site conditions (site dry).
W40	0	Site conditions (site dry).
W41	0	Site not established due to earthworks in area.
W42	33	Seasonal conditions (site frozen and / or unsafe).
W43	11	Seasonal conditions (site frozen and / or dry and / or unsafe).
W44	44	Human error.
W45	11	Site conditions (unsafe and / or dry).

Site Name	2014 WQ sampling events*	2014 Reason(s) for non-conformance events
W46	11	Seasonal conditions (site dry and / or frozen).
W47	0	Site conditions (site dry).
W50	21	Site conditions (site dry).
MC-1	37	Seasonal conditions (site dry and / or frozen).
WC	0	Site conditions (site dry).
WTP	35	Site conditions (site dry).

5.1.2 W2 – Minto Creek at Lower Road Crossing Water Quality

Station W2 2007 to 2014 water quality result statistics are summarized in Table 5-3, below, and are compared to the WUL non-freshet water quality standard (Clause 73). Thirty-nine routine samples were collected from station W2 during the 2014 monitoring period. The W2 station copper, aluminum, cadmium and selenium concentrations, with corresponding non-freshet standards (WUL Clause 73) are displayed in Figure 5-2 and Figure 5-3, below.

Table 5-3: W2 Water Quality Results Summary (2007-2014)

W2	Water Quality Standard (WUL Clause 73)	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters		Mean	Min	Max	Mean	Min	Max
pH	6.0 - 9.0	8.09	7.03	8.46	8.17	7.67	8.43
TSS (mg/L)	-	59.5	0.5	2600	34.2	0.5	472
Nutrients (mg/L)							
Ammonia Nitrogen	0.35	0.0427	0.0005	**0.83**	0.0264	0.0025	0.1
Nitrate Nitrogen	2.9	1.9728	0.0025	**9.4**	0.414	0.01	2.6
Nitrite Nitrogen	0.06	0.0113	0.0005	**0.36**	0.0056	0.0025	0.0243
Phosphorus (Total)	0.02	**0.149**	0.005	**1.65**	**0.076**	**0.005**	**0.679**
Total Metals (mg/L)							
Aluminum	0.62	**1.3817**	0.005	**30.7**	**0.8698**	0.007	**11.3**
Arsenic	0.005	0.00113	0.0001	**0.0151**	0.00102	0.00031	**0.00637**
Cadmium	0.00004	0.00006	0.000005	**0.00094**	0.000023	0.000005	**0.000212**
Chromium	0.002	**0.003**	0.0002	**0.0582**	0.0019	0.0005	**0.0211**
Copper	0.013	0.00799	0.0001	**0.125**	0.00939	0.00154	**0.0486**
Iron	1.1	**1.7508**	0.0005	**51.5**	**1.52**	0.033	**17.7**
Lead	0.004	0.00082	0.00005	**0.029**	0.00048	0.0001	**0.00543**
Molybdenum	0.073	0.00324	0.00024	0.017	0.0019	0.0005	0.0064
Nickel	0.11	0.0039	0.0005	0.0629	0.0027	0.0005	0.0235
Selenium	0.001	0.00074	0.00005	**0.0044**	0.00026	0.00005	0.00074
Zinc	0.03	0.0092	0.0005	**0.136**	0.0097	0.0025	**0.0484**

Bold values indicate exceedances of the WUL water quality standards

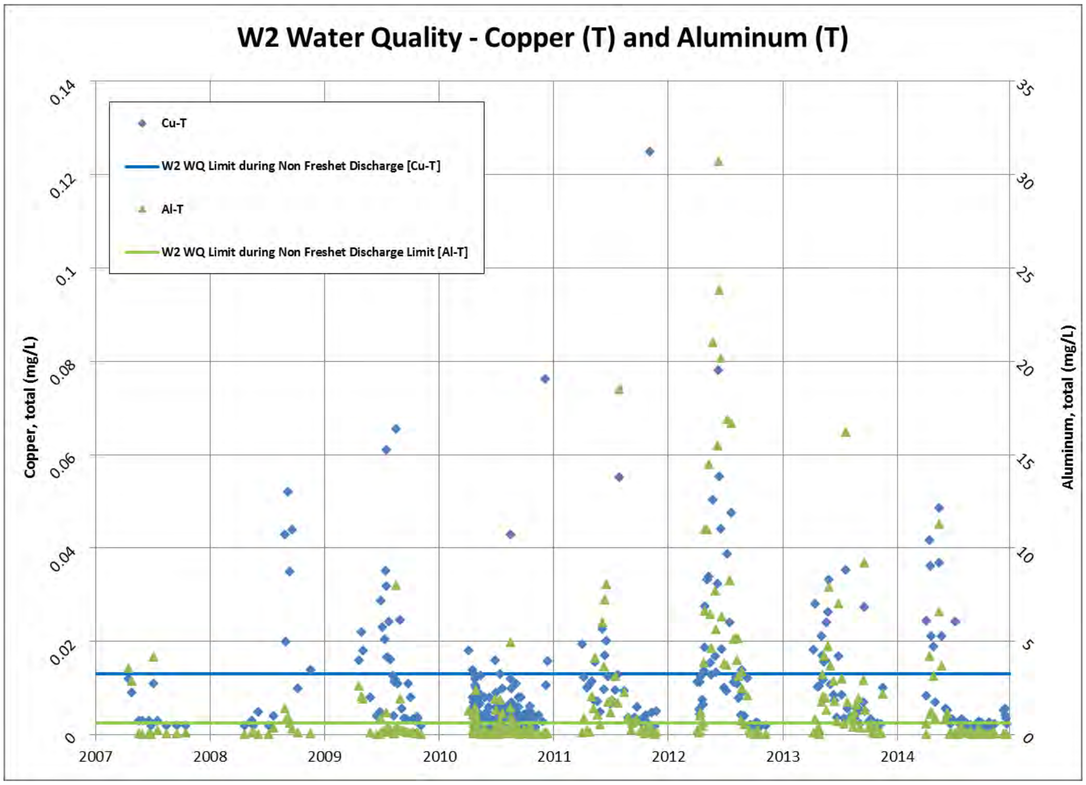

Figure 5-2: W2 Copper and Aluminum Concentrations (2007-2014)

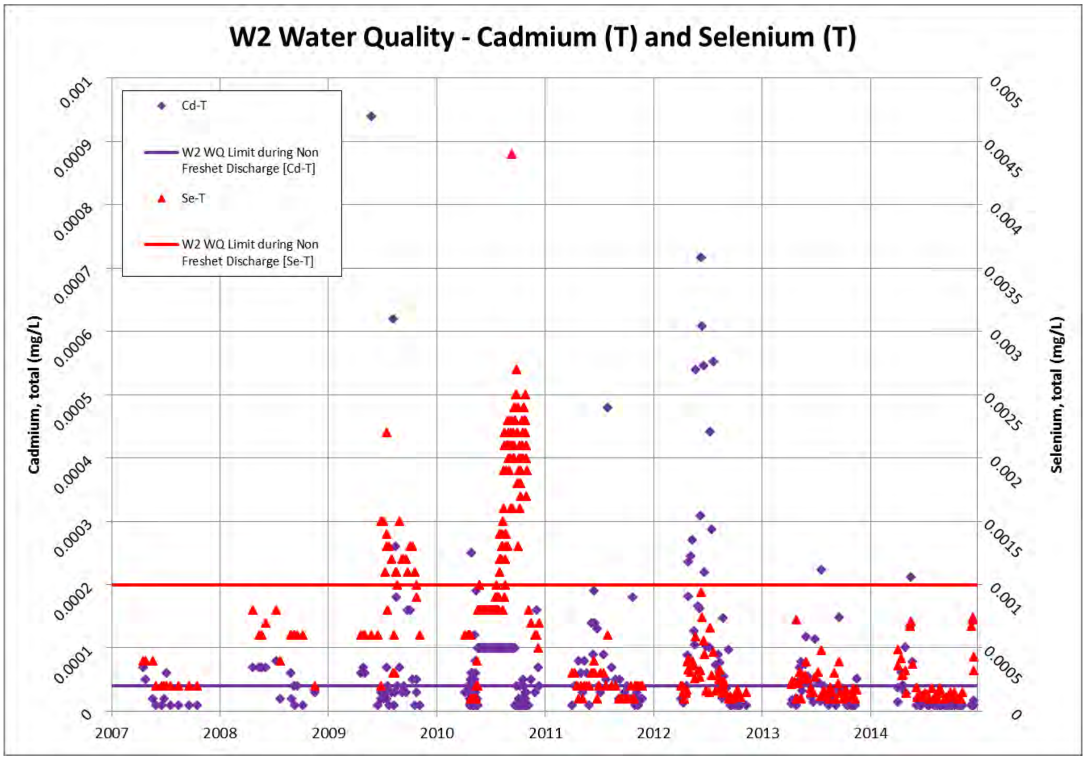

Figure 5-3: W2 Cadmium and Selenium Concentrations (2007-2014)

5.1.3 W3 – Minto Creek, at the Federal Metal Mining Effluent Regulations (MMER) Compliance Point

Station W3 2007 to 2014 water quality result statistics are summarized in Table 5-4, below. Fifty-eight routine samples were collected from station W3 during the 2014 monitoring period. The station W3 2007-2014 copper, aluminum, cadmium and selenium concentrations are further displayed in Figure 5-4 and Figure 5-5.

Table 5-4: W3 Water Quality Results Summary (2007-2014)

W3	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	Mean	Min	Max	Mean	Min	Max
pH	8.08	7.4	8.6	8.17	7.82	8.54
TSS (mg/L)	7.4	0.5	985	7.9	0.5	283
Nutrients (mg/L)						
Ammonia Nitrogen	0.0556	0.0005	0.62	0.0413	0.0087	0.18
Nitrate Nitrogen	3.268	0.01	18.7	0.747	0.163	3.22
Nitrite Nitrogen	0.0489	0.0005	4.13	0.0071	0.0025	0.0364
Total Metals (mg/L)						
Aluminum	0.22285	0.0025	16.6	0.1195	0.0043	1.02
Arsenic	0.000403	0.00005	0.00616	0.00034	0.0002	0.00094
Cadmium	0.0006372	0.0000025	0.372	0.000008	0.000005	0.000037
Chromium	0.00085	0.00005	0.0247	0.0005	0.0005	0.0015
Copper	0.01059	0.0005	0.259	0.01084	0.0016	0.081
Iron	0.2681	0.0005	26.8	0.2195	0.0087	1.77
Lead	0.0003762	0.0000025	0.0935	0.00014	0.0001	0.00175
Molybdenum	0.00594	0.00057	0.102	0.0052	0.0036	0.0096
Nickel	0.001746	0.00025	0.139	0.001	0.0005	0.0038
Selenium	0.001057	0.0001	0.0324	0.00048	0.00025	0.00123
Zinc	0.00627	0.00037	0.168	0.0053	0.0025	0.0649

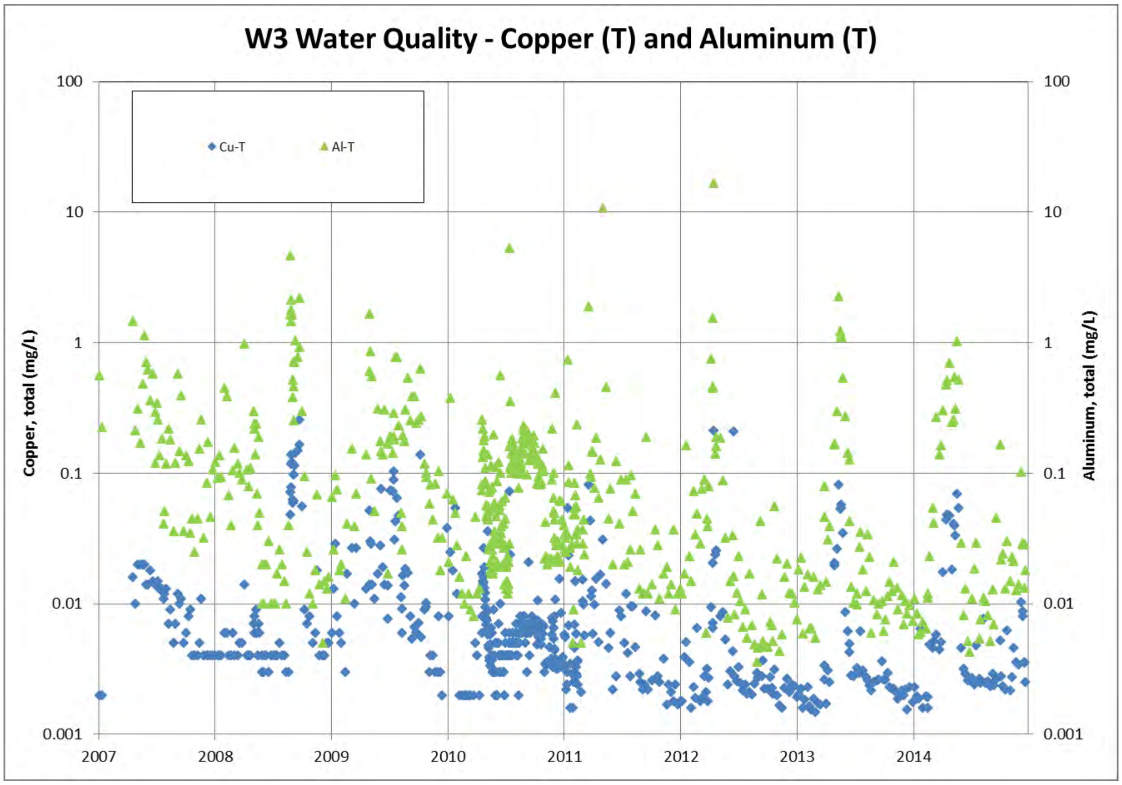

Figure 5-4: W3 Copper and Aluminum Concentrations (2007-2014)

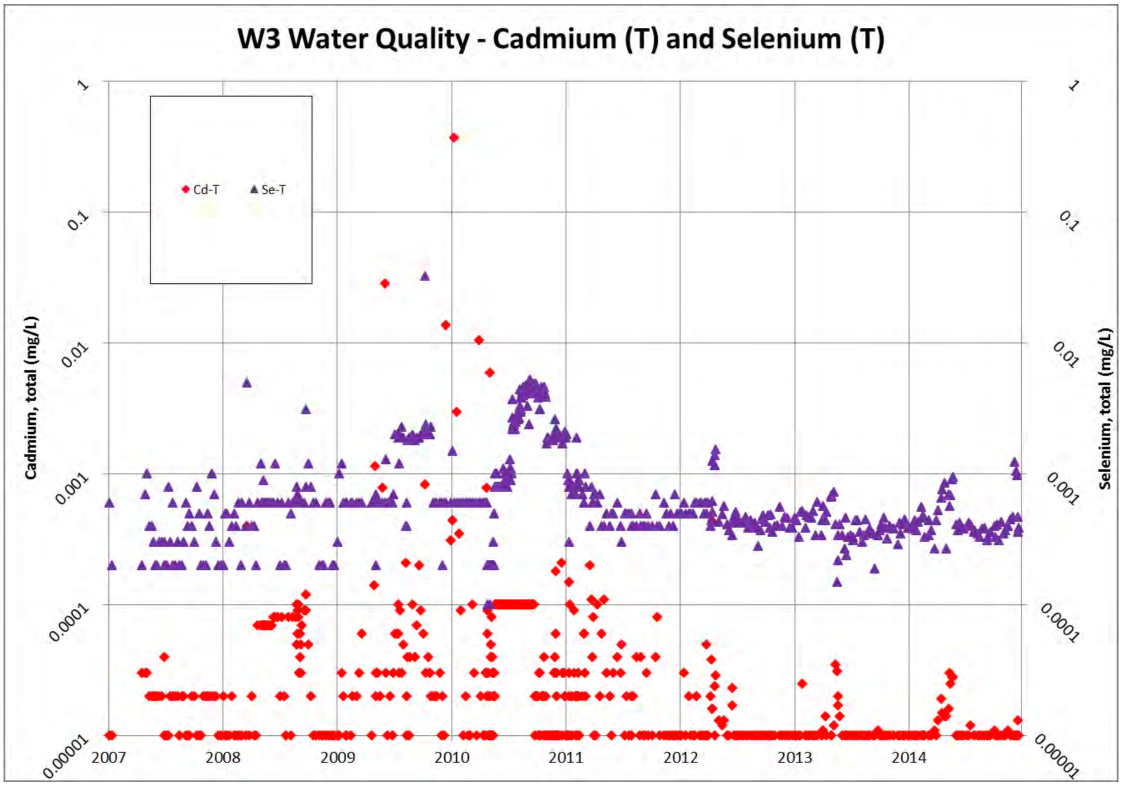

Figure 5-5: W3 Cadmium and Selenium Concentrations (2007-2014)

5.1.4 W7 – North Flowing Tributary to Minto Creek

Station W7 2007 to 2014 water quality result statistics are summarized in Table 5-5, below. Eleven routine samples were taken during the 2014 monitoring period.

Table 5-5: W7 Water Quality Results Summary (2007-2014)

W7	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.96	5.74	8.41	8.1	7.49	8.29
TSS (mg/L)	35.6	0.5	400	5.6	0.5	21.5
Nutrients (mg/L)						
Ammonia Nitrogen	0.0325	0.0025	0.34	0.0186	0.0093	0.027
Nitrate Nitrogen	0.104	0.01	0.324	0.163	0.01	0.282
Nitrite Nitrogen	0.0164	0.0025	0.14	0.0025	0.0025	0.0025
Total Metals (mg/L)						
Aluminum	0.8576	0.0098	10.3	0.1038	0.0079	0.371
Arsenic	0.00081	0.0001	0.006	0.00046	0.00037	0.00063
Cadmium	0.000046	0.000005	0.00091	0.000009	0.000005	0.000026
Chromium	0.0023	0.0002	0.025	0.0006	0.0005	0.0011
Copper	0.00524	0.001	0.0285	0.00309	0.00098	0.0116
Iron	1.4448	0.0288	15.6	0.2737	0.0571	0.721
Lead	0.00054	0.00005	0.0052	0.00013	0.0001	0.00048
Molybdenum	0.00114	0.00016	0.002	0.0014	0.0005	0.0019
Nickel	0.0032	0.0002	0.03	0.0009	0.0005	0.0019
Selenium	0.00026	0.00005	0.0009	0.00023	0.0001	0.00043
Zinc	0.0085	0.002	0.121	0.0036	0.0025	0.0088

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

Station W10 2007 to 2014 water quality result statistics are summarized in Table 5-6, below. Seven routine water quality samples were taken during the 2014 monitoring period.

Table 5-6: W10 Water Quality Results Summary (2007-2014)

W10	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.35	6	8.4	7.53	6.63	8.08
TSS (mg/L)	8.2	0.5	77	7.8	1.6	24
Nutrients (mg/L)						
Ammonia Nitrogen	0.076	0.005	1.1	0.087	0.013	0.51
Nitrate Nitrogen	0.032	0.005	0.3	0.071	0.01	0.397
Nitrite Nitrogen	0.0066	0.0025	0.025	0.0061	0.0025	0.025
Total Metals (mg/L)						
Aluminum	0.3123	0.021	4.53	0.176	0.0159	0.372
Arsenic	0.00052	0.00013	0.0021	0.00038	0.00011	0.00053
Cadmium	0.000048	0.000005	0.00029	0.000013	0.000005	0.000041
Chromium	0.0008	0.0002	0.003	0.0005	0.0005	0.0005
Copper	0.06438	0.00277	1.02	0.03733	0.00157	0.09
Iron	1.344	0.1	14.9	2.209	0.343	10.9
Lead	0.00026	0.00005	0.0044	0.00014	0.0001	0.00041
Molybdenum	0.00042	0.00002	0.001	0.0005	0.0005	0.0005
Nickel	0.0019	0.0002	0.017	0.0012	0.0005	0.0024
Selenium	0.00023	0.00005	0.0012	0.00009	0.00005	0.00016
Zinc	0.0139	0.0025	0.093	0.0057	0.0025	0.0082

5.1.6 W12A – Water in the Main Pit

Station W12A (previously station W12) 2007 to 2014 water quality result statistics are summarized in Table 5-7, below. Fifteen routine water quality samples were taken in the 2014 monitoring period. The 2007-2014 W12A copper, aluminum, cadmium and selenium concentrations are further displayed in Figure 5-6 and Figure 5-7, below.

Table 5-7: W12A Water Quality Results Summary (2007-2014)

W12A	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.04	7.27	10.6	8.21	8.09	8.32
TSS (mg/L)	21.2	0.5	251	9.4	1.1	24.7
Nutrients (mg/L)						
Ammonia Nitrogen	2.2985	0.0025	24	1.36	0.96	1.7
Nitrate Nitrogen	22.6	0.005	141	13.7	10.1	16.8
Nitrite Nitrogen	0.5872	0.007	8.78	0.1985	0.0351	0.457
Total Metals (mg/L)						
Aluminum	1.0517	0.016	13.8	0.402	0.078	4.13
Arsenic	0.00131	0.0001	0.0196	0.00057	0.00037	0.00164
Cadmium	0.000169	0.000011	0.00135	0.00005	0.000005	0.00046
Chromium	0.0012	0.0002	0.0076	0.0008	0.0005	0.006
Copper	0.3549	0.01	6.21	0.29938	0.00156	4.53
Iron	1.6983	0.024	23.3	1.068	0.005	13.7
Lead	0.00082	0.00005	0.0056	0.00037	0.0001	0.00435
Molybdenum	0.02779	0.003	0.0598	0.06	0.0499	0.0758
Nickel	0.0032	0.0002	0.051	0.0027	0.0012	0.0053
Selenium	0.00538	0.00064	0.0185	0.0059	0.00444	0.0102
Zinc	0.0141	0.0025	0.17	0.0064	0.0025	0.0379

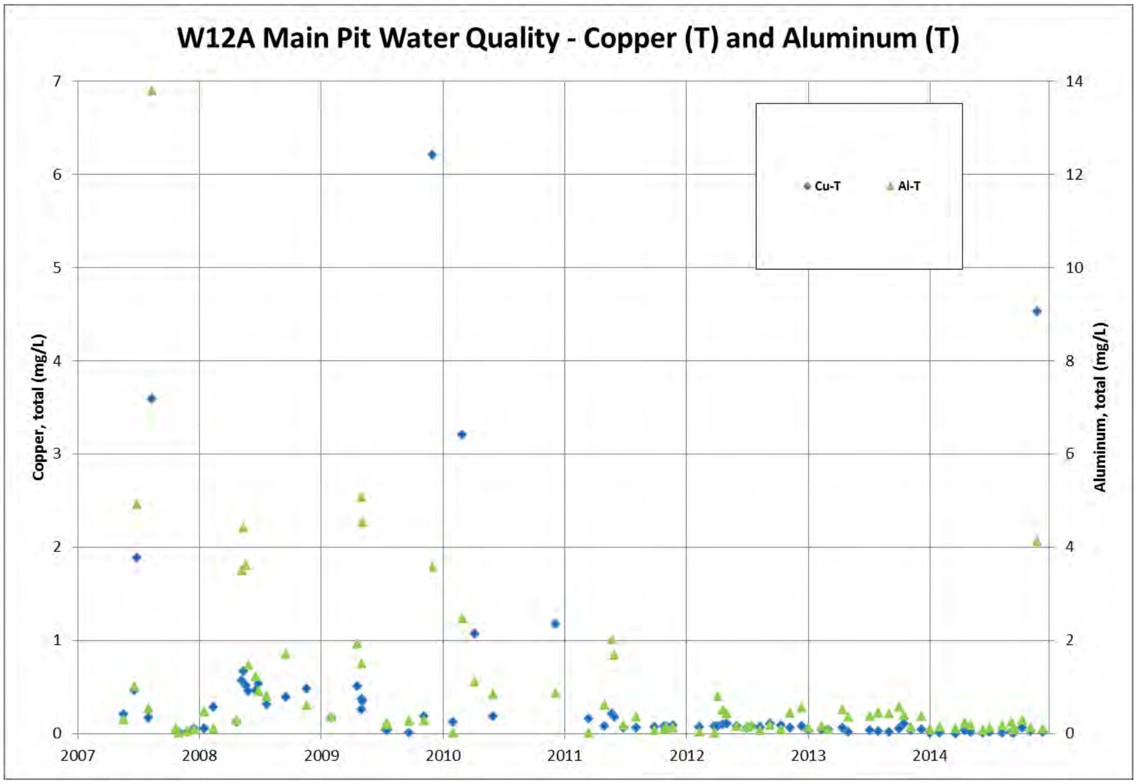

Figure 5-6: W12A Copper and Aluminum Concentrations (2007-2014)

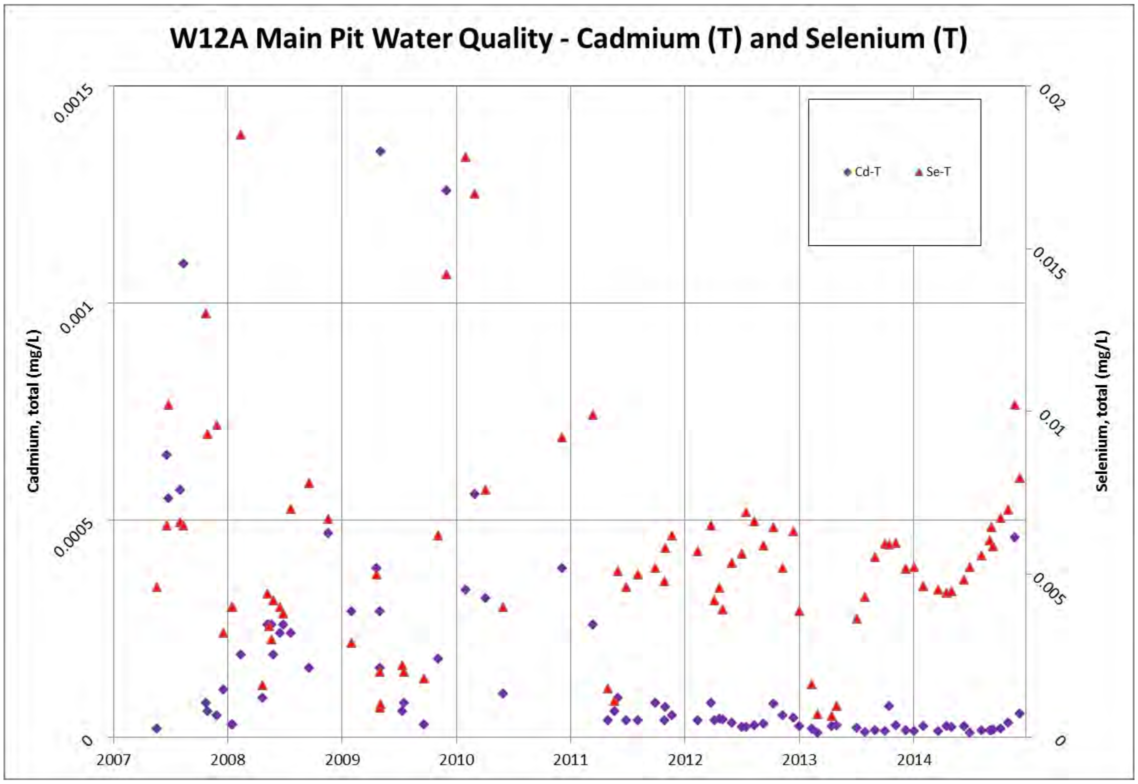

Figure 5-7: W12A Cadmium and Selenium Concentrations (2007-2014)

5.1.7 W13 – Mill Water Storage Pond

Station W13 2007 to 2014 water quality result statistics are summarized in Figure 5-7, below. Two routine water quality samples were taken in 2014.

Table 5-8: W13 Water Quality Results Summary (2007-2014)

W13	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.86	6.97	8.5	8.12	8.09	8.16
TSS (mg/L)	104.2	1	5890	723.6	47.3	1400
Nutrients (mg/L)						
Ammonia Nitrogen	2.12	0.02	7.81	1.7	1.6	1.8
Nitrate Nitrogen	25.47	0.005	86.7	21.1	20.7	21.5
Nitrite Nitrogen	1.16	0.005	24	0.334	0.3	0.368
Total Metals (mg/L)						
Aluminum	2.696	0.005	111	1.122	0.805	1.44
Arsenic	0.00105	0.0001	0.005	0.00036	0.00035	0.00036
Cadmium	0.000472	0.000014	0.0148	0.000062	0.000022	0.000102
Chromium	0.0017	0.0002	0.0264	0.0005	0.0005	0.0005
Copper	0.3116	0.015	5	0.1008	0.0415	0.16
Iron	2.609	0.005	94	0.704	0.41	0.999
Lead	0.00107	0.00005	0.024	0.00038	0.00026	0.00049
Molybdenum	0.0633	0.00269	0.141	0.0616	0.0591	0.0642
Nickel	0.0033	0.0005	0.024	0.0023	0.0022	0.0023
Selenium	0.02375	0.0002	0.192	0.0054	0.00533	0.00546
Zinc	0.0524	0.0025	0.588	0.0094	0.0075	0.0113

5.1.8 W13A – Discharge from Mill Water Storage Pond

In 2014, Minto Mine made a substantial effort to limit/eliminate the overflow of the Mill Pond. Minto Mine did not record any Mill Pond overflow events in 2014 and therefore, no samples were collected for water quality station W13A. Station W13A 2008 to 2011 water quality result statistics are summarized in Table 5-9, below.

Table 5-9: W13A Water Quality Results Summary (2008-2011)

W13A	2008 - 2011 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	7.84	7.47	8.29
TSS (mg/L)	44	3	240
Nutrients (mg/L)			
Ammonia Nitrogen	2.05	0.06	7.5
Nitrate Nitrogen	34.01	0.68	77
Nitrite Nitrogen	0.689	0.04	1.51
Total Metals (mg/L)			
Aluminum	1.118	0.194	4.16
Arsenic	0.0009	0.0001	0.0019
Cadmium	0.00013	0.00005	0.00054
Chromium	0.001	0.0002	0.003
Copper	0.1897	0.02	0.891
Iron	1.334	0.174	6.79
Lead	0.0005	0.00005	0.0022
Molybdenum	0.06906	0.00135	0.106
Nickel	0.003	0.0005	0.035
Selenium	0.0175	0.0003	0.0623
Zinc	0.027	0.002	0.262

5.1.9 W14 – Tailings Thickener Overflow

Station W14 2007 to 2014 water quality result statistics are summarized in Table 5-10, below. Twelve routine water quality samples were taken during the 2014 monitoring period.

Table 5-10: W14 Water Quality Results Summary (2007-2014)

W14	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.88	7.29	8.38	8.15	7.93	8.3
TDS (mg/L)	740	374	4680	663	554	912
Dissolved Metals (mg/L)						
Aluminum	0.1482	0.0381	1.91	0.0968	0.0337	0.303
Arsenic	0.00071	0.0002	0.0052	0.0004	0.00029	0.00051
Cadmium	0.00006	0.00001	0.0003	0.000018	0.000011	0.000035
Chromium	0.001	0.0004	0.0036	0.001	0.001	0.001
Copper	0.01955	0.00028	0.723	0.00229	0.0002	0.00806
Iron	0.129	0.005	4.8	0.0217	0.005	0.116
Lead	0.00023	0.0001	0.0011	0.0002	0.0002	0.0002
Molybdenum	0.0923	0.0458	0.166	0.0841	0.0611	0.124
Nickel	0.0013	0.0005	0.0082	0.0015	0.001	0.0036
Selenium	0.04106	0.00166	0.229	0.00886	0.00448	0.0178
Zinc	0.0055	0.001	0.028	0.0053	0.005	0.0082

5.1.10 W15 – Upper Minto Creek Stormwater Collection Point

Station W15 2007 to 2014 water quality result statistics are summarized in Table 5-11, below. Twenty-eight routine water quality samples were taken during the 2014 monitoring period. The 2007-2014 copper, aluminum, cadmium and selenium concentrations are further displayed in Figure 5-8 and Figure 5-9, below.

Table 5-11: W15 Water Quality Results Summary (2007-2014)

W15	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.87	6.39	8.42	8.15	7.71	8.48
TSS (mg/L)	17.9	0.5	370	18.9	1.1	128
Nutrients (mg/L)						
Ammonia Nitrogen	0.1	0.0025	1.2	0.086	0.017	0.3
Nitrate Nitrogen	8.52	0.005	56.1	9.33	3.57	42.4
Nitrite Nitrogen	0.0845	0.0025	0.402	0.0563	0.008	0.249
Total Metals (mg/L)						
Aluminum	0.5769	0.006	14.7	0.5323	0.0108	2.81
Arsenic	0.000752	0.0002	0.00614	0.00061	0.0003	0.00128
Cadmium	0.000045	0.000005	0.00038	0.000019	0.000005	0.000055
Chromium	0.00101	0.00025	0.0226	0.0006	0.0005	0.0016
Copper	0.04639	0.002	0.493	0.0515	0.0127	0.203
Iron	1.438	0.1	24.5	1.317	0.096	4.75
Lead	0.000339	0.00005	0.0061	0.00034	0.0001	0.00265
Molybdenum	0.00233	0.00016	0.008	0.0031	0.0011	0.0051
Nickel	0.00195	0.00025	0.0187	0.0013	0.0005	0.0023
Selenium	0.00166	0.0001	0.0113	0.00189	0.0008	0.00884
Zinc	0.00696	0.002	0.063	0.0066	0.0025	0.0188

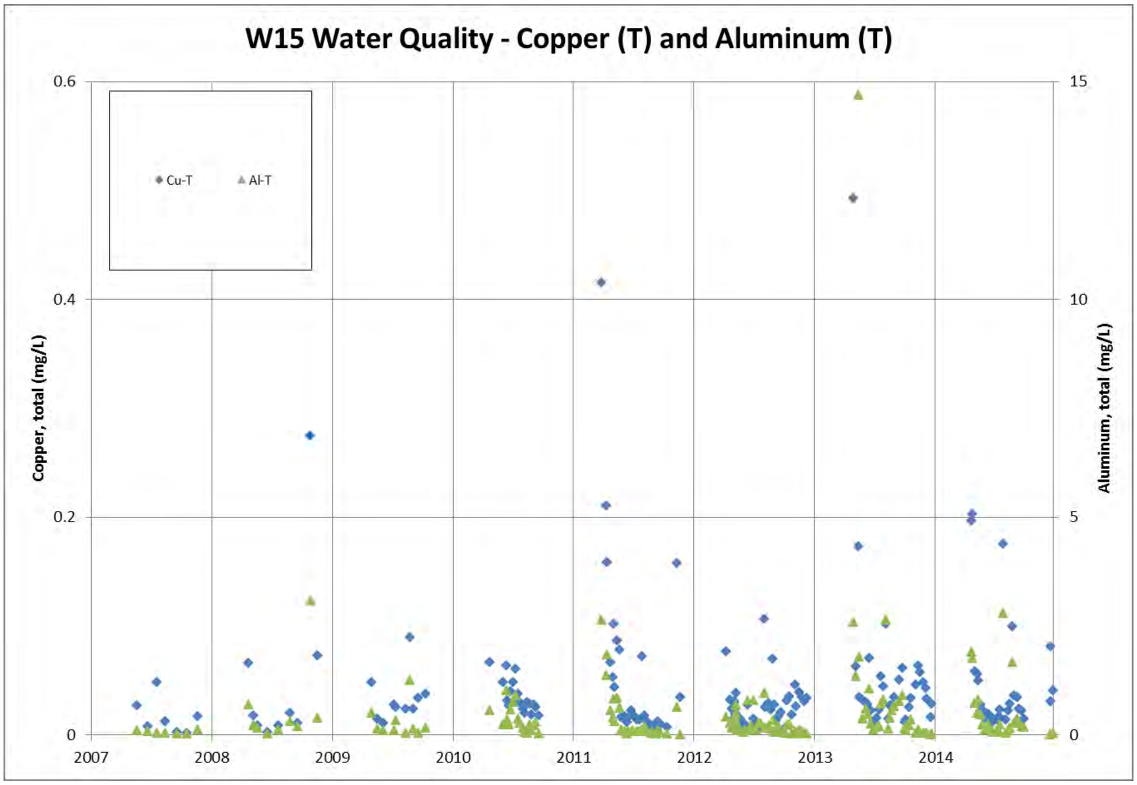

Figure 5-8: W15 Copper and Aluminum Concentrations (2007-2014)

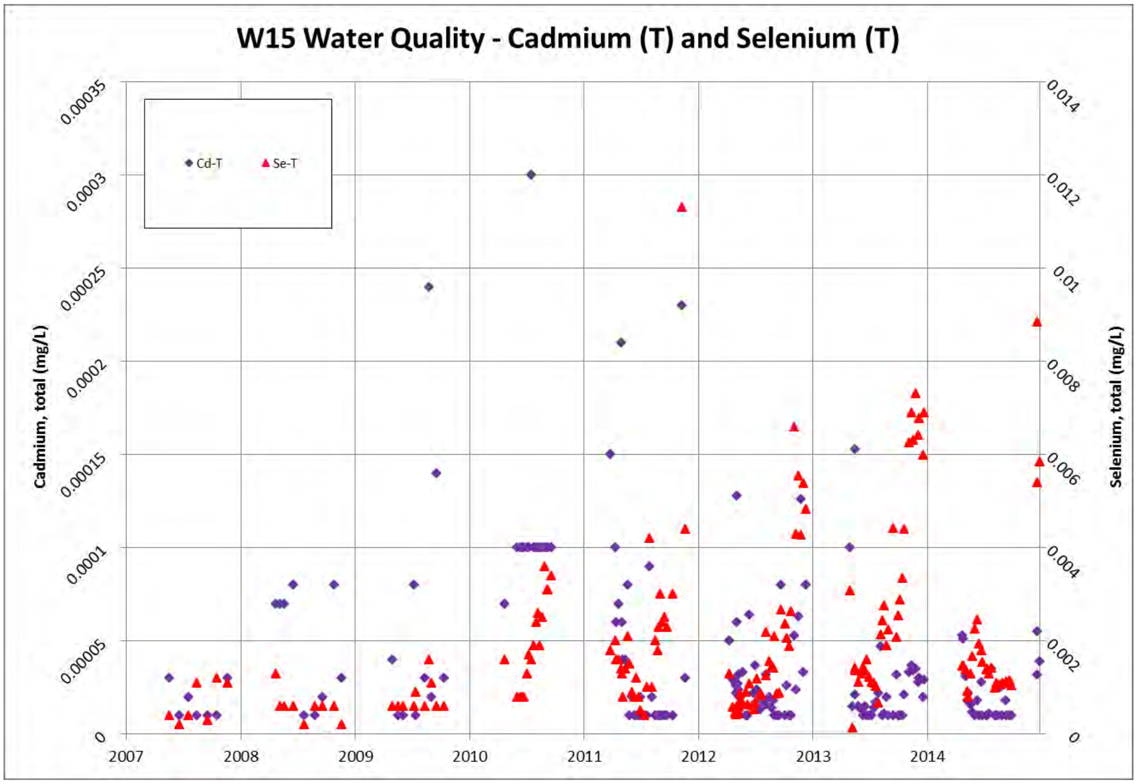

Figure 5-9: W15 Cadmium and Selenium Concentrations (2007-2014)

5.1.11 W16 – Water Storage Pond

Station W16 2007 to 2014 water quality result statistics are summarized in Table 5-12, below, and are compared to the standards outlined in the WUL (Clause 70) for comparative purposes. Forty-eight routine water quality samples were taken during the 2014 monitoring period. The 2007-2014 copper, aluminum, cadmium and selenium concentrations with non-freshet standards (WUL Clause 70) are further displayed in Figure 5-10 and Figure 5-11, below. On Figure 5-11, an outlier cadmium concentration (0.0026 mg/L) from May 5, 2009 is not displayed.

Table 5-12: W16 Water Quality Results Summary (2007-2014)

W16	Water Quality Standard (WUL Clause 70)	2007 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters		Mean	Min	Max	Mean	Min	Max
pH	6.5 - 9.0	7.94	6.74	8.76	8.12	7.55	8.76
TSS (mg/L)	15	7.7	0.5	**181**	7.5	0.5	**31.2**
Nutrients (mg/L)							
Ammonia Nitrogen	0.89	0.1672	0.0025	**2**	0.086	0.013	0.35
Nitrate Nitrogen	7.65	3.944	0.01	**35**	2.299	0.12	4
Nitrite Nitrogen	0.15	0.1286	0.0012	**8.62**	0.0267	0.0025	0.0857
Total Metals (mg/L)							
Aluminum	2.7	0.3153	0.005	**6.06**	0.213	0.0087	1.35
Arsenic	-	0.000525	0.0001	0.005	0.00052	0.00005	0.00098
Cadmium	0.00015	0.000044	0.000005	**0.0026**	0.000022	0.000005	**0.000409**
Chromium	0.008	0.00072	0.00013	0.0066	0.0005	0.0005	0.001
Copper	0.05	0.0455	0.003	**0.468**	0.03481	0.00607	**0.199**
Iron	3.5	0.5549	0.022	**8.2**	0.429	0.021	2.57
Lead	0.02	0.00023	0.000046	0.0025	0.00016	0.0001	0.00052
Molybdenum	0.4	0.00703	0.0005	0.033	0.0073	0.0005	0.0138
Nickel	0.5	0.001922	0.00025	0.025	0.0011	0.0005	0.0022
Selenium	0.003	0.001334	0.0001	**0.0067**	0.00087	0.00005	0.00145
Zinc	0.15	0.0084	0.0005	0.104	0.0052	0.0025	0.0193

Bold values indicate exceedances of the WUL water quality standards

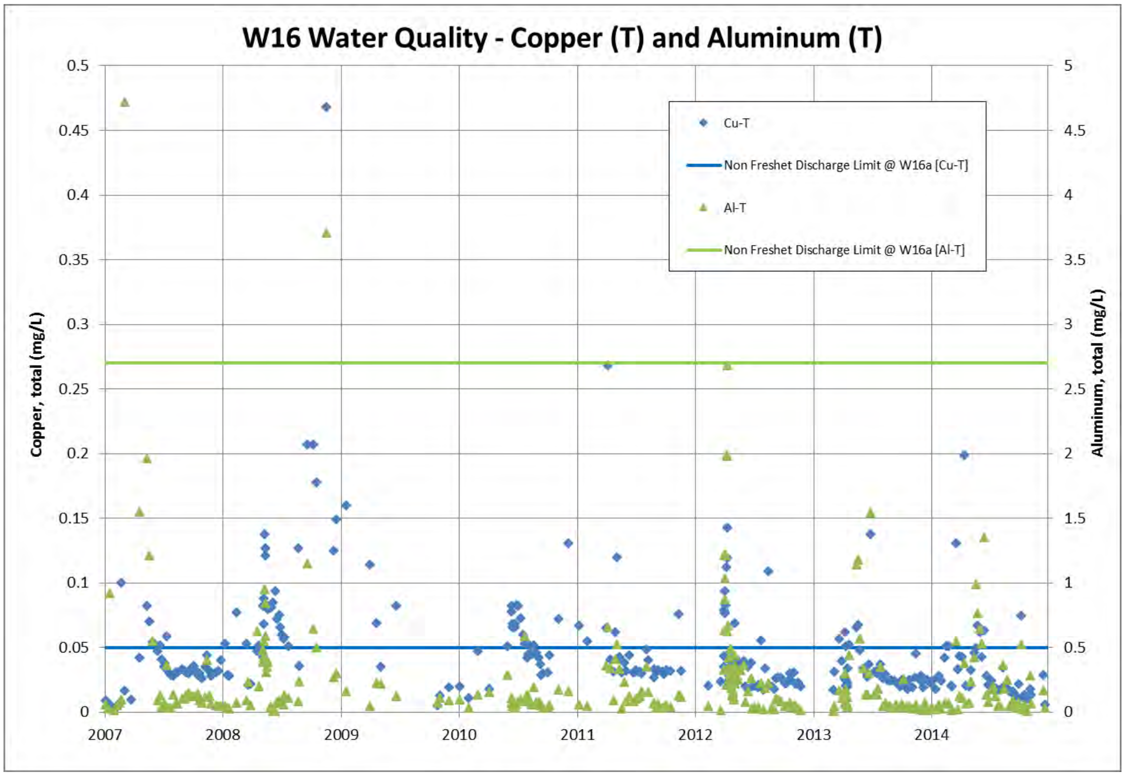

Figure 5-10: W16 Copper and Aluminum Concentrations (2007-2014)

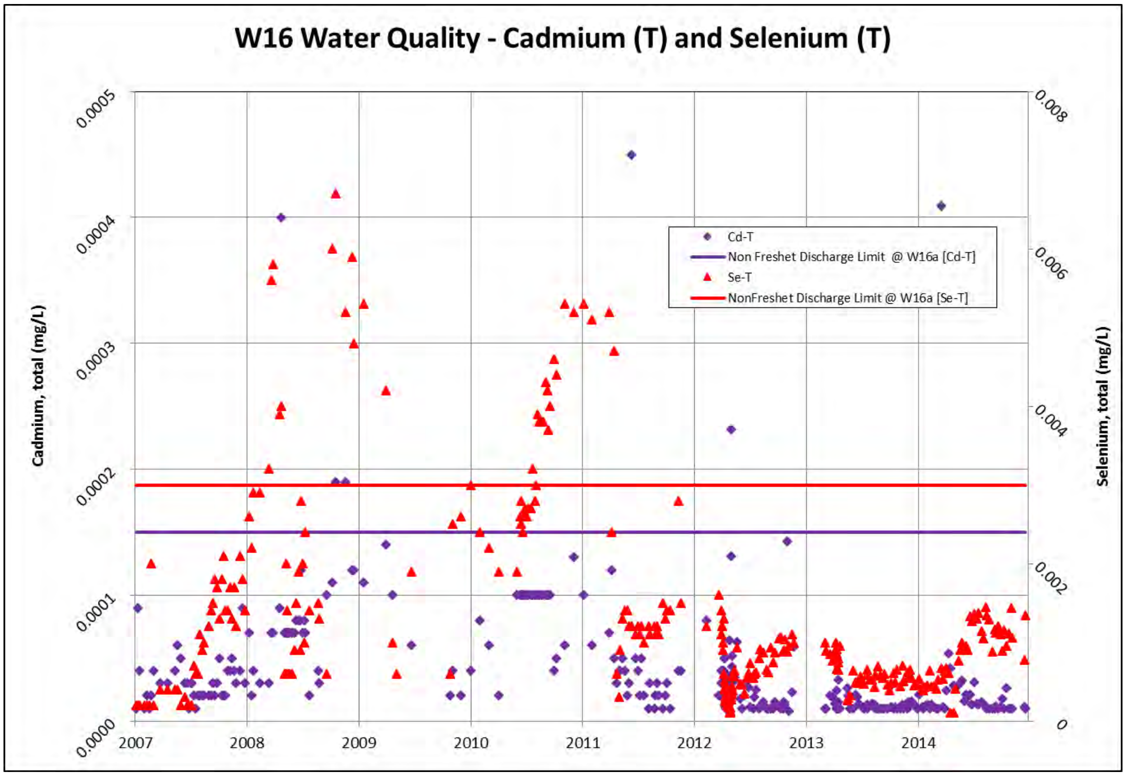

Figure 5-11: W16 Cadmium and Selenium Concentrations (2007-2014)

5.1.12 W30 – Headwaters Minto Creek (northwest fork)

Station W30 2009 to 2014 water quality result statistics are summarized in Table 5-13, below. Six routine water quality samples were taken during the 2014 monitoring period.

Table 5-13: W30 Water Quality Results Summary (2009-2014)

W30	2009 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	Mean	Min	Max	Mean	Min	Max
pH	7.57	6.15	8.32	8.18	7.95	8.33
TSS (mg/L)	23.8	0.5	1110	3.1	1.7	5.3
Nutrients (mg/L)						
Ammonia Nitrogen	0.11	0.002	0.56	0.062	0.02	0.21
Nitrate Nitrogen	3.359	0.005	78.6	4.83	3.96	5.57
Nitrite Nitrogen	0.0361	0.0025	0.579	0.0247	0.0119	0.0633
Total Metals (mg/L)						
Aluminum	2.4183	0.0175	86	0.1022	0.0237	0.226
Arsenic	0.0165	0.0002	0.6	0.00048	0.00037	0.00054
Cadmium	0.001117	0.000005	0.04	0.00001	0.000005	0.000038
Chromium	0.0151	0.0004	0.5	0.0005	0.0005	0.0005
Copper	0.7346	0.0177	22.7	0.0324	0.0235	0.0487
Iron	6.2539	0.0797	219	0.322	0.158	0.583
Lead	0.00335	0.00005	0.1	0.0001	0.0001	0.0001
Molybdenum	0.01573	0.00022	0.5	0.0037	0.0027	0.0044
Nickel	0.0231	0.0005	1	0.0005	0.0005	0.0005
Selenium	0.01591	0.0003	0.5	0.00265	0.00194	0.00333
Zinc	0.1313	0.002	6	0.0047	0.0025	0.0135

5.1.13 W33 – Above Tailings Diversion Ditches

Station W33 2009 to 2014 water quality result statistics are summarized in Table 5-14, below. Six routine water quality samples were taken during the 2014 monitoring period.

Table 5-14: W33 Water Quality Results Summary (2009-2014)

W33	2009 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	Mean	Min	Max	Mean	Min	Max
pH	7.63	6.51	8.25	7.48	5.98	8.1
TSS (mg/L)	10.6	0.5	218	11	0.5	56.4
Nutrients (mg/L)						
Ammonia Nitrogen	0.0597	0.0025	0.33	0.0264	0.0025	0.044
Nitrate Nitrogen	0.17	0.005	4.78	11.818	0.01	60.4
Nitrite Nitrogen	0.005	0.0025	0.025	0.0124	0.0025	0.0376
Total Metals (mg/L)						
Aluminum	0.2399	0.025	3.94	0.0836	0.0035	0.279
Arsenic	0.00039	0.0002	0.00253	0.00036	0.00005	0.00063
Cadmium	0.000067	0.000005	0.00095	0.000007	0.000005	0.000015
Chromium	0.0009	0.0005	0.0065	0.0005	0.0005	0.0005
Copper	0.0226	0.0045	0.125	0.01234	0.00025	0.0306
Iron	0.459	0.108	6.54	0.403	0.005	1.24
Lead	0.00019	0.0001	0.00173	0.0001	0.0001	0.0001
Molybdenum	0.00058	0.0003	0.0016	0.0007	0.0005	0.0016
Nickel	0.002	0.0005	0.0066	0.0015	0.0005	0.0029
Selenium	0.00024	0.00005	0.0015	0.00025	0.00005	0.0008
Zinc	0.0053	0.0025	0.02	0.0033	0.0025	0.0055

5.1.14 W35A and W35B– Storm Water Collection Point – South Diversion Ditch

Stations W35A and W35B are sampled from the same location, internally called W35, and the 2013 to 2014 water quality result statistics are summarized in Table 5-15, below. Ten routine water quality samples were taken during the 2014 monitoring period.

Table 5-15: W35 Water Quality Results Summary (2013-2014)

W35	2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.94	7.39	8.13	7.86	7.57	8.16
TSS (mg/L)	25.8	0.5	222	46.2	0.5	465
Nutrients (mg/L)						
Ammonia Nitrogen	0.047	0.016	0.13	0.0429	0.018	0.16
Nitrate Nitrogen	1.41	0.206	2.64	2.358	0.201	5.17
Nitrite Nitrogen	0.0696	0.0025	0.335	0.0218	0.0025	0.153
Total Metals (mg/L)						
Aluminum	1.149	0.0292	10.3	1.2013	0.0457	11.6
Arsenic	0.00061	0.00033	0.0021	0.00056	0.00029	0.00226
Cadmium	0.00002	0.000005	0.000145	0.000028	0.000005	0.000189
Chromium	0.0009	0.0005	0.0047	0.0009	0.0005	0.0053
Copper	0.1076	0.0225	0.701	0.1319	0.0278	1.07
Iron	1.995	0.145	16.6	1.975	0.12	18.6
Lead	0.00045	0.0001	0.00363	0.00056	0.0001	0.00492
Molybdenum	0.0016	0.0005	0.0048	0.0008	0.0005	0.0015
Nickel	0.0017	0.0005	0.0037	0.0018	0.001	0.0043
Selenium	0.00029	0.00011	0.00074	0.00027	0.00005	0.00073
Zinc	0.0081	0.0025	0.0556	0.0123	0.0025	0.0827

5.1.15 W36 – Minto Creek Detention Structure Pond

Station W36 2009 to 2010 and 2012 to 2014 water quality result statistics are summarized in Table 5-16, below. Twelve routine water quality samples were taken during the 2014 monitoring period.

Table 5-16: W36 Water Quality Results Summary (2009-2010, 2012-2013, 2014)

W36	2009, 2010, 2012, 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.87	6.39	8.42	8.21	7.86	8.34
TSS (mg/L)	17.9	0.5	370	81.7	0.5	625
Nutrients (mg/L)						
Ammonia Nitrogen	0.1	0.0025	1.2	0.029	0.012	0.098
Nitrate Nitrogen	8.52	0.005	56.1	9.24	3.87	16.1
Nitrite Nitrogen	0.0845	0.0025	0.402	0.0191	0.0072	0.0685
Total Metals (mg/L)						
Aluminum	0.5769	0.006	14.7	2.9789	0.01	23.1
Arsenic	0.000752	0.0002	0.00614	0.00129	0.00029	0.00716
Cadmium	0.000045	0.000005	0.00038	0.000117	0.000016	0.000715
Chromium	0.00101	0.00025	0.0226	0.002	0.0005	0.0122
Copper	0.04639	0.002	0.493	0.2049	0.0445	1.11
Iron	1.438	0.1	24.5	5.794	0.124	43.9
Lead	0.000339	0.00005	0.0061	0.00143	0.0001	0.0105
Molybdenum	0.00233	0.00016	0.008	0.0075	0.0051	0.0101
Nickel	0.00195	0.00025	0.0187	0.0023	0.0005	0.0105
Selenium	0.00166	0.0001	0.0113	0.00452	0.00165	0.00717
Zinc	0.00696	0.002	0.063	0.1723	0.0025	0.861

5.1.16 W42 – Storm Water Collection Sump – North side of Mine Access Road 0.5 km

Station W42 2009 to 2014 water quality result statistics are summarized in Table 5-17, below. Thirty-three routine water quality samples were taken during the 2014 monitoring period.

Table 5-17: W42 Water Quality Results Summary (2009-2014)

W42	2009 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	Mean	Min	Max	Mean	Min	Max
pH	7.96	7.41	8.3	8.1	7.57	8.32
TSS (mg/L)	16.2	0.5	257	12.5	0.5	209
Nutrients (mg/L)						
Ammonia Nitrogen	0.0414	0.0025	0.26	0.0245	0.0056	0.14
Nitrate Nitrogen	0.1663	0.01	0.846	0.142	0.01	0.393
Nitrite Nitrogen	0.0116	0.0025	0.089	0.0053	0.0025	0.0316
Total Metals (mg/L)						
Aluminum	0.8111	0.0102	11.5	0.7894	0.0093	11.7
Arsenic	0.00046	0.00011	0.0028	0.00086	0.00013	0.00795
Cadmium	0.000042	0.000005	0.00072	0.000031	0.000005	0.00025
Chromium	0.0009	0.0002	0.0074	0.0017	0.0005	0.0247
Copper	0.06297	0.00658	0.575	0.04132	0.00529	0.217
Iron	1.2206	0.0294	16	1.363	0.023	21.8
Lead	0.00034	0.00005	0.00388	0.00041	0.0001	0.00599
Molybdenum	0.0025	0.0005	0.0071	0.0031	0.0005	0.0052
Nickel	0.0015	0.0005	0.007	0.0023	0.0005	0.031
Selenium	0.00016	0.00005	0.0015	0.0002	0.00005	0.00052
Zinc	0.0066	0.0025	0.0584	0.0094	0.0025	0.0707

5.1.17 W43 – Storm Water Collection Sump – North side of Mine Access Road at Water Storage Pond

Station W43 2011 to 2014 water quality statistics are summarized in Table 5-18, below. Eleven routine water quality samples were taken during the 2014 monitoring period.

Table 5-18: W43 Water Quality Results Summary (2011-2014)

W43	2011 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.79	7.47	8.17	7.93	7.66	8.18
TSS (mg/L)	165.1	0.5	1790	23.5	1.2	100
Nutrients (mg/L)						
Ammonia Nitrogen	0.0347	0.0025	0.19	0.0359	0.0062	0.18
Nitrate Nitrogen	0.488	0.027	1.26	0.553	0.185	1.87
Nitrite Nitrogen	0.0123	0.0025	0.075	0.0094	0.0025	0.0289
Total Metals (mg/L)						
Aluminum	7.3869	0.0121	90.8	0.9343	0.0398	2.3
Arsenic	0.00132	0.00005	0.0123	0.00034	0.00005	0.00066
Cadmium	0.00013	0.000005	0.00126	0.000046	0.000012	0.000086
Chromium	0.0045	0.0005	0.046	0.0007	0.0005	0.0015
Copper	0.53323	0.00867	5.95	0.0853	0.0306	0.156
Iron	13.3377	0.019	172	1.285	0.0858	3.78
Lead	0.00284	0.0001	0.0303	0.00038	0.0001	0.00078
Molybdenum	0.0016	0.0005	0.005	0.0007	0.0005	0.0018
Nickel	0.0037	0.0005	0.034	0.0007	0.0005	0.0015
Selenium	0.00061	0.00005	0.005	0.00033	0.00005	0.00056
Zinc	0.0682	0.0025	0.6	0.0095	0.0025	0.0159

5.1.18 W44 – Area 2 Underground Mine Inflows

Station W44 2013 to 2014 water quality result statistics are summarized in Table 5-19, below. Forty-four routine water quality samples were taken during the 2014 monitoring period.

Table 5-19: W44 Water Quality Results Summary (2013-2014)

W44	2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.95	7.3	8.28	7.96	7.81	8.17
TSS (mg/L)	884.6	26.5	10500	133.5	1.6	2530
Nutrients (mg/L)						
Ammonia Nitrogen	58.3	2.3	230	3.47	0.27	30
Nitrate Nitrogen	123.98	0.59	484	4.973	0.303	37.3
Nitrite Nitrogen	4.378	0.776	12.5	0.4836	0.0323	5.43
Total Metals (mg/L)						
Aluminum	16.231	0.259	165	2.024	0.196	9.14
Arsenic	0.00332	0.0006	0.0219	0.00315	0.00151	0.00684
Cadmium	0.000619	0.000005	0.0162	0.000155	0.000005	0.0015
Chromium	0.0071	0.0005	0.0636	0.0009	0.0005	0.003
Copper	2.8148	0.0188	86.5	0.1545	0.015	1.41
Iron	37.252	0.673	486	3.87	0.288	15.4
Lead	0.02192	0.00085	0.211	0.00154	0.0002	0.00812
Molybdenum	0.0326	0.0084	0.0498	0.0101	0.006	0.0262
Nickel	0.0097	0.0014	0.0575	0.0013	0.0005	0.0043
Selenium	0.00491	0.0001	0.0355	0.0003	0.00005	0.00114
Zinc	0.2549	0.0092	2.66	0.0383	0.0025	0.159

5.1.19 W45 – Area 2 Pit

Station W45 2012 to 2014 water quality result statistics are summarized in Table 5-20, below. Eleven routine water quality samples were taken during the 2014 monitoring period.

Table 5-20: W45 Water Quality Results Summary (2012-2014)

W45	2012 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.05	7.94	8.18	7.99	7.86	8.18
TSS (mg/L)	40.4	1.1	291	28.6	0.5	103
Nutrients (mg/L)						
Ammonia Nitrogen	11.06	2.49	37	3.48	0.92	13
Nitrate Nitrogen	35.84	7.01	77.2	6.87	2.57	17.3
Nitrite Nitrogen	1.631	0.621	2.53	0.535	0.209	1.68
Total Metals (mg/L)						
Aluminum	0.6466	0.019	2.25	0.7797	0.0049	2.65
Arsenic	0.00167	0.00119	0.00266	0.00157	0.00114	0.0024
Cadmium	0.00015	0.000005	0.000579	0.000237	0.000101	0.00046
Chromium	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Copper	0.2653	0.0225	1.24	0.3682	0.0437	1.14
Iron	1.385	0.07	5.7	1.893	0.005	5.94
Lead	0.00042	0.0001	0.0015	0.00067	0.0001	0.0023
Molybdenum	0.0273	0.0127	0.0437	0.0289	0.0185	0.039
Nickel	0.001	0.0005	0.0021	0.0017	0.0005	0.0036
Selenium	0.00576	0.00117	0.0298	0.00179	0.00096	0.0033
Zinc	0.0126	0.0025	0.0425	0.0296	0.015	0.0505

5.1.20 W46 – Minto Creek, Downstream of W7 and W6

Station W46 2012 to 2014 water quality result statistics are summarized in Table 5-21, below. Eleven routine water quality samples were taken during the 2014 monitoring period.

Table 5-21: W46 Water Quality Results Summary (2012-2014)

W46	2012 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.11	7.61	8.33	8.09	7.75	8.24
TSS (mg/L)	25.1	0.5	76.3	17.2	0.5	78.1
Nutrients (mg/L)						
Ammonia Nitrogen	0.0389	0.0099	0.16	0.027	0.022	0.047
Nitrate Nitrogen	0.184	0.059	0.334	0.393	0.01	2.46
Nitrite Nitrogen	0.0025	0.0025	0.0025	0.0047	0.0025	0.0242
Total Metals (mg/L)						
Aluminum	0.5424	0.0119	2.62	0.3845	0.0105	1.81
Arsenic	0.00076	0.00037	0.00129	0.00063	0.00033	0.00111
Cadmium	0.000011	0.000005	0.00004	0.00001	0.000005	0.000036
Chromium	0.0013	0.0005	0.0046	0.001	0.0005	0.0033
Copper	0.005	0.0014	0.0201	0.00502	0.00087	0.02
Iron	1.2022	0.0432	3.75	0.684	0.066	2.63
Lead	0.00026	0.0001	0.0011	0.00022	0.0001	0.00076
Molybdenum	0.0017	0.0005	0.0023	0.0022	0.0005	0.0073
Nickel	0.0023	0.0005	0.0054	0.0018	0.0005	0.0041
Selenium	0.0002	0.00013	0.00053	0.00024	0.00005	0.00084
Zinc	0.0038	0.0025	0.0109	0.005	0.0025	0.0175

5.1.21 W47 – Area 118 Pit Water

Station W47 was dry throughout 2014 and as such, there are no water quality results to present. Additionally, there are no historical water quality results to present for W47 as the Area 118 Pit was not established prior to 2014.

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

Station W50 water quality result statistics for 2008 to 2014 are summarized in Table 5-22, below, and are compared to the WUL non-freshet water quality standard (Clause 70). Twenty-one routine water quality samples were taken during the 2014 monitoring period. The 2007-2014 copper, aluminum, cadmium and selenium concentrations are displayed in Figure 5-12 and Figure 5-13, and are compared to WUL non-freshet water quality standard (Clause 70). An outlier cadmium concentration (0.0185 mg/L value on May 27, 2009) is not displayed on Figure 5-13 to improve the presentation of the figure.

Table 5-22: W50 Water Quality Results Summary (2008-2014)

W50	Water Quality Standard (WUL Clause 70)	2008 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters		Mean	Min	Max	Mean	Min	Max
pH	6.5 - 9.0	8.04	6.82	8.4	8.11	7.77	8.37
TSS (mg/L)	15	6.1	0.5	**42**	6.4	0.5	**24.3**
Nutrients (mg/L)							
Ammonia Nitrogen	0.89	0.0782	0.0025	**1**	0.0757	0.0058	0.24
Nitrate Nitrogen	7.65	5.158	0.01	**16.2**	1.491	0.183	3.3
Nitrite Nitrogen	0.15	0.0218	0.0025	**0.158**	0.0116	0.0025	0.0369
Total Metals (mg/L)							
Aluminum	2.7	0.247	0.008	2.4	0.2959	0.0051	1.17
Arsenic	-	0.00048	0.0002	0.0022	0.00049	0.0003	0.00114
Cadmium	0.00015	**0.000205**	0.000005	**0.0185**	0.000015	0.000005	0.000055
Chromium	0.008	0.00077	0.0002	0.0059	0.0007	0.0005	0.0021
Copper	0.05	0.02462	0.002	**0.103**	0.02661	0.00481	**0.105**
Iron	3.5	0.329	0.0025	**3.85**	0.509	0.018	2.2
Lead	0.02	0.00028	0.00005	0.0021	0.00022	0.0001	0.00088
Molybdenum	0.4	0.00771	0.0005	0.02	0.0055	0.0005	0.0104
Nickel	0.5	0.0018	0.0005	0.018	0.0012	0.0005	0.0029
Selenium	0.003	0.00135	0.00005	**0.0054**	0.00066	0.00018	0.00126
Zinc	0.15	0.0061	0.0025	0.033	0.0069	0.0025	0.038

Bold values indicate exceedances of the WUL water quality standards

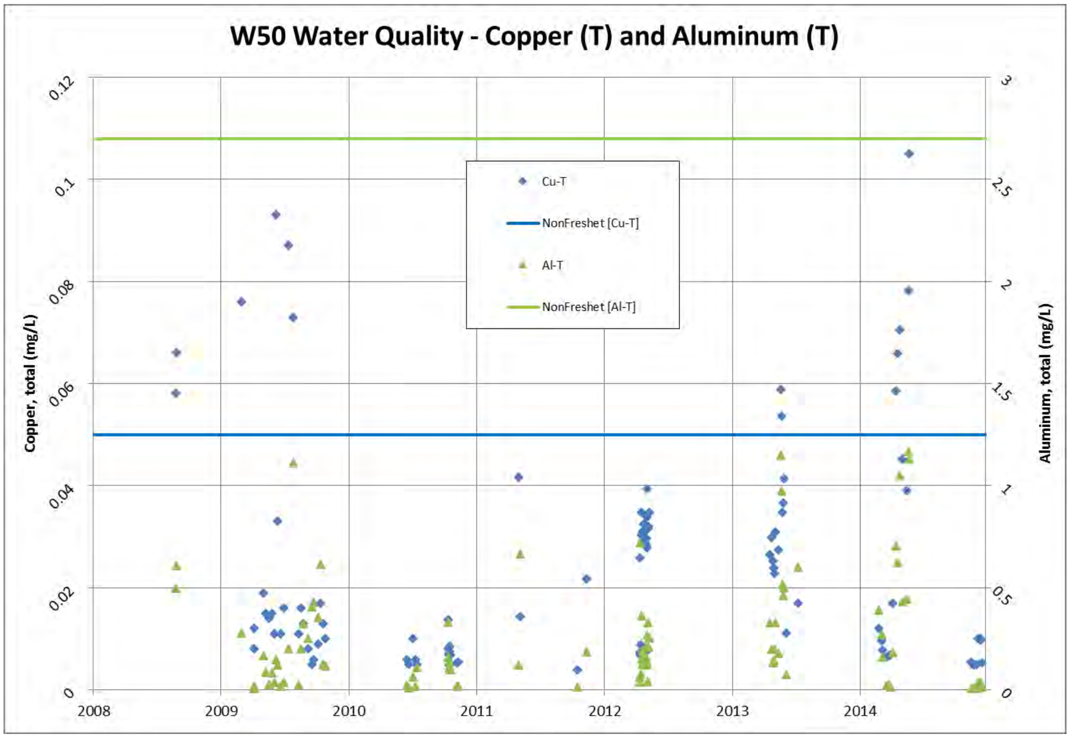

Figure 5-12: W50 Copper and Aluminum Concentrations (2008-2014)

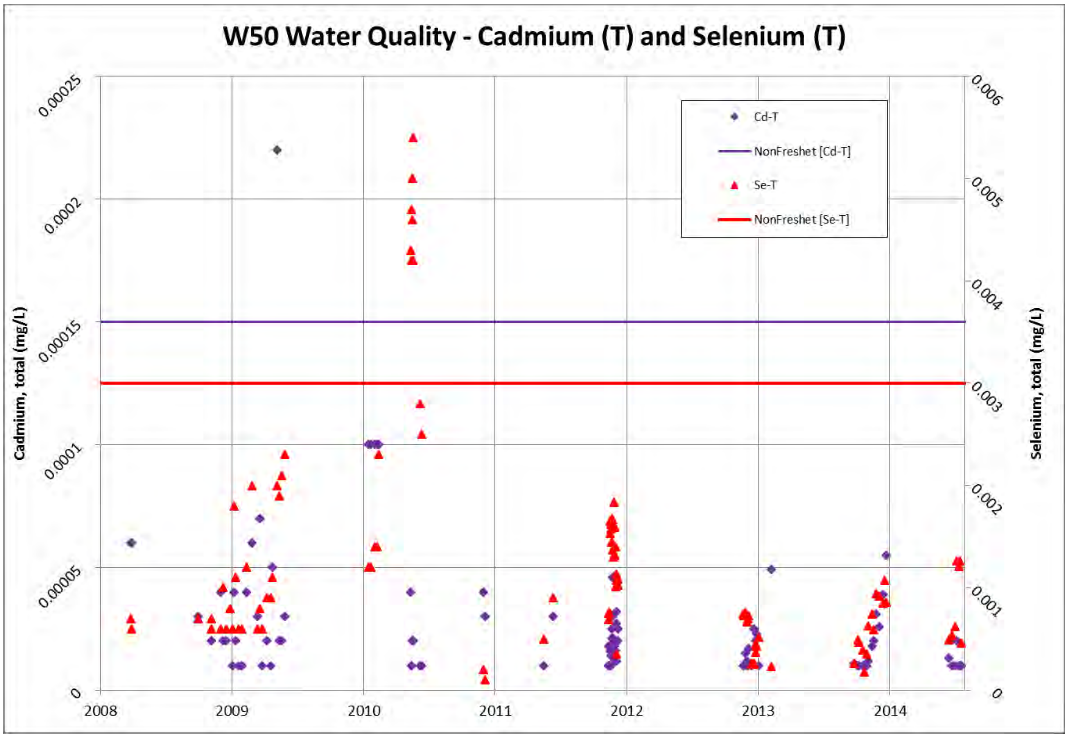

Figure 5-13: W50 Cadmium and Selenium Concentrations (2008-2014)

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

Station MC-1 2009 to 2014 water quality result statistics are summarized in Table 5-23, below. Thirty-seven routine water quality samples were taken during the 2014 monitoring period.

Table 5-23: MC-1 Water Quality Results Summary (2009-2014)

MC-1	2009 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	8.12	7.5	8.4	8.19	7.65	8.49
TSS (mg/L)	67.9	0.5	660	35.7	0.5	385
Nutrients (mg/L)						
Ammonia Nitrogen	0.0408	0.0025	0.36	0.0291	0.0059	0.093
Nitrate Nitrogen	0.5588	0.0025	7.3	0.258	0.01	2.59
Nitrite Nitrogen	0.0065	0.0005	0.0342	0.0041	0.0025	0.0206
Total Metals (mg/L)						
Aluminum	1.59	0.0104	14.9	0.7207	0.0107	9.38
Arsenic	0.00132	0.0002	0.00794	0.00098	0.00031	0.00556
Cadmium	0.000051	0.000005	0.00045	0.00002	0.000005	0.000187
Chromium	0.0035	0.0005	0.033	0.0016	0.0005	0.0176
Copper	0.00754	0.001	0.0488	0.00632	0.00142	0.0426
Iron	2.7078	0.03	23.9	1.421	0.069	16.7
Lead	0.00075	0.0001	0.00652	0.00041	0.0001	0.00479
Molybdenum	0.0017	0.0004	0.009	0.0017	0.0005	0.0074
Nickel	0.0044	0.0005	0.033	0.0027	0.0005	0.0223
Selenium	0.00036	0.00005	0.0022	0.00025	0.00005	0.00092
Zinc	0.0078	0.002	0.056	0.0064	0.0025	0.0407

5.1.24 WC – Convergence Point for W15 and W35 Inflows

Station WC 2011 and 2013 water quality result statistics are summarized in Table 5-24, below. Station WC was dry throughout the 2014 monitoring period and as such there are no results to present for 2014.

Table 5-24: WC Water Quality Results Summary (2011, 2013)

WC	2011, 2013 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**
pH	7.94	7.34	8.41
TSS (mg/L)	27.9	1	130
Nutrients (mg/L)			
Ammonia Nitrogen	0.19	0.023	1
Nitrate Nitrogen	4.29	0.11	11.1
Nitrite Nitrogen	0.0968	0.007	0.512
Total Metals (mg/L)			
Aluminum	1.174	0.067	6.23
Arsenic	0.00101	0.0004	0.00221
Cadmium	0.000056	0.000005	0.00013
Chromium	0.002	0.0005	0.009
Copper	0.1362	0.0161	0.39
Iron	2.33	0.246	10.1
Lead	0.00077	0.0001	0.0024
Molybdenum	0.0057	0.0005	0.0202
Nickel	0.0056	0.001	0.059
Selenium	0.00151	0.0001	0.0053
Zinc	0.0384	0.0025	0.151

5.2 Metal Mine Effluent Monitoring Program

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

5.3 Hydrology

In 2014 and as part of the EMSRP, Minto monitored hydrological conditions at water quality stations including the following: stations within the operational mine area; stations downstream from the mine operational area that are influenced by mine effluent discharge; and reference stations downstream from the mine operational area that are not exposed to effluent. Hydrological monitoring is performed using a variety of methods including: manual discrete discharge measurements through the use of a flow meter, continuous stage measurement through the deployment of Solinst Level Loggers and Barometric Loggers and monitoring of an engineered flume.

5.3.1 Minto Creek Hydrology

Hydrological monitoring on Minto Creek is conducted in accordance with the requirements outlined in the WUL. During the 2014 monitoring period, Minto Mine maintained and collected data from the following four hydrometric stations along Minto Creek (see Figure 5-1):

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

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

For details on the 2014 results of Minto Creek hydrology see the *Minto and McGinty Creek 2014 Hydrology Update* in Appendix E.

5.3.2 McGinty Creek Hydrology

In 2014, hydrological monitoring on McGinty Creek was conducted as per the schedule outlined in the EMSRP. During the 2014 monitoring period, Minto Mine maintained and collected data from the following three hydrometric stations along McGinty Creek:

- MN-0.5 (West branch of McGinty Creek);
- MN-2.5 (East branch of McGinty Creek); and
- MN-4.5 (McGinty Creek near the mouth).

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

For details on the 2014 results of McGinty Creek hydrology see the *Minto and McGinty Creek 2014 Hydrology Update* in Appendix E.

5.4 Yukon River Monitoring Program

The Yukon River Monitoring program includes water quality sampling at locations on the Yukon River upstream and downstream of the Minto Creek confluence. Results of the 2014 monitoring program are summarized in this section.

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

Station W4 2011 to 2014 water quality result statistics are summarized in Table 5-25, below. Forty-nine routine water quality samples were taken during the 2014 monitoring period.

Table 5-25: W4 Water Quality Results Summary (2011-2014)

W4	2011 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.96	7.56	8.17	7.98	5.48	8.26
TSS (mg/L)	29.2	0.5	270	11.4	0.5	115
Nutrients (mg/L)						
Ammonia Nitrogen	0.0272	0.0025	0.19	0.0748	0.0025	2.4
Nitrate Nitrogen	0.07	0.01	0.849	0.089	0.01	0.233
Nitrite Nitrogen	0.0042	0.0025	0.025	0.0025	0.0025	0.0025
Total Metals (mg/L)						
Aluminum	0.6636	0.0044	7.95	0.262	0.0015	2.48
Arsenic	0.00093	0.0003	0.00671	0.00073	0.00005	0.00666
Cadmium	0.00004	0.000005	0.00204	0.000012	0.000005	0.000068
Chromium	0.0015	0.0005	0.0152	0.0008	0.0005	0.0046
Copper	0.00295	0.00042	0.0173	0.00167	0.00025	0.00847
Iron	0.9594	0.0215	10.4	0.391	0.005	3.65
Lead	0.00043	0.0001	0.00451	0.00021	0.0001	0.00151
Molybdenum	0.0009	0.0005	0.0019	0.0008	0.0005	0.0013
Nickel	0.0021	0.0005	0.0179	0.0015	0.0005	0.0241
Selenium	0.00015	0.00005	0.0003	0.00015	0.00005	0.0003
Zinc	0.0044	0.0025	0.0319	0.0039	0.0025	0.0144

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

Station W5 2011 to 2014 water quality result statistics are summarized in Table 5-25, below. Forty-five routine water quality samples were taken during the 2014 monitoring period.

Table 5-26: W5 Water Quality Results Summary (2011-2014)

W5	2011 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters	**Mean**	**Min**	**Max**	**Mean**	**Min**	**Max**
pH	7.94	7.58	8.1	7.98	7.68	8.25
TSS (mg/L)	49.1	0.5	340	29.8	0.5	330
Nutrients (mg/L)						
Ammonia Nitrogen	0.0265	0.0025	0.382	0.0249	0.0025	0.21
Nitrate Nitrogen	0.055	0.01	0.378	0.054	0.01	0.35
Nitrite Nitrogen	0.0046	0.0025	0.0324	0.0029	0.0025	0.01
Total Metals (mg/L)						
Aluminum	1.2145	0.0135	11.2	0.4264	0.0049	3.89
Arsenic	0.00126	0.00037	0.0069	0.00085	0.00044	0.00424
Cadmium	0.000039	0.000005	0.00029	0.000016	0.000005	0.000135
Chromium	0.0024	0.0005	0.025	0.0011	0.0005	0.0085
Copper	0.00443	0.00061	0.0331	0.0029	0.00065	0.0256
Iron	1.8944	0.0305	18.2	0.7577	0.0712	7.47
Lead	0.00068	0.0001	0.0058	0.00028	0.0001	0.00236
Molybdenum	0.0011	0.0005	0.002	0.0011	0.0005	0.0015
Nickel	0.0031	0.0005	0.027	0.0015	0.0005	0.0135
Selenium	0.00016	0.00005	0.0004	0.00018	0.00005	0.0005
Zinc	0.0061	0.0025	0.051	0.0044	0.0025	0.0269

5.5 Seepage Water Quality Monitoring Program

As per the WUL Clause 77, Minto Mine is required to implement a Seepage Monitoring Program to assess acid rock drainage and metal leaching conditions from several sources including: ore stockpile areas, overburden dumps, waste rock dumps, DSTSF, MVF, the mill area and other seepage locations. The seepage monitoring that was conducted in 2014 was carried out in accordance with the *Seepage Monitoring Plan V2014-01* (SMP).

The SMP states that seepage surveys will be conducted twice a year, during spring runoff and in early fall, by walking the toe of each waste dump, stockpile or other area of interest. Each seepage monitoring event survey routes are recorded using the tracking function of a GPS. A map showing the 2014 survey routes and monitoring locations can be found in Figure 5-14.

The WUL Water Quality Surveillance Program requires regular monitoring of seepage at a number of permanent seepage water quality stations. These stations include: W8, W8A, W17, W32, W36, W37, W38, W39 and W40. The water quality results for these permanent water quality stations are reported to the YWB on a monthly basis. Additionally, seepage sites are recorded by GPS, visited and if water is present sampled twice annually. All lab results for 2014 spring and fall seepage monitoring surveys are provided in Appendix F.

Seepage site locations are marked by GPS and data are stored in the Minto Mine Water Quality Database along with results from WUL sampling stations. Minto will continue to monitor these seepage areas and monitor the site workings for seeps on a semi-annual basis. In 2014, the spring seepage monitoring survey was completed; however, the GPS was lost during field activities shortly thereafter and the spring survey route had not been downloaded. As such, the survey route for the spring survey is not available for the Annual Report.

Observations from the 2014 Seepage Monitoring Program indicate that the majority of the seepage sites identified are seasonally variable with flows observed during spring and fall months. Analysis of seepage results and water quality assists in improving understanding of water chemistry, load, and water balance from waste dumps, overburden dumps, ore stockpiles, and tailings facilities.

Aerial imagery obtained from Challenger Geomatics. Imagery acquired September 9th 2014.

Datum: NAD 83 Projection: UTM Zone 8N

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Figure 5-14: Seepage Monitoring Survey Routes and Monitoring Locations (2014)

5.5.1 Mill Valley Fill

The MVF was completed in 2012 and vertical culverts were installed at both W8 and W8A to enable water quality monitoring at these locations. Obtaining water samples at W8 has been sporadic since the installation of the vertical culvert. The last time this station produced water was in late 2013. 2014 water quality results for W8 and W8A are outlined in Figure 5-15 through Figure 5-22 and include historic water quality results for dissolved copper, cadmium, iron, and selenium and nutrient levels for ammonia, nitrite and nitrate.

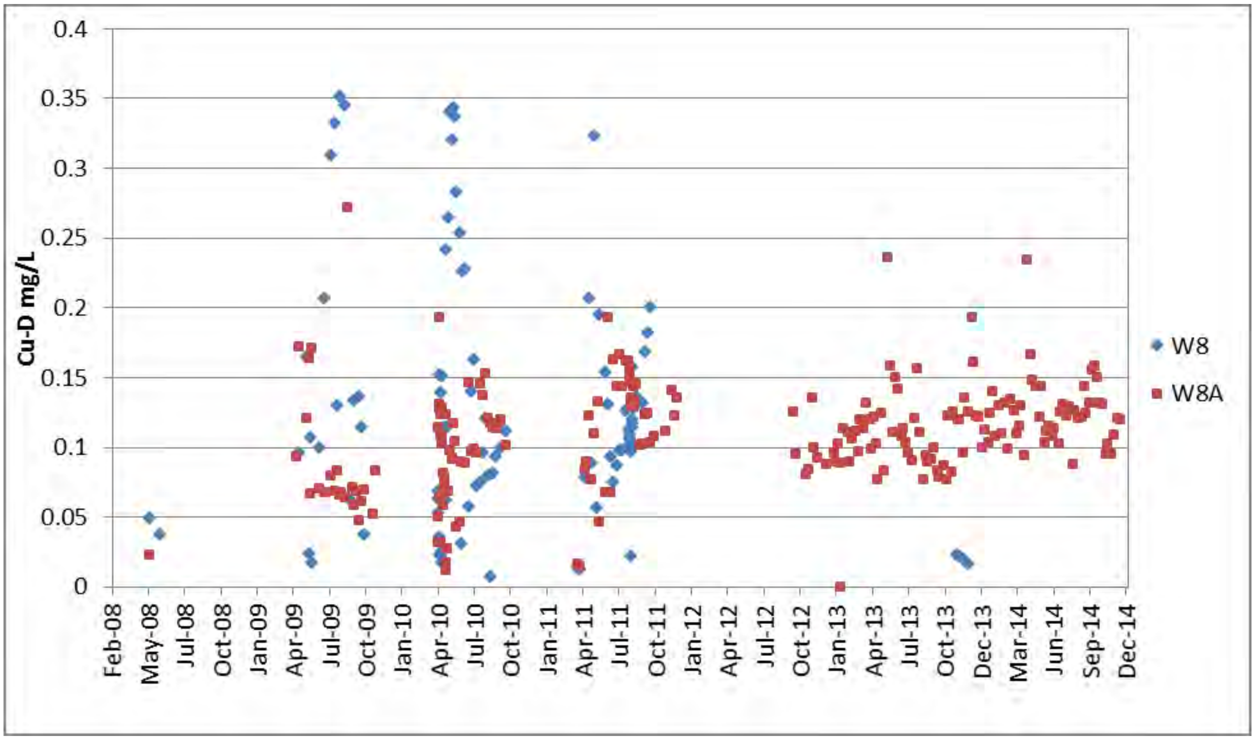


Figure 5-15 : Dissolved Copper Concentrations for W8 and W8A (2008 – 2014)

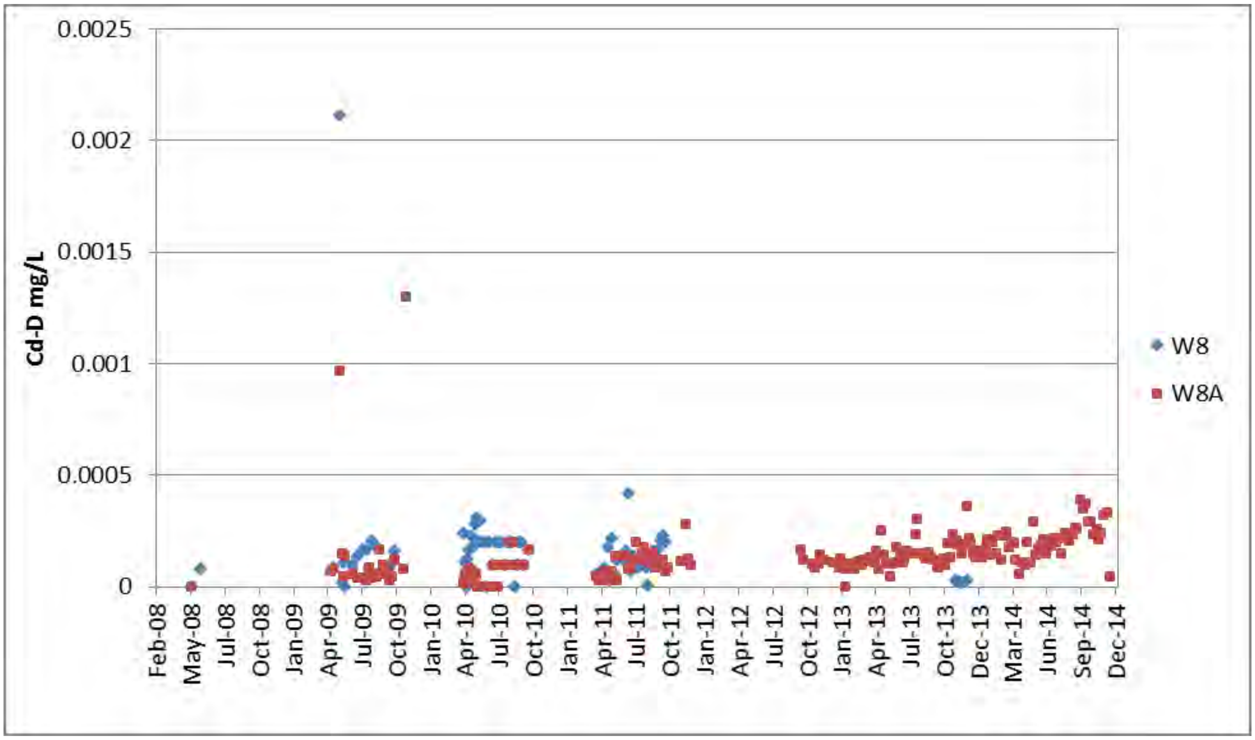


Figure 5-16: Dissolved Cadmium Concentrations for W8 and W8A (2008 – 2014)

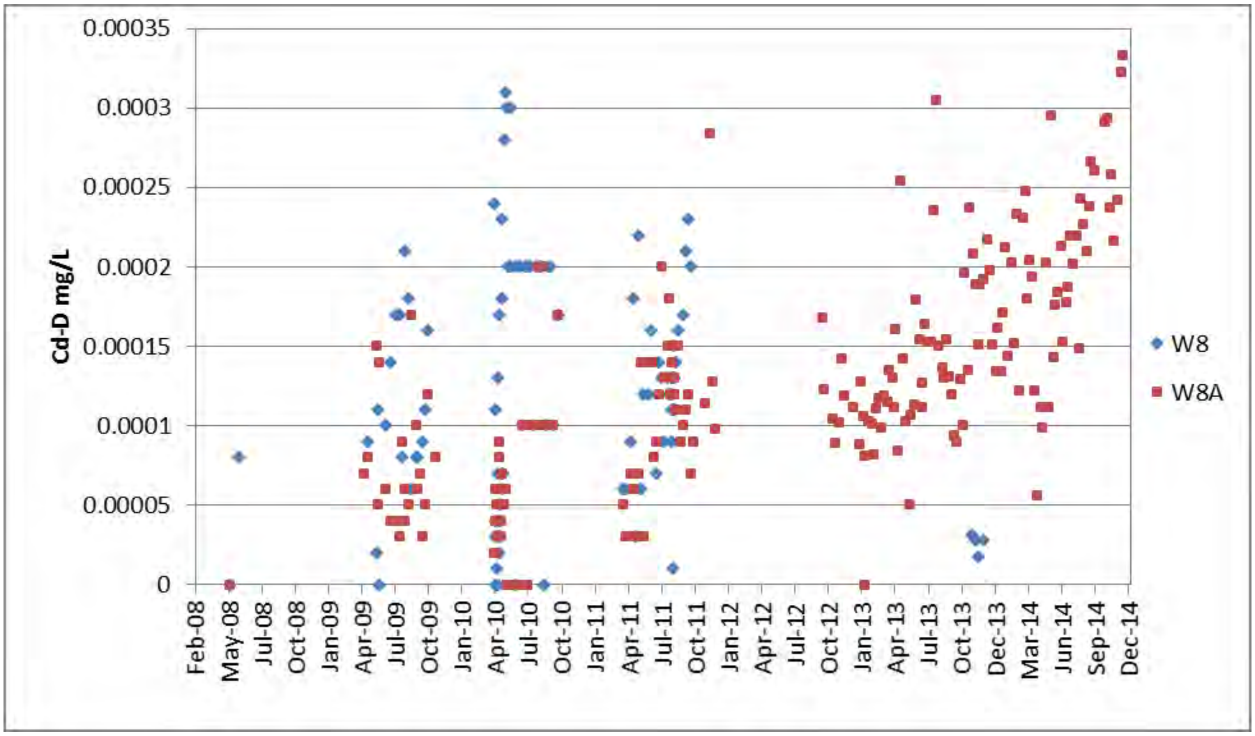


Figure 5-17: Dissolved Cadmium Concentrations for W8 and W8A, with Reduced Concentration Range (2008-2014)

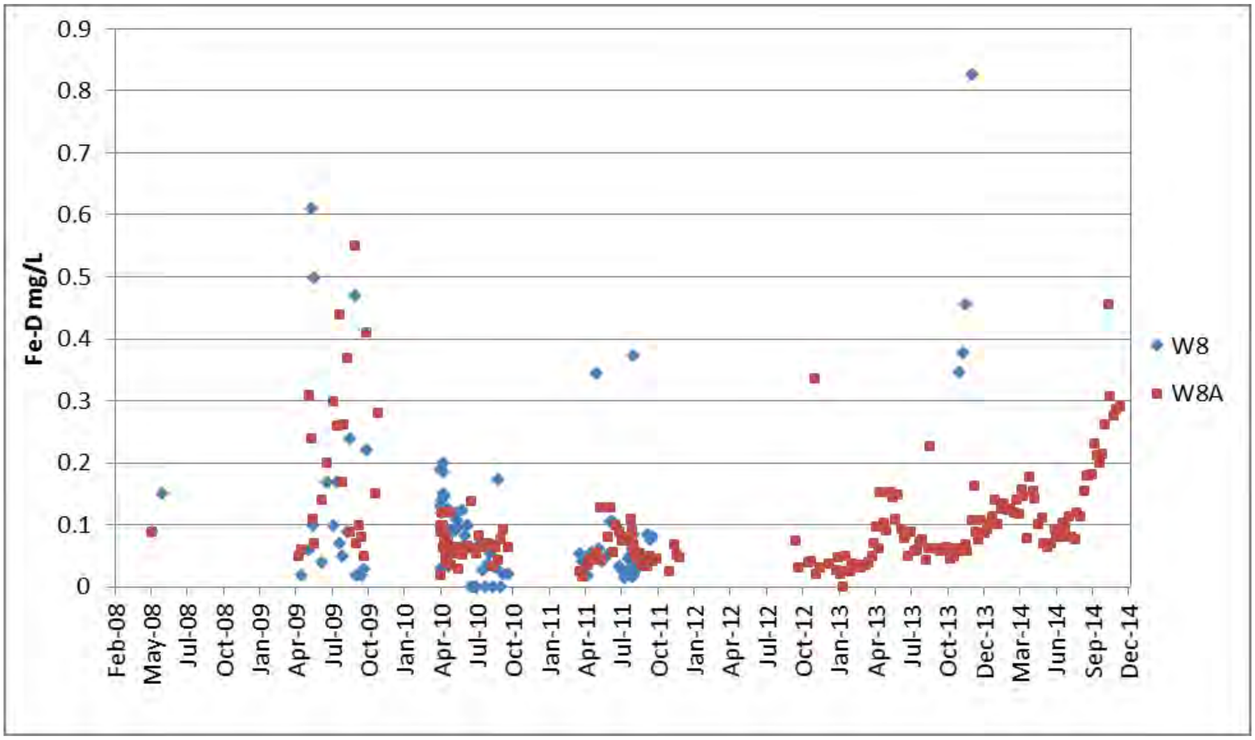


Figure 5-18: Dissolved Iron Concentrations for W8 and W8A (2008-2014)

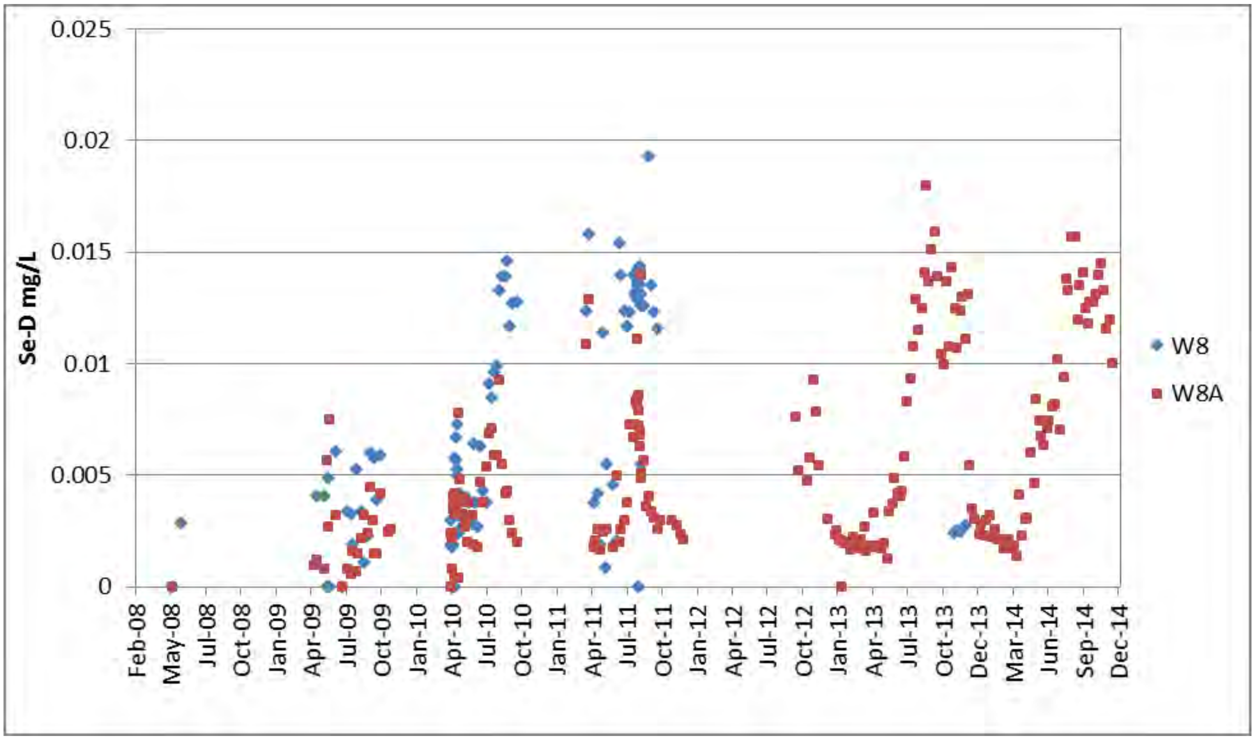


Figure 5-19: Dissolved Selenium Concentrations for W8 and W8A (2008-2014)

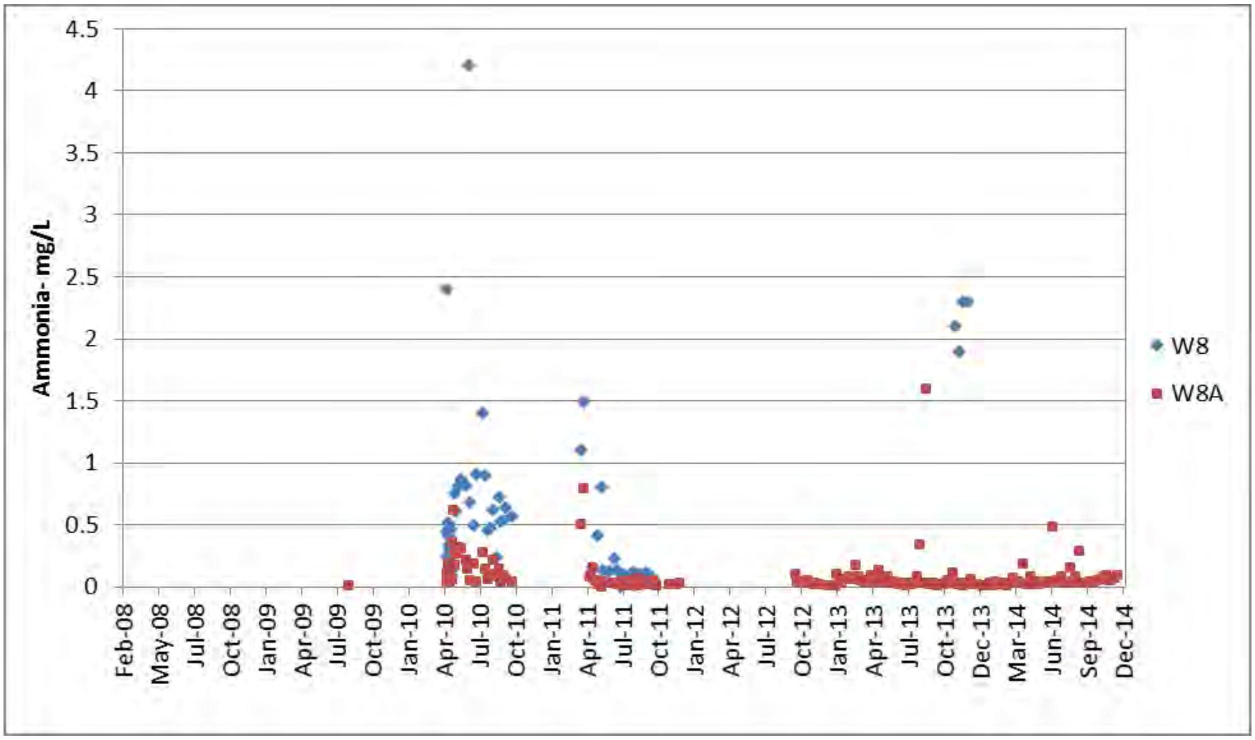


Figure 5-20: Ammonia Concentrations for W8 and W8A (2009-2014)

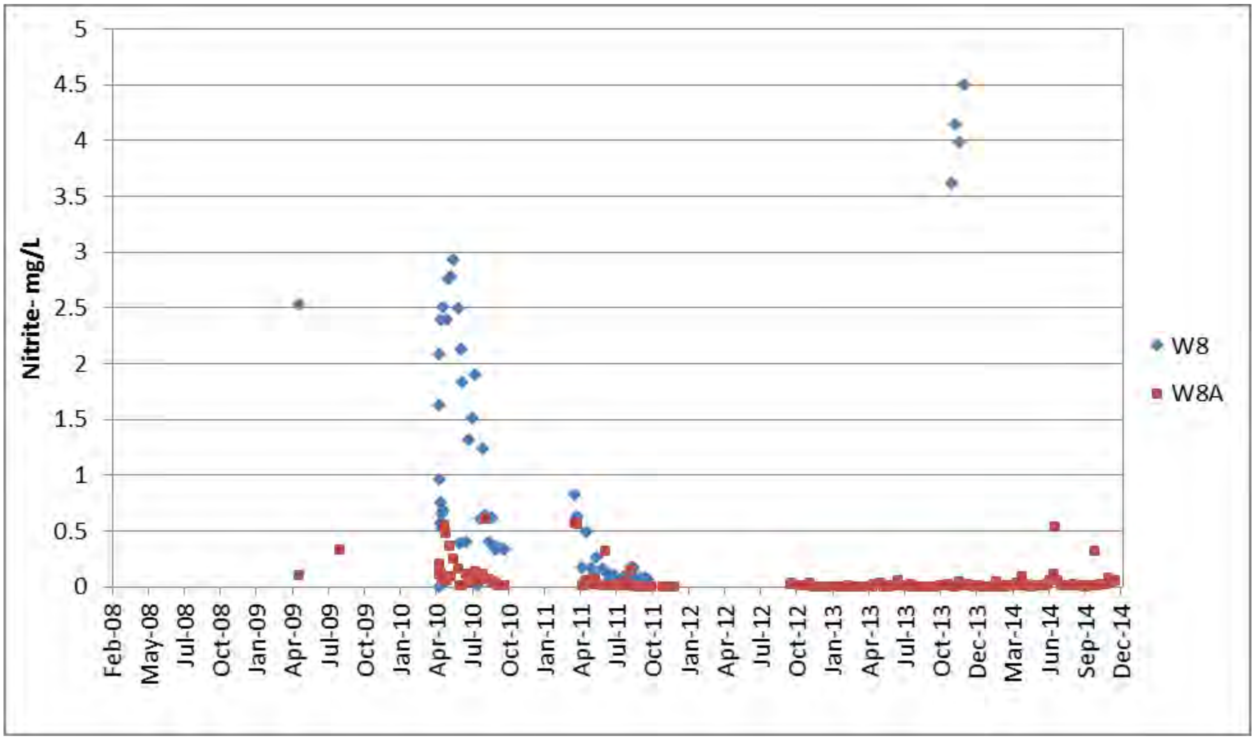


Figure 5-21: Nitrite Concentrations for W8, and W8A (2009-2014)

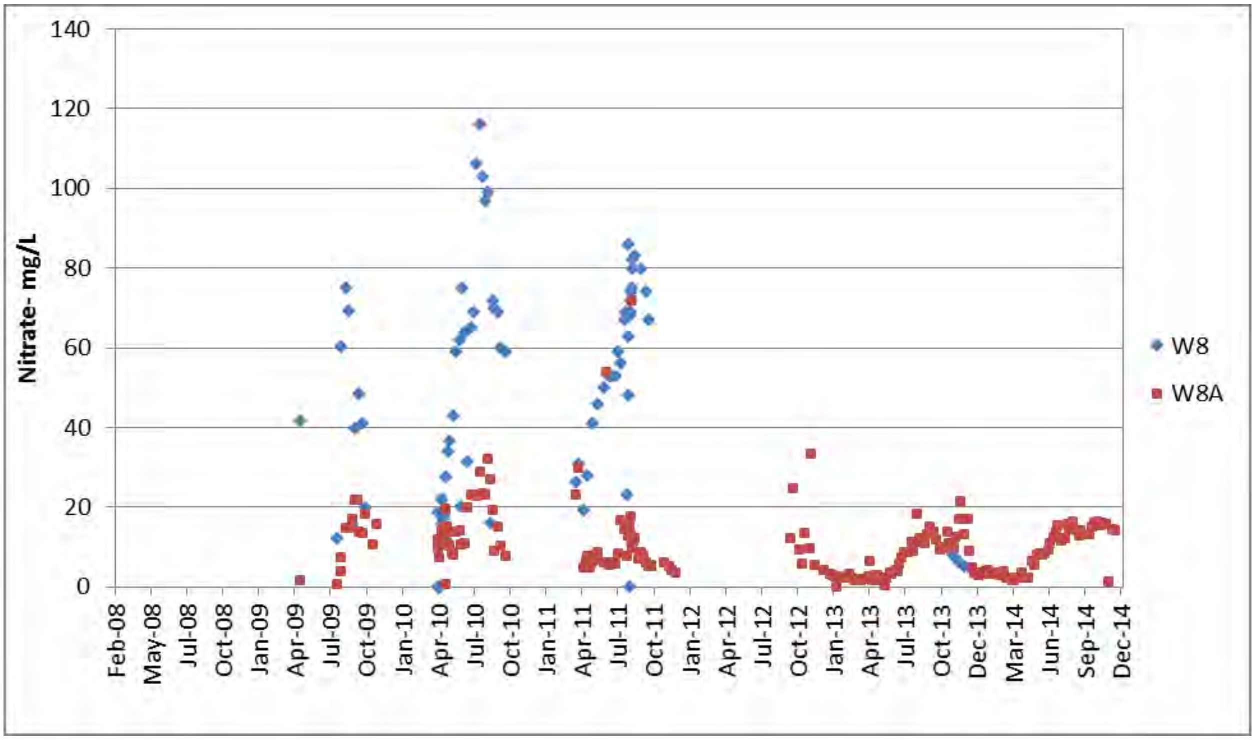


Figure 5-22: Nitrate concentrations for W8, and W8A (2009-2014)

5.5.2 Southwest Dump

Seepage monitoring at the toe of the Southwest Dump (SWD) includes monthly water quality sampling at stations W32, W38, W39 and W40, as described in Table 5-1. Additionally, seepage is collected at stations SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 which are monitored during spring and fall. Samples are taken within ±5 m of the original GPS point. If there is no seepage within the 5 m buffer the site is considered dry during that sampling session. 2014 water quality results for W32, W38, W39, and W40 are outlined in Figure 5-23 through Figure 5-31 and seepage water quality results are summarized in Figure 5-32 through Figure 5-38. The summary figures include historic water quality results for dissolved copper, cadmium, iron, selenium and nutrient levels for ammonia, nitrite and nitrate.

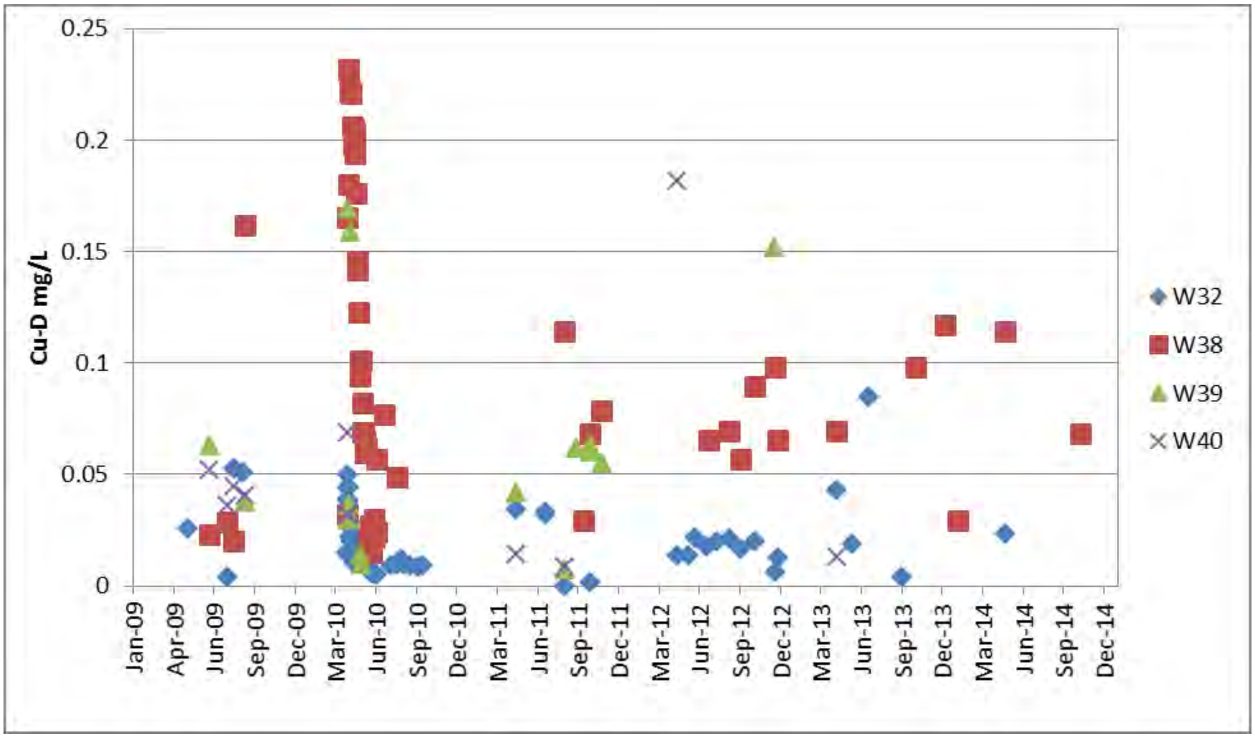


Figure 5-23: Toe of the SWD - Dissolved Copper Concentrations (2009-2014)

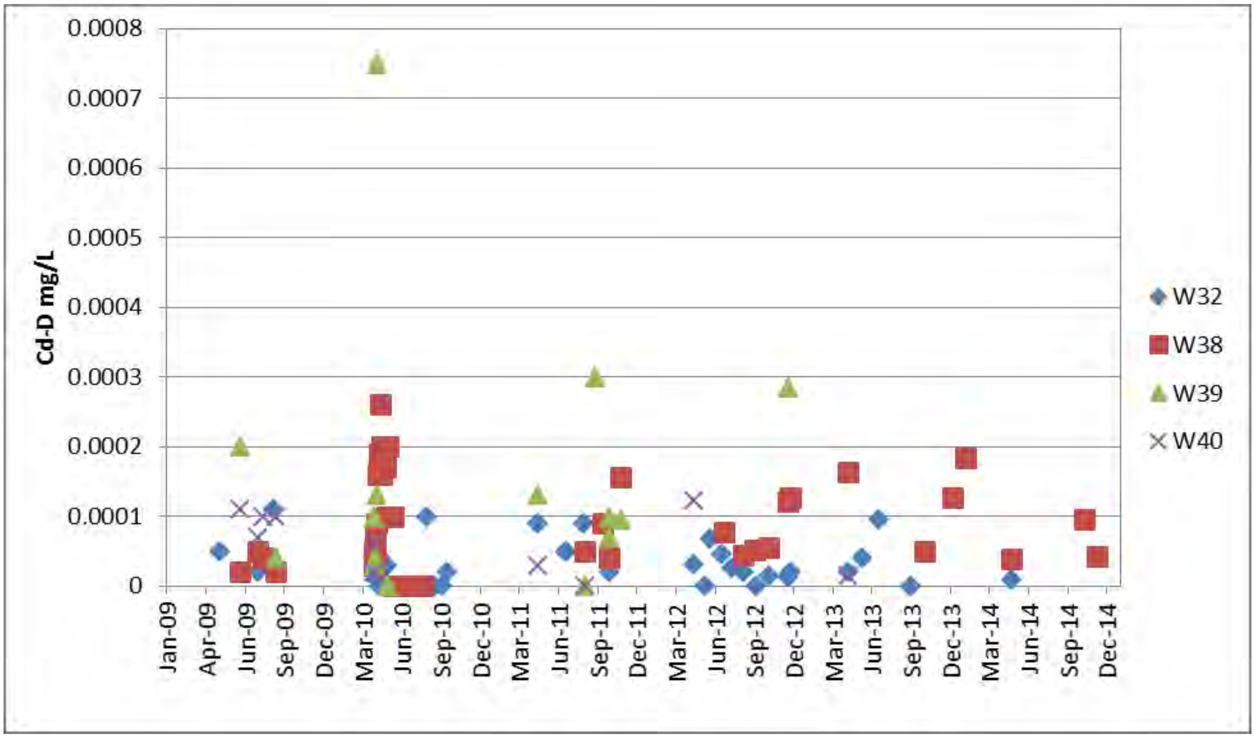


Figure 5-24: Toe of the SWD - Dissolved Cadmium Concentrations (2009-2014)

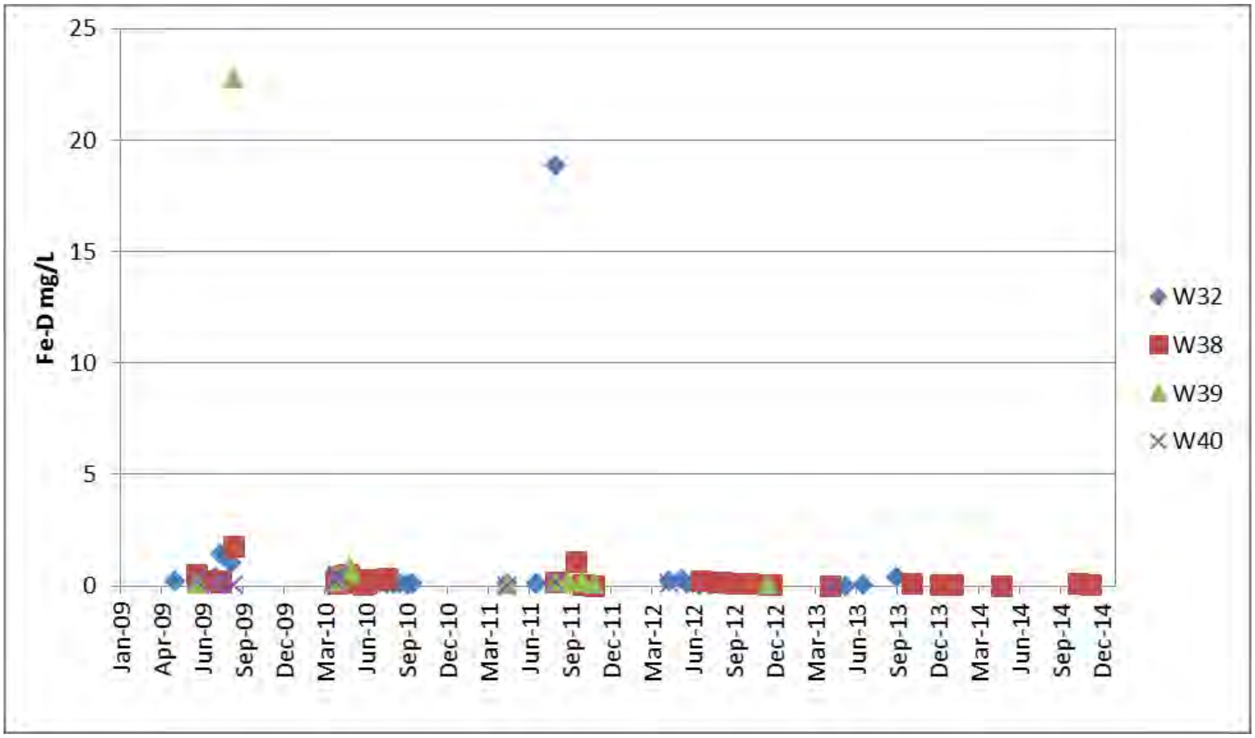


Figure 5-25: Toe of the SWD - Dissolved Iron Concentrations (2009-2014)

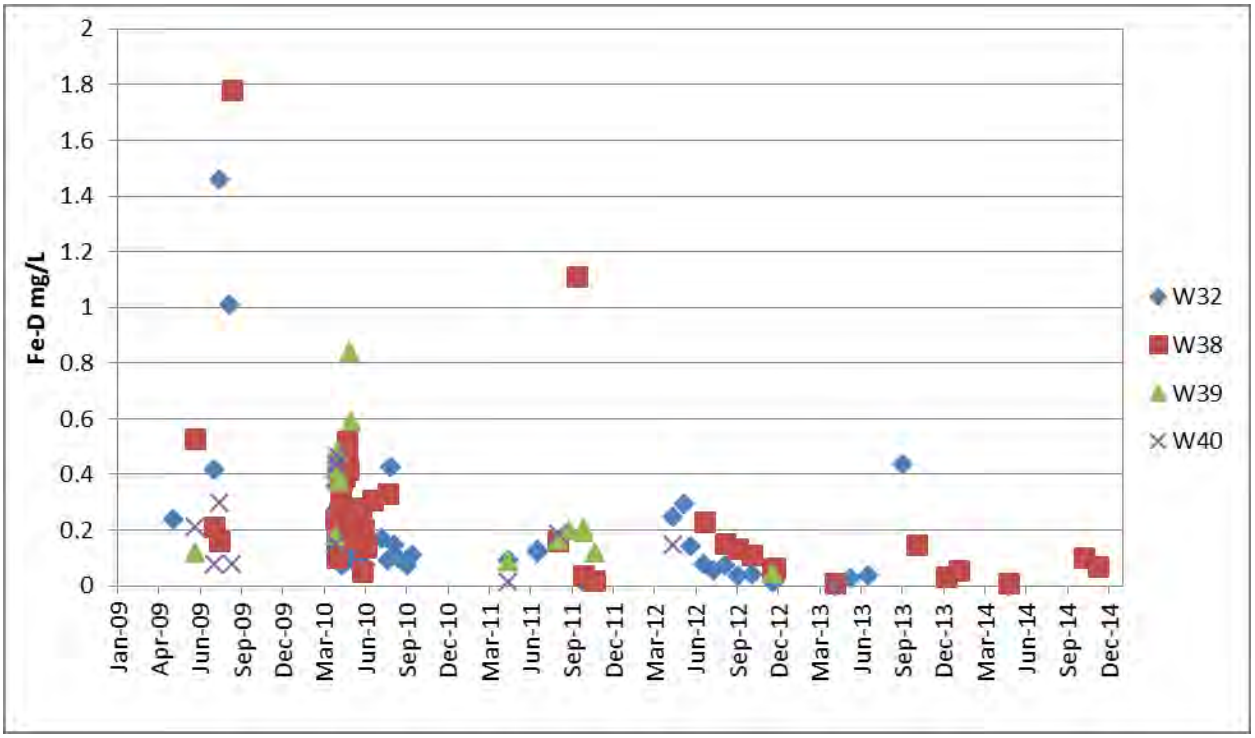


Figure 5-26: Toe of the SWD - Dissolved Iron Concentrations, with Reduced Concentration Range (2009-2014)

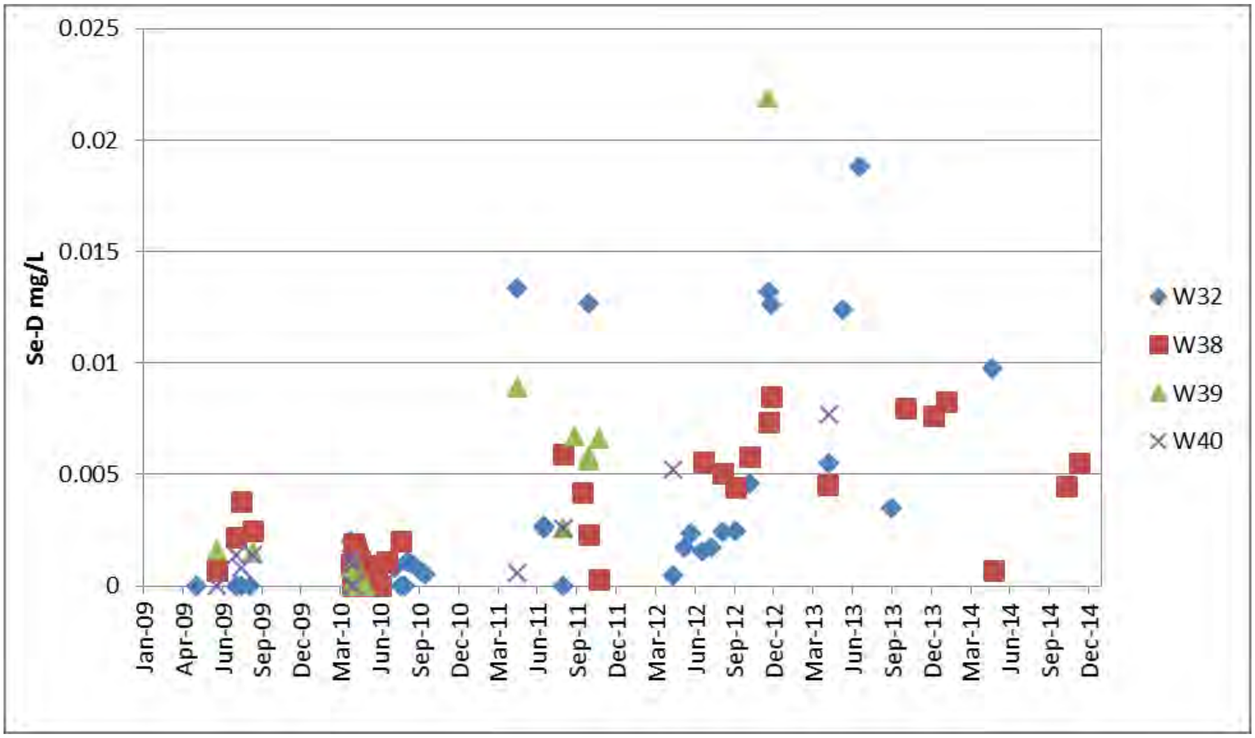


Figure 5-27: Toe of the SWD - Dissolved Selenium Concentrations (2009-2014)

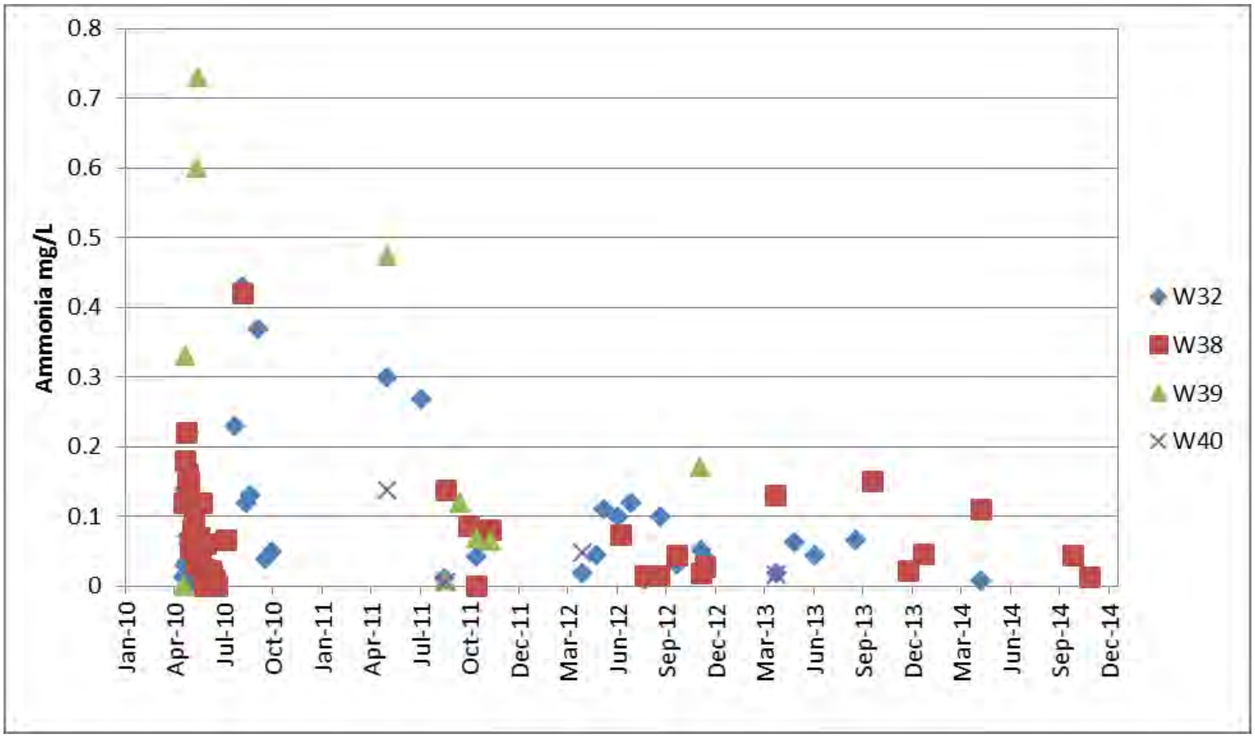


Figure 5-28: Toe of the SWD - Ammonia Concentrations (2010-2014)

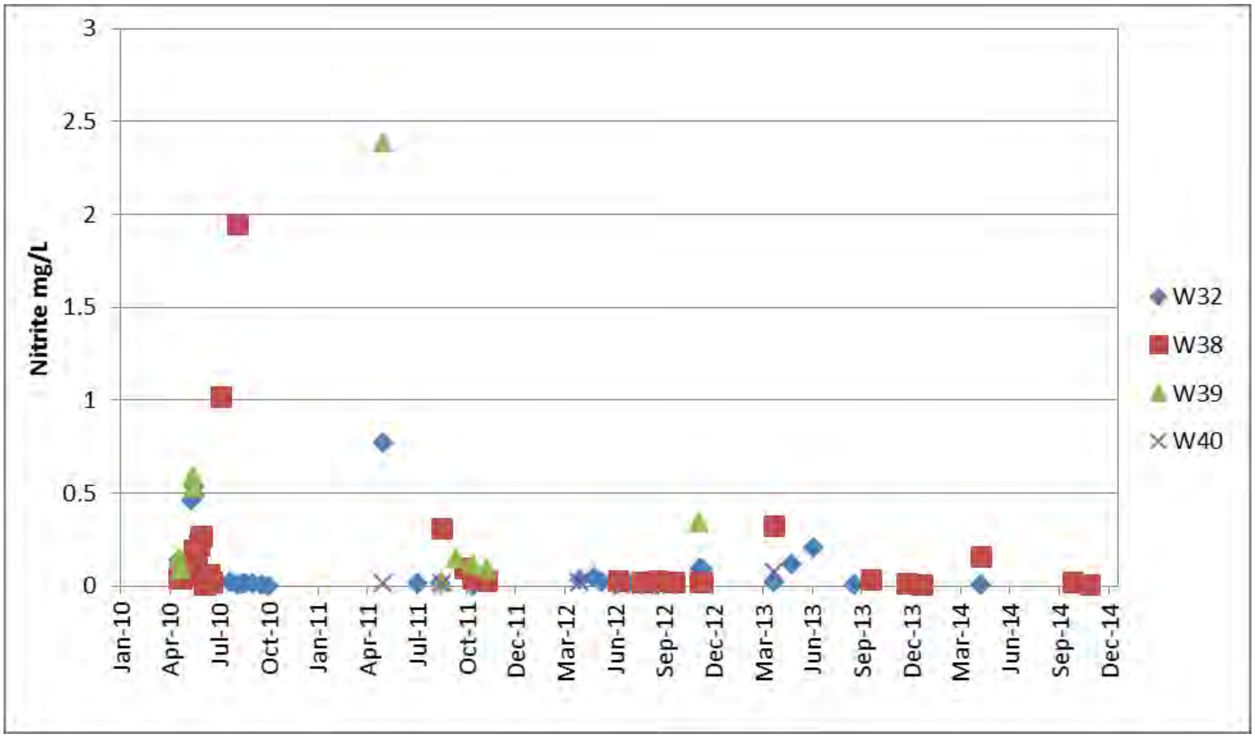


Figure 5-29: Toe of the SWD - Nitrite Concentrations (2010-2014)

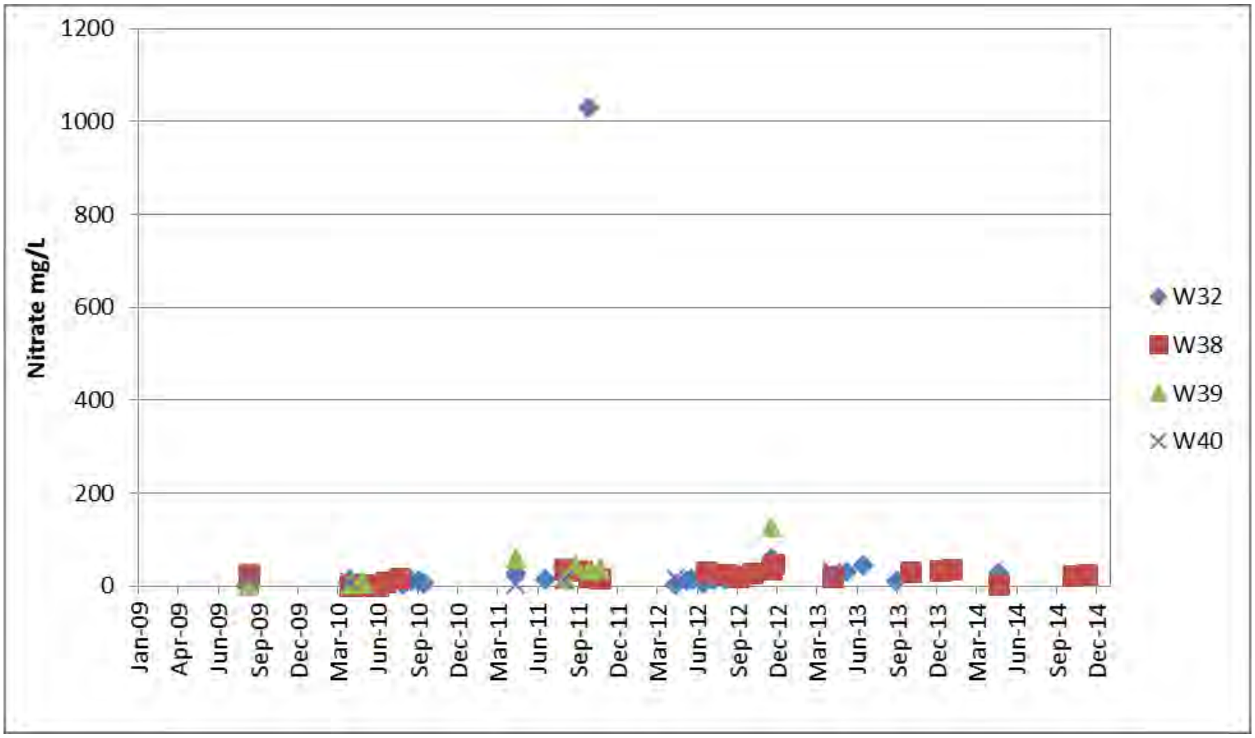


Figure 5-30: Toe of the SWD - Nitrate Concentrations (2009-2014)

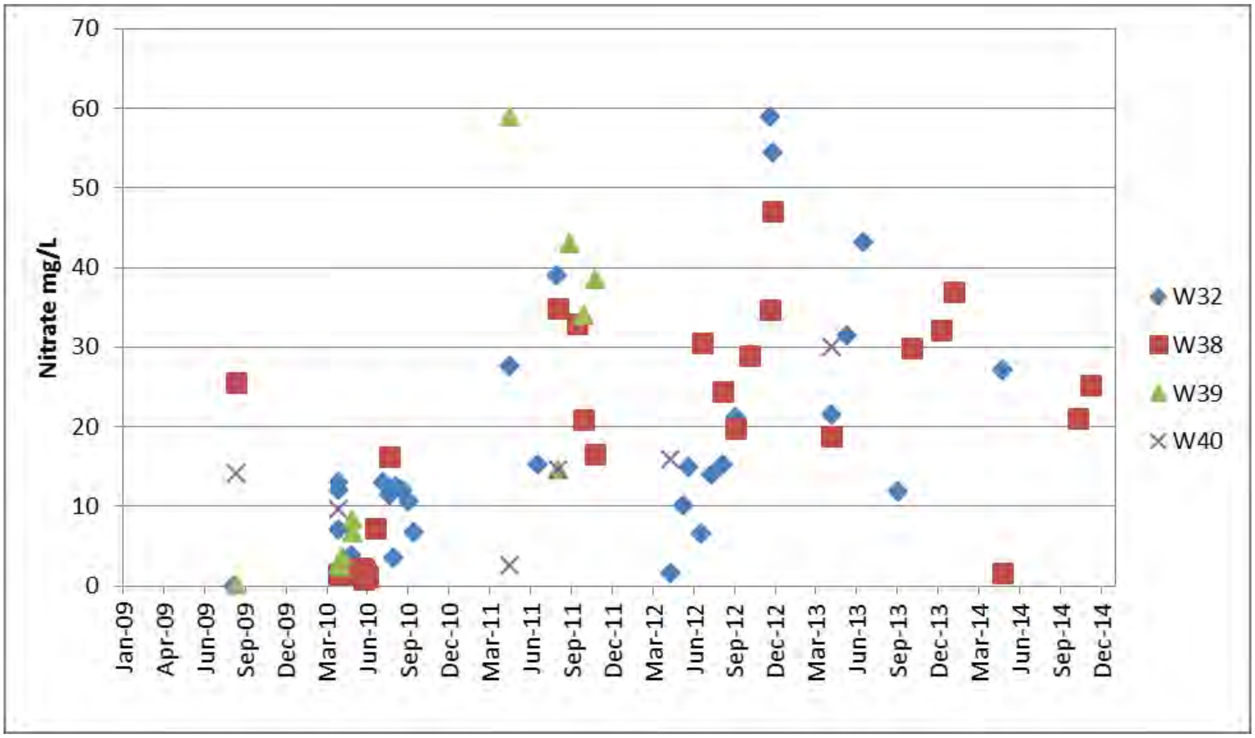


Figure 5-31: Toe of the SWD - Nitrate Concentrations, with Reduced Concentration Range (2009-2014)

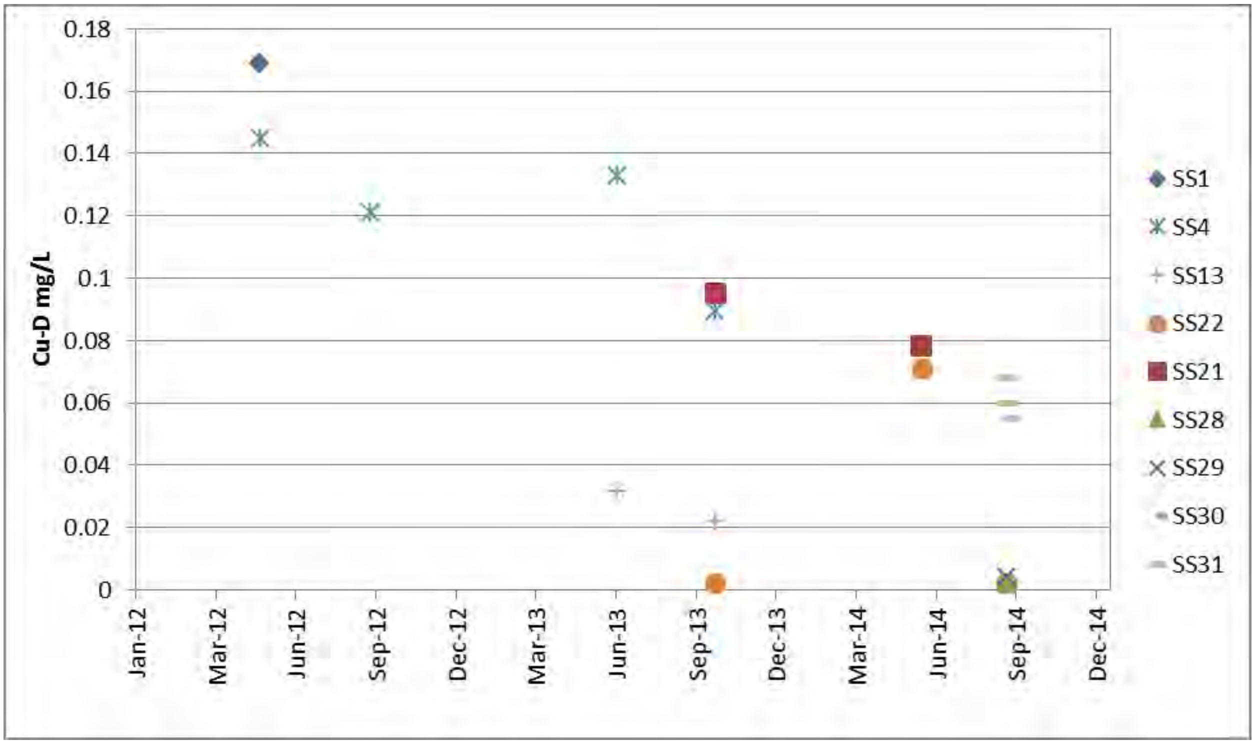


Figure 5-32: Dissolved Copper Concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

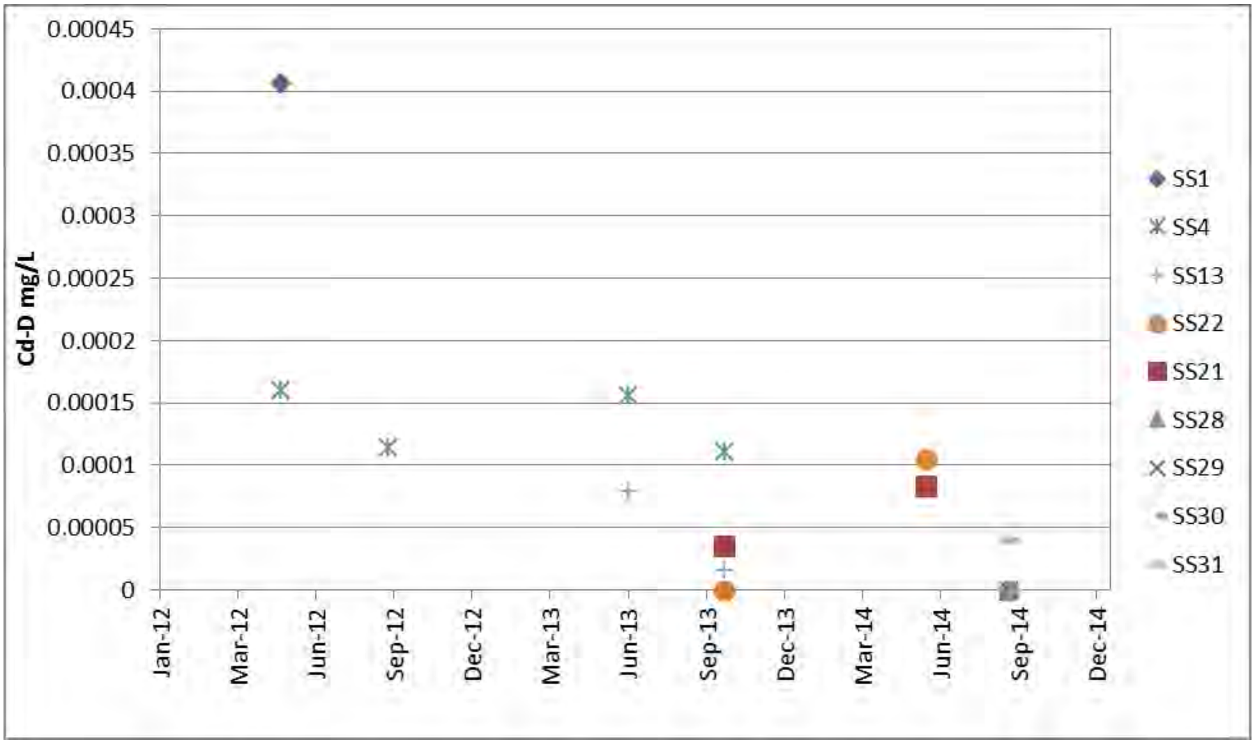


Figure 5-33: Dissolved Cadmium Concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

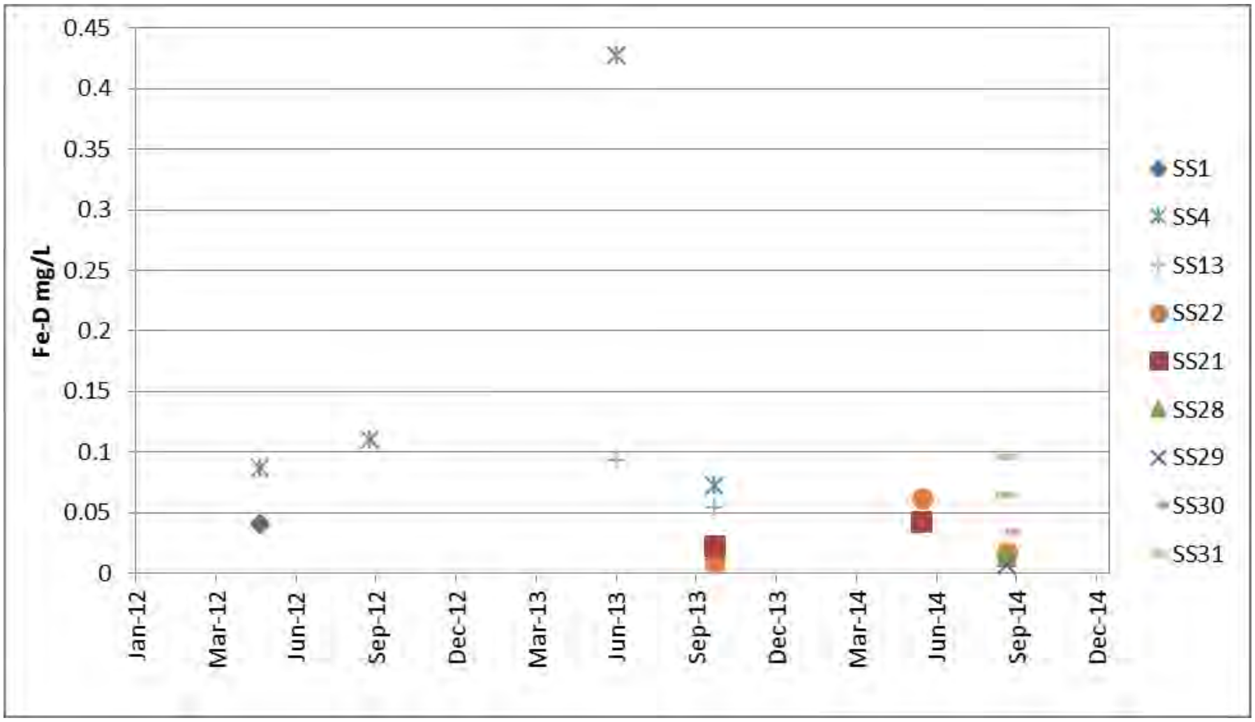


Figure 5-34: Dissolved Iron Concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

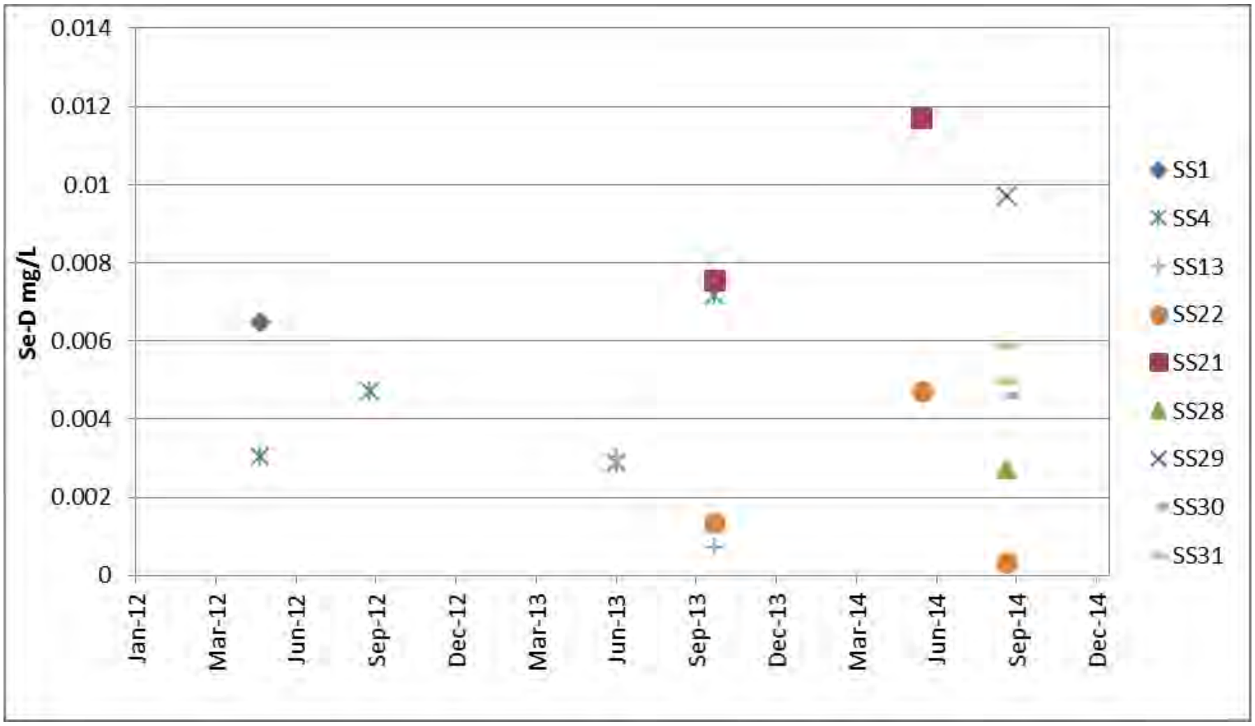


Figure 5-35: Dissolved selenium concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

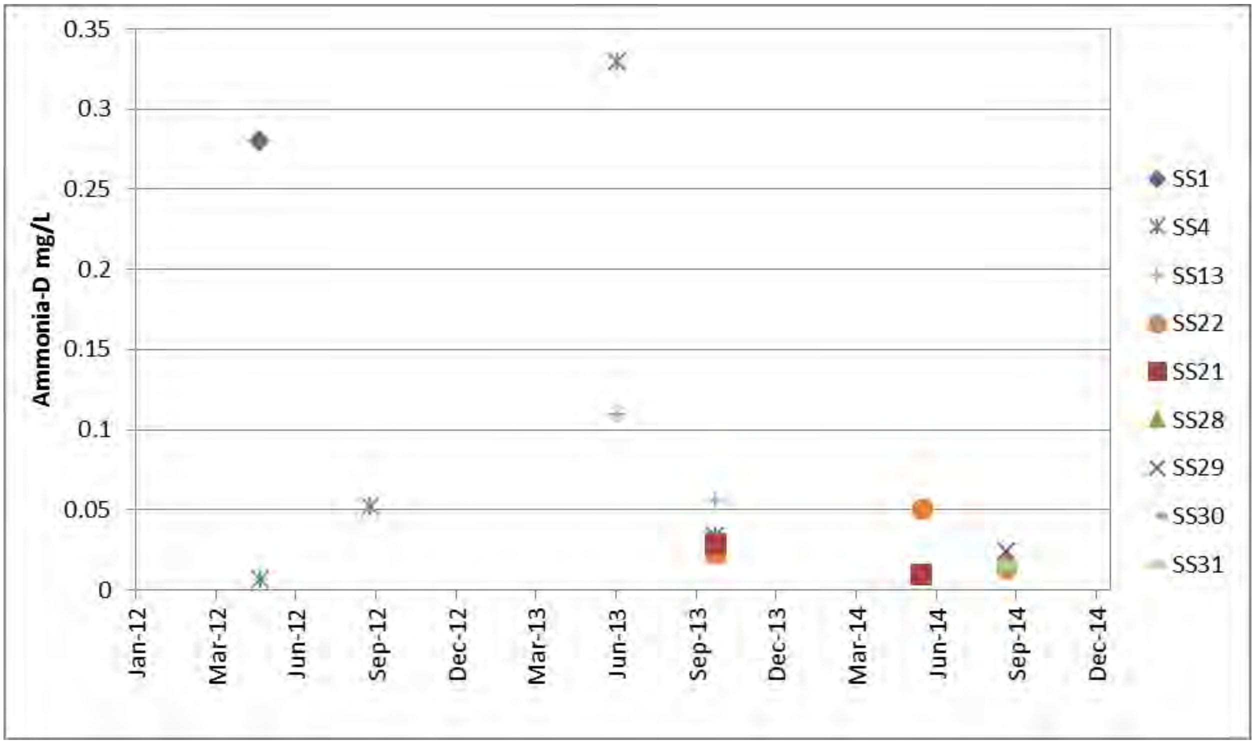


Figure 5-36: Ammonia Concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

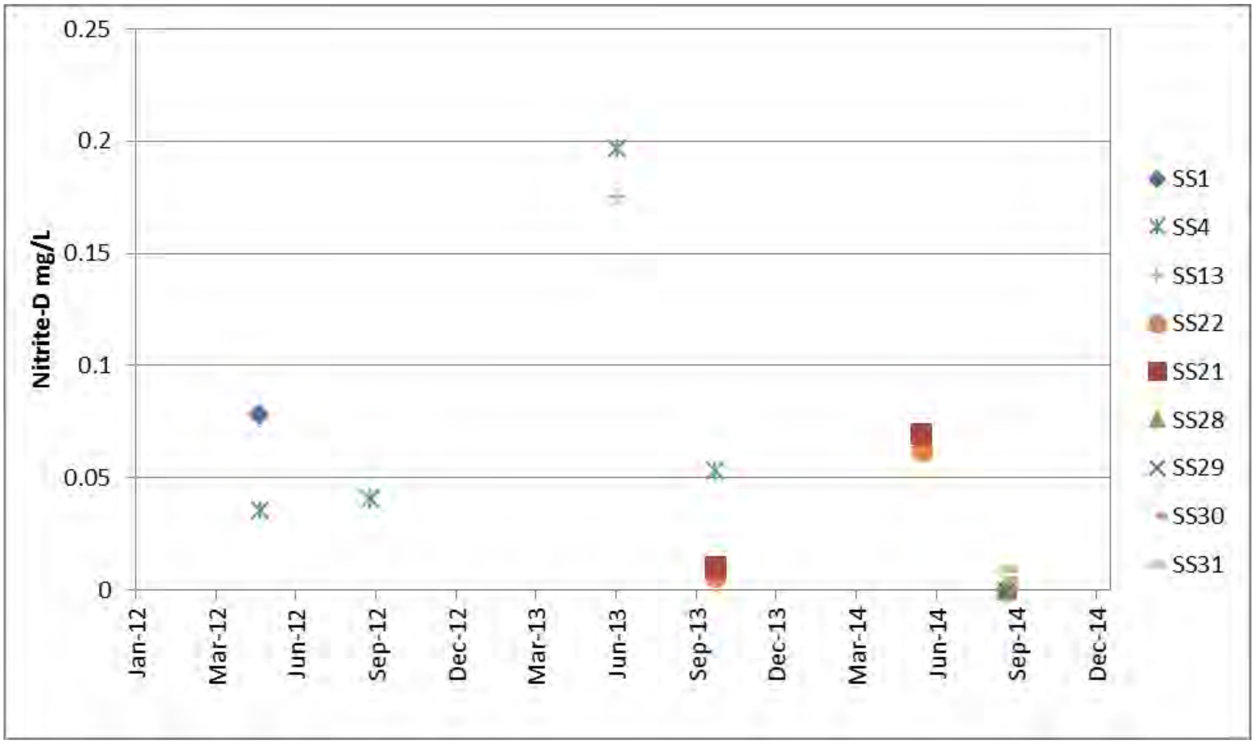


Figure 5-37: Nitrite Concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

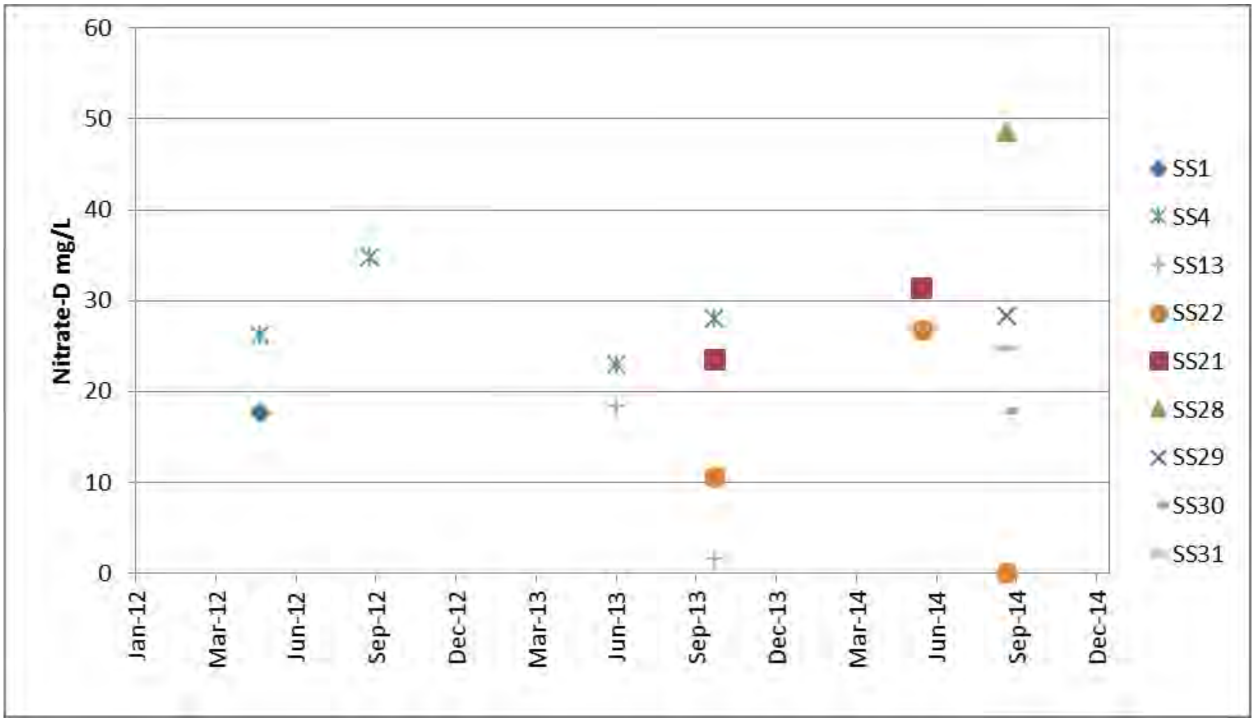


Figure 5-38: Nitrate concentrations for SS1, SS4, SS13, SS21, SS22, SS28, SS29, SS30 and SS31 (2012-2014)

5.5.3 Minto Creek Detention Structure and Water Storage Pond

W37 is 100 m downstream from the Minto Creek Detention Structure (MCDS) (W36 collection sump). W37 is often dry during monthly sampling sessions and there may be gaps in data for this sample site. 2014 water quality results for W37 are outlined in Figure 5-39 through Figure 5-45 and include historic water quality results for dissolved copper, cadmium, iron, and selenium and nutrient levels for ammonia, nitrite and nitrate.

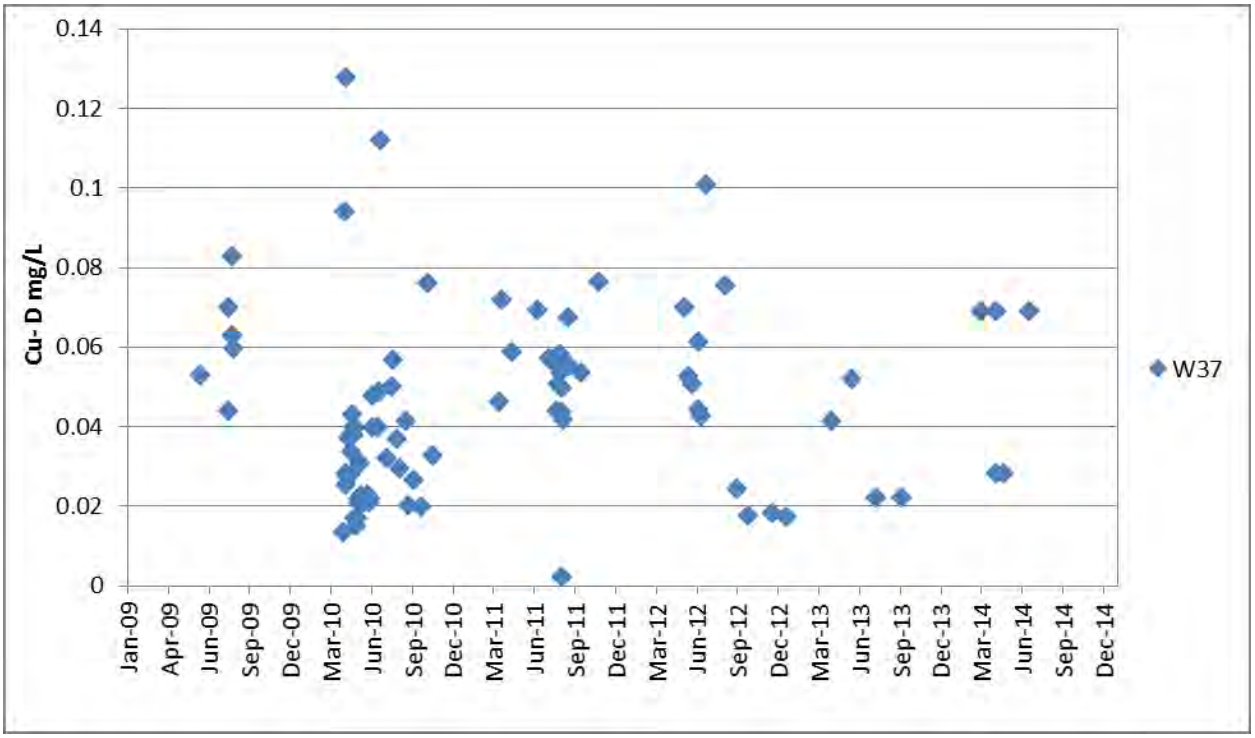


Figure 5-39: Dissolved Copper concentrations at W37 (2009-2014)

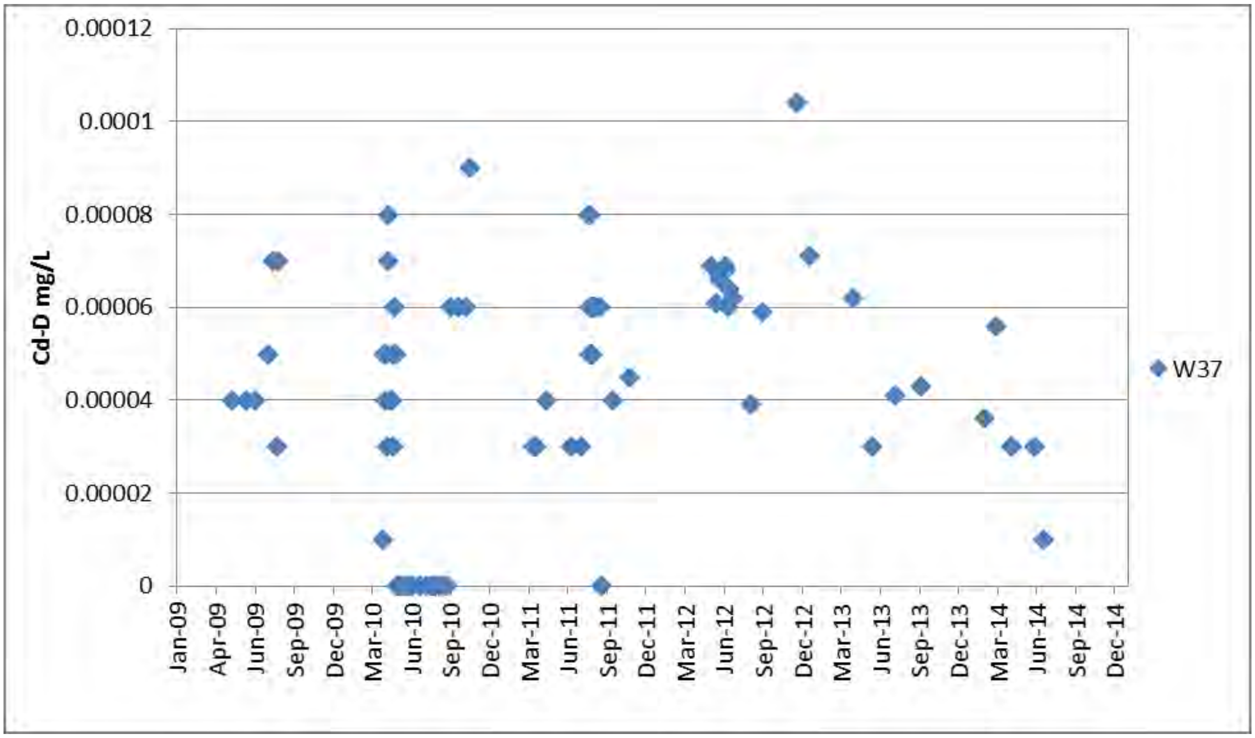


Figure 5-40: Dissolved Cadmium Concentrations at W37 (2009-2014)

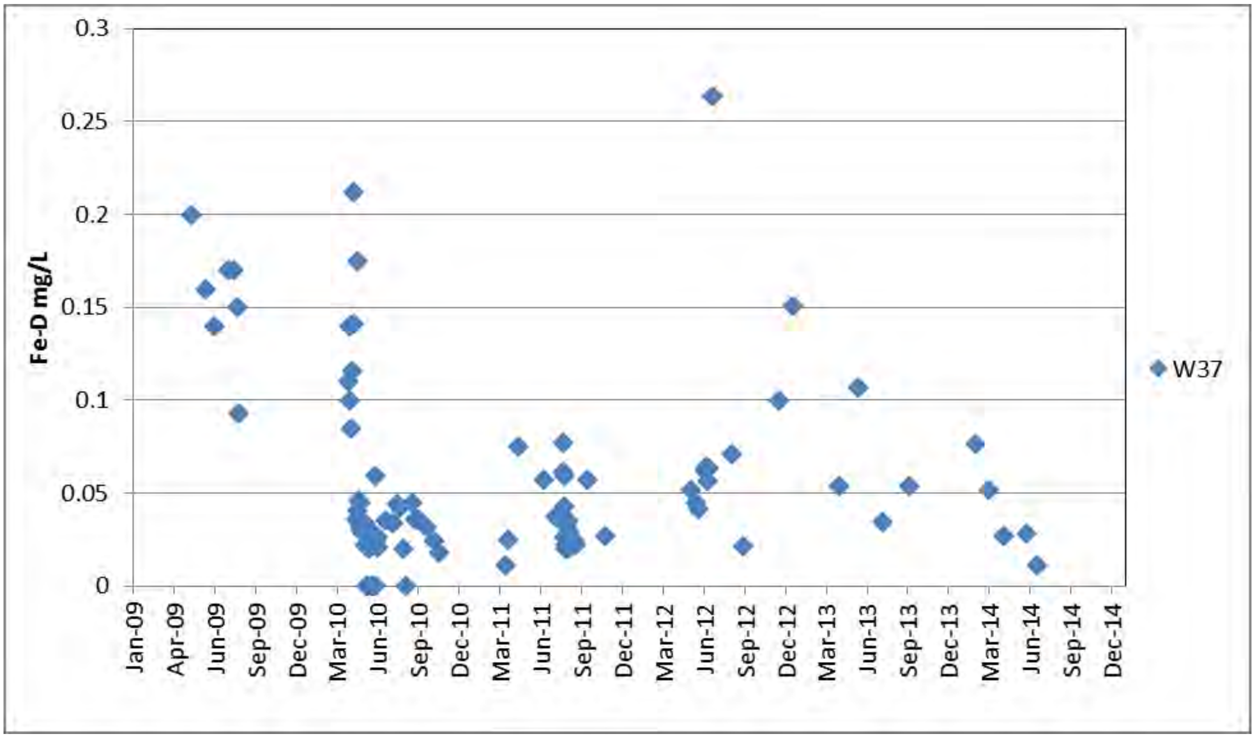


Figure 5-41: Dissolved Iron Concentrations at W37 (2009-2014)

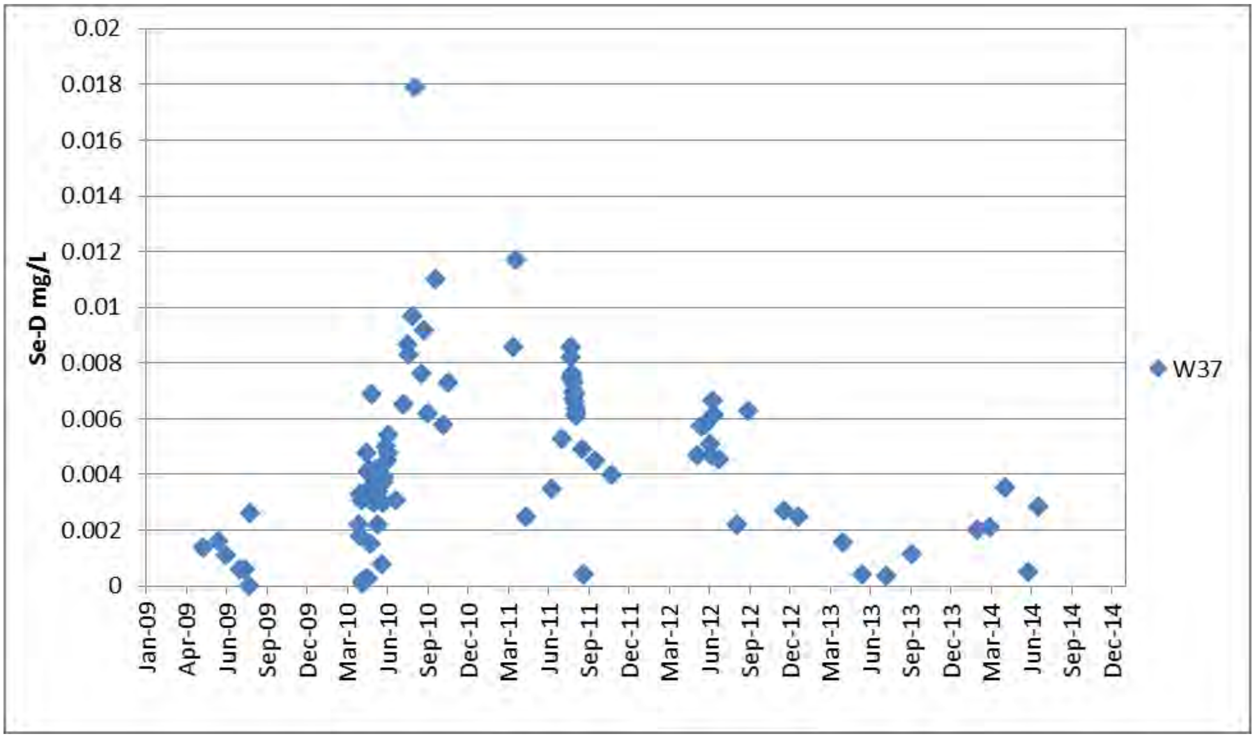


Figure 5-42: Dissolved Selenium Concentrations at W37 (2009-2014)

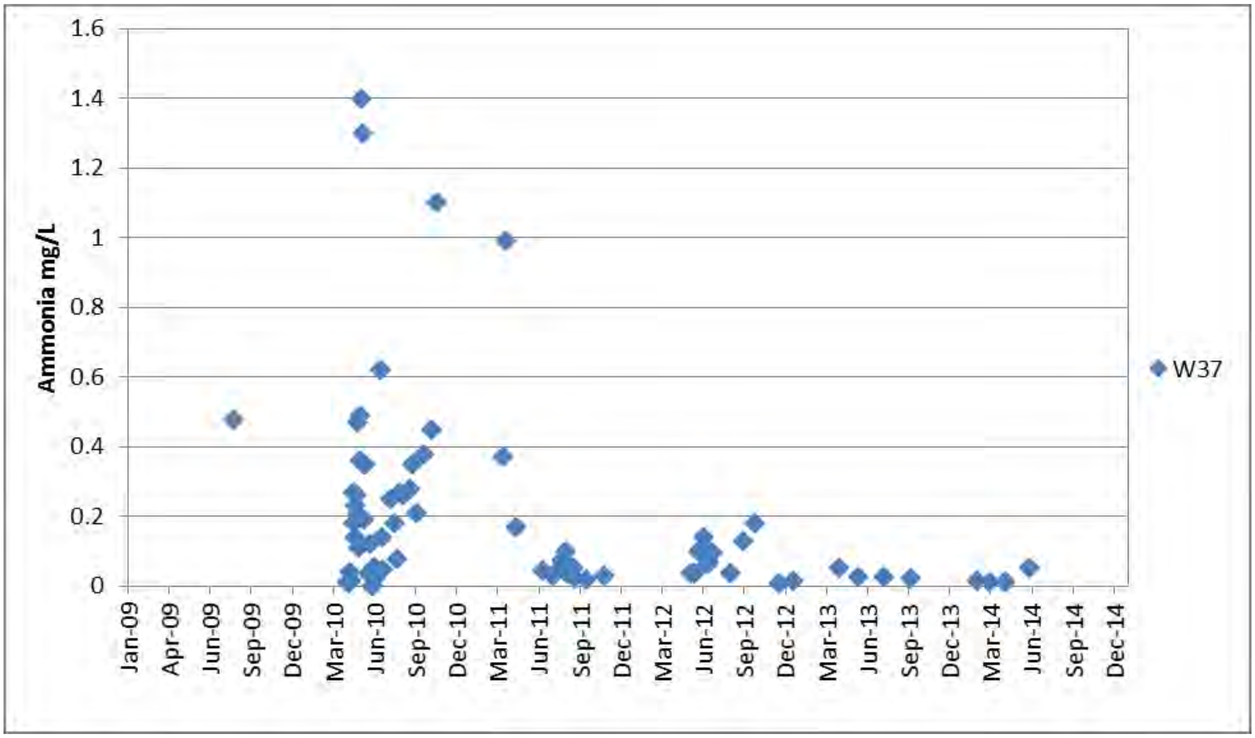


Figure 5-43: Ammonia Concentrations at W37 (2009-2014)

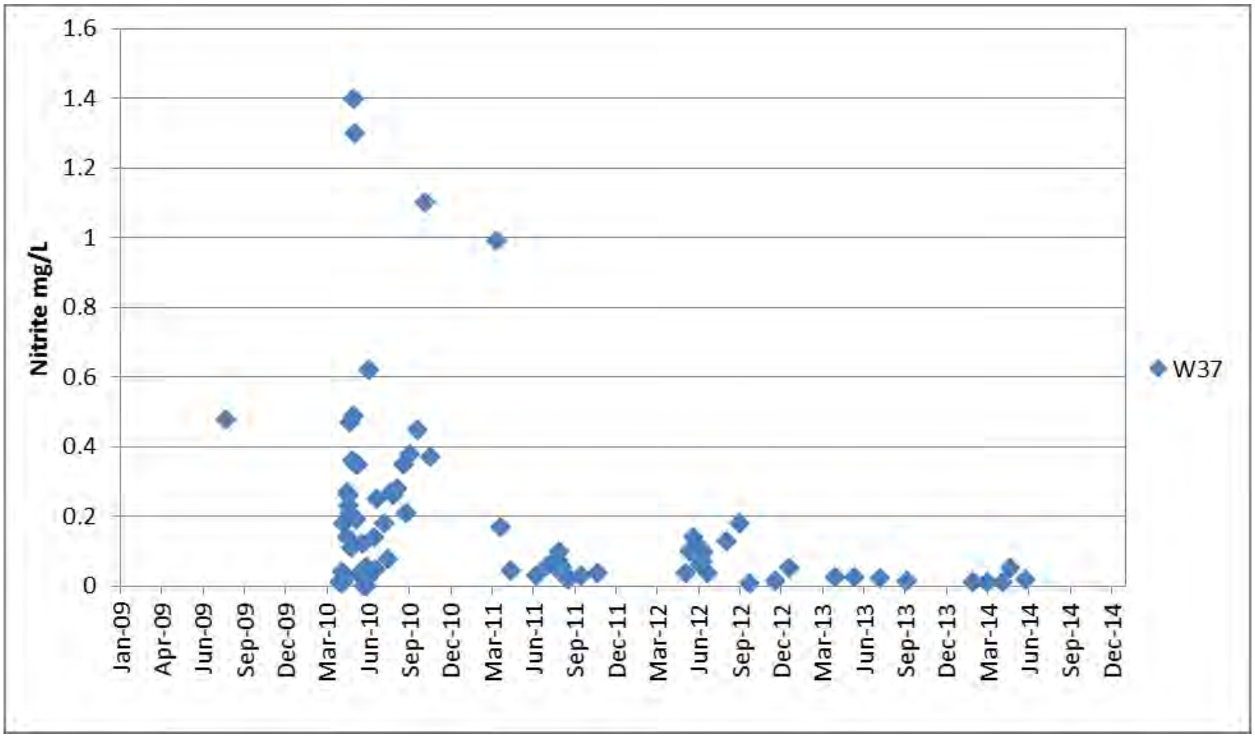


Figure 5-44: Nitrite Concentrations at W37 (2009-2014)

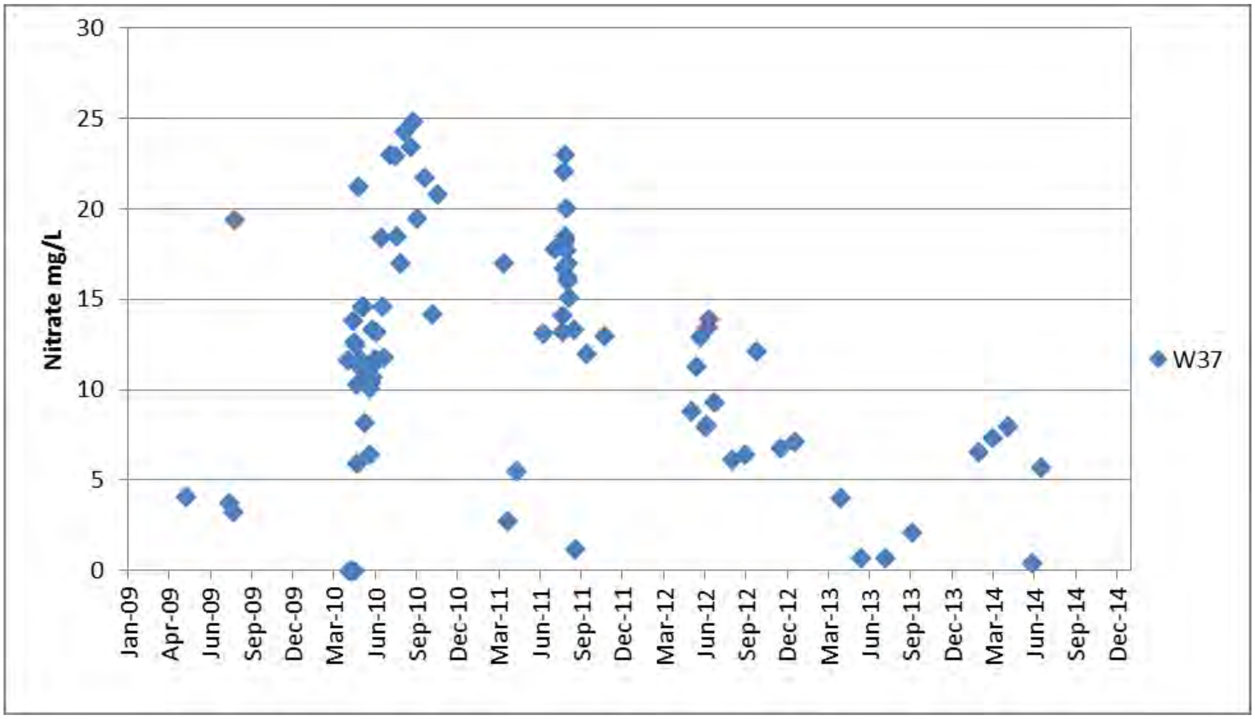


Figure 5-45: Nitrate Concentrations at W37 (2009-2014)

5.5.4 Water Storage Pond Dam

Seepage quality at the WSP Dam is represented from water quality at station W17. Water quality at station W17 is relatively consistent due to it being fed by a large stable body of water (WSP). All dam seepage is collected in a vertical culvert and pumped back to the WSP via a 4 inch insulated heat traced pipe. 2014 water quality results for W17 are outlined in Figure 5-46 through Figure 5-52 and include historic water quality results for dissolved copper, cadmium, iron, and selenium and nutrient levels for ammonia, nitrite and nitrate.

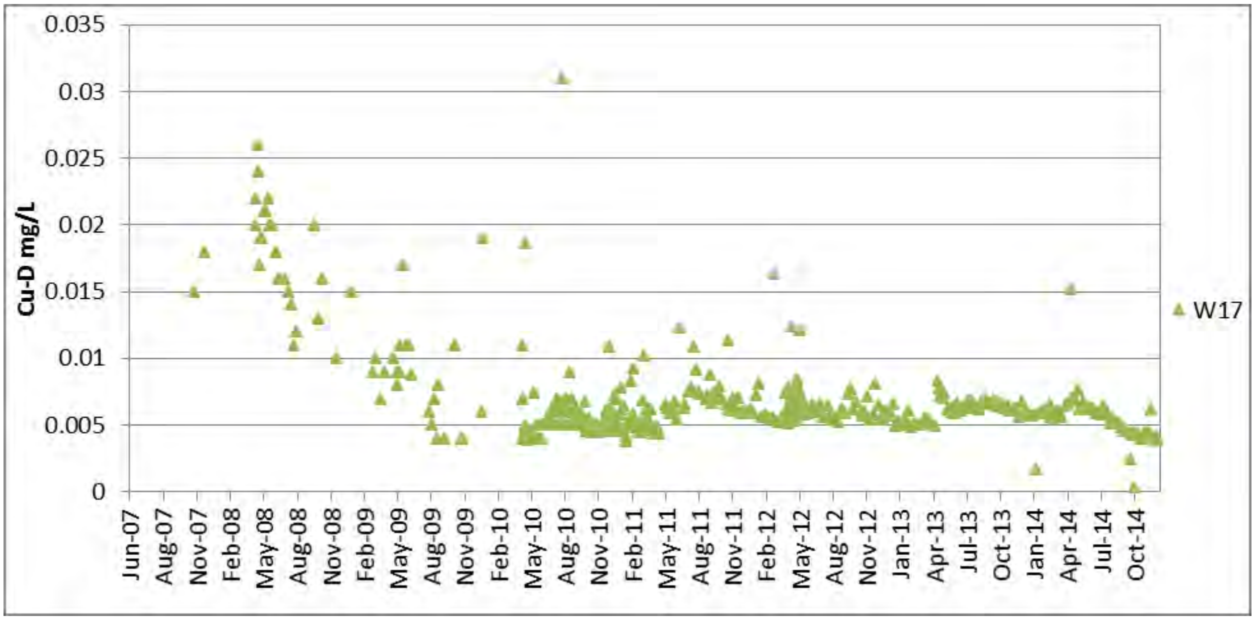
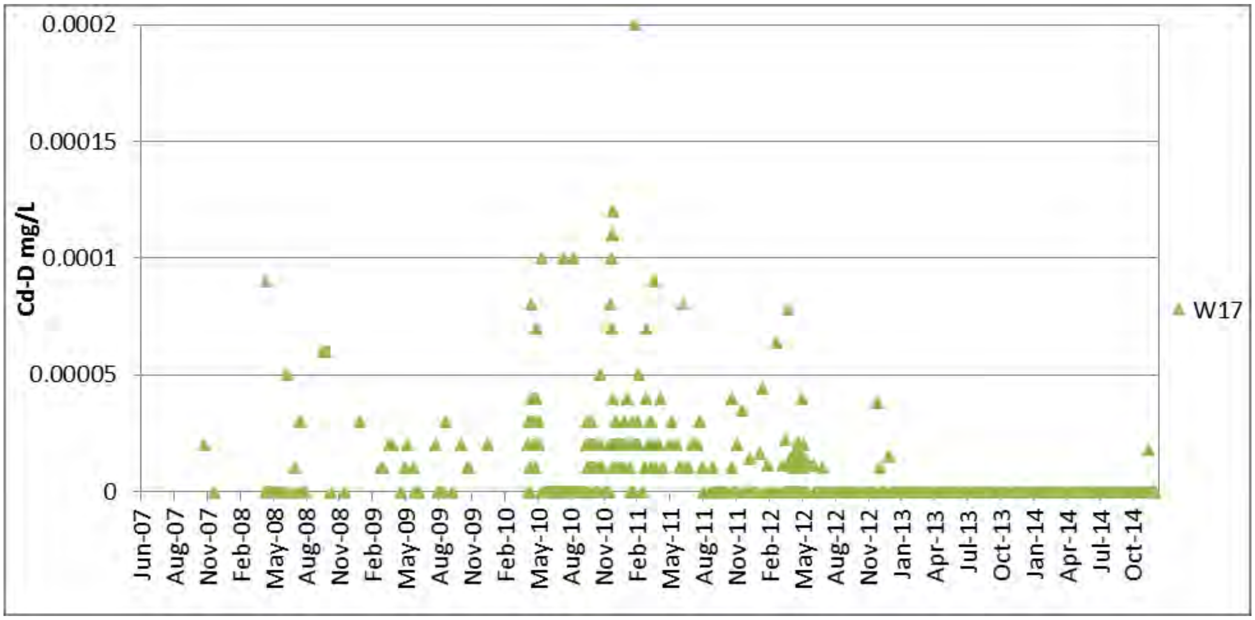
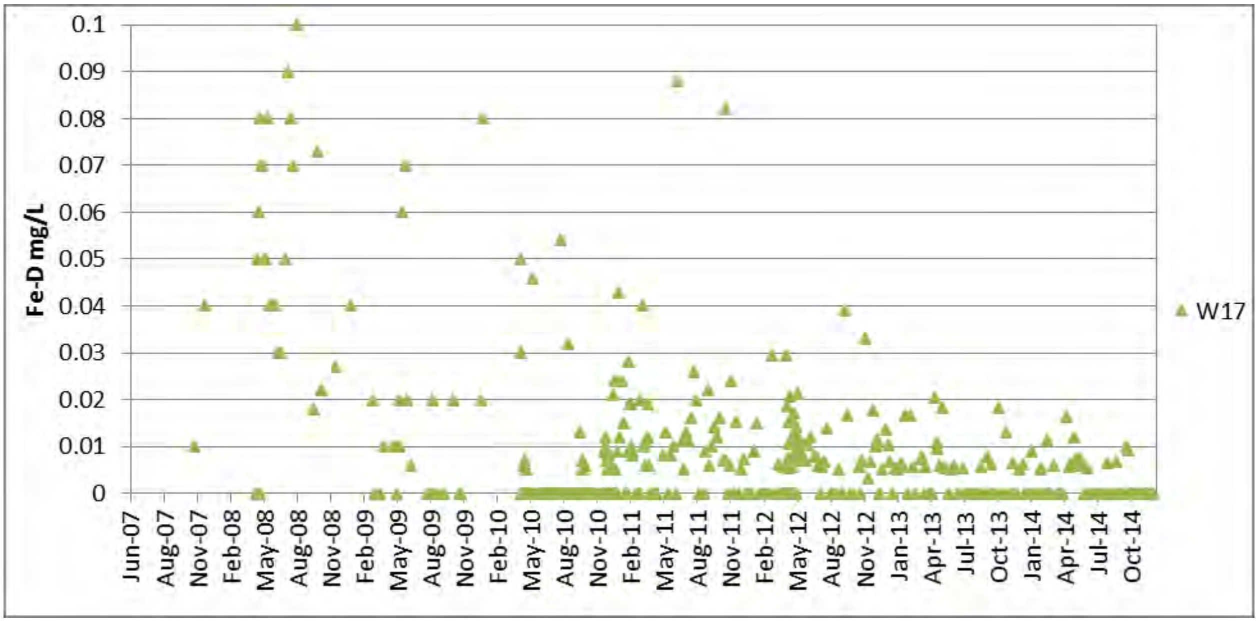


Figure 5-46: Dissolved Copper Concentrations at W17 (2007-2014)



Note: Outliers (i.e., concentrations one order of magnitude higher than the majority of samples) from August 24, 2010 (0.0016 mg/L); January 5, 2010 (0.00113 mg/L); May 27, 2009 (0.00208 mg/L); and June 3, 2009 (0.00278 mg/L) have been omitted from the above graph.

Figure 5-47: Dissolved Cadmium Concentrations at W17 (2007-2014)



Note: An outlier (i.e., concentrations one order of magnitude higher than the majority of samples) from April 26, 2010 (0.358 mg/L) has been omitted from the above graph.

Figure 5-48: Dissolved Iron Concentrations at W17 (2007-2014)

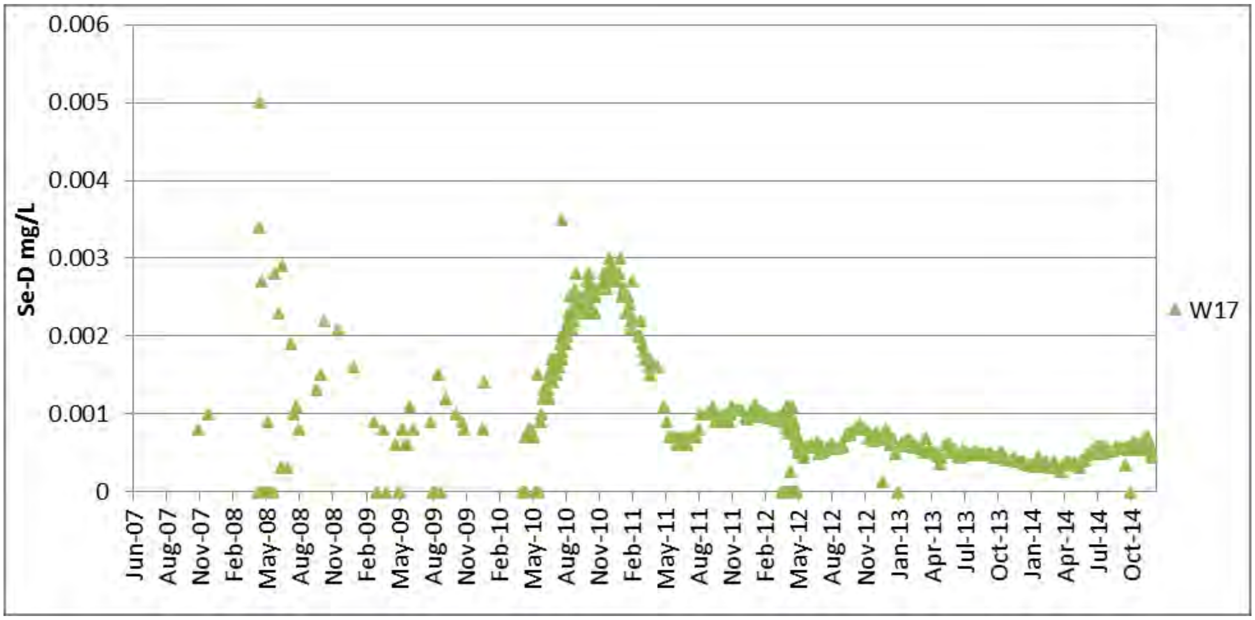
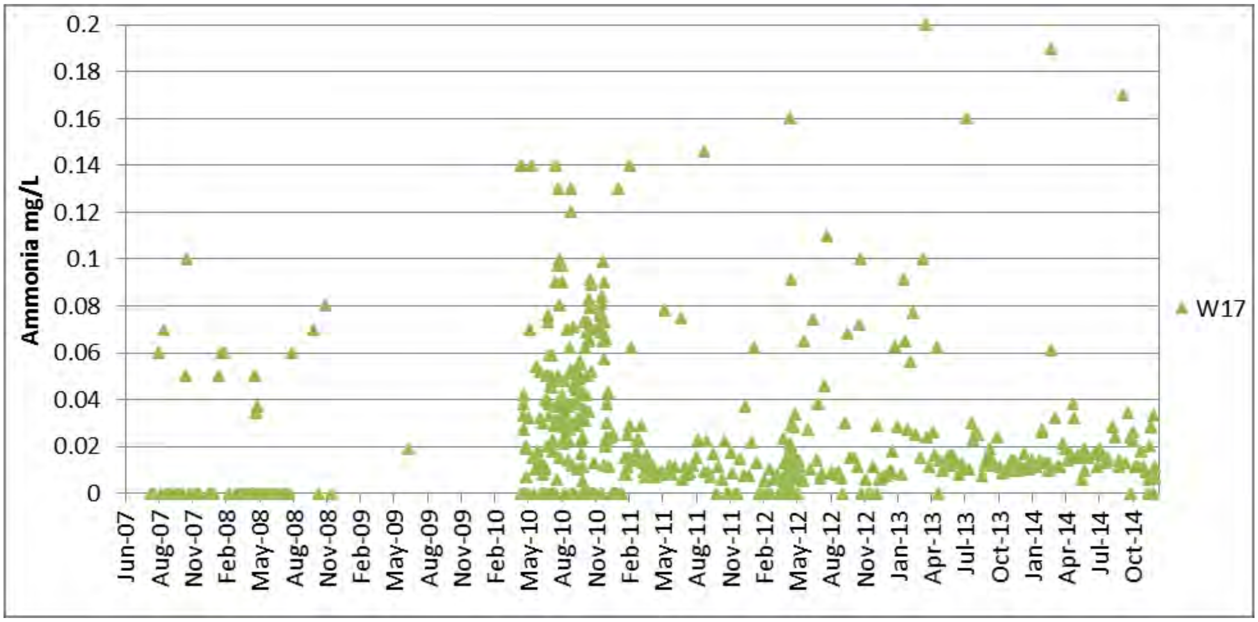
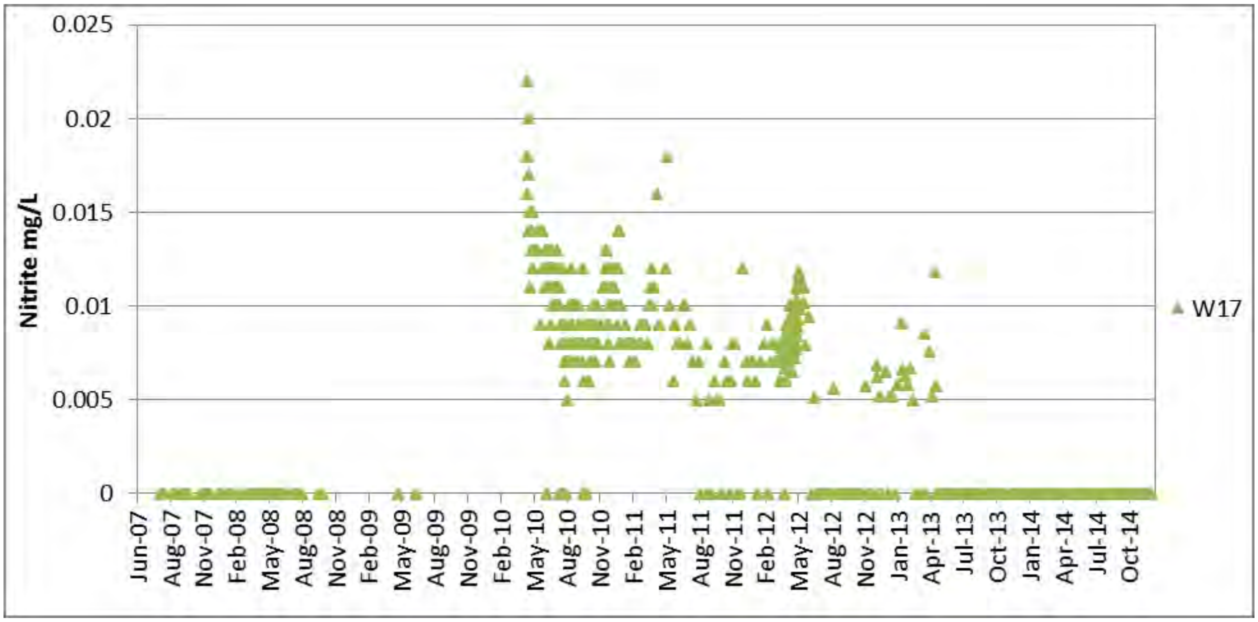


Figure 5-49: Dissolved Selenium Concentrations at W17 (2007-2014)



Note: Outliers (i.e., concentrations one order of magnitude higher than the majority of samples) from February 26, 2011 (0.85 mg/L) and April 28, 2010 (0.8 mg/L) have been omitted from the above graph.

Figure 5-50: Ammonia Concentrations at W17 (2007-2014)



Note: An outlier (i.e., concentrations one order of magnitude higher than the majority of samples) from October 20, 2007 (7.84 mg/L) has been omitted from the above graph.

Figure 5-51: Nitrite Concentrations at W17 (2007-2014)

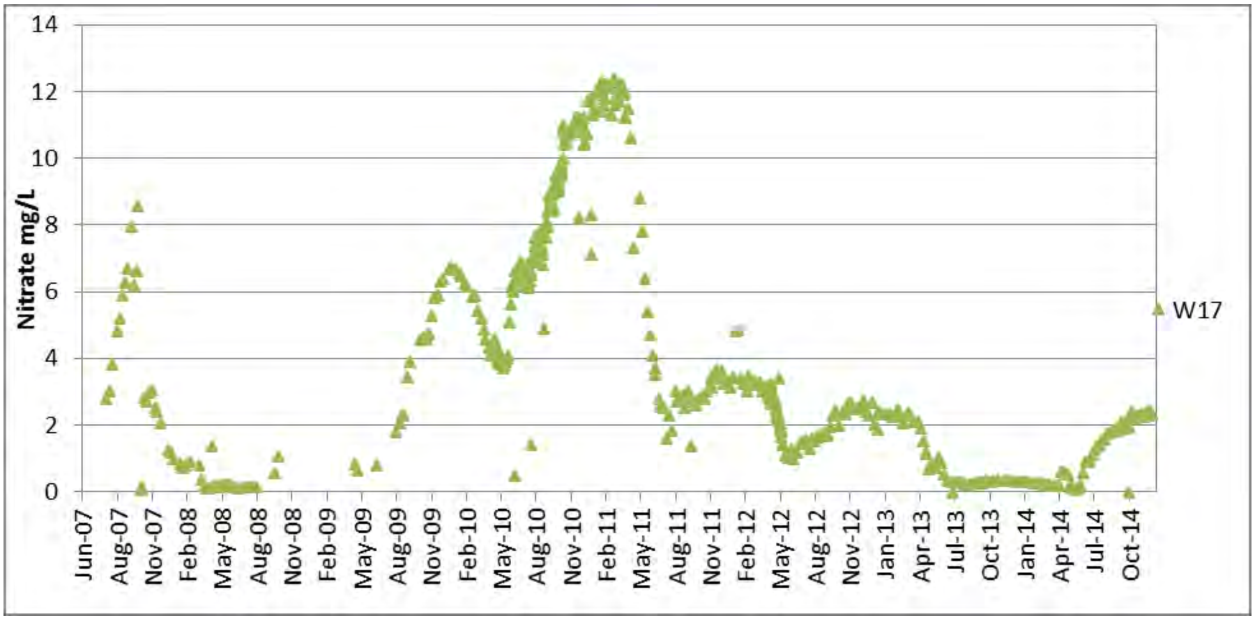


Figure 5-52: Nitrate Concentrations at W17 (2007-2014)

5.5.5 Dry Stack Tailings Storage Facility

Water flows out along the TDD road and travels along the toe of the south side of the DSTSF. Samples were taken as close to the source and to previous seepage survey locations as possible, within ±5 m of the original GPS location. Seepage water quality monitoring sites SS9, SS10, SS17, SS18 and SS32 are sampled from the TDD and the south side of the DSTSF, and are monitored during spring and fall. 2014 water quality results for SS9, SS10, SS17, SS18 and SS32 are outlined in Figure 5-53 through Figure 5-59 and include historic water quality results for dissolved copper, cadmium, iron, and selenium and nutrient levels for ammonia, nitrite and nitrate.

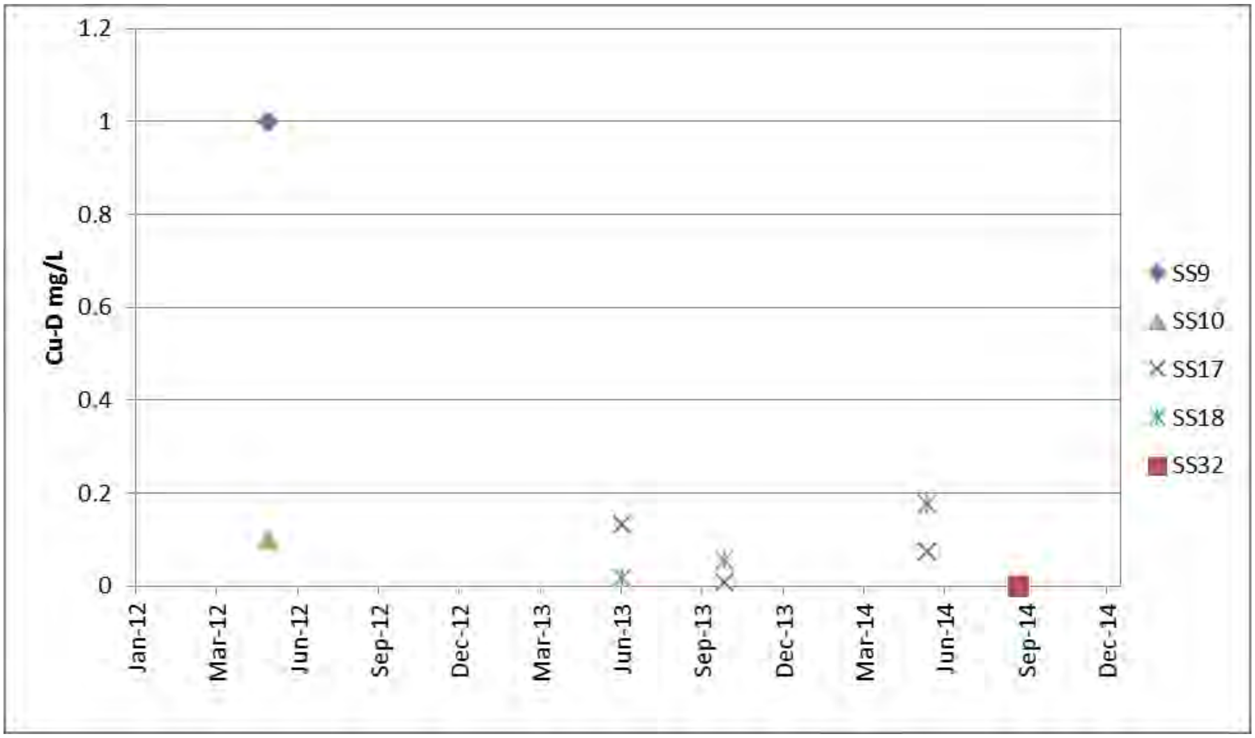


Figure 5-53: Dissolved Copper Concentrations around the DSTSF (2012-2014)

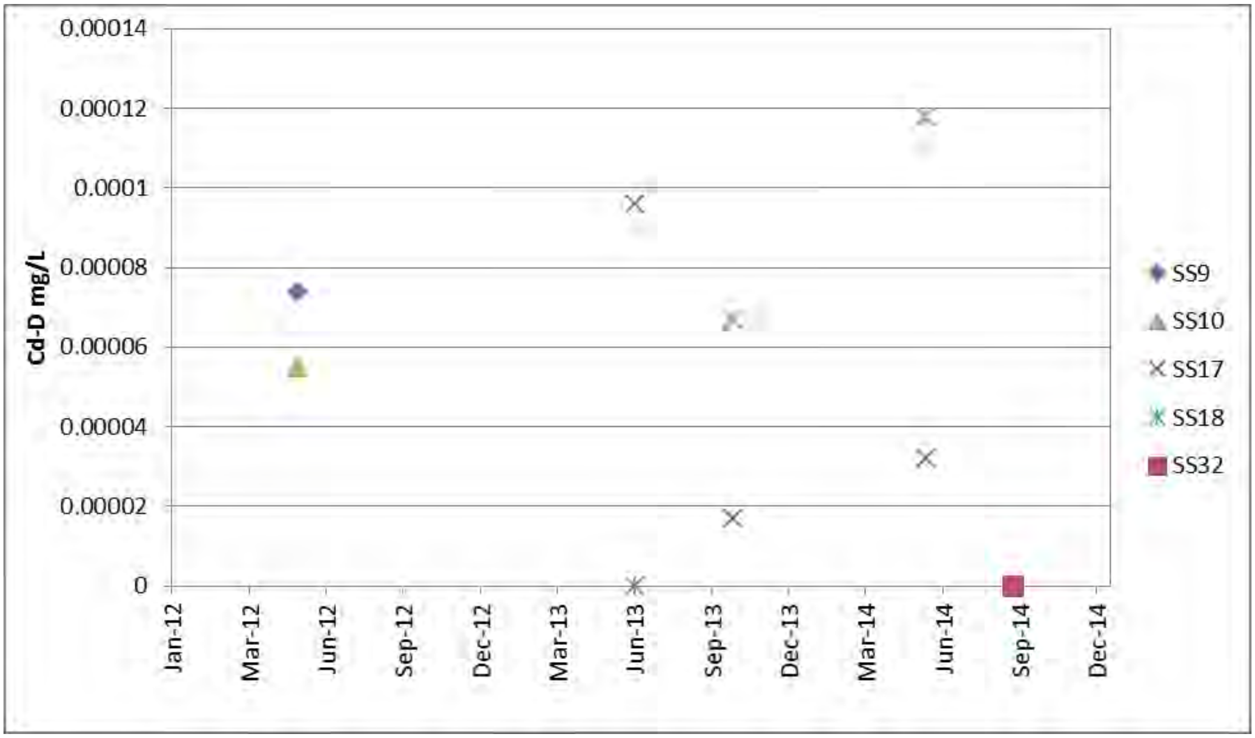


Figure 5-54: Dissolved Cadmium Concentrations around the DSTSF (2012-2014)

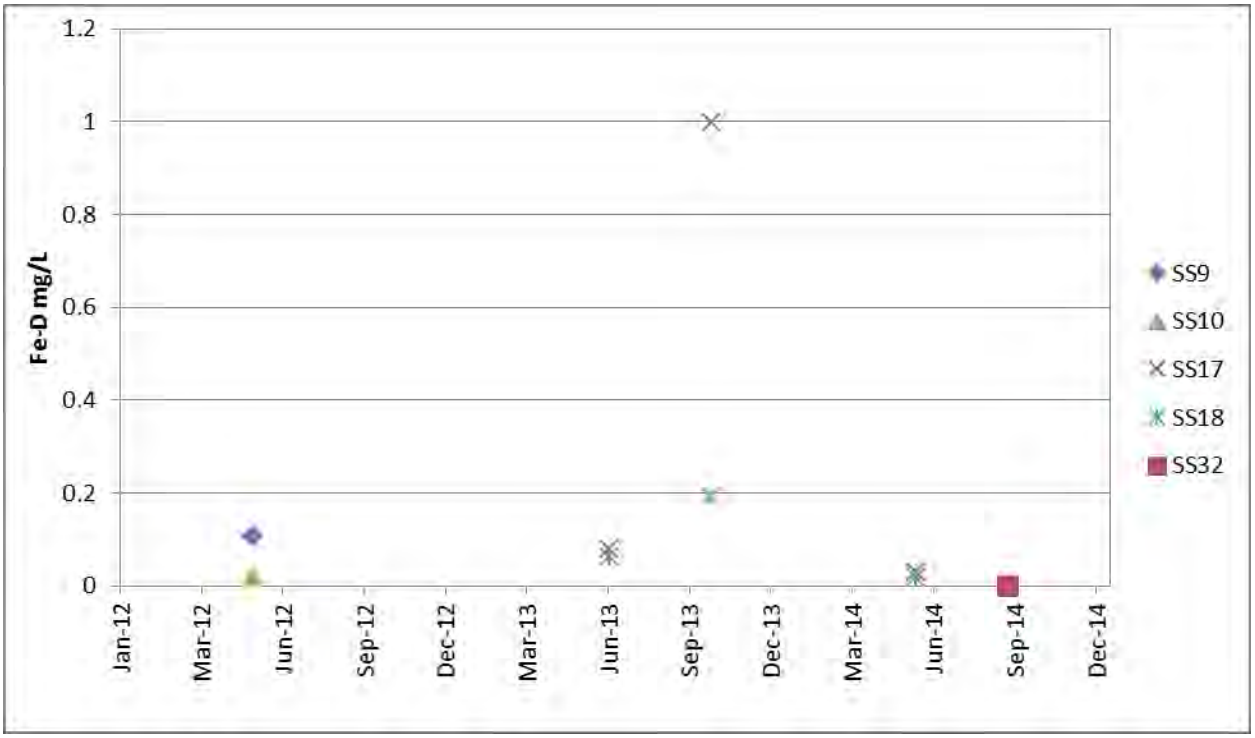


Figure 5-55: Dissolved Iron Concentrations around the DSTSF (2012-2014)

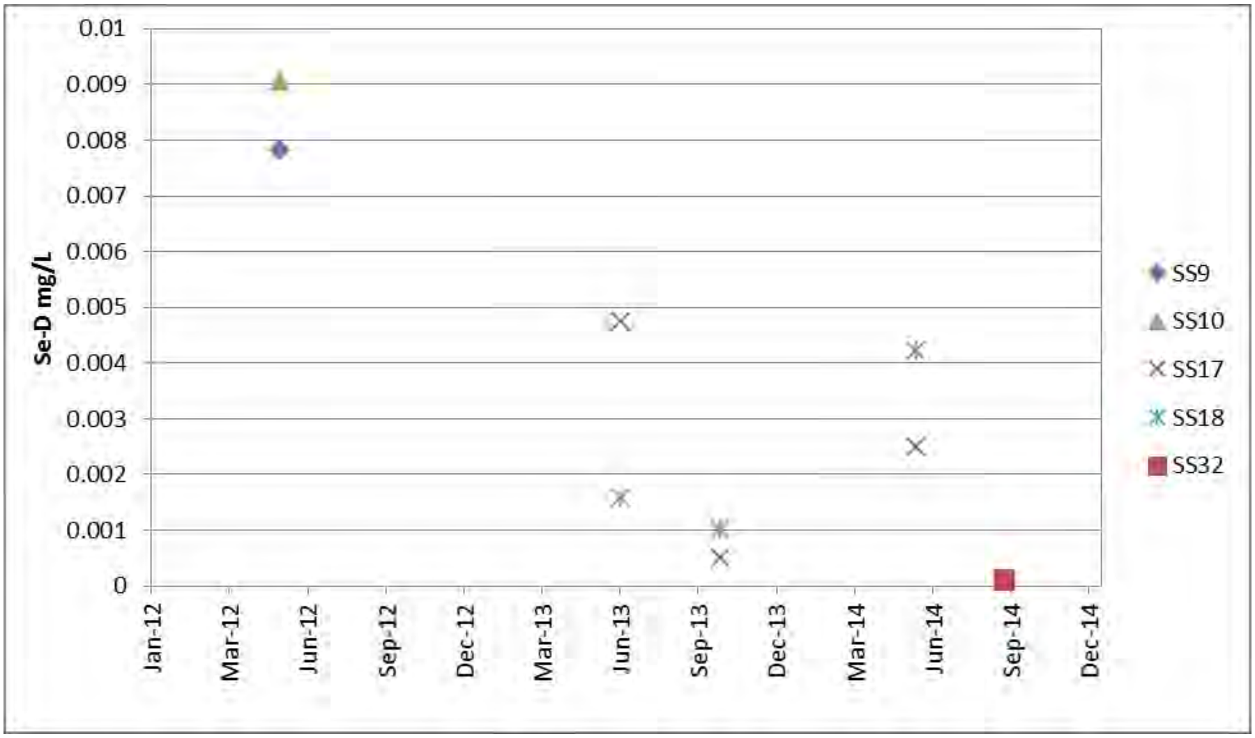


Figure 5-56: Dissolved Selenium Concentrations around the DSTSF (2012-2014)

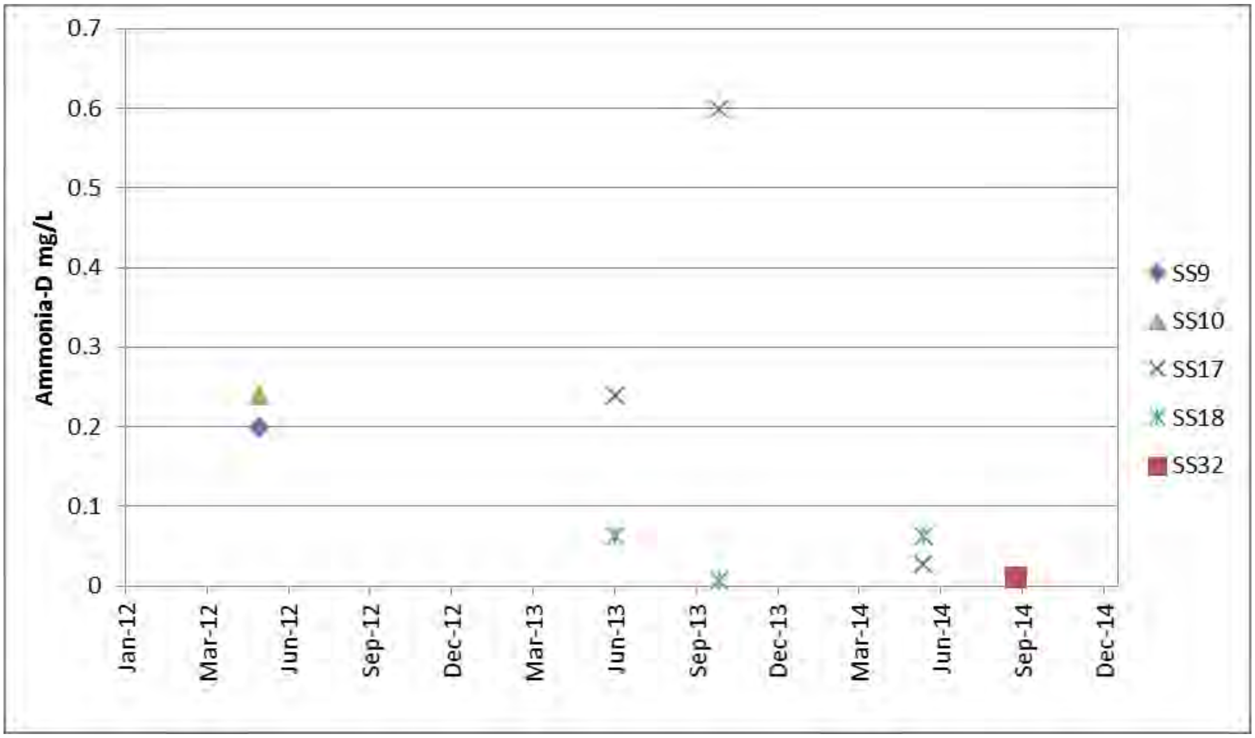


Figure 5-57: Ammonia Concentrations around the DSTSF (2012-2014)

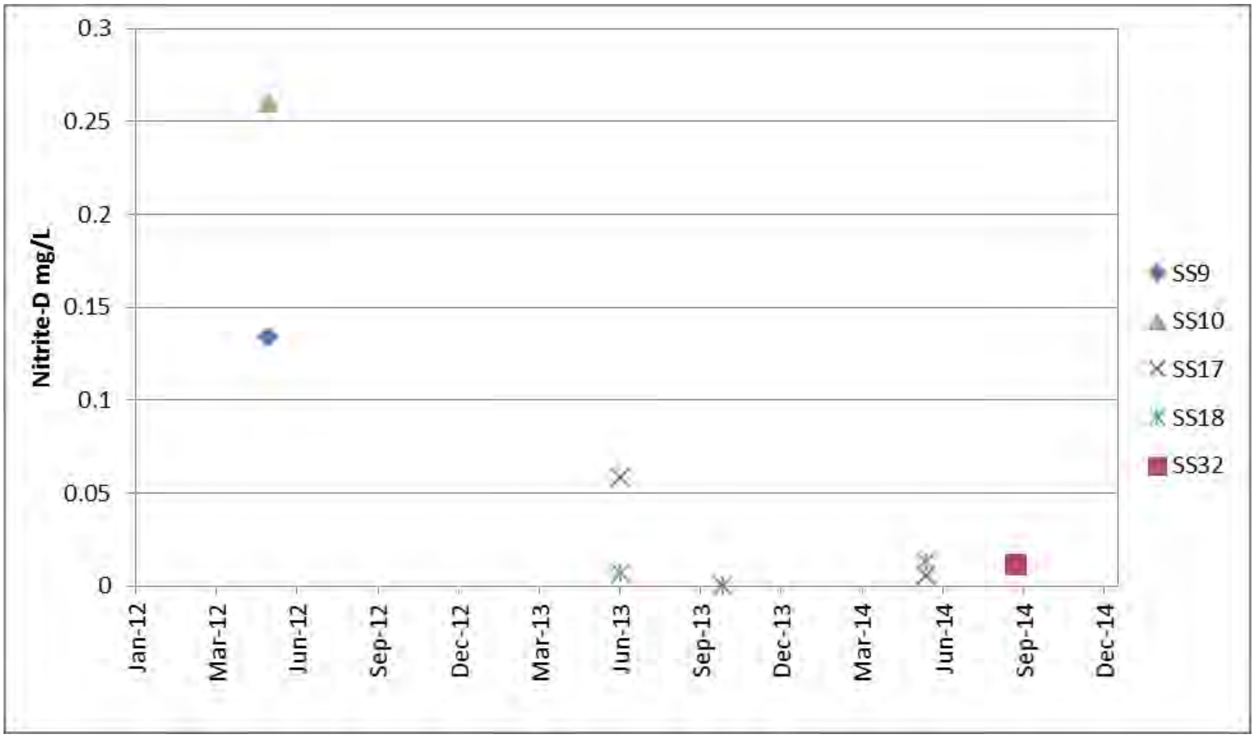


Figure 5-58: Nitrite Concentrations around the DSTSF (2012-2014)

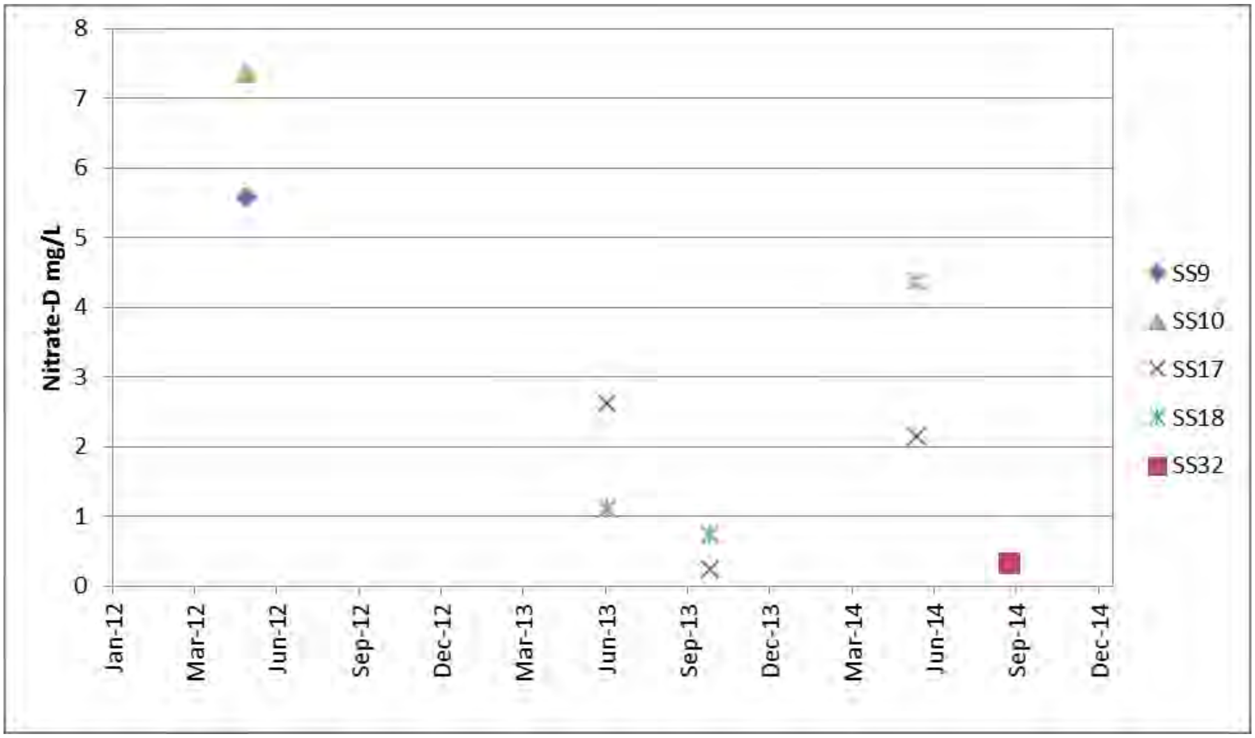


Figure 5-59: Nitrate Concentrations around the DSTSF (2012-2014)

5.5.6 South East side of the East Stockpile

Surface seepage runs along the toe of the yellow ore stockpile (east stockpile) and into the ditch parallel to the heavy vehicle road. All seeps in this area drain into the east stockpile sump and are pumped to the Main Pit. Seepage water quality monitoring stations SS5, SS6, SS7, SS8, SS24 and SS33 capture seepage from the stockpile, and are monitored during the spring and fall sampling program. 2014 water quality results are outlined in Figure 5-60 through Figure 5-66 and include historic water quality results for dissolved copper, cadmium, iron and selenium and nutrient levels for ammonia, nitrite and nitrate.

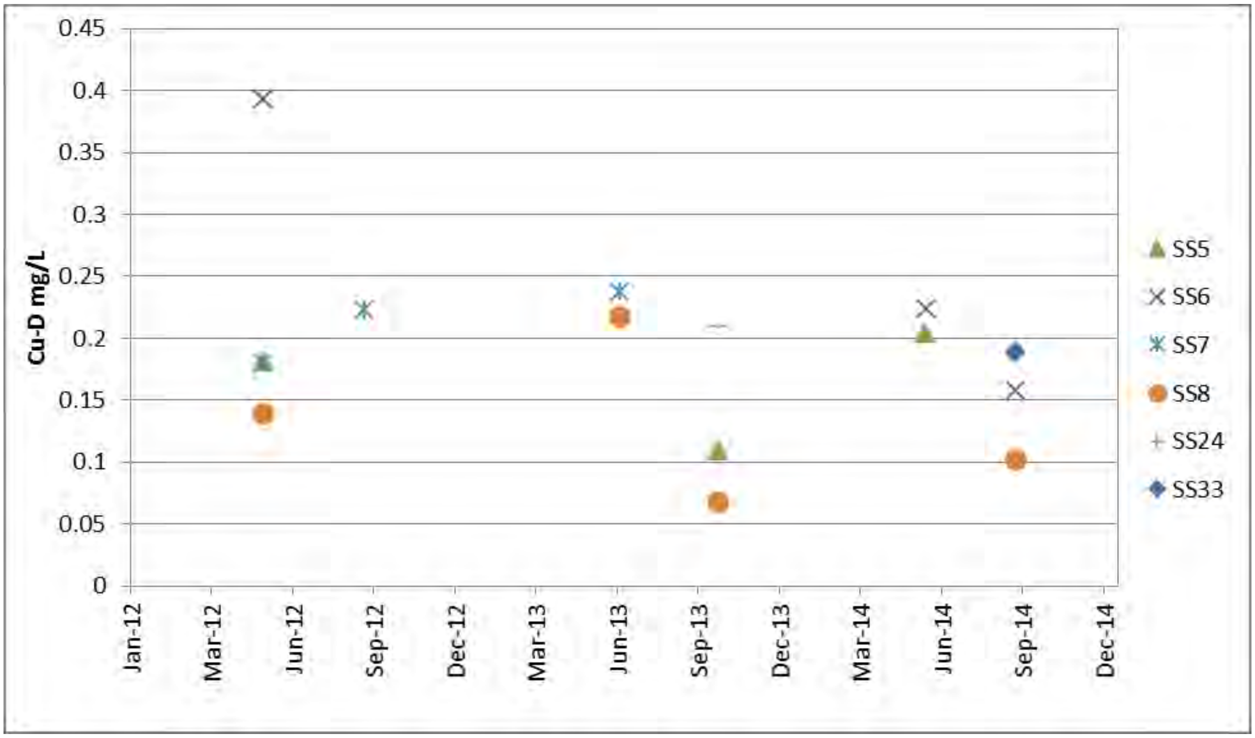


Figure 5-60: Dissolved Copper Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

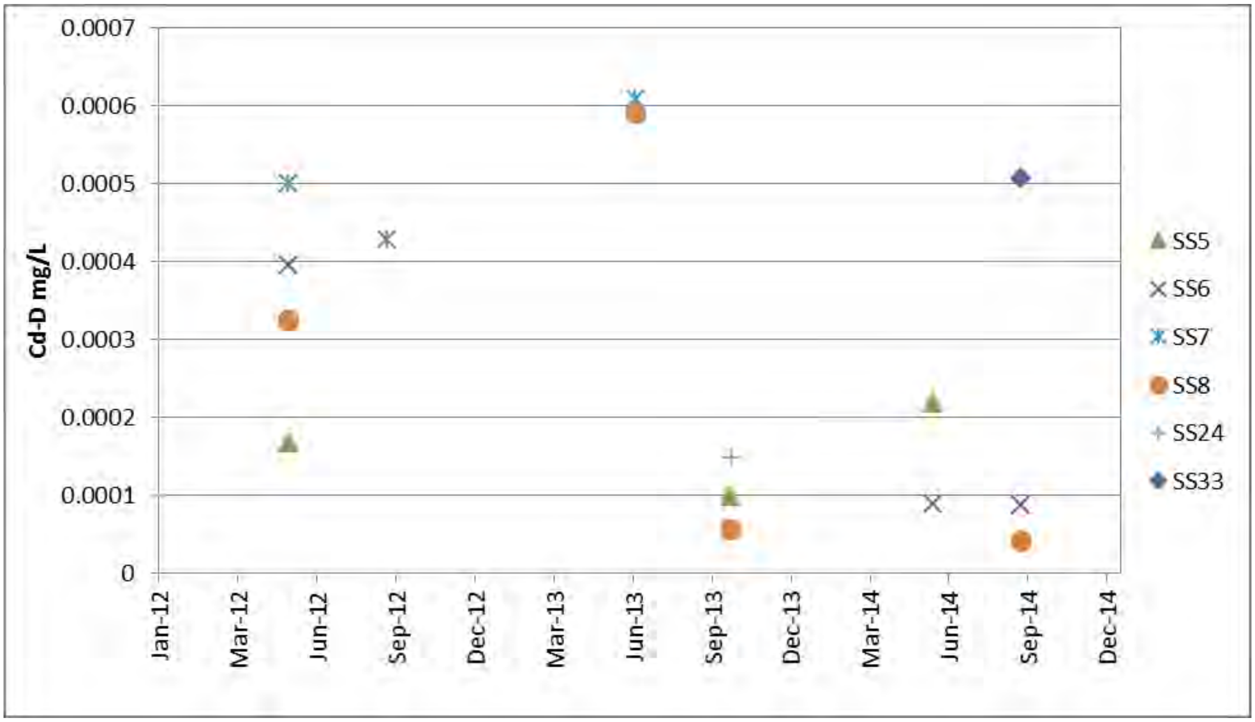


Figure 5-61: Dissolved Cadmium Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

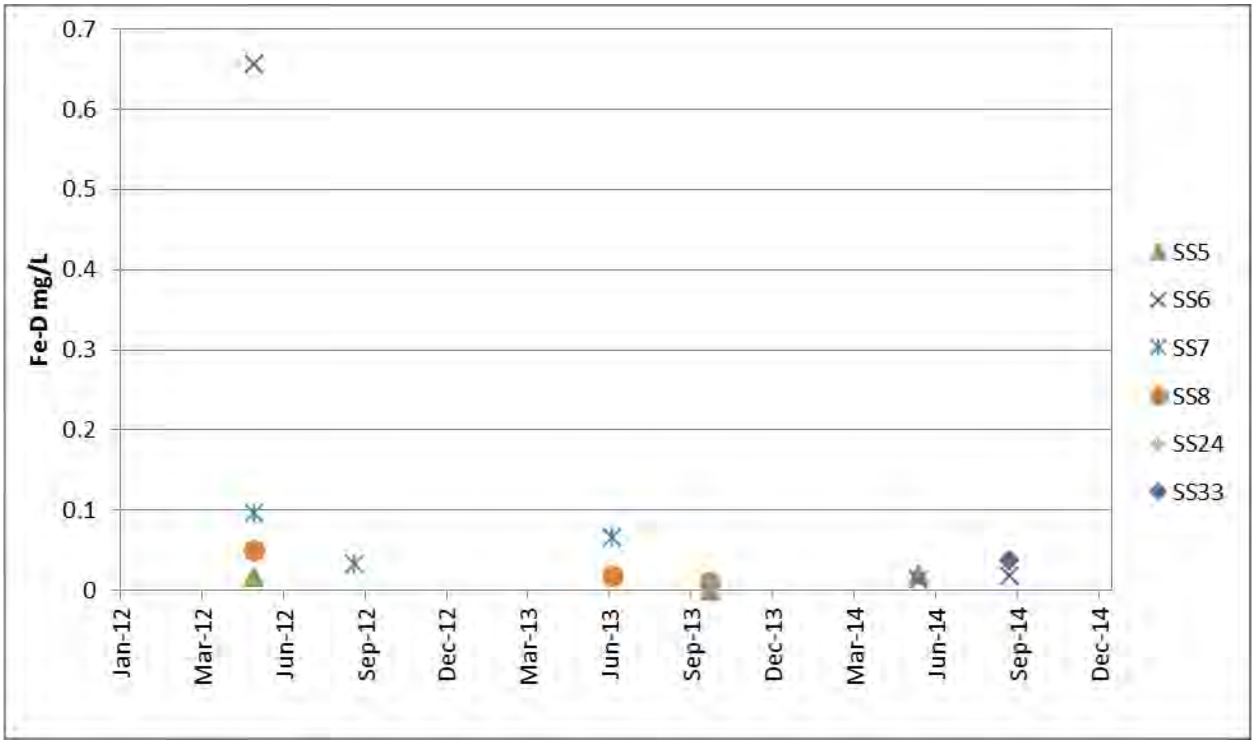


Figure 5-62: Dissolved Iron Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

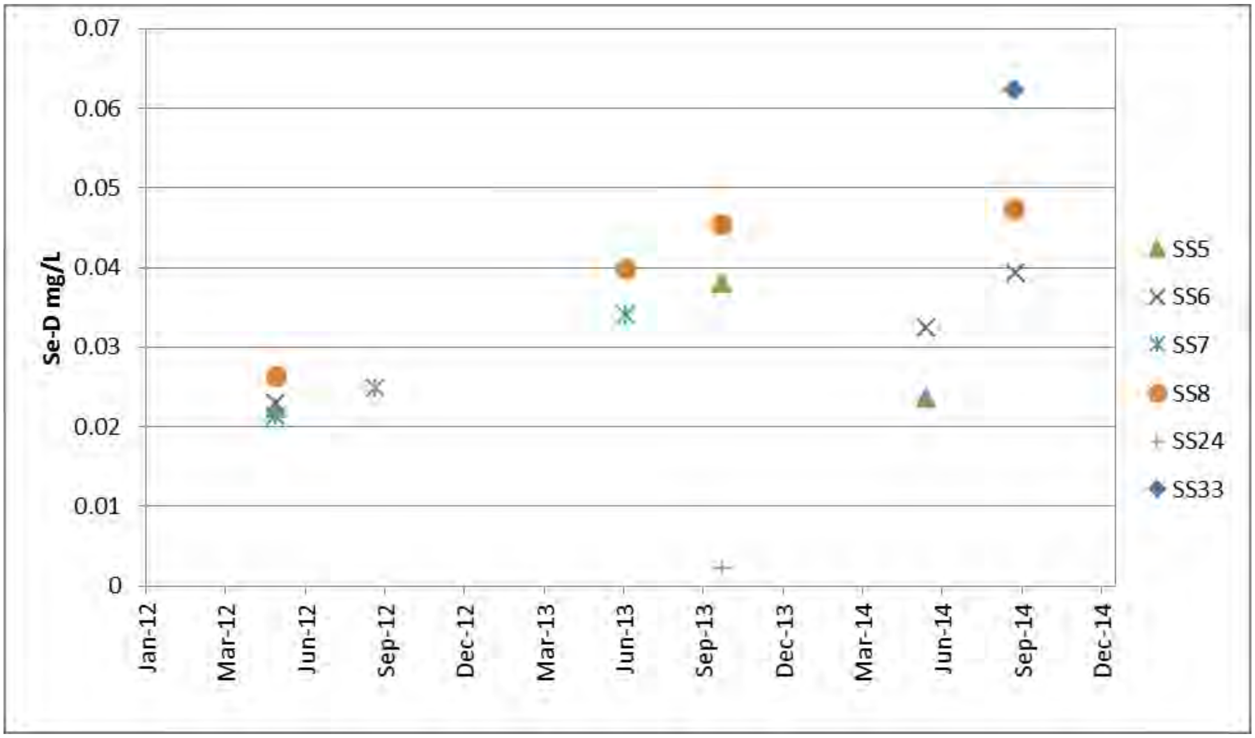


Figure 5-63: Dissolved Selenium Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

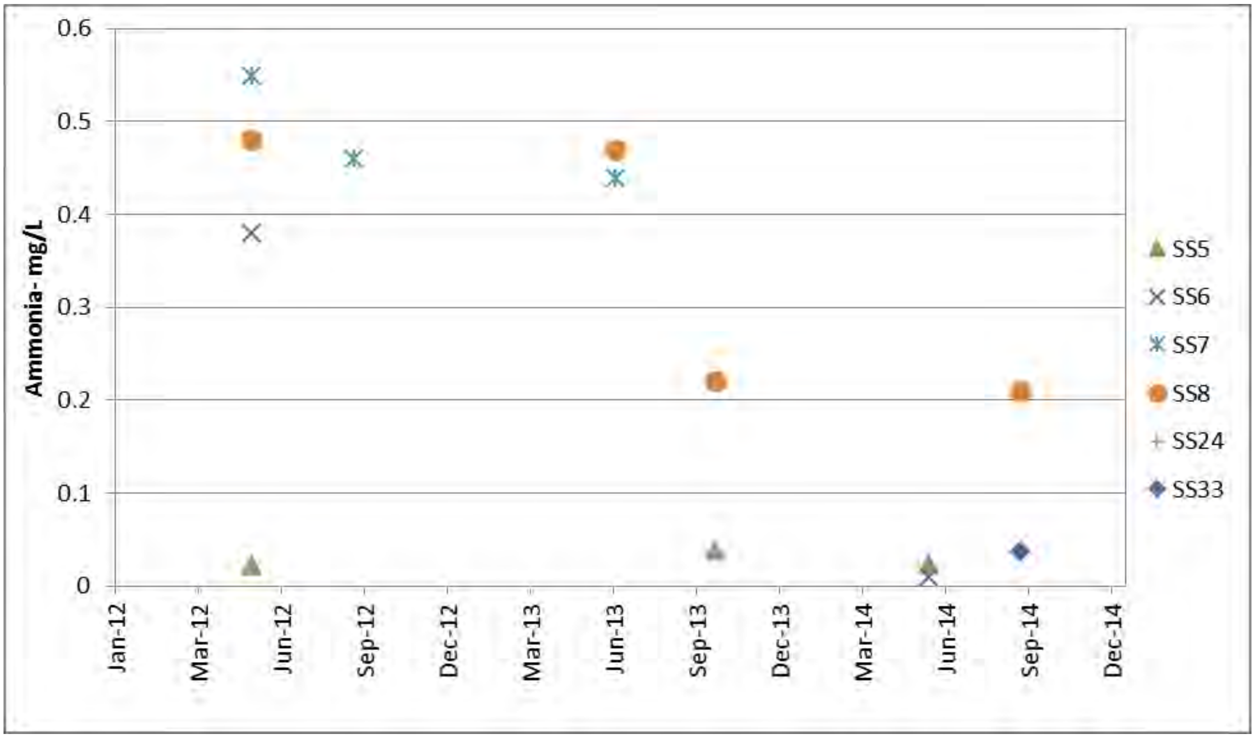


Figure 5-64: Ammonia Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

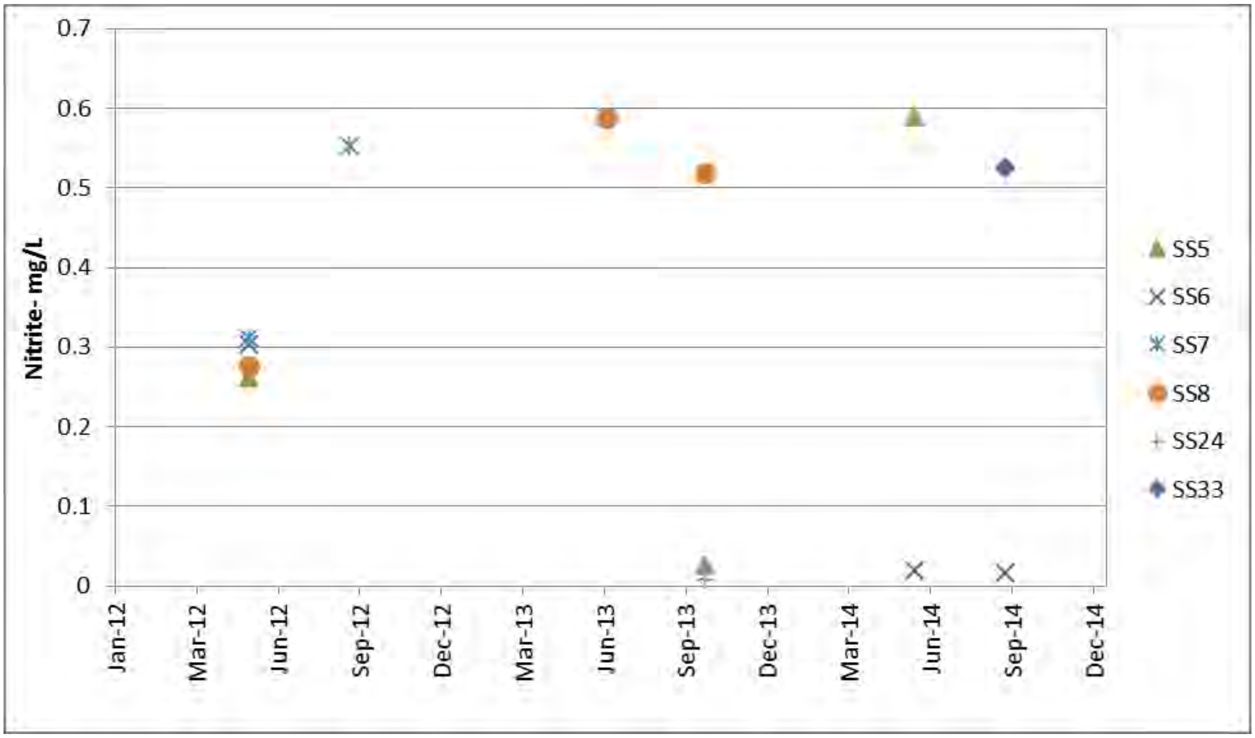


Figure 5-65: Nitrite Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

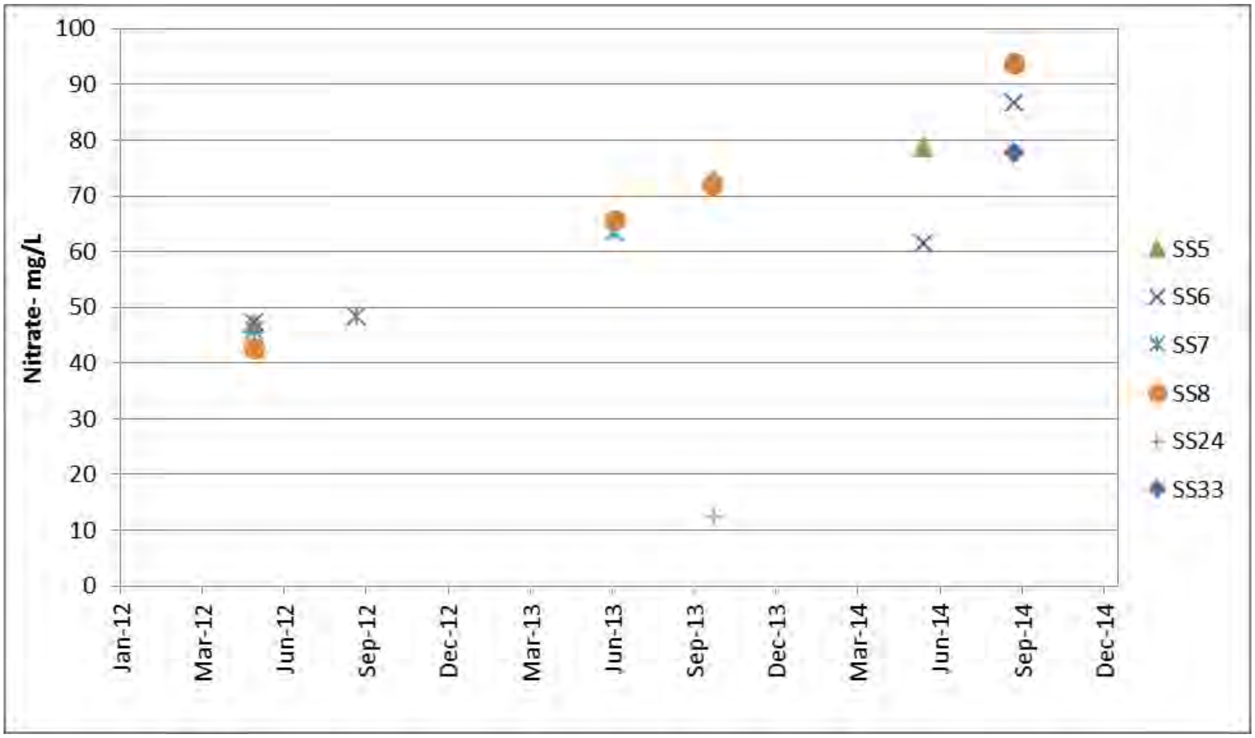


Figure 5-66: Nitrate Concentrations for Seepage at the Toe of the East Stockpile (2012-2014)

5.5.7 Reclamation Overburden Dump

The majority of sample locations at the reclamation overburden dump (ROD) are seepage from original ground which runs along the toe of the overburden dump at various locations. Seepage water quality monitoring stations SS2, SS3, SS11, SS14 and SS15 capture seepage from the ROD, and are monitored during spring and fall. Seepage was not observed at the ROD in 2014 but historic water quality results are outlined in Figure 5-67 through Figure 5-73 and include historic water quality results for dissolved copper, cadmium, iron and selenium and nutrient levels for ammonia, nitrite and nitrate.

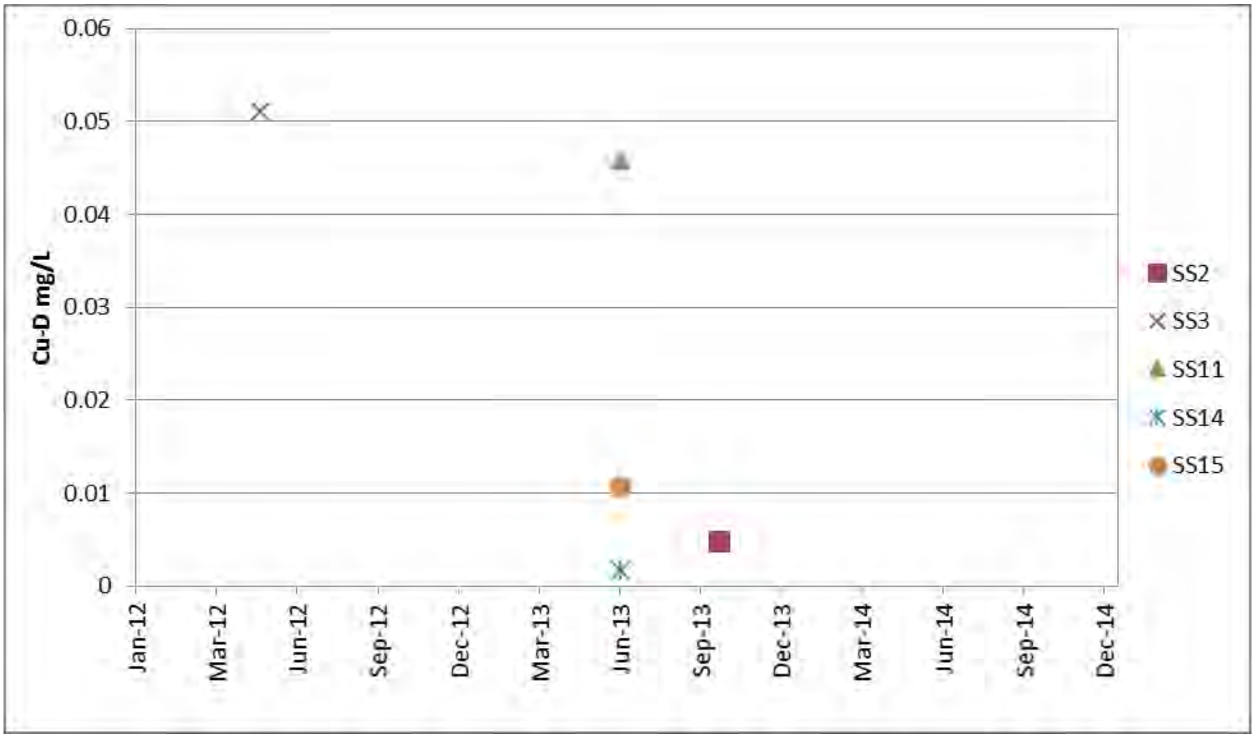


Figure 5-67: Dissolved Copper Concentrations at the ROD (2012-2013)

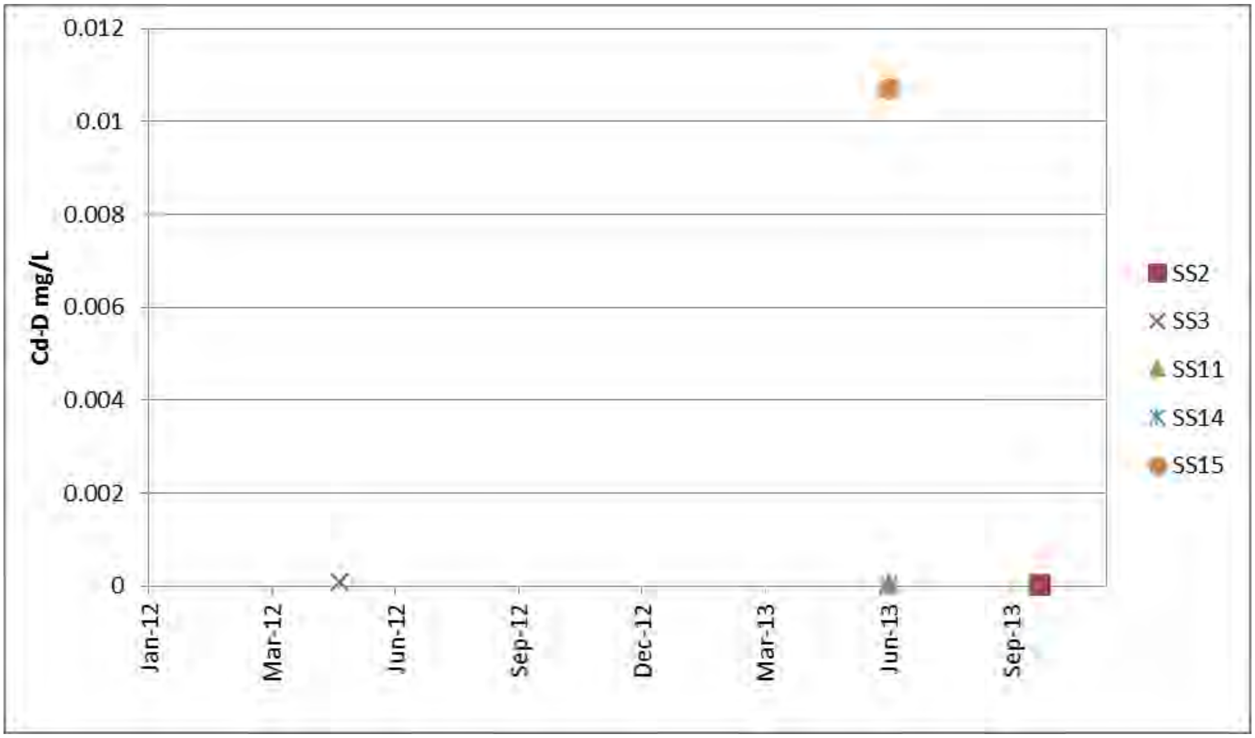


Figure 5-68: Dissolved Cadmium Concentrations at ROD (2012-2013)

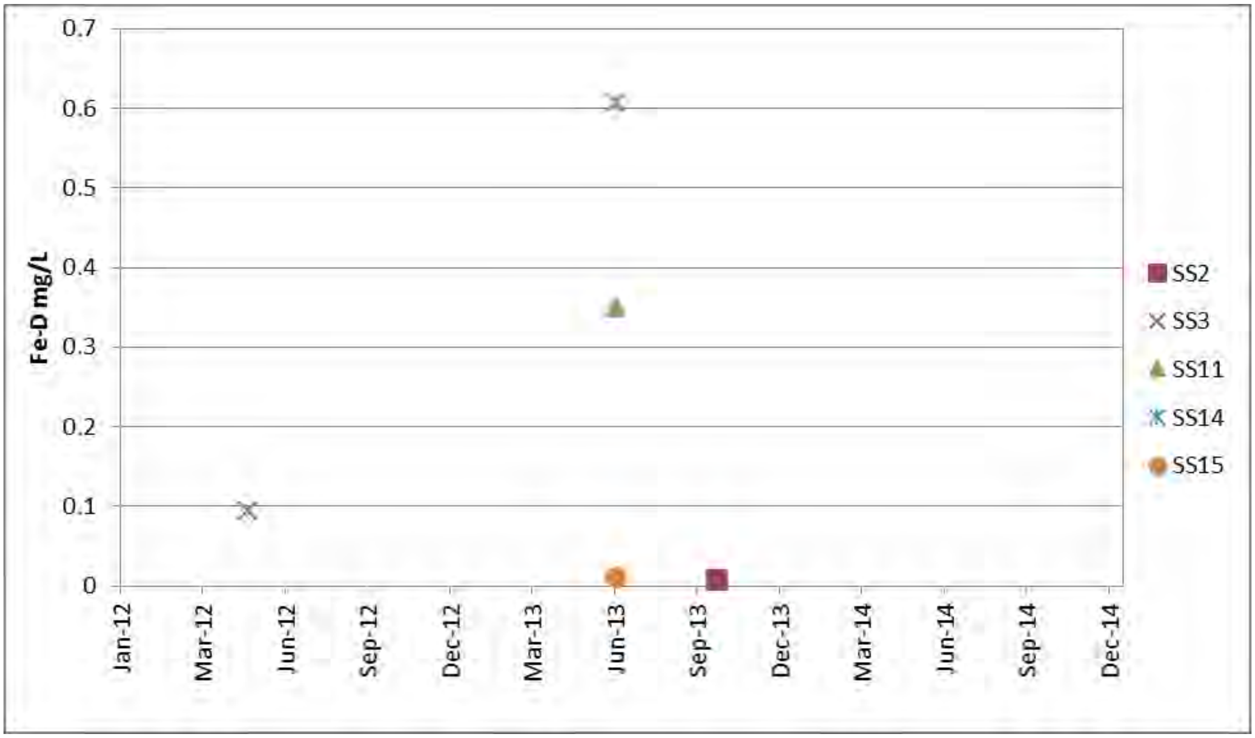


Figure 5-69: Dissolved Iron Concentrations at ROD (2012-2013)

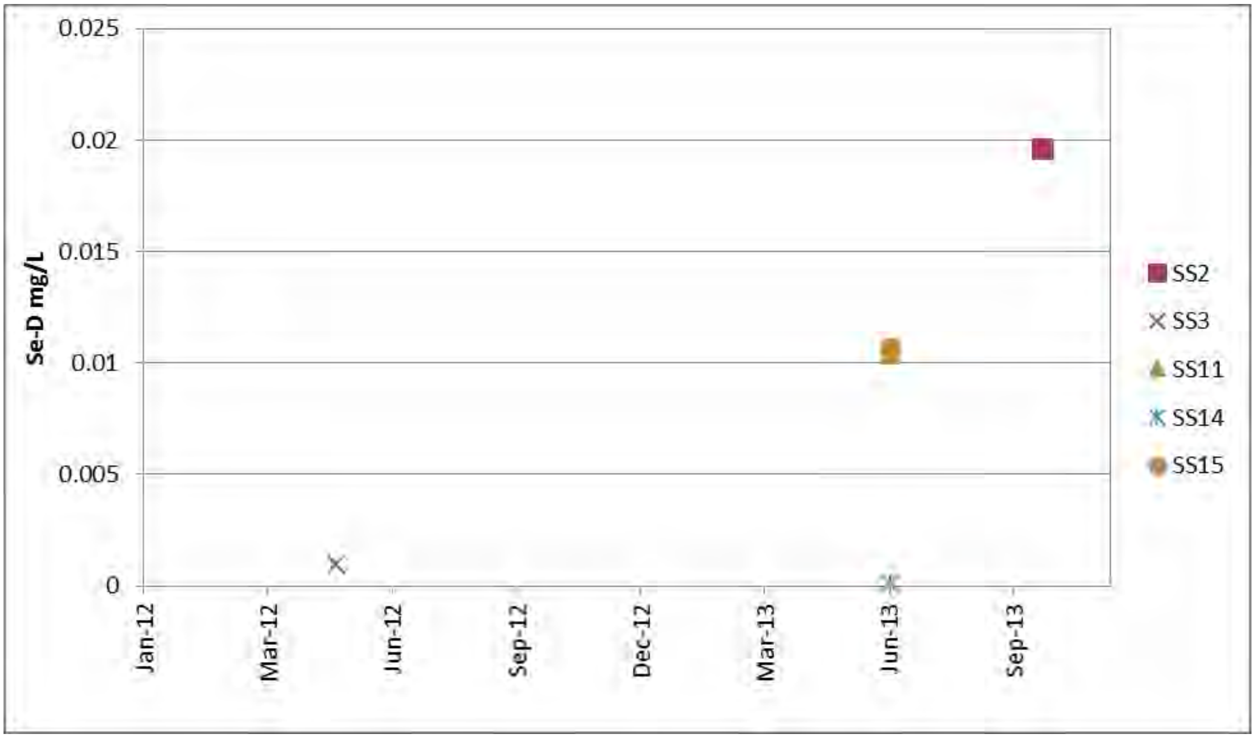


Figure 5-70: Dissolved Selenium Concentrations at ROD (2012-2013)

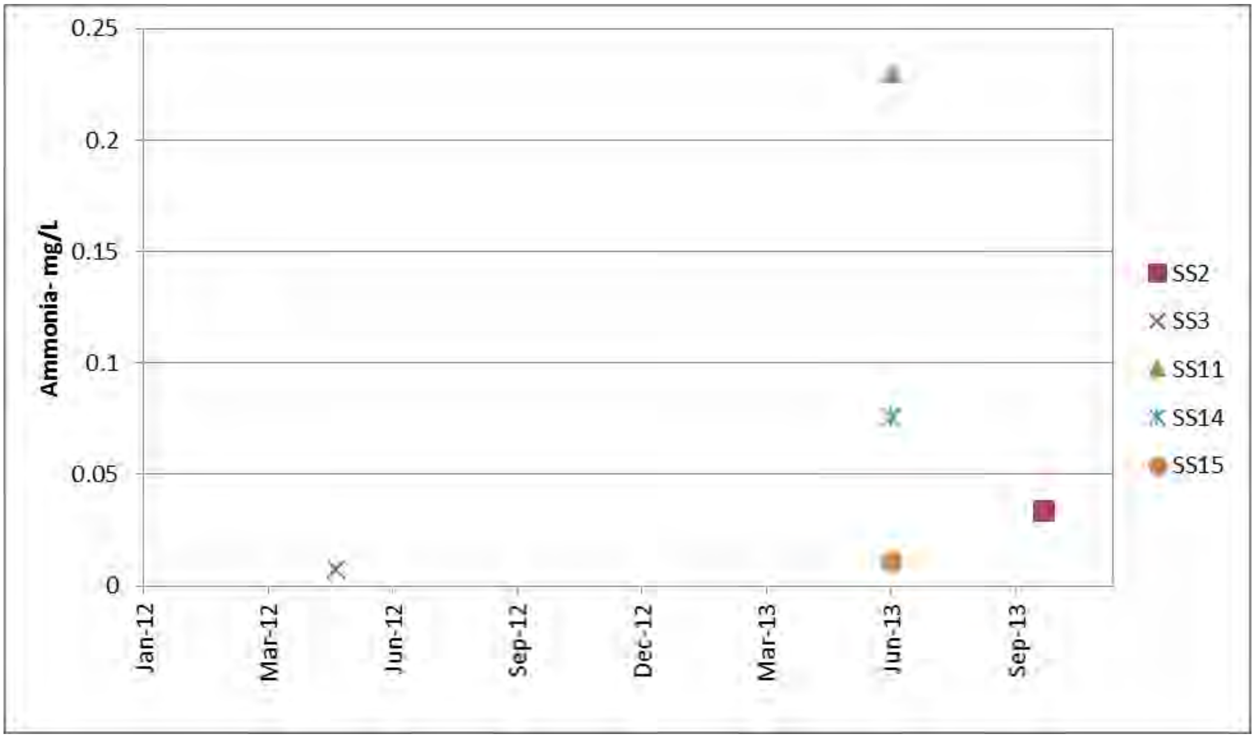


Figure 5-71: Ammonia Concentrations at ROD (2012-2013)

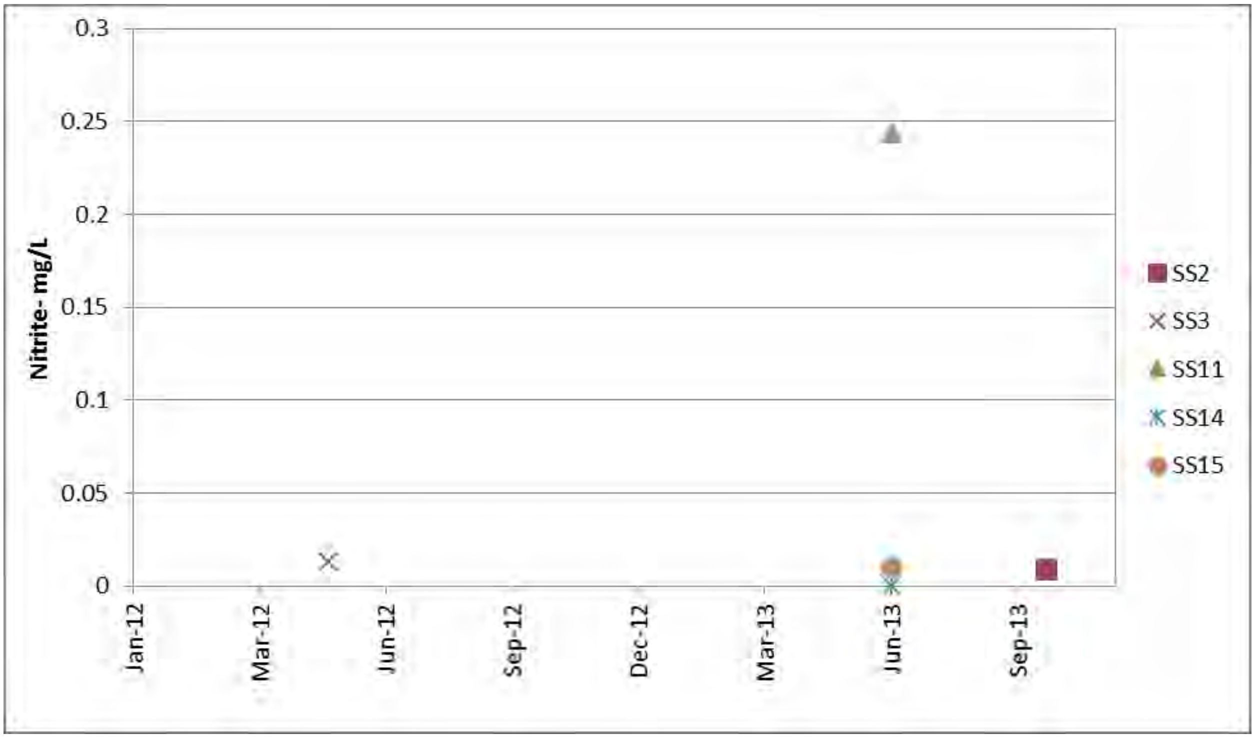


Figure 5-72: Nitrite Concentrations at ROD (2012-2013)

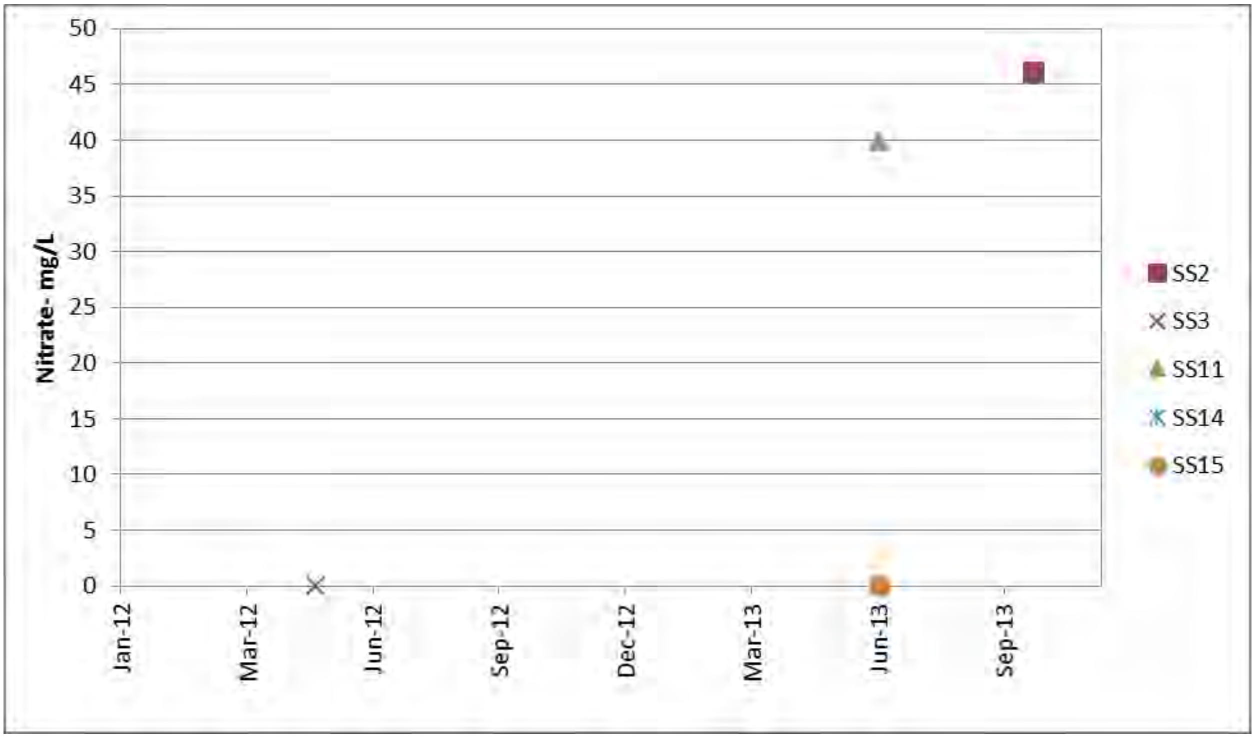


Figure 5-73: Nitrate Concentrations at ROD (2012-2013)

5.5.8 Main Waste Dump

Seepage found around the main waste dump (MWD) is thought to emerge from original ground and flows over onto the MWD. Seepage from the MWD is captured at water quality monitoring stations SS12, SS16 and SS23. 2014 water quality results are summarized in Figure 5-74 through Figure 5-80 and include historic water quality results for dissolved copper, cadmium, iron and selenium and nutrient levels for ammonia, nitrite and nitrate.

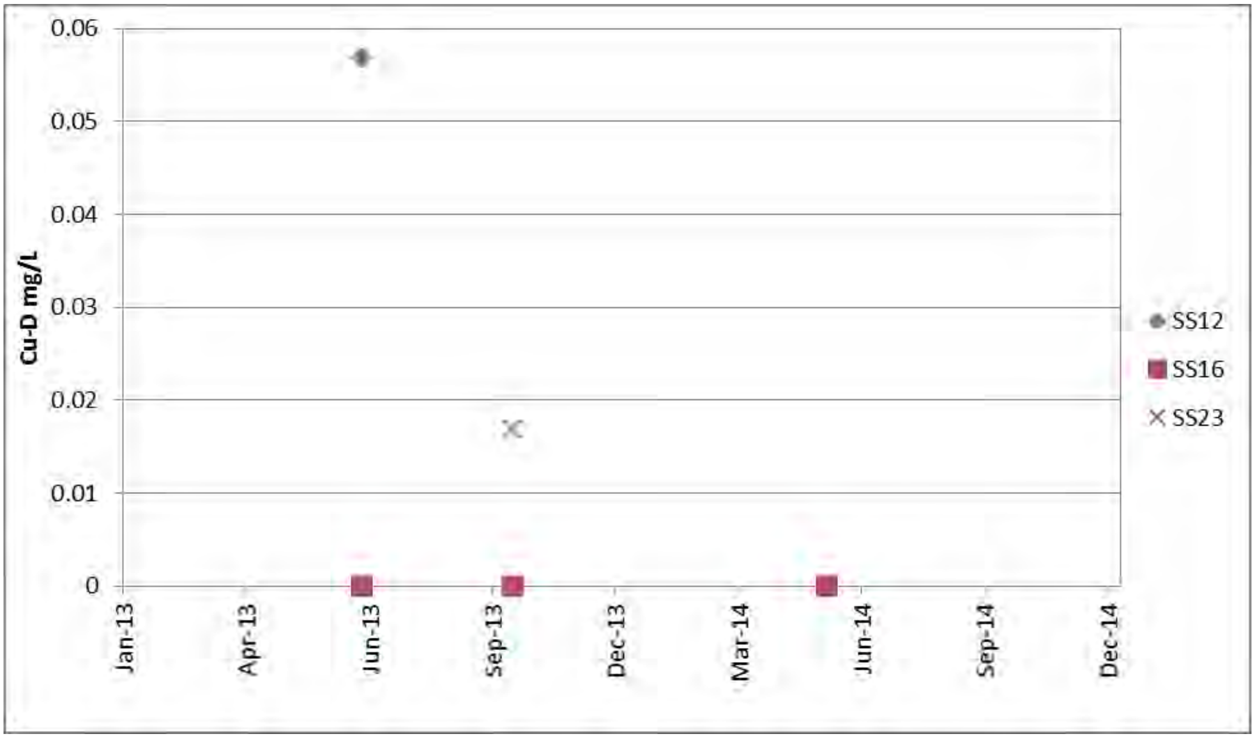


Figure 5-74: Dissolved Copper Concentrations at SS12, SS16, SS23 (2013-2014)

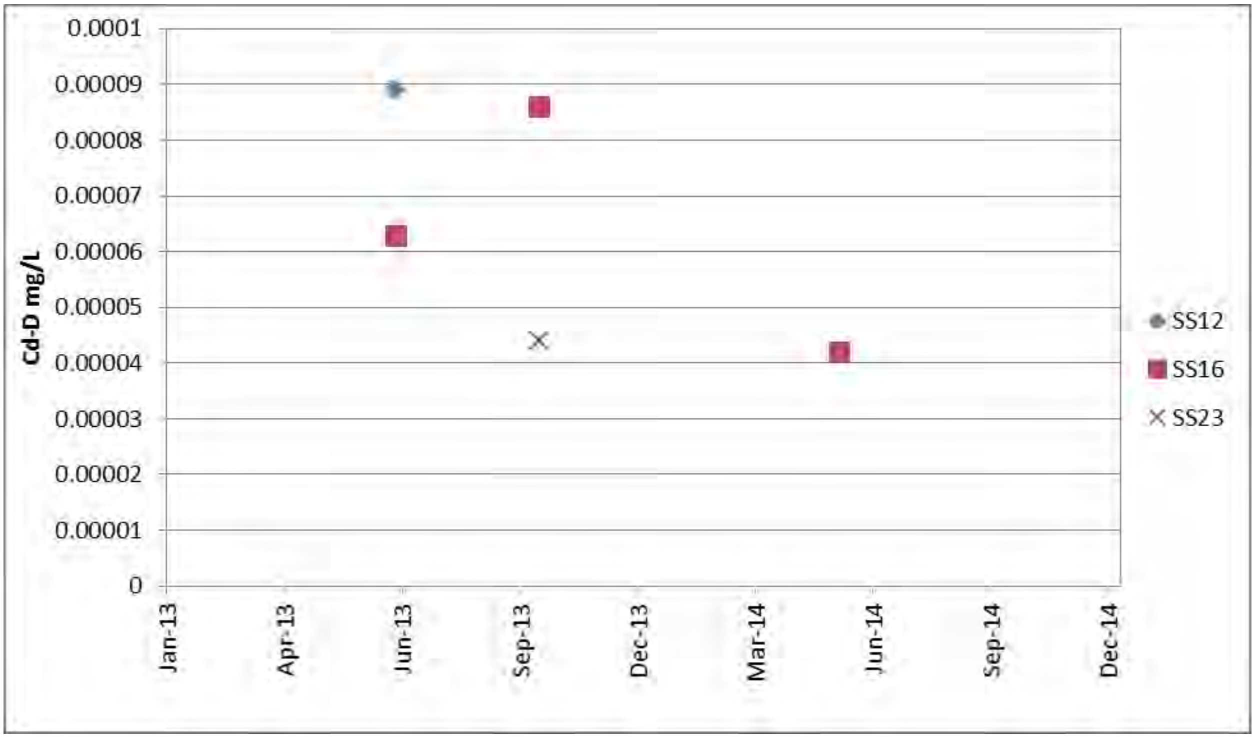


Figure 5-75: Dissolved Cadmium Concentrations at SS12, SS16, SS23 (2013-2014)

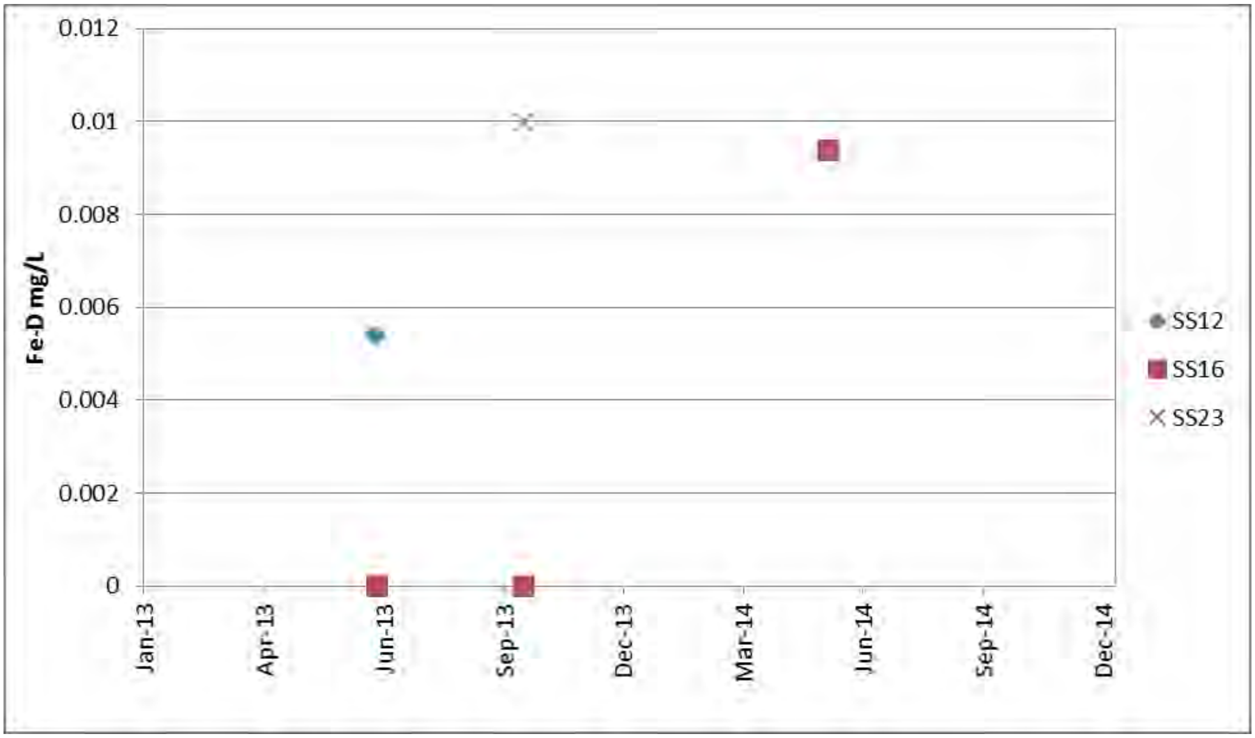


Figure 5-76: Dissolved Iron Concentrations at SS12, SS16, SS23 (2013-2014)

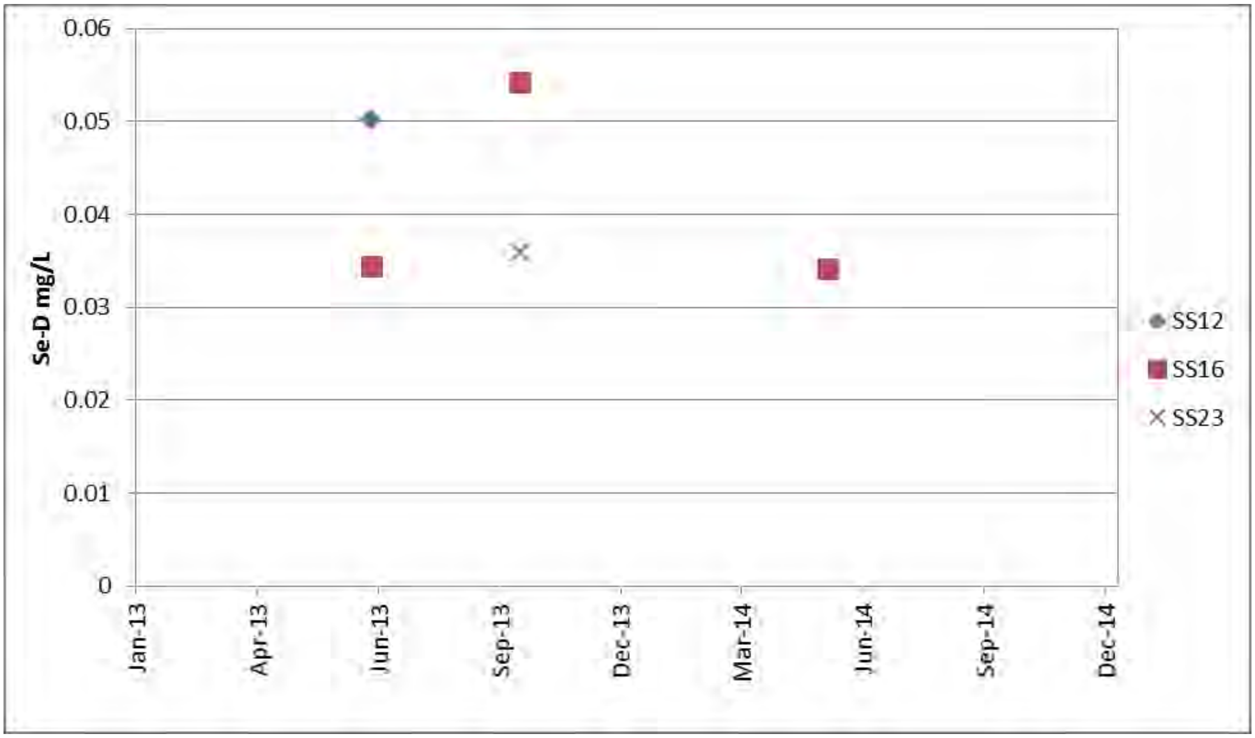


Figure 5-77: Dissolved Selenium Concentrations at SS12, SS16, SS23 (2013-2014)

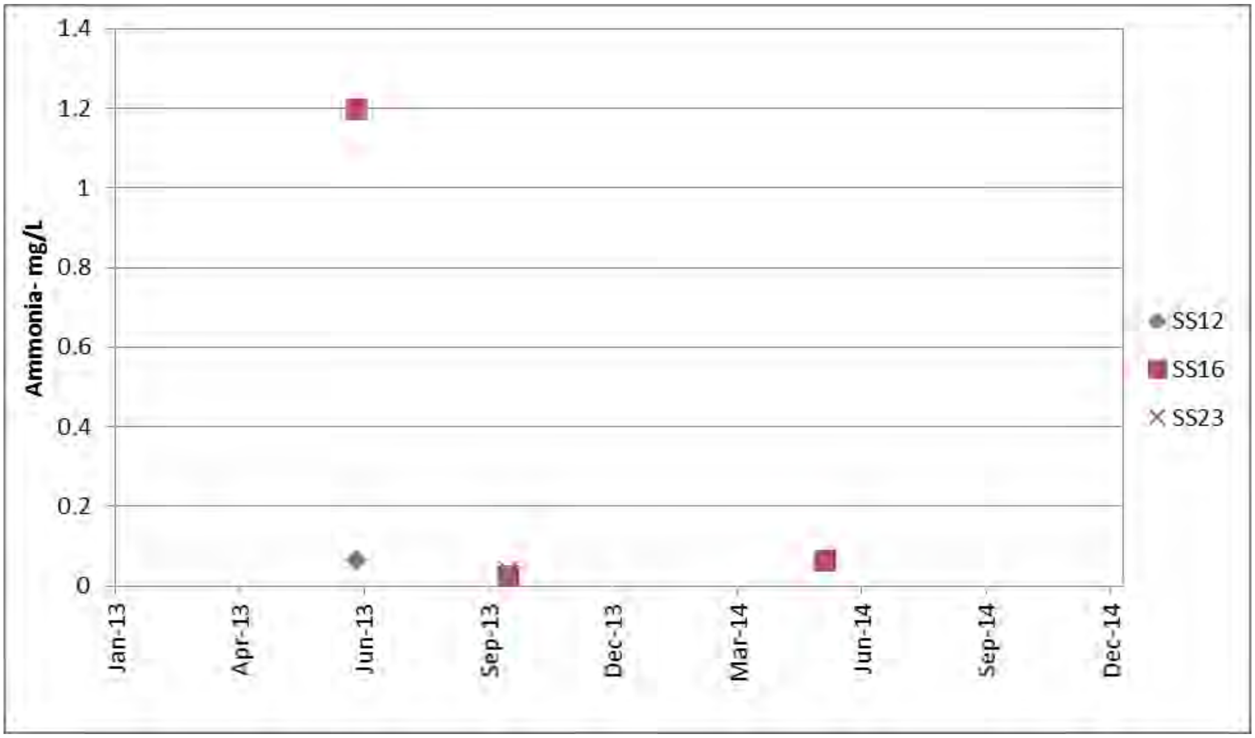


Figure 5-78: Ammonia Concentrations at SS12, SS16, SS23 (2013-2014)

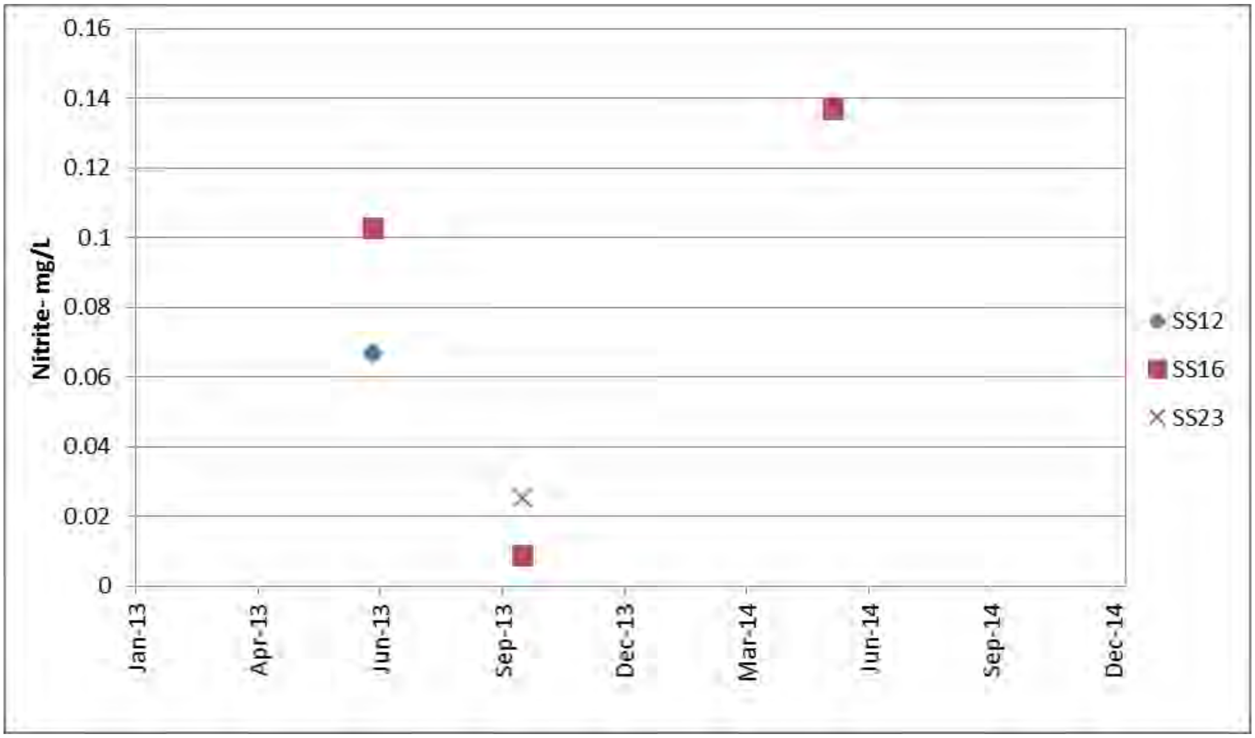


Figure 5-79: Nitrite Concentrations at SS12, SS16, SS23 (2013-2014)

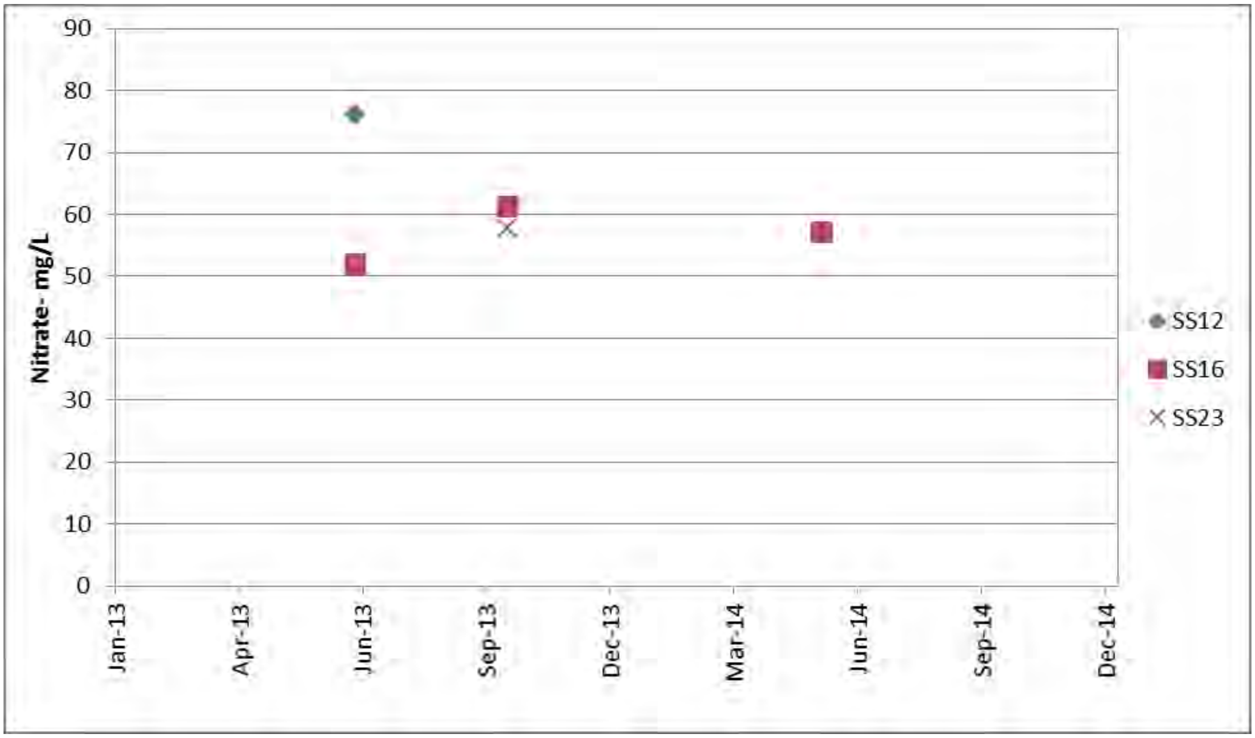


Figure 5-80: Nitrate Concentrations at SS12, SS16, SS23 (2013-2014)

5.6 Minto Creek Detention Structure Seepage Monitoring Program

As required by Clause 85 of the WUL, Minto Mine is required to implement a MCDS Seepage Monitoring Program and report the results of the program in the Annual Report. The *MCDS Seepage Monitoring Plan* was submitted to the YWB on January 15, 2013 and includes regular physical monitoring, and assessment of foundation thawing, contaminant monitoring and transport assessment, and the establishment of appropriate triggers and adaptive responses.

5.6.1 Physical Monitoring

Semi-annual geotechnical inspections were completed on May 1, 2014 and September 17, 2014. The first was undertaken by Eamon Mauer, P.Eng, PMP, of Minto Explorations and the second by Peter Mikes, P.Eng, of SRK Consulting. The inspections documented the physical condition of the site based on visual observations and provided geotechnical assessment, noting potential signs of physical instability such as erosion, differential settlement, sloughing or bulging of material, seepage, and permafrost degradation.

Weekly inspections were performed by Minto Mine Environmental Monitors and any questionable findings were reported to the Mine Technical department for further inspection and resolution.

There were no problematic findings at the MCDS from weekly or semi-annual inspections in 2014. Recommendations from SRK Consulting consisted of continued semi-annual monitoring to inspect for signs of instability or seepage on the downstream site of the MCDS.

5.6.2 Equipment and Instrumentation

During 2014, flow rates were measured by a totalizing flow meter located at the MCDS. Water was pumped back to the Main Pit.

5.6.3 Water Quality Monitoring

Groundwater quality monitoring equipment downstream of the MCDS consists of two drive point piezometers (MW12-DP4 and MW13-DP5) and the groundwater well MW12-06. Surface water quality monitoring is undertaken at site W37. As W37 is downstream of the MCDS (W36), it is often dry due to water being pumped back to the Main Pit from W36. Therefore, station W37 was only sampled five times in 2014. 2014 water quality monitoring laboratory results are summarized in Table 5-27; laboratory results are provided in Appendix G.

Table 5-27: MCDS Groundwater and Surface Water Quality Sampling Results (2014)

Station Name	Sample Date	Parameters (mg/L)						
		Cadmium (D)	Copper (D)	Iron (D)	Selenium (D)	Ammonia	Nitrite	Nitrate
W37	2/2/2014	0.000036	0.0414	0.0764	0.00203	0.014	0.0128	6.52
W37	3/3/2014	0.000056	0.0521	0.0519	0.00212	0.01	0.0176	7.3
W37	4/6/2014	0.00003	0.0223	0.0269	0.00352	0.012	0.0515	7.93
W37	4/6/2014	0.00003	0.0223	0.0269	0.00352	0.012	0.0515	7.93
W37	5/28/2014	0.00003	0.069	0.0282	0.00053	0.053	<0.0050	0.384
W37	6/19/2014	0.00001	0.0396	0.011	0.00283	0.018	<0.0050	5.7
MW12-DP4	9/27/2014	0.000052	0.00497	0.0095	0.00224	0.052	0.0588	4.47
MW13-DP5	9/1/2014	0.000018	0.00538	0.0053	0.00342	0.023	<0.0050	7.88
MW12-06-02	5/30/2014	<0.000010	<0.00020	0.454	0.0001	0.02	0.834	0.248
MW12-06-02	5/30/2014	<0.000010	0.00027	0.974	<0.00010	0.046	0.525	0.165
MW12-06-02	7/25/2014	0.000042	0.0004	1.22	<0.00010	0.072	0.164	0.054
MW12-06-02	10/6/2014	<0.000010	0.0003	1.21	<0.00010	0.05	0.0882	0.026
MW12-06-04	5/30/2014	<0.000010	0.00025	0.531	<0.00010	0.022	1.12	0.324
MW12-06-04	7/25/2014	<0.000010	<0.00020	0.69	<0.00010	0.012	0.204	0.059
MW12-06-04	7/25/2014	0.000016	0.00049	0.694	<0.00010	0.016	0.276	0.089
MW12-06-04	10/6/2014	<0.000010	<0.00020	0.699	<0.00010	0.023	0.0998	0.029
MW12-06-06	5/30/2014	0.000124	0.00072	0.0423	0.0002	0.033	-	-
MW12-06-06	7/25/2014	<0.000010	0.00031	0.0081	0.00019	0.01	0.0521	0.953
MW12-06-06	10/6/2014	<0.000010	0.00022	0.013	0.00019	0.0093	0.102	0.993

5.7 Water Discharge

Minto Mine discharged approximately 488,000 m^3 of water to Minto Creek in 2014. Water quality was monitored at the end of the pipe, known as station W16A. Station W16A 2012 to 2014 water quality results statistics are summarized in Table 5-28, below, and are compared to WUL water quality standards (Clause 70). During the 2014 monitoring period, fourteen water quality samples were taken from station W16A and sent to the external laboratory for processing. During the discharge period (April through May; December 2014), W16A was further monitored with daily water quality samples provided to the mine's internal water quality laboratory.

During the 2014 discharge period, Minto Mine followed the *Freshet Water Management and Discharge Plan* (a component of the *Adaptive Management Plan* (AMP)). The plan outlined the steps and timelines for discharging water from the WSP and Water Treatment Plant; and diverting run-off water from un-impacted drainages such as W35 and W15. Level 2 Performance Monitoring (as per the AMP) was undertaken during the discharge period, resulting in increased frequency of water sampling to ensure that Minto met the conditions of the WUL.

The station W16A copper, aluminum, cadmium and selenium concentrations, with corresponding freshet (WUL Clause 71) and non-freshet standards (WUL Clause 70) are displayed in Figure 5-81 and Figure 5-82.

Table 5-28: W16A Water Quality Results Summary (2012-2014)

W16A	Water Quality Standard (WUL Clause 70)	2012 - 2013 Summary Statistics			2014 Summary Statistics		
Parameters		Mean	Min	Max	Mean	Min	Max
pH	6.5 - 9.0	8.02	6.86	8.32	8.03	7.79	8.24
TSS (mg/L)	15	6.2	1.5	**55.1**	8.1	0.5	**19.6**
Nutrients (mg/L)							
Ammonia Nitrogen	0.89	0.0403	0.0169	0.26	0.128	0.081	0.19
Nitrate Nitrogen	7.65	4.079	0.794	5.2	1.904	0.549	3.29
Nitrite Nitrogen	0.15	0.0119	0.0025	0.0519	0.0204	0.0025	0.0412
Total Metals (mg/L)							
Aluminum	2.7	0.3769	0.0733	**3.07**	0.403	0.0079	1.04
Arsenic	-	0.00044	0.00025	0.0014	0.00057	0.00039	0.00094
Cadmium	0.00015	0.000024	0.000005	0.000101	0.000018	0.000005	0.000035
Chromium	0.008	0.00066	0.00025	0.0034	0.0006	0.0005	0.0014
Copper	0.05	0.0389	0.0219	**0.105**	0.04024	0.00912	**0.0798**
Iron	3.5	0.551	0.14	4.45	0.723	0.022	1.89
Lead	0.02	0.0005	0.0001	0.0047	0.00032	0.0001	0.00144
Molybdenum	0.4	0.005	0.0012	0.0063	0.0058	0.0038	0.0101
Nickel	0.5	0.0014	0.0005	0.0058	0.0013	0.0005	0.0022
Selenium	0.003	0.00137	0.00017	0.0019	0.00086	0.00041	0.00121
Zinc	0.15	0.0046	0.0025	0.0306	0.0063	0.0025	0.0145

Bold values indicate exceedances of the WUL water quality standards

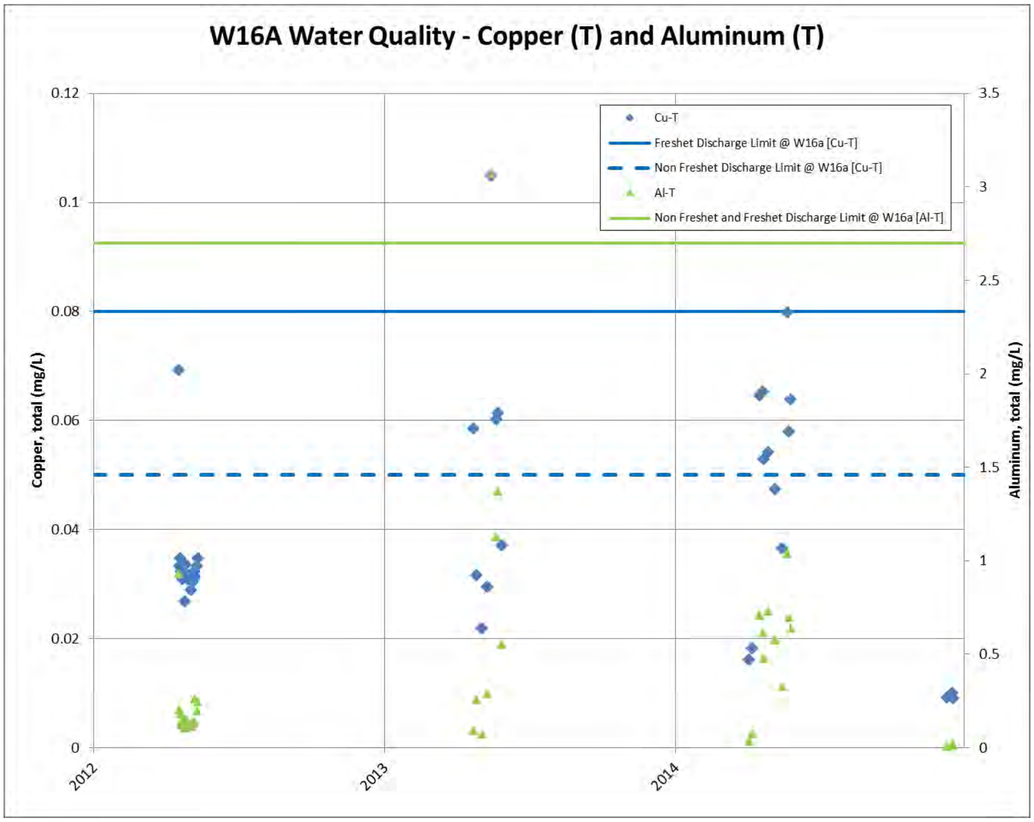


Figure 5-81: W16A Copper and Aluminum Concentrations (2012-2014)

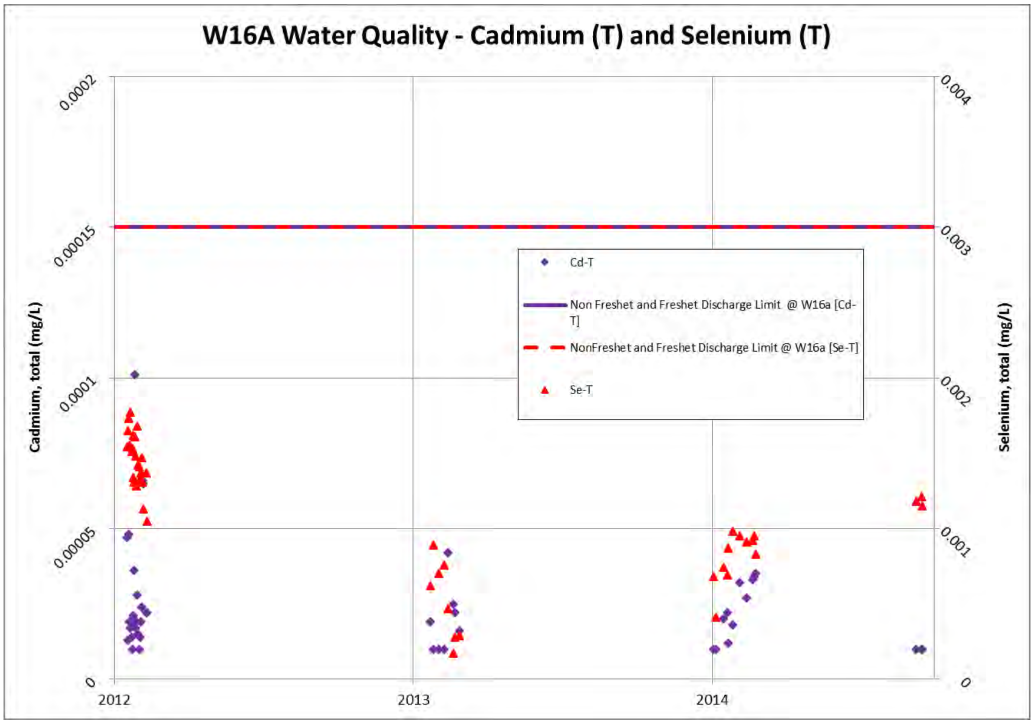


Figure 5-82: W16A Cadmium and Selenium Concentrations (2012-2014)

5.8 Aquatic Environmental Monitoring Program

The Aquatic Environmental Monitoring Program (a component of the EMSRP) at Minto Mine is comprised of a Biological Monitoring Program and an Environmental Effects Monitoring (EEM) Program. The Biological Monitoring Program is a requirement of WUL Clause 86, and outlines the monitoring program for sediment, periphyton, benthic invertebrates, fish and fish habitat. The EEM Program is required under the MMER of the federal Fisheries Act. Both programs focus on aquatic effects of mine effluent in Upper Minto Creek (discharge sites), Lower Minto Creek (receiving environment sites) and comparable unaffected areas (reference sites). The following sections summarize the 2014 results of the Aquatic Environmental Monitoring Program at Minto Mine.

5.8.1 Biological Monitoring Program

Clause 86 of the WUL requires an Annual Biological Monitoring Program that includes monitoring of sediment, periphyton, benthic invertebrates, fish and fish habitat. The following sections summarize the monitoring programs and more detailed reports can be found in Appendix H and Appendix I. Appendix H – *Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment* - 2014 contains information with respect to the sediment, periphyton, and benthic invertebrate monitoring programs and Appendix I – *Fisheries Monitoring Program, Minto Creek, 2014 Summary Report* contains information relative to the fish monitoring program.

5.8.1.1 Sediment Monitoring Program

The objectives of the sediment monitoring program were to characterize particle size, total organic carbon content and concentrations of metals, metalloids and nutrients in sediments collected from the lower Minto Creek receiving environment and reference sites (lower Wolverine Creek and upper McGinty Creek). Sediments collected in 2014 were largely composed of fine particles in the silt and sand size categories (Table 5-29). Mean total organic carbon (TOC) content of sediment collected from lower Minto Creek (4.2%) and upper Minto Creek (1.9%) were lower than the comparable reference areas; lower Wolverine Creek (6.8%) and upper McGinty Creek (5.4%; Table 5-29). Only mean copper concentrations in Minto Creek (both upper and lower) were greater than Interim Sediment Quality Guidelines (ISQG) for the protection of aquatic life and the levels observed in the reference areas, indicating a geological or mine-related influence on sediment quality. Moving downstream, the mean copper concentration decreased substantially from a mean concentration of 114 mg/kg in upper Minto Creek to 50 mg/kg in lower Minto Creek (Figure 5-83).

Due to the predominantly erosional habitat in upper Minto Creek, there are relatively few areas where sediment is deposited; and deposition occurs only in small quantities that likely wash away each year during freshet. Therefore, elevated sediment copper in fine sediment in the upper reaches of Minto Creek may be of limited importance in terms of exposure and potential effects to biota. In lower Minto Creek, fine sediment deposits are somewhat more common and therefore more relevant to aquatic life. Previous toxicity testing in 2011 indicated no adverse effects at lower Minto Creek under sediment quality conditions that were generally similar to those observed in 2014 (Minnow 2012).

Table 5-29: Sediment Chemistry Data Collected at Exposed and Reference Areas, Minto Mine (2014)

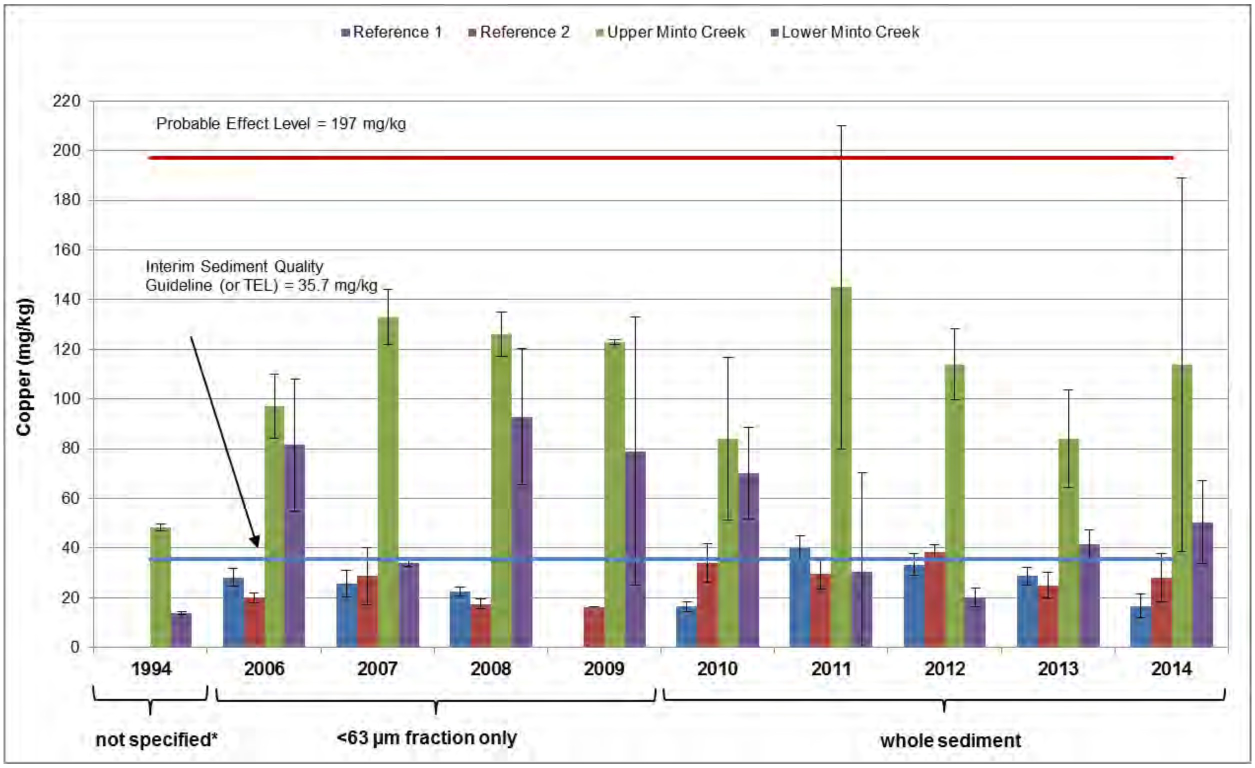
	Analytes	Units	CSQG [a]		Upper McGinty Creek (Reference)				Lower Wolverine Creek (Reference)				Upper Minto Creek (Exposure)				Lower Minto Creek (Exposure)			
			ISQG	PEL	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Particle size, TKN, carbon analytes and pH	Loss on Ignition	%	-	-	11	4.4	5.0	16	14	5.9	7.0	23	4.4	3.7	< 1.0	10	7.6	2.6	4.0	11
	pH (1:2 soil:water)	pH units	-	-	7.1	0.24	6.9	7.5	7.2	0.24	7.0	7.6	8.2	0.16	8.1	8.5	8.1	0.06	8.0	8.2
	% Gravel (>2mm)	%	-	-	-	-	-	-	< 0.10	0.0	< 0.10	< 0.10	-	-	-	-	**1.3**	1.7	0.25	**4.3**
	% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	32	17	7.2	50	-	-	-	-	24	6.7	17	31
	% Silt (0.063mm - 4um)	%	-	-	-	-	-	-	62	17	45	87	-	-	-	-	67	5.4	61	72
	% Clay (<4um)	%	-	-	-	-	-	-	5.6	0.6	4.8	6.1	-	-	-	-	8.4	0.7	7.8	9.4
	Total Kjeldahl Nitrogen	%	-	-	0.273	0.111	0.115	0.382	0.385	0.151	0.212	0.614	0.117	0.089	0.023	0.232	0.246	0.054	0.156	0.302
	Inorganic Carbon	%	-	-	< 0.1	0	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1
	Inorganic Carbon (as CaCO3 Equivalent)	%	-	-	< 0.8	0	< 0.8	< 0.8	< 0.8	0	< 0.8	< 0.8	< 0.8	0	< 0.8	< 0.8	< 0.8	0	< 0.8	< 0.8
	Total Carbon by Combustion	%	-	-	5.4	2.2	2.5	7.7	6.8	2.8	3.5	11	2.0	1.6	0.4	4.5	4.2	1.4	2.3	5.6
	Total Organic Carbon	%	-	-	5.4	2.2	2.5	7.7	6.8	2.8	3.5	11	1.9	1.7	0.4	4.5	4.2	1.4	2.3	5.6
Total Metals	Aluminum (Al)	mg/kg	-	-	9,464	2,613	5,250	11,300	13,160	1,760	11,100	15,500	7,840	2,844	4,980	11,700	13,840	915	12,800	14,700
	Antimony (Sb)	mg/kg	-	-	0.37	0.069	0.27	0.42	0.45	0.11	0.31	0.59	0.35	0.086	0.24	0.46	0.52	0.11	0.39	0.61
	Arsenic (As)	mg/kg	5.9	17	7.3	1.1	5.8	8.5	5.6	1.5	3.5	7.3	4.9	0.58	4.1	5.6	6.8	1.1	5.7	7.9
	Barium (Ba)	mg/kg	-	-	176	54	93	222	197	59	129	270	150	54	81	209	226	40	183	269
	Beryllium (Be)	mg/kg	-	-	0.29	0.064	< 0.20	0.35	0.71	0.18	0.50	0.94	0.67	0.75	< 0.20	**2.0**	0.47	0.069	0.38	0.54
	Bismuth (Bi)	mg/kg	-	-	< 0.2	0	< 0.2	< 0.2	< 0.2	0	< 0.2	< 0.2	< 0.2	0	< 0.2	< 0.2	< 0.2	0	< 0.2	< 0.2
	Cadmium (Cd)	mg/kg	0.6	3.5	0.13	0.034	0.084	0.15	0.27	0.14	0.12	0.46	0.14	0.062	0.059	0.21	0.19	0.062	0.12	0.26
	Calcium (Ca)	mg/kg	-	-	6,986	1,825	4,240	8,390	10,890	4,019	6,640	16,200	5,200	1,922	3,160	7,370	11,940	2,913	8,350	14,700
	Chromium (Cr)	mg/kg	37	90	18	6.3	8.0	23	43	5.5	36	50	22	7.6	14	32	32	2.9	28	35
	Cobalt (Co)	mg/kg	-	-	8.5	1.9	5.8	10	13	1.6	11	15	8.0	2.0	5.9	10	11	1.1	10	12
	Copper (Cu)	mg/kg	36	197	17	4.7	10	22	28	10	17	40	**114**	75	33	**207**	50	17	32	**67**
	Iron (Fe)	mg/kg	-	-	21,600	4,616	14,200	25,600	26,280	2,257	23,000	29,200	22,120	5,985	16,400	31,300	25,600	2,473	23,000	27,900
	Lead (Pb)	mg/kg	35	91	4.0	0.86	2.7	4.8	5.9	0.91	4.8	7.0	4.9	1.0	3.4	5.8	6.1	0.92	5.0	7.0
	Lithium (Li)	mg/kg	-	-	6.0	0.89	< 5.0	6.8	9.0	1.1	7.7	11	5.9	1.3	< 5.0	8.0	10	1.1	9.0	11
	Magnesium (Mg)	mg/kg	-	-	3,610	864	2,170	4,270	8,378	787	7,730	9,550	4,630	1,460	3,240	6,700	6,964	406	6,510	7,400
	Manganese (Mn)	mg/kg	-	-	868	250	548	1,160	564	317	212	966	1,389	820	357	2,150	772	223	521	1,010
	Mercury (Hg)	mg/kg	0.17	0.49	0.031	0.010	0.018	0.040	0.045	0.026	0.018	0.082	0.016	0.0079	0.0052	0.024	0.039	0.014	0.023	0.055
	Molybdenum (Mo)	mg/kg	-	-	0.53	0.024	< 0.50	0.56	0.55	0.046	< 0.50	0.62	**1.2**	0.39	0.66	**1.6**	0.65	0.13	< 0.50	0.81
	Nickel (Ni)	mg/kg	-	-	15	3.8	8.6	18	37	4.5	32	43	19	6.1	14	27	29	2.4	27	32
	Phosphorus (P)	mg/kg	-	-	775	130	586	932	1,031	66	955	1,100	786	164	641	1,030	848	25	826	887
	Potassium (K)	mg/kg	-	-	624	136	400	730	970	86	890	1,060	1,008	334	570	1,440	1,218	109	1,060	1,340
	Selenium (Se)	mg/kg	-	-	0.45	0.10	0.34	0.56	0.42	0.22	< 0.20	0.71	0.33	0.13	< 0.20	0.49	0.44	0.15	0.27	0.59
	Silver (Ag)	mg/kg	-	-	< 0.10	0	< 0.10	< 0.10	0.12	0.030	< 0.10	0.17	0.10	0.009	< 0.10	0.12	0.11	0.01	< 0.10	0.13
	Sodium (Na)	mg/kg	-	-	184	43	110	210	398	38	350	450	224	69	140	310	328	23	290	350
	Strontium (Sr)	mg/kg	-	-	61	10	50	68	106	40	62	159	58	21	33	82	105	24	77	128
	Thallium (Tl)	mg/kg	-	-	0.061	0.010	< 0.050	0.069	0.077	0.013	0.056	0.092	0.063	0.018	< 0.050	0.087	0.10	0.014	0.079	0.12
	Tin (Sn)	mg/kg	-	-	< 2.0	0	< 2.0	< 2.0	< 2.0	0	< 2.0	< 2.0	< 2.0	0	< 2.0	< 2.0	< 2.0	0.0	< 2.0	< 2.0
	Titanium (Ti)	mg/kg	-	-	568	158	300	678	846	100	687	950	540	151	391	702	785	67	692	864
	Uranium (U)	mg/kg	-	-	1.1	0.32	0.69	1.5	2.8	1.4	1.4	4.9	0.55	0.19	0.31	0.75	1.0	0.28	0.71	1.27
	Vanadium (V)	mg/kg	-	-	42	9.3	27	48	66	4.9	60	71	51	16	37	78	54	3.8	50	58
	Zinc (Zn)	mg/kg	123	315	39	10	22	47	55	6.0	49	63	49	14	31	64	59	5.3	53	65

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

🟦 Indicates sediment concentration exceeding CSQG ISQG.

🟩 Indicates sediment concentration exceeding CSQG PEL.

bold Indicates sediment concentration exceeding the higher reference mean by more than 2 times



*Reference 1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2014; Reference 2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2014; * = no data. TEL: Threshold Effect Levels. Methods were not specified, fine sediment was collected in triplicate in the mainstem of Minto Creek (HKP, 1994)*

Figure 5-83: Mean Copper Concentrations in Sediment Collected in Minto Creek and Reference Locations) (mean ± standard deviation) (1994-2014)

5.8.1.2 Periphyton and Chlorophyll a Monitoring

The productivity of lower Minto Creek and lower Wolverine Creek was assessed through measurements of chlorophyll *a* in periphyton (used as a surrogate for the productivity of photosynthetic organisms) and collection of periphyton for community assessment. Concentration of chlorophyll *a* was significantly higher at lower Minto Creek than at lower Wolverine Creek (Figure 5-84). Chlorophyll *a* concentrations at both areas were well below the British Columbia Water Quality Guideline (BCWQG) of 100 mg/m^2 for the protection of aquatic life (BC MOE 1985). During 2014 sampling, it appeared that periphyton was more prevalent in lower Minto Creek than in lower Wolverine Creek, which was not evident in previous years. The production of both creeks is classified as low (oligotrophic) based on the classification system of Dodds et al. (1998), which sets the oligotrophic-mesotrophic boundary for benthic chlorophyll at 20 mg/m^2. This differs from the classification based only on total phosphorus which would define lower Minto Creek as mesotrophic and lower Wolverine Creek as oligotrophic (Dodds et al. 1998). The lower concentrations of chlorophyll *a* despite relatively high phosphorus concentrations suggest constraints on productivity other than nutrient concentrations, perhaps environmental factors associated with a northern system such as low water temperatures, limited light and a short growing season.

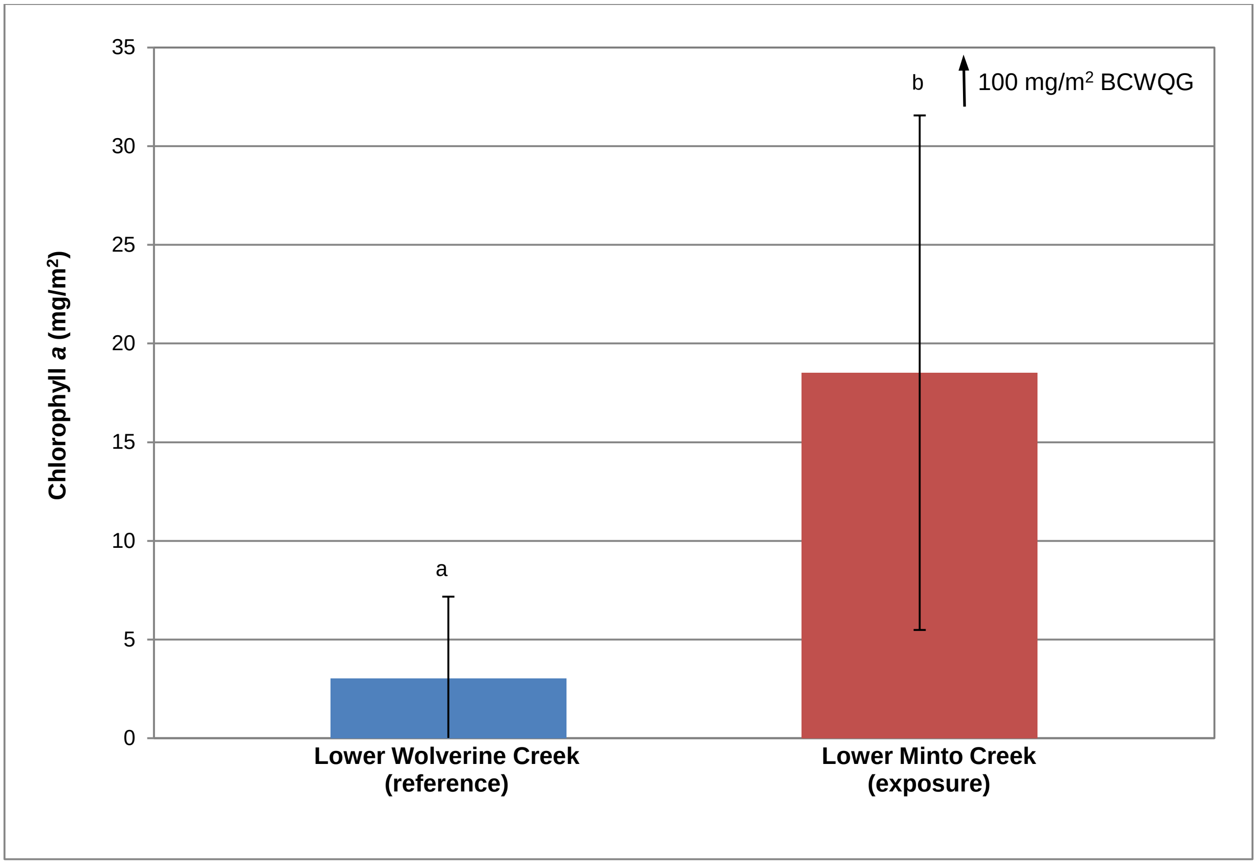
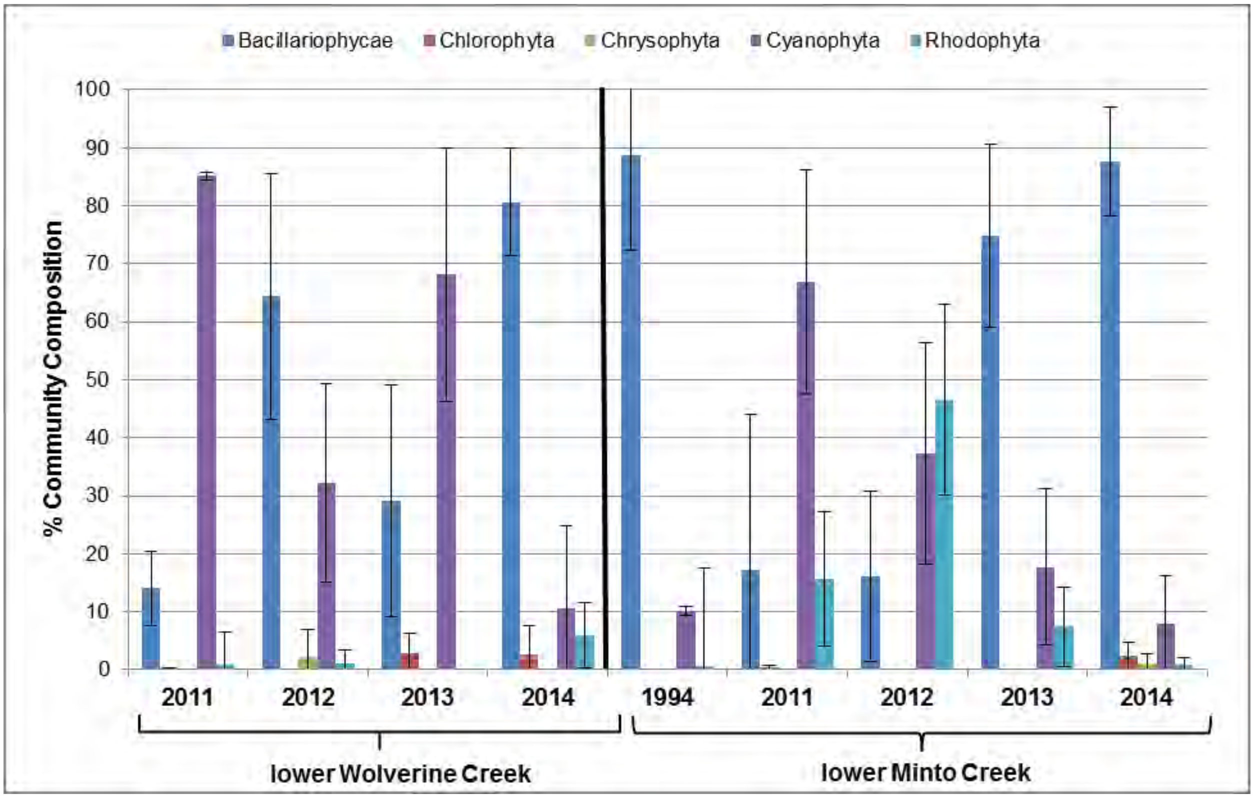


Figure 5-84: Mean Chlorophyll a on Cobble Substrate in Lower Wolverine Creek and Lower Minto Creek (mean ± standard deviation), Minto Mine WUL (2014)

The periphyton community of lower Minto Creek was evaluated and compared to lower Wolverine Creek for any potential mine-related effects. Both creeks had similar periphyton community structures with *Bacillariphycae* (diatoms) and *Cyanophyta* (blue-green algae) being the two dominant phyla. *Bacillariophycae* made up 88% of the community at lower Minto Creek and 81% of the community at lower Wolverine Creek. Temporal variability in community composition has been high in both exposure and reference areas (Figure 5-59). For example, at lower Minto Creek, *Bacillariophycae* were dominant in 1994, *Cyanophyta* in 2011, *Rhodophyta* and *Cyanophyta* in 2012 and *Bacillariophycae* in 2013 and 2014 (Figure 5-59). This lack of consistency was also observed at lower Wolverine Creek, with *Cyanophyta* dominant in 2011 and 2013 and *Bacillariophycae* in 2012 and 2014 (Figure 5-85; Minnow 2013a; 2014a).



Data presented as mean ± standard deviation

Figure 5-85: Periphyton Community Composition in Lower Minto Creek (1994, 2011-2014) and Lower Wolverine Creek (2011-2014)

5.8.1.3 Benthic Invertebrate Monitoring

The benthic invertebrate communities at erosional areas in lower Minto Creek were evaluated and compared to erosional areas of lower Wolverine Creek for any potential mine-related effects. The erosional benthic invertebrate community of lower Minto Creek differed from that of lower Wolverine Creek on the basis of density (higher), number of taxa (higher), Bray-Curtis distance (greater), percent EPT (higher), percent Oligochaetae (lower) and CA Axis-1 (higher) (see Table 5-30). Greater diversity, greater dominance of EPT taxa and lower dominance of Oligochaetae are typically considered to be indicative of a healthy erosional benthic invertebrate community. Therefore, the benthic invertebrate community condition of lower Minto Creek suggests limited influence of the mine.

Comparisons of benthic invertebrate community metrics in 2014 to those documented in previous years indicated substantial temporal variability (as also observed with periphyton communities) at both the receiving environment and reference areas. Benthic invertebrate density in 2014 was higher than in 2013 and was significantly higher at lower Minto Creek than at lower Wolverine Creek (Figure 5-86). From 2012 to 2014, there appears to have been a decline in the number of taxa at lower Minto Creek; however, number of taxa at lower Minto Creek (twelve) was greater than at the lower Wolverine Creek reference (8.6) (Figure 5-86).

Taxon richness was significantly greater at lower Minto Creek than at lower Wolverine Creek from 2012 to 2014, except in 2013 when there was no significant difference (Minnow 2013b, 2014a). Differences in density and number of taxa over time likely reflect high temporal variability of benthic invertebrate communities in the region, also evident at reference areas (Minnow 2009; 2011, 2012, 2013b, 2014a). This might be due to high inter-annual variability in environmental conditions such as flow, deep freezing, and occasional pulses of high sediment loads.

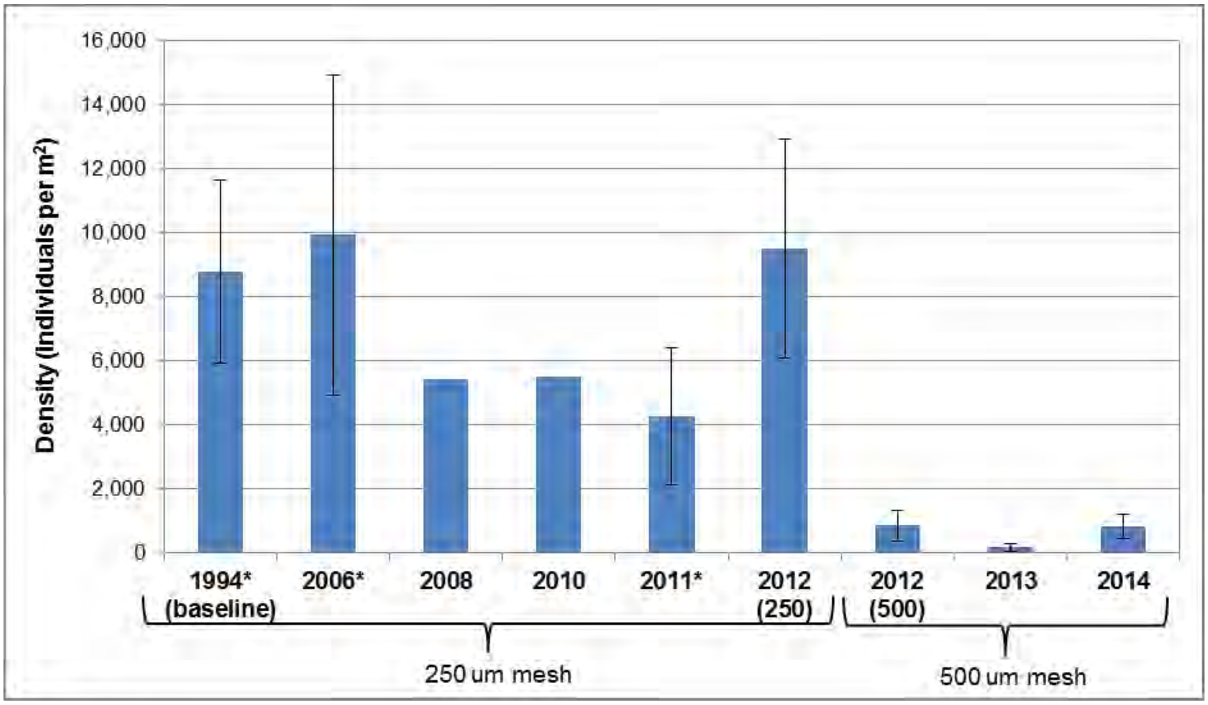
Table 5-30: Benthic Invertebrate Community Metrics and Statistical Comparisons, Minto Mine WUL (2014)

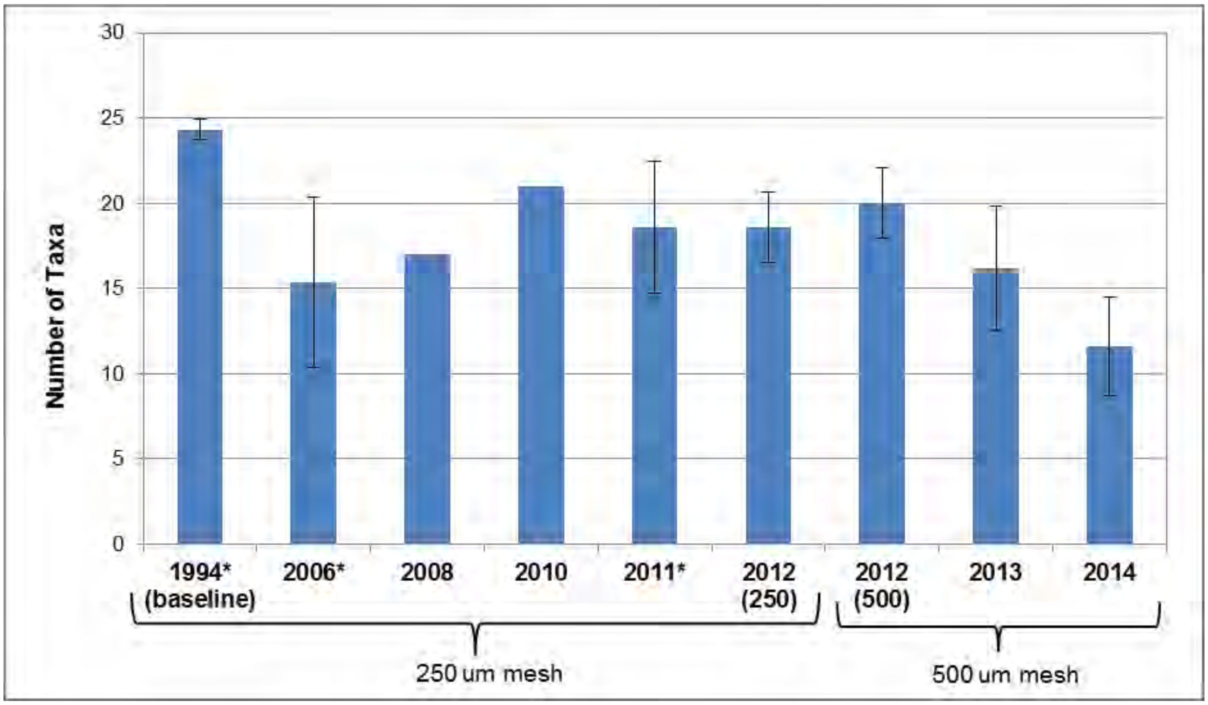
Metric	Lower Wolverine Creek (Reference)				Lower Minto Creek (Exposed)				**Statistical Contrasts**		
	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Significant Difference between areas?	p-value	**Magnitude of Difference (# of SDs)[b]**
Density (organisms/m^2)	309	344	30	903	835	397	333	1,250	YES	0.055	1.5
Number of Taxa	8.6	1.5	6.0	10.0	12	3	8	16	YES	0.073	2.0
Simpson's Diversity[a]	0.56	0.24	0.19	0.81	0.56	0.22	0.35	0.86	NO	0.960	~
Simpson's Evenness[a]	0.38	0.30	0.14	0.90	0.25	0.12	0.14	0.44	NO	0.402	~
Bray-Curtis Distance	0.51	0.23	0.31	0.81	0.93	0.08	0.80	0.98	YES	0.004	1.9
EPT (%)[b]	22	26	2	67	63	20	31	80	YES	0.024	1.6
Chironomidae (%)	37	28	5	74	29	13	16	45	NO	0.565	~
Oligochaetae (%)	35	35	8	90	3.7	6.3	0.3	15.0	YES	0.086	-0.9
CA Axis-1 (46.4%)	-1.0	0.2	-1.2	-0.7	0.59	0.09	0.46	0.72	YES	0.000	7.5
CA Axis-2 (14.9%)	0.087	0.503	-0.505	0.860	-0.017	0.525	-0.779	0.516	NO	0.757	~
CA Axis-3 (13.2%)	0.054	0.810	-0.982	1.262	0.045	0.284	-0.245	0.448	NO	0.982	~

▨ indicates a statistically significant difference between exposed and reference areas

[a] Calculated as recommended by Environment Canada 2012

[b] Percent Ephemeroptera, Plecoptera, Trichoptera





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

Figure 5-86: Benthic Invertebrate Community Density and Taxon Richness at Lower Minto, Minto Creek (1994-2014)

5.8.1.4 *Fisheries Monitoring Program*

The objectives of the 2014 Fisheries Monitoring Program were to monitor, assess and characterize fish usage in Minto Creek during open water season, and to provide data allowing interpretation of the potential role and influence of the Minto Mine on the fish community. The 2014 fisheries program was a continuation of the previous year's components, and targeted all species that have previously been encountered as well as any new species. As part of the 2014 monitoring program, assessments at Big Creek were made concurrently with sampling in Minto Creek, to compare fish use in a neighbouring system relative to Minto Creek. Fish monitoring studies were conducted in support of the requirements of the WUL.

Fish monitoring of Minto Creek and Big Creek was conducted monthly during open water season, from June to October 2014, at trapping sites consistent with the 2010 mark-recapture study and the 2011 to 2013 fish monitoring programs. Capture effort included the use of Gee-type Minnow traps with 0.635 cm wire mesh size baited with Yukon River origin Chinook salmon roe. A total of seventeen or eighteen minnow traps were set each time in Minto Creek, depending on water levels and availability of pools and backwater areas. Four traps were set each time in Big Creek, in the vicinity of the Minto road bridge.

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

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

Aerial reconnaissance survey for potential fish spawning activity was conducted by ACG/Minnow on September 10th, 2014 for approximately ten minutes. The survey was completed from a helicopter which flew over the mouth of McGinty Creek, Minto Creek, and the Yukon River between the barge landing and McGinty Creek, including the Ingersoll Islands located downstream of the mine area.

For details on the 2014 results of Fisheries Monitoring Program see the *Fisheries Monitoring Program, Minto Creek, 2014 Summary Report in* Appendix I.

5.8.2 Environmental Effects Monitoring Program

The EEM Program (a component of the EMSRP) was developed in accordance with Schedule 5 of the MMER and the program's objective is to characterize the impact of effluent on the receiving environment through water quality and biological monitoring. The EEM Program is comprised of the EEM Water Quality Program (Section 5.8.2.1) and the EEM Biological Monitoring Program (Section 5.8.2.2). On an annual basis Minto submits the results of the EEM Program to Environment Canada through the Regulatory Information Submission System. A summary of the 2014 EEM Program is provided in this section.

5.8.2.1 EEM Water Quality Monitoring

The EEM Water Quality Monitoring Program is designed to characterize water quality in the exposure area surrounding the point of entry of effluent and compares the results to those in reference (unimpacted) areas. Water quality samples must be collected four times a year, not less than one month apart, while the mine is discharging effluent. Water quality samples are also collected concurrently with the EEM Biological Monitoring Program samples. Samples are collected at receiving environment station W2 and reference station W7 and a summary of water quality at these stations in 2014 is provided in Section 5.1.

5.8.2.2 EEM Biological Monitoring

The EEM Biological Monitoring Program outlines fish population, fish tissue and benthic invertebrate tests conducted under Schedule 5, Part 2 of the MMER. Minto Mine has submitted the results of three study designs with the last study design taking place in 2014. This section summarizes Cycle 3 EEM Biological Monitoring study design that occurred in 2014.

Previous EEM benthic invertebrate community surveys indicated some differences between mine-exposed and reference areas in both EEM cycles (Table 5-31). Bray-Curtis index of dissimilarity [hereafter referred to as Bray-Curtis distance] was the only EEM endpoint that differed in all comparisons to references creeks, indicating a consistent difference in the benthic invertebrate community composition of upper Minto Creek relative to upper McGinty and upper Wolverine Creeks. Such differences in Bray-Curtis index are neither unusual, nor necessarily attributable to the Minto Mine (Minnow 2014b). The EEM endpoints, number of taxa, density and Simpson's Evenness returned equivocal results when comparing Cycle 1 and 2 studies, but in general, indicated higher density, higher number of taxa, and lower Simpson's evenness index (Simpson's E) in upper Minto Creek relative to reference areas (Table 5-31). Higher number of taxa is often associated with good environmental quality and likely also contributes to lower Simpson's Evenness as is often observed in communities with greater taxon richness. Supporting analyses suggested that upper Minto Creek had lower proportions of EPT taxa (mayflies, stoneflies and caddisflies) and higher proportions of chironomids (non-biting midge larvae) compared to reference areas. These differences may have been the cause of differences in the Bray-Curtis Index, and could be attributable to a slight mine-related influence on nutrient concentrations in Minto Creek (although the relationship between benthic invertebrate community characteristics did not clearly establish causation due to leveraging associated with clustering of exposed versus reference stations). The occurrence of consistent differences in Bray-Curtis Index between EEM studies triggered an Investigation of Cause (IOC) study for the Cycle 3 EEM which was completed in September 2014 (see Appendix J for complete IOC report).

An IOC study was conducted to investigate the consistent differences in benthic invertebrate community composition in Minto Creek relative to reference creeks as detected by the Bray-Curtis Index of Dissimilarity (Bray-Curtis distance). Two primary hypotheses were developed: 1) a general difference associated with comparison to a small number of reference areas (two) that do not completely match upper Minto Creek nor capture the range in reference area variability; and 2) a slight mine-related water quality effect (nutrient concentrations, temperature and/or specific conductance). These hypotheses were addressed using a Reference Condition Approach (RCA) to benthic invertebrate community assessment, through the incorporation of more reference sites. Comparison to more reference stations better characterizes the regional range of benthic invertebrate community characteristics associated with areas similar to Minto Creek and determines whether Minto Creek is within that range. Overall, the Minto Mine IOC Study Design included a benthic invertebrate community survey using a local, site-specific RCA design, supported by detailed physical and chemical measurements (Table 5-32).

Table 5-31: **Summary of comparisons of benthic invertebrate community EEM metrics in upper Minto Creek to reference, Minto Mine Cycle 1 (2008) and Cycle 2 (2011)**

Metric	**Significantly Different? (effect size expressed as number of reference area standard deviations)[a]**				
	250 Õm mesh			500 Õm mesh	
	Cycle 1 (2008)	Cycle 2 (2011)		Cycle 2 (2011)	
	Minto versus McGinty reference	Minto versus McGinty Reference	Minto versus Wolverine Reference	Minto versus McGinty Reference	Minto versus Wolverine Reference
Density	Yes (13.9)	Yes (46.1)	Yes (22.6)	No	No
Number of Taxa	No	No	Yes (3.2)	Yes (3.8)	Yes (2.3)
Simpson's E	No	Yes (-2.4)	Yes (-3.5)	Yes (-2.8)	Yes (-1.5)
Bray-Curtis to upper McGinty Creek	Yes (12.7)	Yes (11.5)	-	Yes (10.5)	-
Bray-Curtis to upper Wolverine Creek	n/a	-	Yes (6.0)	-	Yes (6.4)

[a] Where a statistically significant difference was found, the value represents the number of standard deviations and direction of change (positive or negative) by which the exposure area differed from the reference areas.

n/a - not available

Table 5-32: Overview of the Minto Mine Cycle 3 EEM (IOC) Study (2014)

Area	Benthic Invertebrate Community Survey (RCA Design)		Index of Primary Productivity	Supporting Water Quality	
	Overview	Supporting Data		Field-Based Measures[a]	Analytical Samples[b]
Effluent-Exposed Area					
Upper Minto Creek	Quantitative survey conducted August or September 2014 in erosional habitat, 7 stations to provide replication at the near-field exposure site and an upstream-to-downstream gradient. One sample per station with each a 3-grab composite using a Hess sampler equipped with 500 μm mesh	Substrate characterization, water velocity and depth, field-based water quality (meter measures), habitat notes, and GPS coordinates at each station	One sample of periphyton for chlorophyll a determination (per unit stream area [m^2]) at each station	Collected at each benthic invertebrate station	One water sample at each station collected during benthic invertebrate survey. Parameter suite includes all MMER compliance monitoring analytes and additional nutrients
Reference Areas					
Upper McGinty Creek	Quantitative survey conducted August or September 2014 in erosional habitat, one station per creek. One sample per station, each a 3-grab composite using a Hess sampler equipped with 500 μm mesh	Substrate characterization, water velocity and depth, field-based water quality (meter measures), habitat notes, and GPS coordinates at each station	One sample of periphyton for chlorophyll a determination (per unit stream area [m^2]) at each station	Collected at all benthic invertebrate stations	One water sample at each station collected during benthic invertebrate survey. Parameter suite includes all MMER compliance monitoring analytes and additional nutrients
Upper Wolverine Creek					
Ten new RCA Reference Creeks					

[a] Field-based water quality parameter suite includes water temperature, dissolved oxygen, pH and conductivity

[b] Analytical water quality parameter suite includes hardness, alkalinity, pH, TSS, ammonia, nitrate, ICP total metal scan (including aluminum, arsenic, cadmium, copper, iron, lead, molybdenum, nickel, selenium, zinc), mercury, total nitrog
total Kjeldahl nitrogen, nitrite, total phosphorus, and phosphate

The RCA evaluation of upper Minto Creek indicated that two of three upper Minto Creek replicates (UMC-1 and UMC-2) did not differ from the reference condition on the basis of any of the four primary EEM-effect metrics (abundance, taxon richness, Simpson's evenness or Bray-Curtis distance; Table 5-33). Replicate UMC-3 was within reference condition for taxon richness and Simpson's evenness, had organism abundance significantly greater than the reference condition, and had a Bray-Curtis distance that could not be conclusively categorized as within the reference condition nor significantly different from the reference condition (Table 5-33). The limited number of differences and the lack of consistent differences from reference across replicates suggests that effluent exposure has had minimal influence on benthic invertebrate communities of upper Minto Creek. The IOC indicated that the differences in benthic invertebrate community structure of upper Minto Creek detected using Bray-Curtis distance in previous EEM studies were likely due to comparison to too few reference areas (resulting in inadequate characterization of the range of reference condition). The investigation did not support a mine-related water quality influence on Bray-Curtis distance in upper Minto Creek.

Table 5-33: Statistical comparisons of benthic community metrics for mine-exposed stations UMC-1, UMC-2, and UMC-3, relative to the reference condition, Minto Mine September (2014)

Type	Endpoint	Reference Mean (n = 12) (URC-1, UWC-1, NRC-1, NRC-2, NRC-3, NRC-4, NRC-5, NRC-6, NRC-7, NRC-8, NRC-9, NRC-10)	Upper Minto Creek		
			UMC-1	UMC-2	UMC-3
Primary Metrics	Density/Abundance	177	136	309	652
	Richness	11	11	11	10
	Evenness (Simpson's)	0.40	0.32	0.39	0.33
	B-C Distance	0.58	0.71	0.84	0.90
Supporting Metrics	Diversity (Simpson's)	0.7	0.71	0.77	0.70
	%EPT	40.7	22.8	10.4	8.3
	%Ephemeroptera	13.1	0.7	0.6	0.3
	%Plecoptera	24.8	2.9	1.9	2.8
	%Trichoptera	2.8	19.1	7.8	5.2
	%Diptera(excluding Chironomidae)	14.2	21.3	40.1	39.3
	%Chironomidae	29.9	47.1	36.9	44.5
	%Arachnida	3.5	0.0	5.2	1.8
	%Oligocheata	11.27818906	8.1	7.4	6.1
	CA1	4.37 / 5.84 / 5.32 *	-69.68	-78.69	-74.37
	CA2	-3.88 / -5.92 / -3.76 *	49.87	60.16	41.37

* CA is conducted seperately for each exposure site, therefore reference CA values are calculated for each exposure analysis.
Reference means are presented for UMC-1, UMC-,2 and UMC-3, respectively.

[a] Monte Carlo P-value was below 0.10, therefore statistical inference not appropriate.

Note. Family level taxonomic resolution was used to calculate richness, diversity, evenness, and CA values.

ncP - probability that metric value at exposure area is inside the range of reference values.

🟩 Within reference range (ncP>0.9)
🟨 Possibly outside of reference range (0.1<ncP<0.9)
🟧 Outside of reference range (ncP<0.1)

5.9 Meteorological Monitoring Program

Meteorological monitoring at the Minto Mine consists of data collection for the following parameters: rainfall, snowfall, temperature, evaporation, wind speed and direction, and total sunshine hours. The Meteorological Monitoring Program is comprised of the Climate Monitoring Program (Section 5.9.1) and the Snow Survey Program (Section 5.9.2) as per the EMSRP. Data collected under the Meteorological Monitoring Program, along with baseline climatic data, provides input for the following mine projects:

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

5.9.1 Climate Monitoring Program

Up to June 2014, Minto Mine had two meteorological stations located approximately 70 m northeast of the north end of the airstrip, in an area that allows ample meteorological exposure from all directions. Trees are clear for a radius of 30 m from both meteorology stations and beyond that radius is a sparse growth of 2 m tall conifers.

The first meteorology station (Met Station 1) was installed September 18, 2005 and recorded data on a HOBO datalogger. Met Station 1 consisted of a 3 m tripod with instrumentation to measure air temperature, relative humidity, barometric pressure, incident solar radiation and rainfall (wet precipitation). Data was averaged over the one-hour archiving period and then was saved to the datalogger. This weather station was removed in June 2014, and is available for eventual redeployment – either in the McGinty Creek drainage (once planned work on Minto North development begins), or closer to the Yukon River, where weather conditions differ more widely from those observed at its original location at the mine.

The second meteorology station (Met Station 2) was installed October 15, 2010 and runs on a Campbell Scientific CR1000 datalogger. Met Station 2 consists of a 10 m tower with instrumentation to measure air temperature (Figure 5-87), incident solar radiation (Figure 5-88), precipitation – rain and snowfall (Figure 5-89), barometric pressure (Figure 5-90), evapotranspiration (Figure 5-91), relative humidity (Figure 5-92), and wind speed, direction and events (Figure 5-93 and Figure 5-94). Data are averaged over the one-hour archiving period and then saved to the datalogger.

During the 2014 reporting period, Met Station 2 underwent firmware upgrades which resulted in some data not being logged; specifically, from September 22 to November 18, 2014 barometric pressure and precipitation data were not recorded and November 1 to 18, 2014 temperature data was not recorded.

In late November 2014, a microwave link was established with the Met Station 2 to allow remote real-time data viewing and downloads. Additionally, in November 2014, a Geonor T200 vibrating wire precipitation gauge was installed, replacing the older (Tipping Bucket) model. It is expected that the Geonor will produce more reliable precipitation results in extreme weather.

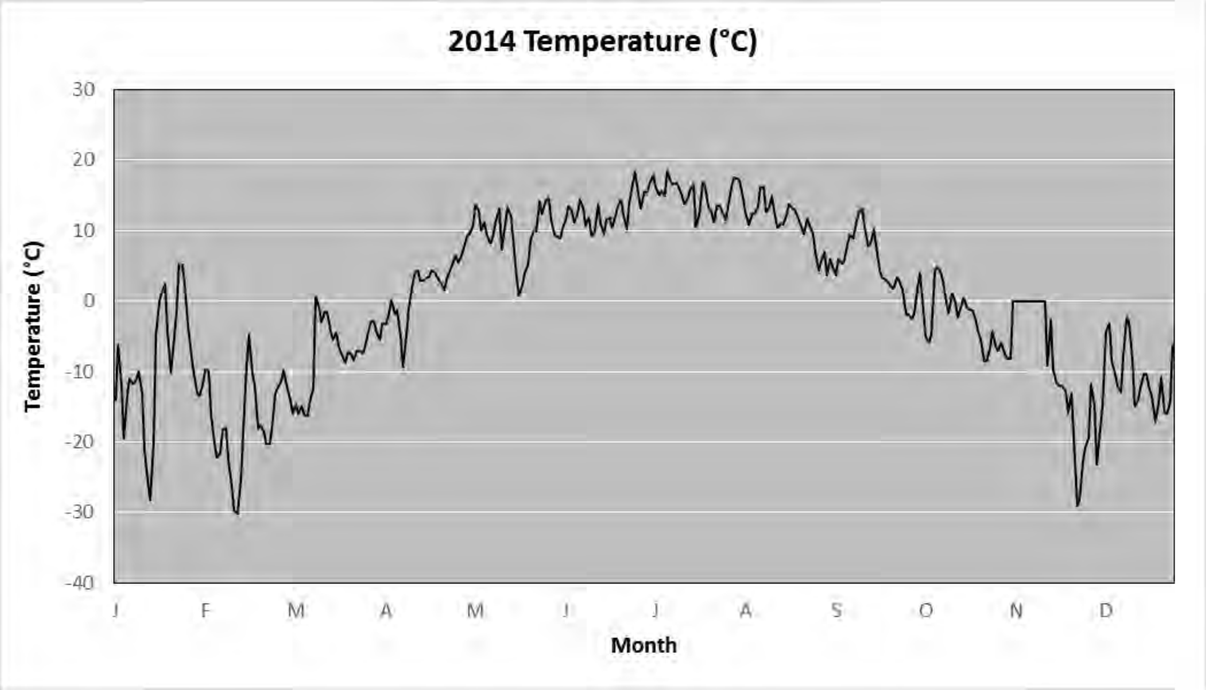


Figure 5-87: Temperature (2014)

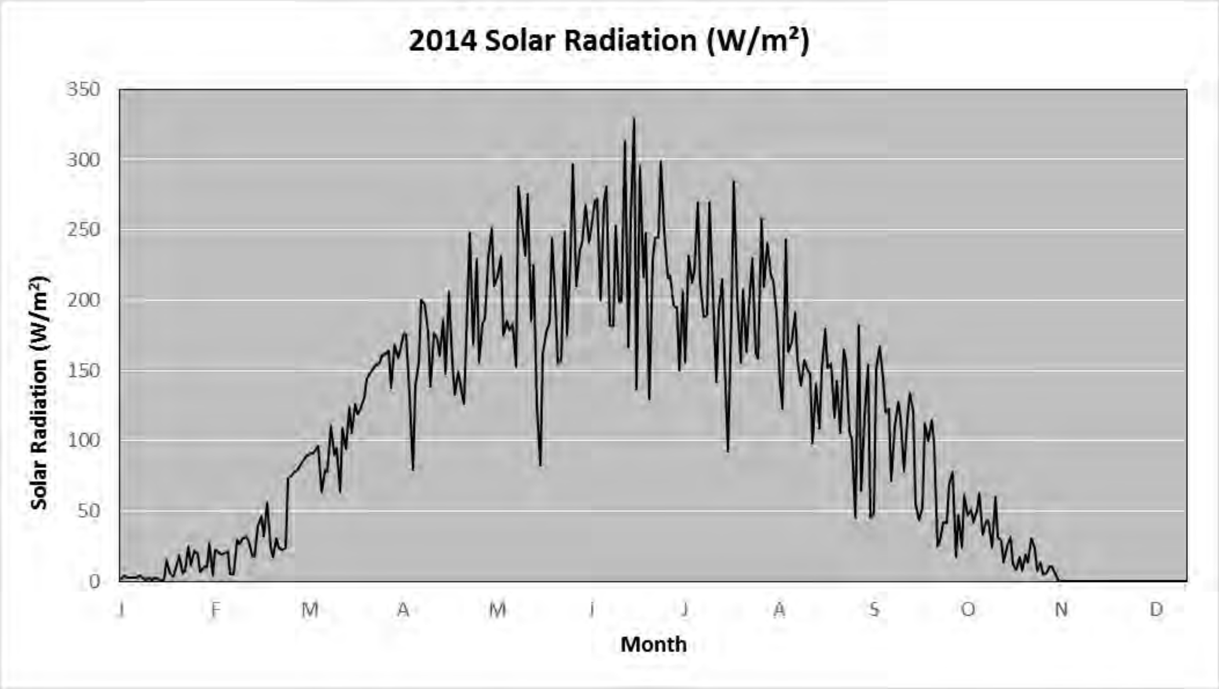


Figure 5-88: Solar Radiation (2014)

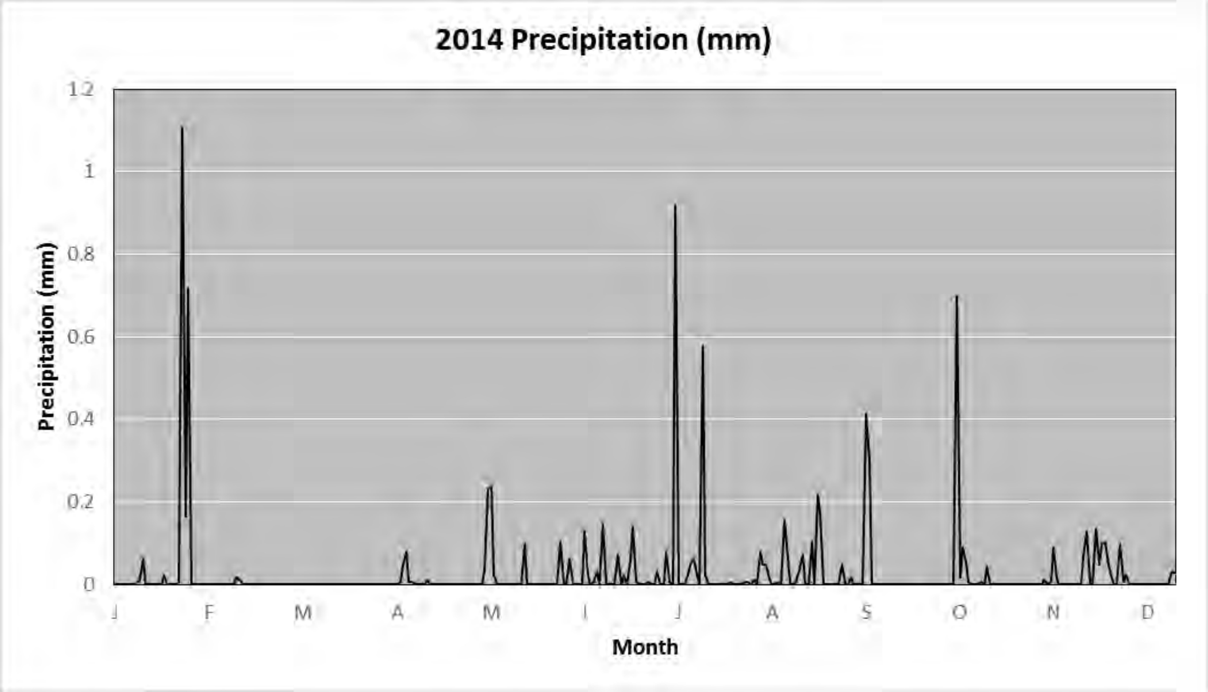


Figure 5-89: Precipitation (2014)

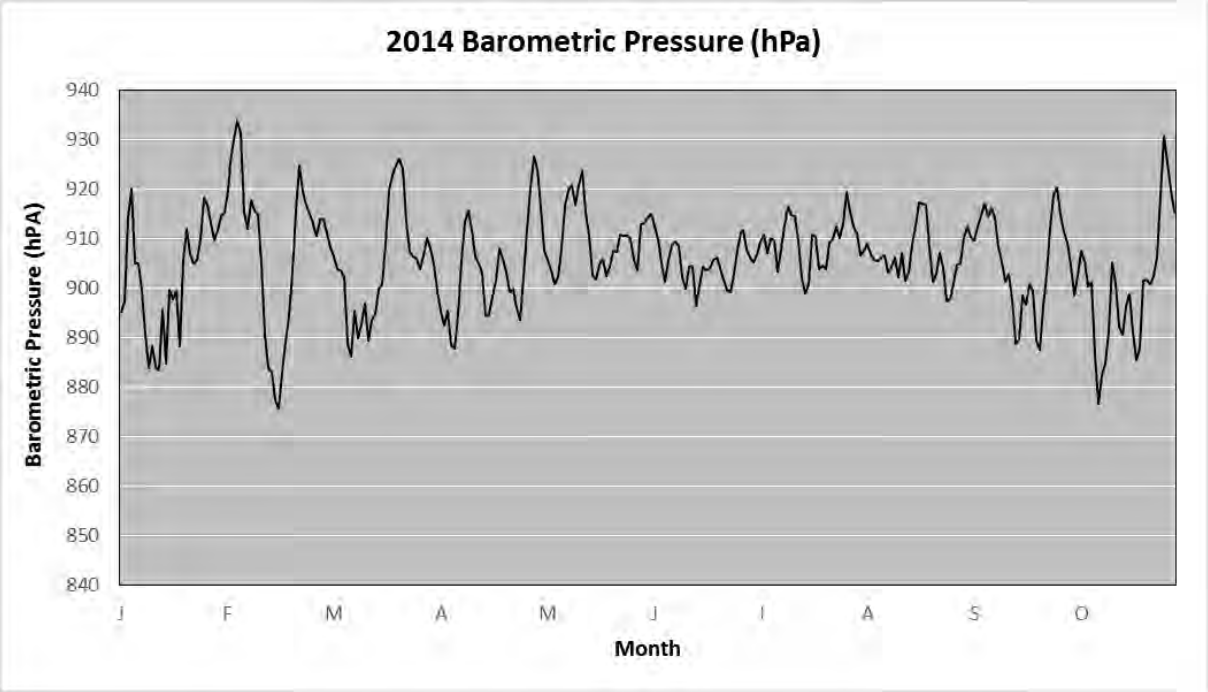


Figure 5-90: Barometric Pressure (2014)

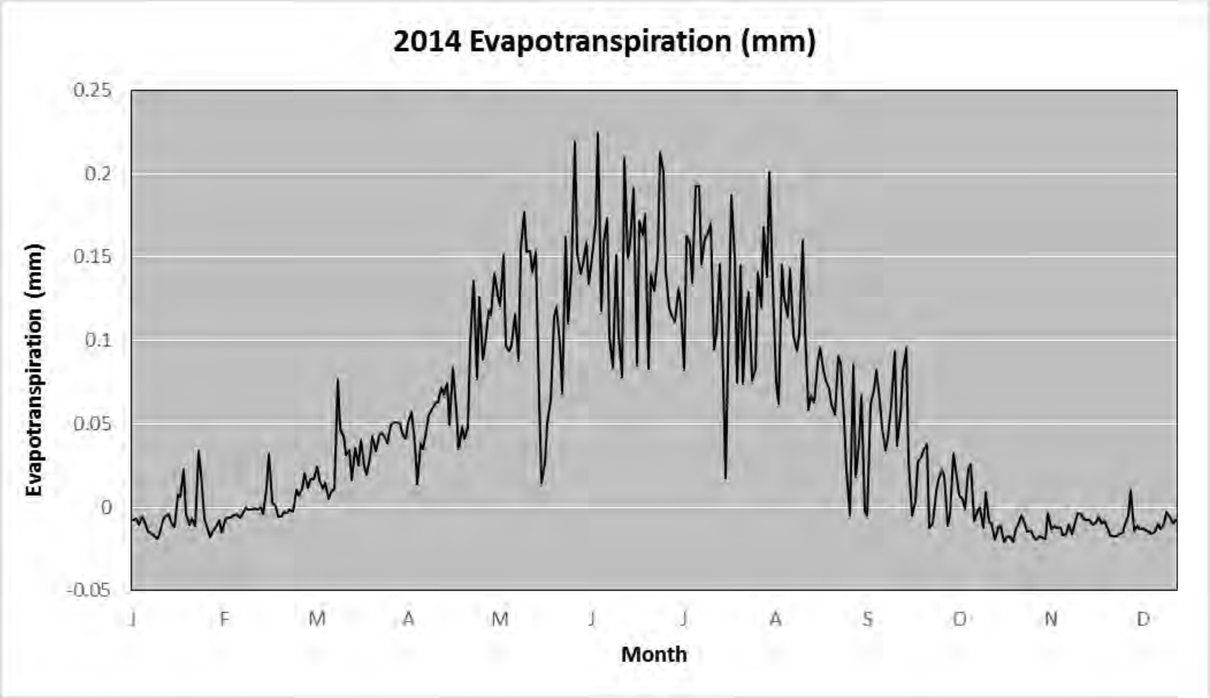


Figure 5-91: Evapotranspiration (2014)

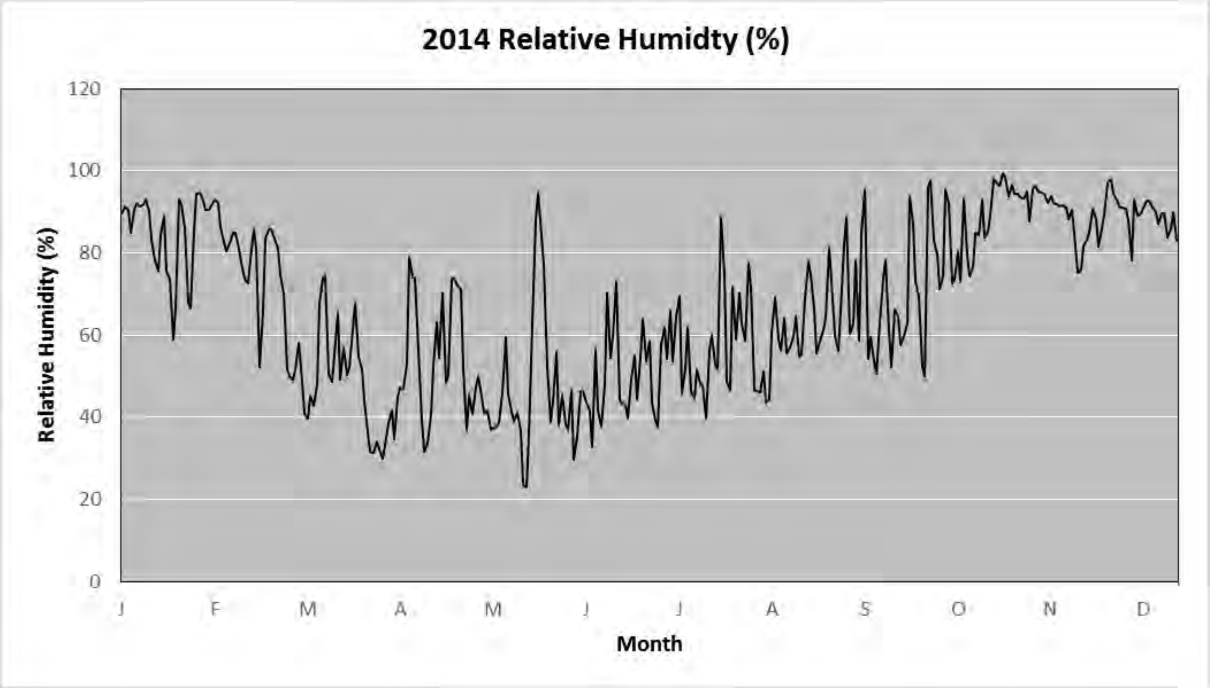
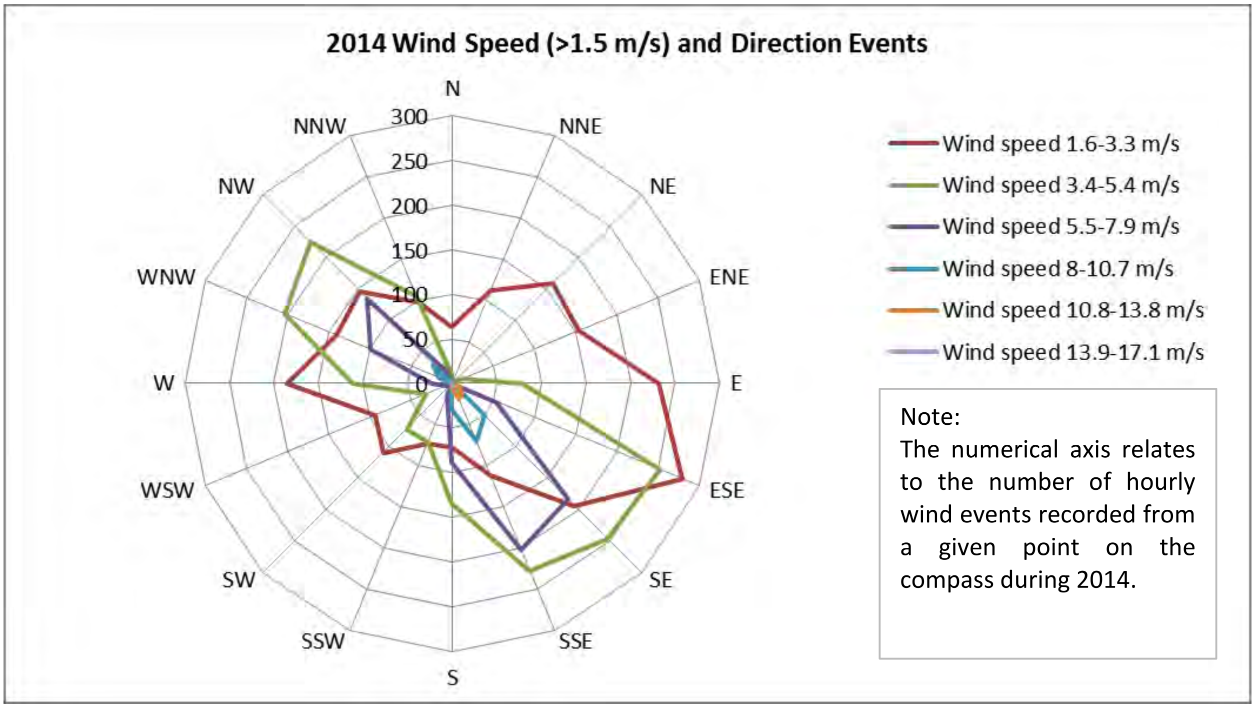
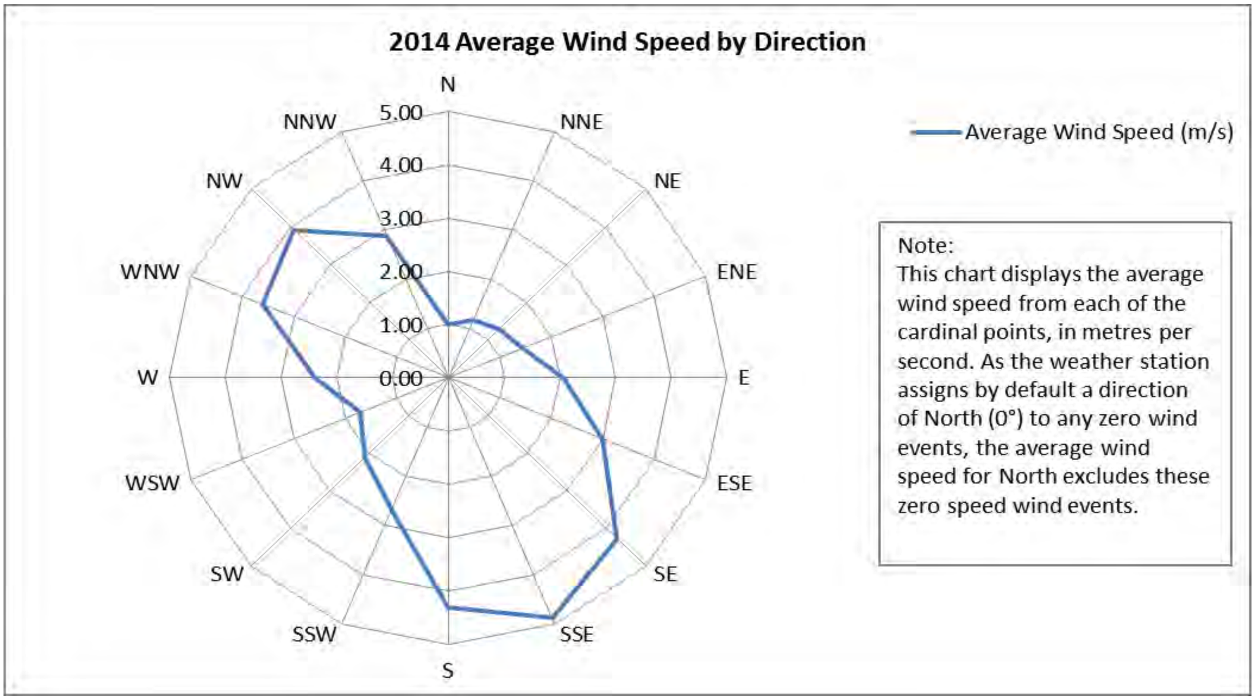


Figure 5-92: Relative Humidity (2014)



Note:
The numerical axis relates to the number of hourly wind events recorded from a given point on the compass during 2014.

Figure 5-93: Wind Speed (>1.5 m/s) and Direction Events (2014)



Note:
This chart displays the average wind speed from each of the cardinal points, in metres per second. As the weather station assigns by default a direction of North (0°) to any zero wind events, the average wind speed for North excludes these zero speed wind events.

Figure 5-94: Wind Direction (2014)

5.9.2 Snow Survey Program

As required by the WUL Clause 79 and as part of the EMSRP, Minto collects snow data used for calculating the snow water equivalent specifically at the Minto Mine. Snow water equivalents are inputs to the Water Balance model (Section 7.3.3). Three snow courses are surveyed monthly from February through April each year. Snow depth, density and snow water equivalent are measured along three established snow courses, which have north-, east- and south-facing aspects respectively. Multi-year results to 2014 (averaged across the three snow courses) are presented in Appendix K – *2014 Water Balance and Water Quality Model Summary for the Minto Mine Site*.

5.10 Wildlife Monitoring Program

The *Minto Mine Wildlife Protection Plan* (a component of the EMSRP) establishes guidelines for minimizing wildlife disturbance at the Minto Mine site and along the development corridor and includes a monitoring program to yield information about wildlife use in the area. The 2014 activities under the Wildlife Monitoring Program including the area monitored and frequency of monitoring, are summarized in Table 5-34, below.

Table 5-34: Wildlife Monitoring Activities (2014)

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

In addition to the Wildlife Monitoring Activities listed in Table 5-34, the Minto Environmental Department gathered observations by mine site staff with wildlife observation forms. The wildlife observation forms were posted around site, and employees were encouraged to record their wildlife observations whenever they observed wildlife on site. The forms were collected periodically and the sightings entered in a wildlife tracking sheet, which is included in Appendix L.

In 2014, 162 wildlife sightings were recorded. Large mammals were the most frequently reported, with seventy-five black bear sightings. Wolves were sighted on three occasions, including a family of five (two adults and three young), observed at the southeast perimeter of the mine site.

Eight moose sightings, involving sixteen animals, were recorded, all between mid-June and mid-October. During the same period, there were six sightings of mule deer, including three doe with young. Other species observed at or near the mine site included otter, porcupine and sandhill crane.

Additional activities that took place on site included wildlife education including training on bear awareness and safety flashes concerning preventing wildlife habituation on site.

5.11 Adaptive Management Plan

The 2014 actions carried out under the current AMP are discussed and presented in the Water Discharge section of this report (Section 5.7). A revised AMP was submitted to the YWB in November 2014 as part of the Phase V/VI expansion application. An updated AMP will not be submitted for Phase IV activities.

5.12 Invasive Plant Species Monitoring Program

As part of the EMSRP, Minto developed an *Invasive Species Monitoring Plan* in 2014 with the objective to monitor invasive plan species in and around the mine site. For 2014, monitoring of invasive plants focused on invasive plant training for the Minto Environmental Department. The Minto Environmental Department attended a one-day workshop hosted by the Yukon Invasive Species Council (YISC). The workshop reviewed the most prevalent species found in the Yukon and techniques to identify distribution pathways were demonstrated. Species identification and best management practices for invasive species were also further discussed. Information obtained from the workshop helped guide the procedures in the *Invasive Species Monitoring Plan*.

The extent and location to which invasive plants may exist at the Minto Mine is unknown. However, vegetation surveys have been completed annually since September 2012 on the MWD and both seed mix and natural regeneration species have been noted during the survey. The invasive plant species monitoring program for site is expected to be expanded in 2015 and will likely include areas where there is high visitor traffic, recently exposed soils and areas that have been reclaimed.

5.13 Socio-Economic Monitoring Program

The Minto Mine Socio-Economic Monitoring Program defines a framework for monitoring direct and indirect socio-economic effects from the Minto Mine. In 2014, as per the framework, Minto tracked and collected administrative data and other information relating to the mine's direct employment, training and procurement; worker safety; and Minto contributions to cultural well-being and community wellness. The 2014 socio-economic data which Minto tracked is summarized in Appendix M – *2014 Annual Socio-Economic Monitoring* .

5.14 Erosion and Sedimentation Monitoring Program

As part of the EMSRP, Minto has developed and implemented a *Sediment and Erosion Control Plan* (SECP). The objective of the SECP is to minimize local site impacts from erosion and prevent sedimentation to the receiving environment of Minto Creek. The 2014 activities associated with the Erosion and Sedimentation Monitoring Program are identified in Table 5-35, below.

Table 5-35: Erosion and Sedimentation Monitoring Activities (2014)

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

5.15 Site Characterization Report

The *Site Characterization Report* was submitted to EMR in May 2014. As per Clause 13.1 of the QML, the report will be updated in three years from the effective date of the licence (December 2014). No updates were made to the *Site Characterization Report* following its submission in May 2014.

5.16 Quality Assurance and Quality Control Program

As required by Clause 18(l) of the WUL, Minto Mine is required to submit the results and interpretations of the Quality Assurance and Quality Control Program (QA/QC Program). The QA/QC program is directed through the *Minto Mine Quality Assurance and Quality Control Plan*. Implementation of the Minto Mine QA/QC Program occurred in November 2012.

The primary objective of the QA/QC Program is to ensure that data collected, analyzed and evaluated through the environmental monitoring programs at the Minto Mine are representative of the environmental conditions present at the time of sampling. The *Minto Mine Quality Assurance and Quality Control Plan* has been developed using recognized QA/QC protocols. Specific procedures for data collection at the Minto Mine are detailed in Standard Operating Procedures (SOPs) included as Appendices to the *Minto Mine Quality Assurance and Quality Control Plan*. SOPs are internal documents to the Minto Mine that may be modified or improved as required.

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

5.16.1 Water Quality QA/QC

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

In 2014, approximately 1,045 water quality samples (surface and groundwater) were collected for the water quality monitoring programs. QC samples represented 10.3% of the total number of samples collected in 2014, and included eighty-four field duplicates, twenty-two field blanks, and four trip blanks. The *Minto Mine Surface Water Quality Monitoring Standard Operating Procedures* describes a 1:10 quality control to routine sampling ratio and this ratio was achieved in 2014.

5.16.2 External Laboratory QA/QC

The 2014 external laboratory water quality analysis were performed by Maxxam Environmental in Burnaby, BC. As described in the *Minto Mine Quality Assurance and Quality Control Plan*, all results provided by the external laboratory were accompanied by a Quality Assurance Report. If procedural deviations or exceedances in standard holding time occurred, the details of such nonconformities were included in each report. Additionally, each report contained QC batch numbers enhancing sample result traceability.

5.16.3 On-site Laboratory QA/QC

Procedures for analyzing water samples at the on-site laboratory are detailed in a variety of SOPs such as, but not limited to the *Laboratory QA/QC Guidelines SOP*; *Preparation of Dissolved and Total Metals (Cu, Al, Cd) SOP; Preparation of Dissolved and Total Selenium SOP*; and *Total Dissolved Solids SOP*. There were no updates made to the on-site laboratory SOPs in 2014. All on-site laboratory equipment was calibrated according to manufacturer's specifications in 2014.

2014 on-site laboratory analysis of water quality samples occurred at W3, W8A, W16, W16A and W50 as per the WUL Appendix 3 monitoring requirements (as environmental conditions allowed). No internal samples were provided to the internal laboratory from W8 as the site remained dry throughout 2014. Additionally, the on-site laboratory analyzed water from sites W2, MC-1, W15, W17, W35, W36, W44 and WTP during spring freshet in order to inform day-to-day discharge-related decisions.

The 2014 QC procedures performed by the on-site laboratory included spiked blanks and calibration checks. In the event that two or more QC failures occurred, the 2014 QC procedures involved re-analyzing the entire batch of samples. In 2014, the on-site laboratory reported that selenium spiked blanks and calibration tests could not be performed when limited quantities of selenium were present in the sample water. This was a function of the laboratory equipment's (Vapour Gas Generator) inability to execute a spiked blank or calibration with limited quantities of selenium.

On-site and external laboratory water quality results for water quality sites W3, W8, W8A, W16, W16A and W50 are presented in each Monthly Report submitted to the Water Board. In 2014, it was noted that discrepancies in results from the external and on-site laboratories occurred and were likely as a result of different methods and/or equipment utilized in analyzing water samples, different processing times between sampling and processing the samples, and the associated use of non-preserved versus preserved samples.

5.16.4 Hydrology QA/QC

Procedures for hydrology monitoring at the Minto Mine are detailed in the *Minto Mine Surface Water Hydrology Standard Operating Procedures*. Improvements to the *Minto Mine Surface Water Hydrology SOP* in 2014 included a twice monthly audit of the hydrology data downloaded from the Level Loggers and Barologgers. This ensured that the loggers were functioning and downloading appropriately.

5.16.5 Meteorology QA/QC

Procedures for meteorology monitoring at the Minto Mine are detailed in the *Meteorology Station Download Procedures*. For the first part of 2014, data downloads were performed twice per month and reviewed after the download to ensure that the meteorological stations were recording all necessary parameters. In November 2014, Minto installed a satellite connection to the Met Station 2 to enable real time viewing of the weather station data. Post-installation of the satellite connection, the meteorology data were still reviewed twice monthly by Environmental Department staff and routine visual inspections of the monitoring stations occur on a twice monthly basis.

5.16.6 Hydrogeology QA/QC

Schedules and general procedures for hydrogeology monitoring at the Minto Mine are detailed in the *Minto Mine Groundwater Monitoring Plan Version 2014-01*. In 2014, fifty-seven groundwater samples were taken at the Minto Mine. QC samples represented 19.3% of the total number of samples collected in 2014, and included eleven field duplicates.

The *Minto Mine Groundwater Monitoring Plan Version 2014-01* recommends field duplicate sampling be conducted at a frequency of one field duplicate sample per ten groundwater monitoring samples; and a higher rate of field duplicate sampling was achieved in 2014 (19.3%). Additionally the *Minto Mine Groundwater Monitoring Plan Version 2014-01* states that “one field blank sample will be collected during each Spring/Fall groundwater monitoring event”. The 2014 groundwater sampling program did not obtain the prescribed field blank samples and effort will be made to ensure that field staff collect the appropriate quality control samples as detailed in the *Minto Mine Groundwater Monitoring Plan Version 2014-01*.

Collection rates for trip blanks are not detailed in the *Minto Mine Groundwater Monitoring Plan Version 2014-01* and in 2014 there were no trip blanks collected in conjunction with the hydrogeology monitoring.

5.17 Groundwater Monitoring Program

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

5.17.1 Groundwater Wells

The Minto Mine EMSRP details the groundwater wells at the Minto Mine, including operative and inoperative wells. Figure 5-95 shows a location map of the operative wells.

No new groundwater wells were added during 2014 monitoring season. Infrastructure such as barricades and shelters for winter sampling was installed at MW12-07.

Groundwater sampling frequency increased from twice a year to three times a year in 2014. Sites were typically visited in the spring, summer and fall and samples collected as conditions permitted.

Sampling frequency at groundwater well MW12-07 was conducted on a monthly basis throughout most of 2014 in order to monitor the Main and Area 2 Pit potential influence on the groundwater in the area of

MW12-07. The 2014 results for MW12-07 have been presented with average, minimum and maximum values due to the data available for 2014.

In 2014, groundwater wells MW12-DP3, MW09-01-03 and MW12-06-06 did not produce enough water during sampling events to run all analyses required as detailed in the EMSRP; therefore only partial results are presented.

Table 5-36 lists the operational status and location of the groundwater wells at the Minto Mine for 2014. Complete results for the 2014 Groundwater Monitoring Program groundwater wells are presented in Appendix G.

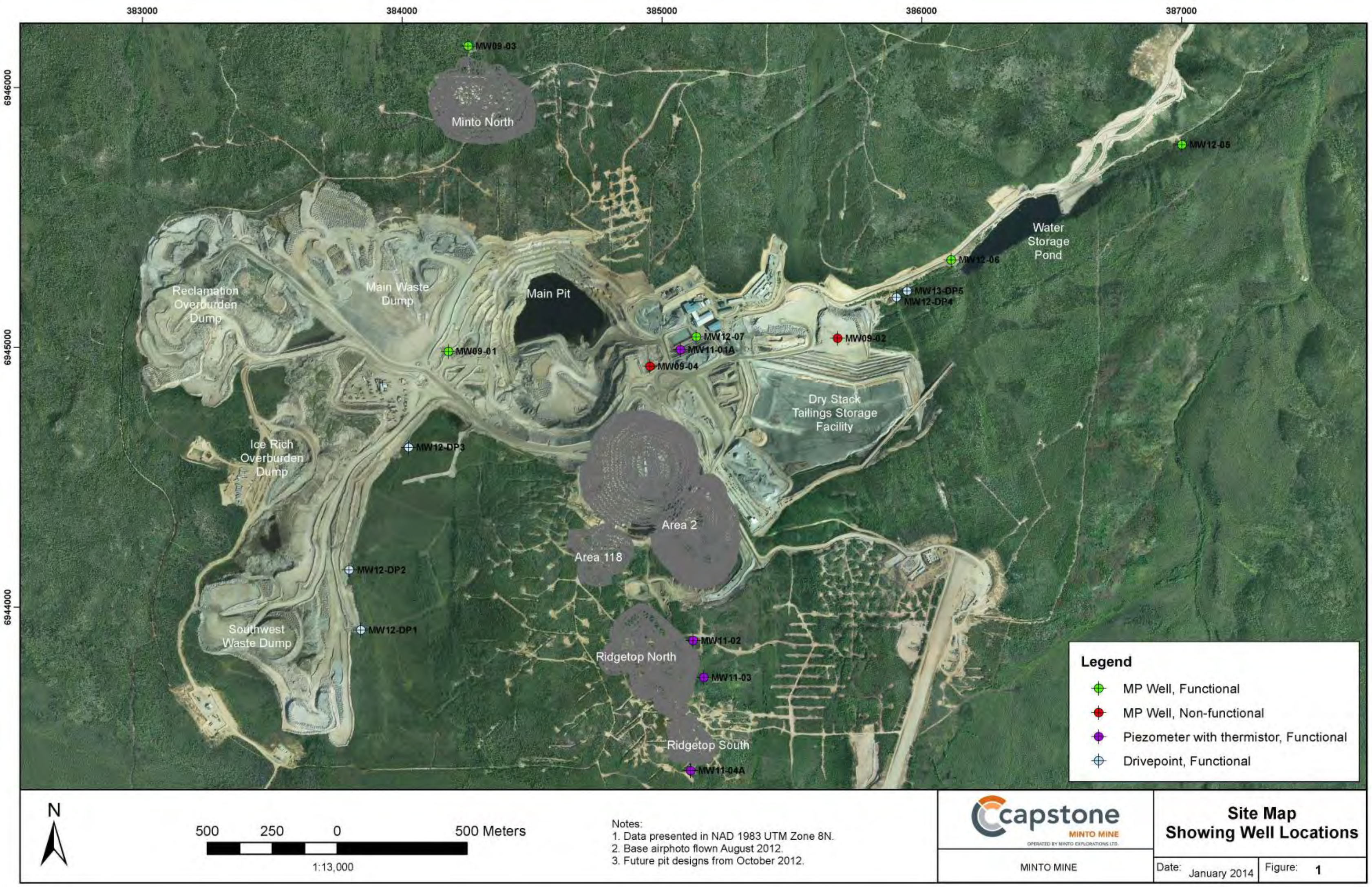


Figure 5-95: Minto Mine Groundwater Well Locations (2014)

Table 5-36: Minto Mine Groundwater Wells Operational Status Summary (2014)

Groundwater Well Name	Location	Status
08SWC270	Southwest Waste Dump area	*Destroyed*
08SWC271	Southwest Waste Dump area	*Destroyed*
08SWC272	Southwest Waste Dump area	*Destroyed (Buried by waste rock)*
08SWC273	Southwest Waste Dump area	*Destroyed*
08SWC274	Southwest Waste Dump area	*Destroyed*
08SWC275	Southwest Waste Dump area	*Destroyed*
08SWC277	Southwest Waste Dump area	*Destroyed*
08SWC278	Southwest Waste Dump area	*Destroyed*
08SWC280	Southwest Waste Dump area	*Destroyed (Buried by waste rock)*
MW09-01	Main Waste Dump area	Operational
MW09-02	DSTSF Area	*Destroyed*
MW09-03	Minto North Pit area	Operational
MW09-04	Main Pit area	*Destroyed*
MW11-01A	Down gradient of Main Pit	Operational (sometimes frozen)
MW11-02	NE of Ridgetop North Pit	Operational (sometimes frozen)
MW11-03	SE of Ridgetop North Pit	Operational (sometimes frozen)
MW11-04A	S of Ridgetop South Pit	Operational
MW12-05	Down gradient of WSP	Operational
MW12-06	Down gradient of MVF/DSTSF	Operational
MW12-07	Down gradient of Main Pit	Operational
MW12-DP1	West of Southwest Waste Dump	Operational
MW12-DP2	West of Southwest Waste Dump	Operational
MW12-DP3	West of Southwest Waste Dump	Operational
MW12-DP4	Down gradient of MVF/DSTSF	Operational
MW13-DP5	Down gradient of MVF/DSTSF	Operational
P93-E	Main Pit area	*Destroyed during mining*
P94-20	Main Water Dam area	*Destroyed*
Unnamed auxiliary well near mill	Mill area	Operational
Unnamed camp water well	Camp area	Operational

5.17.1.1 MW09-01

Groundwater well MW09-01 water quality results are summarized in Table 5-37 for samples taken in 2013 and 2014. MW09-01 was monitored in 2012, however all zones were dry. A pressure profile was completed in March 2013; however, water could not be extracted from the well. In 2014, a limited volume of water was produced during the July 24, 2014 sampling session which resulted in analysis of dissolved metals and not the full suite of parameters outlined in the EMSRP. Zone three (MW09-03-01) was the single zone to produce a water quality sample in the summer of 2014.

Table 5-37: MW09-01-03 Water Quality Results Summary (2014)

MW09-01-03	2013 Results	2014 Results
Parameters	14-Oct	24-Jul
pH	7.69	*
TDS (mg/L)	3220	*
Sulfate-dissolved (mg/L)	*	*
Nutrients (mg/L)		
Ammonia Nitrogen	31	*
Nitrate Nitrogen	124	*
Nitrite Nitrogen	4.99	*
Dissolved Metals (mg/L)		
Calcium	436	444
Cadmium	0.000163	0.000603
Copper	0.0056	0.199
Iron	0.0246	0.0196
Selenium	0.0146	0.0139

*Not available

5.17.1.2 MW09-03

Groundwater well MW09-03 water quality results are summarized in Table 5-38 through Table 5-40 for samples taken in 2012 to 2014. MW09-03 produced results from all sampling zones (01, 02 and 03) during the 2014 monitoring period.

Table 5-38: MW09-03-01 Water Quality Results Summary (2012 - 2014)

MW09-03-01	2012 Results		2013 Results			2014 Results		
Parameters	10-May	17-Nov	12-Mar	18-Aug	12-Oct	2-Jun	24-Jul	6-Oct
pH	7.99	*	8.23	8.18	8.03	8.1	8.13	8.19
TDS (mg/L)	162	160	188	184	196	610	162	162
Sulfate-dissolved (mg/L)	21.4	22.2	24.4	21.9	22.1	0.53	23.5	22.7
Nutrients (mg/L)								
Ammonia Nitrogen	0.073	0.12	0.065	0.053	0.05	0.17	0.031	0.035
Nitrate Nitrogen	0.109	0.069	0.052	0.669	<0.020	<0.020	0.067	0.024
Nitrite Nitrogen	0.182	0.118	0.161	1.63	0.174	0.0742	0.143	0.12
Dissolved Metals (mg/L)								
Calcium	42	46.9	38.8	40.6	44.2	152	39.6	41.5
Cadmium	0.000085	0.000683	0.000028	0.000022	0.000018	0.000046	0.000017	0.00015
Copper	0.00281	0.00182	0.00031	0.00075	0.00028	0.00364	0.00036	0.00021
Iron	<0.0050	0.0116	<0.0050	0.0065	<0.0050	23.5	0.0208	<0.0050
Selenium	<0.00010	0.000052	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010

*Not available

Table 5-39: MW09-03-02 Water Quality Results Summary (2012 - 2014)

MW09-03-02	**2012 Results**		**2013 Results**			**2014 Results**		
Parameters	10-May	17-Nov	12-Mar	18-Aug	12-Oct	2-Jun	24-Jul	6-Oct
pH	7.59	*	8.03	8.08	7.92	8.16	7.93	8.02
TDS (mg/L)	716	648	670	622	598	172	572	577
Sulfate-dissolved (mg/L)	<0.50	<0.50	0.53	9.2	0.98	21.6	<0.50	<0.50
Nutrients (mg/L)								
Ammonia Nitrogen	0.23	0.23	0.33	0.24	0.21	0.031	0.2	0.15
Nitrate Nitrogen	0.1	0.035	0.021	<0.020	<0.020	0.047	<0.020	<0.020
Nitrite Nitrogen	0.171	0.0924	0.0915	0.0888	0.0805	0.149	0.053	0.0429
Dissolved Metals (mg/L)								
Calcium	154	161	158	149	166	40.5	136	147
Cadmium	0.000028	<0.000025	0.000011	0.000026	<0.000010	0.00006	<0.000010	0.000032
Copper	0.00107	0.00073	<0.00020	0.00066	0.00119	0.00071	0.00318	0.00207
Iron	19.2	19.4	14.7	19.3	23.8	0.0531	20.3	19.2
Selenium	0.0002	<0.00020	0.00017	0.00011	<0.00010	<0.00010	0.00013	0.00079

*Not available

Table 5-40: MW09-03-03 Water Quality Results Summary (2012 - 2014)

MW09-03-03	**2012 Results**		**2013 Results**			**2014 Results**		
Parameters	10-May	17-Nov	12-Mar	18-Aug	14-Oct	2-Jun	24-Jul	6-Oct
pH	7.92	*	7.91	7.99	7.99	8.07	7.99	8.1
TDS (mg/L)	106	114	130	104	128	138	94	106
Sulfate-dissolved (mg/L)	11.2	9.79	12.8	9.4	11.2	12.8	10.9	10.3
Nutrients (mg/L)								
Ammonia Nitrogen	<0.0050	0.0054	0.025	0.013	0.063	0.012	0.015	0.009
Nitrate Nitrogen	0.302	0.248	0.366	0.426	0.412	0.53	0.484	0.507
Nitrite Nitrogen	0.0145	0.0058	0.01	0.0239	<0.0050	0.0183	0.0079	0.0051
Dissolved Metals (mg/L)								
Calcium	28.1	31.9	28.1	30.3	28.7	30.7	26.7	33.5
Cadmium	0.000069	0.000023	0.000015	0.00001	0.0001	0.000015	<0.000010	0.000022
Copper	0.0032	0.00174	0.00139	0.00222	0.00217	0.00172	0.00247	0.00154
Iron	0.0164	0.0113	0.0195	0.157	0.0068	0.0059	0.0838	0.483
Selenium	0.00031	0.000414	0.00036	0.00029	0.0003	0.00028	0.00024	0.0004

*Not available

5.17.1.3 MW11-01A

MW11-01A was frozen throughout 2014, therefore water quality results are not available for the 2014 monitoring period. Historical results are not presented as MW11-01A has not produced water in years previous to the reporting year.

5.17.1.4 MW11-02

MW11-02 was frozen throughout 2014, therefore water quality results are not available for the 2014 monitoring period. Historical results are not presented as MW11-02 has not produced water in years previous to the reporting year.

5.17.1.5 MW11-03

MW11-03 was frozen throughout 2014, therefore water quality results are not available for the 2014 monitoring period. Historical results are not presented as MW11-03 has not produced water in years previous to the reporting year.

5.17.1.6 MW11-04A

Groundwater well MW11-04A water quality results are summarized in Table 5-41 for samples taken in 2012 to 2014. MW11-04A was sampled three times in 2014.

Table 5-41: MW11-04A Water Quality Results Summary (2012 – 2014)

MW11-04A	2012 Results	2013 Results		2014 Results		
Parameters	18-May	2-Jul	15-Oct	1-Jul	15-Aug	6-Oct
pH	11.5	11.7	11.3	11	10.3	10.8
TDS (mg/L)	*	396	200	178	148	151
Sulfate-dissolved (mg/L)	<5.0	3.47	3.72	7.4	6.84	7.7
Nutrients (mg/L)						
Ammonia Nitrogen	1.5	0.18	0.081	0.058	0.12	0.11
Nitrate Nitrogen	1.6	1.15	1.16	1	1.19	1.22
Nitrite Nitrogen	0.0234	0.0098	0.0116	0.0071	0.013	0.0216
Dissolved Metals (mg/L)						
Calcium	86	170	86.5	54.3	54.3	52.5
Cadmium	0.000015	<0.000010	<0.000010	0.00001	0.000013	0.000045
Copper	0.0932	0.0406	0.0345	0.0119	0.137	0.0824
Iron	0.0161	0.0107	0.0057	<0.0050	0.0059	0.0053
Selenium	0.00334	0.00175	0.00201	0.00186	0.00233	0.00218

*Not available

5.17.1.7 MW12-DP1

Drivepoint well MW12-DP1 has not produced adequate quantity of water since installation in 2012; in 2013 an insufficient volume of water was produced; however, the volume was not sufficient for analysis of the parameters outlined in the EMSRP. There was no water produced at MW12-DP1 in 2014 and therefore water quality results are not available for both historic and 2014 monitoring at MW12-DP1.

5.17.1.8 MW12-DP2

Drivepoint well MW11-03 was dry and / or frozen throughout 2014, therefore water quality results are not available for the 2014 monitoring period. Historical results are not presented as M12-DP2 has not produced water in years previous to the reporting year.

5.17.1.9 MW12-DP3

Drivepoint well MW12-DP3 produced an insufficient amount of water to complete water quality analysis in 2013 for the parameters outlined in the EMSRP. In 2014, MW12-DP3 produced a limited volume of water, which was sufficient to analyze for dissolved metals; there was not enough water to analyze for the remaining parameters outlined in the EMSRP. The 2014 results for MW12-DP3 are summarized in Table 5-42, below.

Table 5-42: MW12-DP3 Water Quality Results Summary (2014)

MW12-DP3	2014 Results
Parameters	**1-Jun**
pH	*
TDS (mg/L)	*
Sulfate-dissolved (mg/L)	*
Nutrients (mg/L)	
Ammonia Nitrogen	*
Nitrate Nitrogen	*
Nitrite Nitrogen	*
Dissolved Metals (mg/L)	
Calcium	24.3
Cadmium	0.000161
Copper	0.0153
Iron	1.93
Selenium	0.0001

*Not available

5.17.1.10 MW12-DP4

Drivepoint well MW12-DP4 water quality results are summarized in Table 5-43 for samples taken in 2013 to 2014.

Table 5-43: MW12-DP4 Water Quality Results Summary (2013-2014)

MW12-DP4	2013 Results		2014 Results
Parameters	27-Jul	9-Oct	27-Sep
pH	7.93	8.07	7.9
TDS (mg/L)	612	506	634
Sulfate-dissolved (mg/L)	96.2	89.3	121
Nutrients (mg/L)			
Ammonia Nitrogen	0.038	0.043	0.052
Nitrate Nitrogen	1.12	3.78	4.47
Nitrite Nitrogen	0.0093	0.0744	0.0588
Dissolved Metals (mg/L)			
Calcium	104	*	100
Cadmium	0.000046	*	0.000052
Copper	0.0044	*	0.00497
Iron	0.0229	*	0.0095
Selenium	0.00097	*	0.00224

*Not available

5.17.1.11 MW12-05

Groundwater well MW12-05 water quality results are summarized in Table 5-44 through Table 5-47 for samples taken in 2012 to 2014. MW12-05 produced results from all sampling zones (01, 03, 05 and 07) during the 2014 monitoring period.

Table 5-44: MW12-05-01 Water Quality Results Summary (2012 - 2014)

MW12-05-01	2012 Results	2013 Results		2014 Results		
Parameters	11-Nov	21-Aug	10-Oct	30-May	25-Jul	4-Oct
pH	*	8.31	8.23	8.26	8.03	8.15
TDS (mg/L)	706	912	1030	1190	1220	1280
Sulfate-dissolved (mg/L)	350	483	532	647	703	728
Nutrients (mg/L)						
Ammonia Nitrogen	<0.0050	0.078	0.37	0.18	0.075	0.11
Nitrate Nitrogen	0.368	0.021	<0.020	0.026	<0.020	0.023
Nitrite Nitrogen	0.0517	0.0581	0.195	0.106	0.0362	0.139
Dissolved Metals (mg/L)						
Calcium	117	160	168	194	197	221
Cadmium	0.00014	0.000012	<0.000010	0.000012	0.000049	<0.000010
Copper	0.00737	<0.00020	<0.00020	0.00031	<0.00020	0.00021
Iron	0.0085	0.0323	0.0218	0.0234	0.0268	0.0183
Selenium	0.00047	0.00033	0.0009	<0.00010	0.00023	0.00021

*Not available

Table 5-45: MW12-05-03 Water Quality Results Summary (2012 - 2014)

MW12-05-03	2012 Results	2013 Results		2014 Results		
Parameters	12-Nov	21-Aug	10-Oct	29-May	25-Jul	4-Oct
pH	*	8.16	8.1	8.22	8.06	8.19
TDS (mg/L)	880	1240	1330	1400	1370	1400
Sulfate-dissolved (mg/L)	456	633	686	717	754	736
Nutrients (mg/L)						
Ammonia Nitrogen	0.019	0.051	0.066	0.033	0.037	0.04
Nitrate Nitrogen	0.03	0.035	<0.020	<0.020	<0.020	<0.020
Nitrite Nitrogen	0.109	0.0252	0.0565	0.132	0.0354	0.0404
Dissolved Metals (mg/L)						
Calcium	120	188	189	198	192	209
Cadmium	0.000214	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Copper	0.0022	<0.00020	0.00023	<0.00020	<0.00020	<0.00020
Iron	0.0981	1.82	1.9	3.43	3.62	4.14
Selenium	0.000364	<0.00010	<0.00010	<0.00010	<0.00010	0.00011

*Not available

Table 5-46: MW12-05-05 Water Quality Results Summary (2012 - 2014)

MW12-05-05	2012 Results	2013 Results		2014 Results		
Parameters	12-Nov	21-Aug	10-Oct	29-May	25-Jul	5-Oct
pH	*	8.21	8.26	8.35	8.08	8.23
TDS (mg/L)	288	276	292	278	252	258
Sulfate-dissolved (mg/L)	46.3	40.7	42.5	36.4	35.1	33.3
Nutrients (mg/L)						
Ammonia Nitrogen	0.016	0.013	0.014	0.019	0.036	0.018
Nitrate Nitrogen	0.817	0.614	0.467	0.291	0.224	0.2
Nitrite Nitrogen	0.195	0.122	0.16	0.0905	0.0305	0.0433
Dissolved Metals (mg/L)						
Calcium	47.2	46.4	43.9	43.7	41.8	45.9
Cadmium	0.000016	0.00001	<0.000010	<0.000010	0.000015	0.000011
Copper	0.00154	0.0014	0.00119	0.00043	0.00065	0.00088
Iron	0.0152	0.0284	0.044	0.0205	0.0457	0.0404
Selenium	0.000164	0.00012	0.00017	<0.00010	<0.00010	<0.00010

*Not available

Table 5-47: MW12-05-07 Water Quality Results Summary (2012 - 2014)

MW12-05-07	2012 Results	2013 Results		2014 Results	
Parameters	12-Nov	21-Aug	10-Oct	25-Jul	5-Oct
pH	*	8.4	8.23	8.22	8.45
TDS (mg/L)	260	298	306	262	362
Sulfate-dissolved (mg/L)	40.6	11.5	18.5	11.4	38.6
Nutrients (mg/L)					
Ammonia Nitrogen	0.21	0.1	0.068	0.08	0.24
Nitrate Nitrogen	<0.020	<0.020	<0.020	<0.020	<0.20
Nitrite Nitrogen	0.0298	0.0427	<0.0050	0.0137	2.91
Dissolved Metals (mg/L)					
Calcium	49.4	51.9	49	47.2	52.4
Cadmium	<0.0000050	<0.000010	<0.000010	<0.000010	0.000019
Copper	0.000477	0.00065	0.0002	<0.00020	0.00031
Iron	0.867	0.928	0.387	0.113	0.0602
Selenium	0.000108	0.00014	0.0003	0.00022	0.00034

*Not available

5.17.1.12 MW12-06

Groundwater well MW12-06 water quality results are summarized in Table 5-48 through Table 5-50 for samples taken in 2012 to 2014. MW12-06 produced results from all sampling zones (02, 04 and 06) during the 2014 monitoring period.

Table 5-48: MW12-06-02 Water Quality Results Summary (2012 – 2014)

MW12-06-02	2012 Results	2013 Results		2014 Results		
Parameters	16-Nov	18-Aug	11-Oct	30-May	25-Jul	6-Oct
pH	*	8.2	8.16	8.08	7.97	8.05
TDS (mg/L)	636	646	686	646	640	630
Sulfate-dissolved (mg/L)	208	206	227	185	199	187
Nutrients (mg/L)						
Ammonia Nitrogen	0.0074	0.048	0.052	0.046	0.072	0.05
Nitrate Nitrogen	0.081	0.25	0.052	0.165	0.054	0.026
Nitrite Nitrogen	0.263	0.787	0.302	0.525	0.164	0.0882
Dissolved Metals (mg/L)						
Calcium	113	132	137	131	114	128
Cadmium	0.000047	<0.000010	0.000018	<0.000010	0.000042	<0.000010
Copper	0.00115	0.0007	0.00042	0.00027	0.0004	0.0003
Iron	0.726	0.954	1.67	0.974	1.22	1.21
Selenium	0.000238	0.00028	0.00018	<0.00010	<0.00010	<0.00010

*Not available

Table 5-49: MW12-06-04 Water Quality Results Summary (2012 – 2014)

MW12-06-04	2012 Results	2013 Results		2014 Results		
Parameters	16-Nov	18-Aug	11-Oct	30-May	25-Jul	6-Oct
pH	*	8.21	8.12	8.23	8.07	8.14
TDS (mg/L)	618	602	620	644	602	618
Sulfate-dissolved (mg/L)	178	163	161	159	173	164
Nutrients (mg/L)						
Ammonia Nitrogen	0.0059	0.021	0.019	0.022	0.012	0.023
Nitrate Nitrogen	0.08	0.128	0.022	0.324	0.059	0.029
Nitrite Nitrogen	0.229	0.463	0.167	1.12	0.204	0.0998
Dissolved Metals (mg/L)						
Calcium	97.2	103	104	102	97	105
Cadmium	0.000012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Copper	0.000106	<0.00020	0.00038	0.00025	<0.00020	<0.00020
Iron	0.717	0.67	0.713	0.531	0.69	0.699
Selenium	0.000083	0.00014	<0.00010	<0.00010	<0.00010	<0.00010

*Not available

Table 5-50: MW12-06-06 Water Quality Results Summary (2012 – 2014)

MW12-06-06	2012 Results	2013 Results		2014 Results		
Parameters	16-Nov	18-Aug	11-Oct	30-May	25-Jul	6-Oct
pH	*	8.26	8.25		8.1	8.23
TDS (mg/L)	538	510	528		472	519
Sulfate-dissolved (mg/L)	171	154	158		153	146
Nutrients (mg/L)						
Ammonia Nitrogen	0.085	0.011	0.018	0.033	0.01	0.0093
Nitrate Nitrogen	0.45	0.952	0.871		0.953	0.993
Nitrite Nitrogen	0.0651	0.0953	0.0896		0.0521	0.102
Dissolved Metals (mg/L)						
Calcium	81.2	79.2	82.7	74.7	73	78
Cadmium	0.000012	0.000011	<0.000010	0.000124	<0.000010	<0.000010
Copper	0.000261	0.00036	0.00047	0.00072	0.00031	0.00022
Iron	0.0833	0.009	0.0197	0.0423	0.0081	0.013
Selenium	0.000511	0.00022	0.00018	0.0002	0.00019	0.00019

*Not available

5.17.1.13 MW12-07

Groundwater well MW12-07 water quality results are summarized in Table 5-51 and Table 5-52 for samples taken in 2012 to 2014. MW12-07 produced results from all sampling zones (01 and 02) during the 2014 monitoring period.

Table 5-51: MW12-07-01 Water Quality Results Summary (2012 – 2014)

MW12-07-01	2012-2013 Results			2014 Results		
Parameters	Average	Min	Max	Average	Min	Max
pH	8.24	8.12	8.33	8.11	7.66	8.38
TDS (mg/L)	886	852	924	879	774	1080
Sulfate-dissolved (mg/L)	218	185	263	336	266	640
Nutrients (mg/L)						
Ammonia Nitrogen	0.0761	0.0025	0.32	0.45	0.2	0.96
Nitrate Nitrogen	37.23	6.99	53.5	3.535	0.318	16.1
Nitrite Nitrogen	1.479	0.0731	3.05	2.715	0.025	4.96
Dissolved Metals (mg/L)						
Calcium	180	176	186	170	154	192
Cadmium	0.000214	0.000005	0.000633	0.000034	0.000005	0.000102
Copper	0.03734	0.00437	0.077	0.00214	0.00042	0.00426
Iron	0.232	0.189	0.294	0.319	0.111	0.705
Selenium	0.0235	0.00703	0.0347	0.00241	0.00005	0.00633

*Not available

Table 5-52: MW12-07-02 Water Quality Results Summary (2012 – 2014)

MW12-07-02	2012-2013 Results			2014 Results		
Parameters	Average	Min	Max	Average	Min	Max
pH	8.03	7.99	8.06	7.94	7.81	8.08
TDS (mg/L)	1003	782	1110	1085	1050	1160
Sulfate-dissolved (mg/L)	546	283	639	634	617	658
Nutrients (mg/L)						
Ammonia Nitrogen	0.1094	0.0025	0.27	0.251	0.045	0.61
Nitrate Nitrogen	5.483	0.158	21.3	0.391	0.225	0.66
Nitrite Nitrogen	0.391	0.148	0.652	0.958	0.495	1.47
Dissolved Metals (mg/L)						
Calcium	178	140	197	192	177	207
Cadmium	0.000071	0.000005	0.000269	0.000008	0.000005	0.000016
Copper	0.0057	0.0001	0.0217	0.00074	0.0001	0.00255
Iron	0.6895	0.0069	1.3	0.2057	0.0091	0.266
Selenium	0.00392	0.00019	0.0148	0.00016	0.00005	0.00029

*Not available

5.17.1.14 MW13-DP5

Drivepoint well MW13-DP5 was installed in 2013. Once installed, MW13-DP5 was found to be dry and / or frozen during the 2013 monitoring period. In 2014, MW13-DP5 was monitored in the spring and fall but only produced water during the fall (September 1, 2014) sampling event. The 2014 results are summarized in Table 5-53, below.

Table 5-53: MW13-DP5 Water Quality Summary (2014)

MW13-DP5	2014 Results
Parameters	1-Sep
pH	8.36
TDS (mg/L)	548
Sulfate-dissolved (mg/L)	119
Nutrients (mg/L)	
Ammonia Nitrogen	0.023
Nitrate Nitrogen	7.88
Nitrite Nitrogen	<0.0050
Dissolved Metals (mg/L)	
Calcium	94
Cadmium	0.000018
Copper	0.00538
Iron	0.0053
Selenium	0.00342

5.17.2 Vibrating Wire Piezometers

There are currently 18 operating vibrating wire piezometers installed on site, listed in Table 5-54. There were no changes to the operational status of any piezometers in 2014. Summaries of data collected from each piezometer are provided in the following sections.

Table 5-54: Vibrating Wire Piezometer Summary (2014)

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

5.17.2.1 DSTSF Piezometers

Data collected from DSTSF vibrating wire piezometers are presented in Figure 5-96. Sensor DSP-6A is reading negative pressures and hasn't been included in the figure. Data are collected monthly.

Pore water pressures in DSP-5A and DSP-5B have been gradually increasing since early 2014. Analysis carried out by SRK Consulting indicates that these increasing pressures are not a concern, with factors of safety greater than 2 for the current conditions; pressures are expected to decrease significantly with the planned Mill Valley Fill Extension (MVFE) Stage 2.

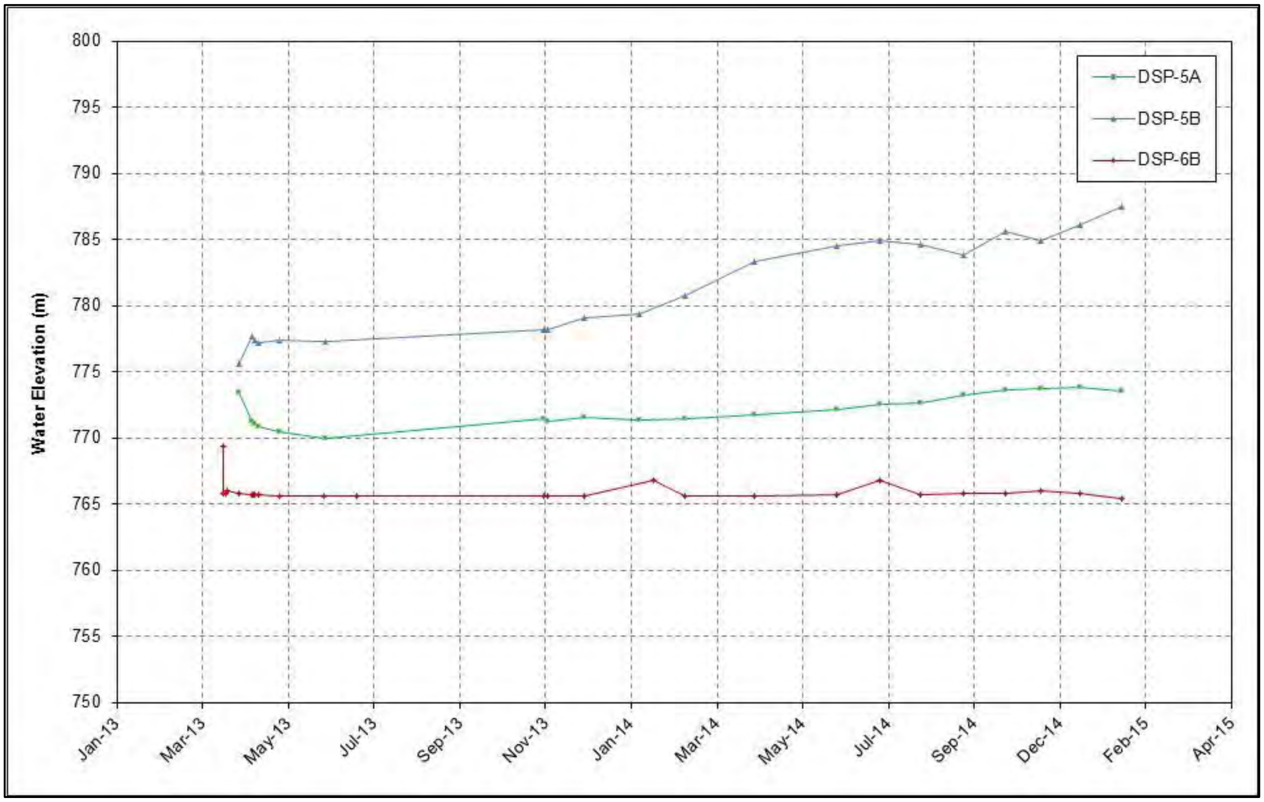


Figure 5-96: DSTSF Piezometer Data (2013-2014)

5.17.2.2 Southwest Dump Piezometers

Data collected from Southwest Dump vibrating wire piezometers are presented in Figure 5-97. Sensors SDP-3A and SDP-3B are reading negative pressures and haven't been included in the figure. Data are collected monthly. Data indicate relatively consistent conditions in 2014.

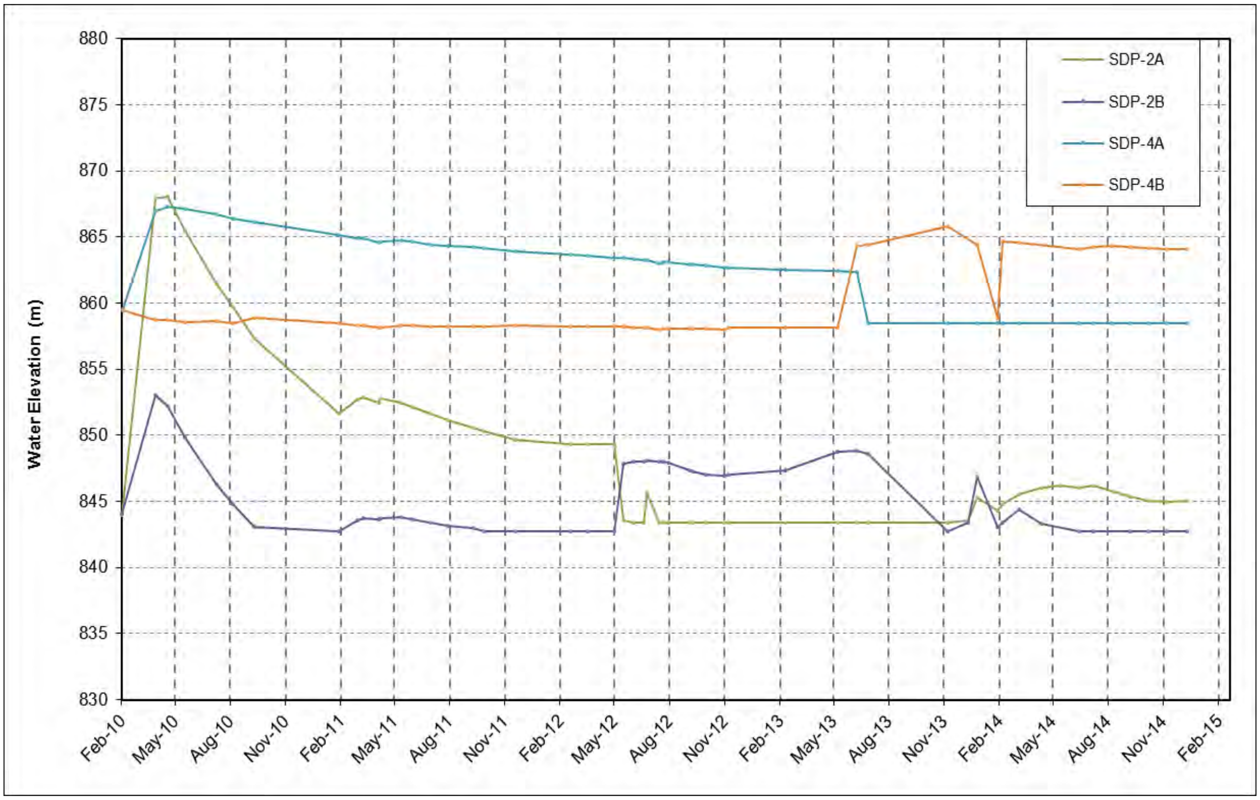


Figure 5-97: Southwest Dump Piezometer Data (2010-2014)

5.17.2.3 Water Storage Pond Dam Piezometers

Data collected from WSP Dam vibrating wire piezometers are presented in Figure 5-98. WDP-2, WDP-3, WDP-5, and WDP-11 are reading negative pressures and have not been included in the figure. Data are collected monthly.

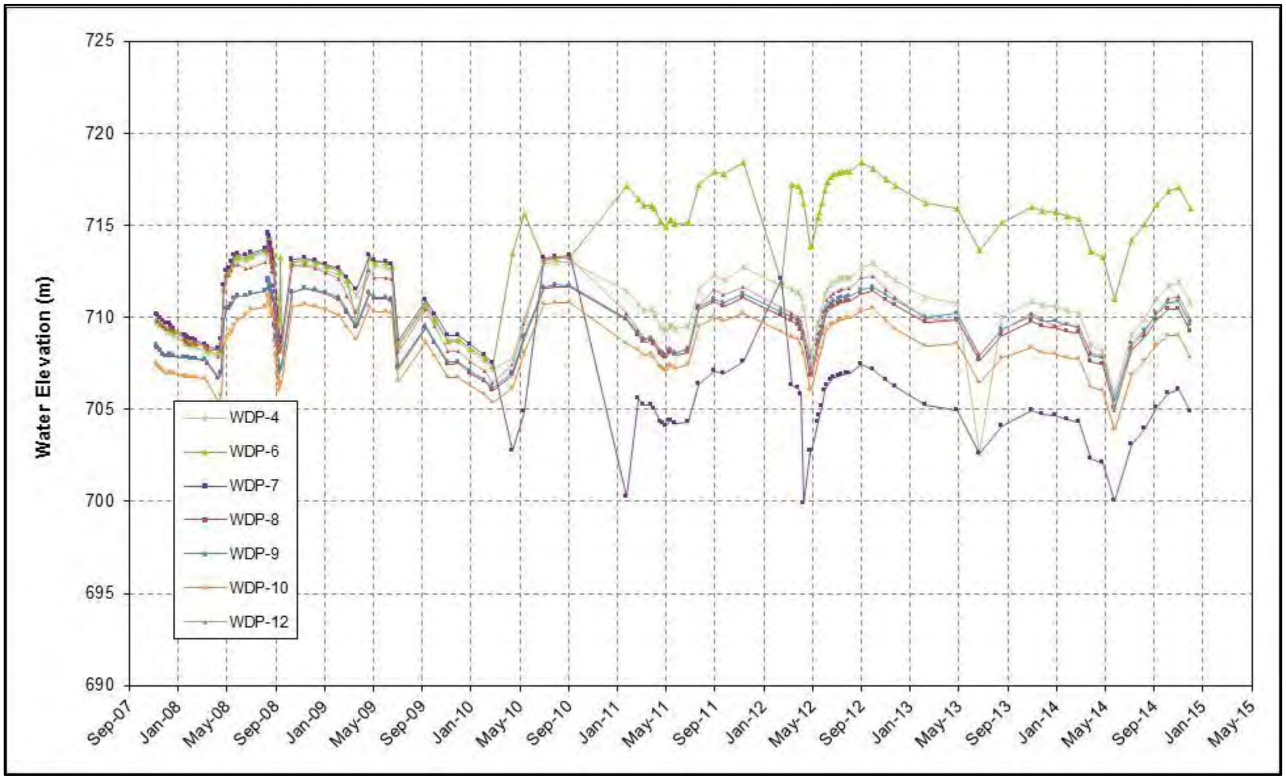


Figure 5-98: WSP Dam Piezometer Data (2007-2014)

5.17.3 Ground Temperature Cables

There are currently twenty-two operating thermistors (ground temperature cables) installed on site, listed in Table 5-55. There were no changes to the operational status of any of the existing thermistors in 2014. Summaries of data collected from each thermistor are contained in the following sections.

Table 5-55: Thermistor Summary (2014)

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

5.17.3.1 DSTSF Thermistors

Data collected from DSTSF thermistors are presented in Figure 5-99 through Figure 5-104. Data are collected monthly (only quarterly data are shown in the figures for clarity). No major changes to ground temperatures at the DSTSF were observed in 2014.

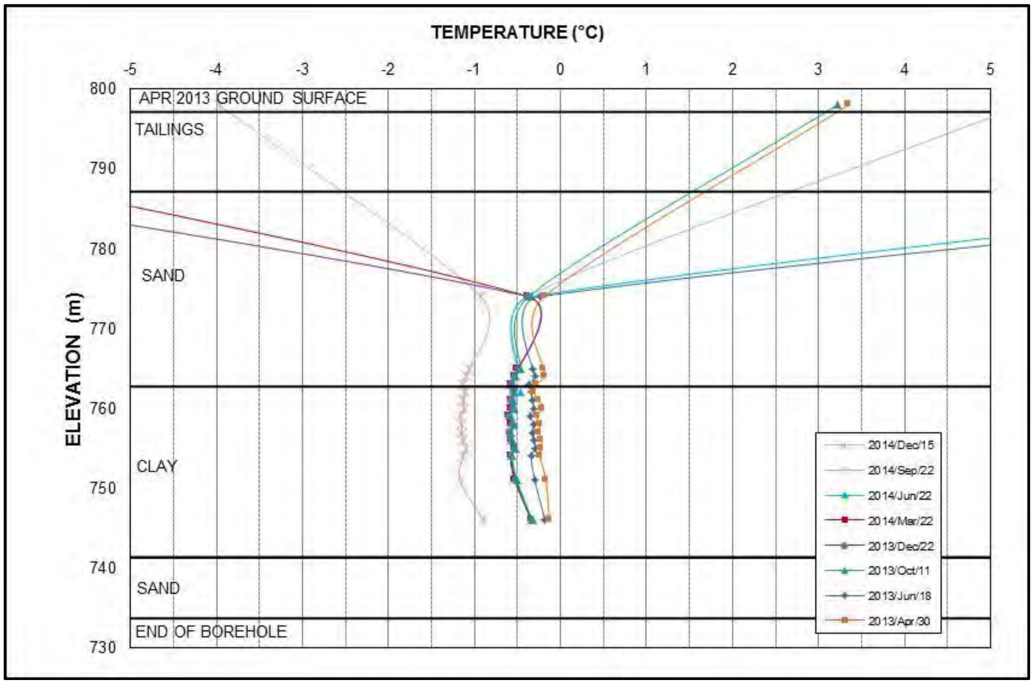


Figure 5-99: Thermistor DST-10 (2013-2014)

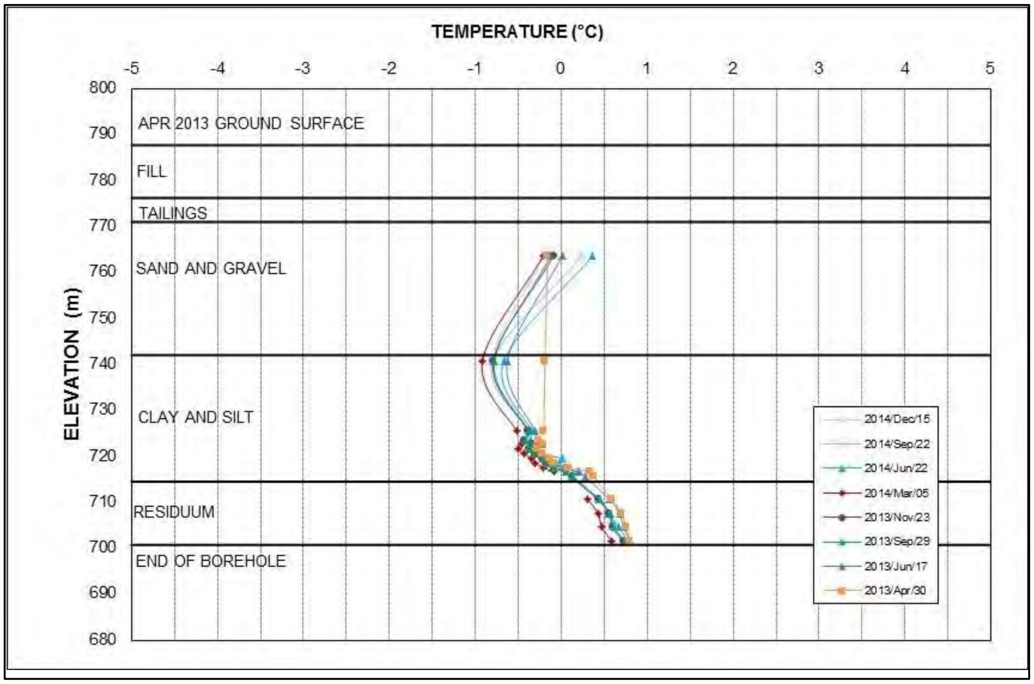


Figure 5-100: Thermistor DST-11 (2013-2014)

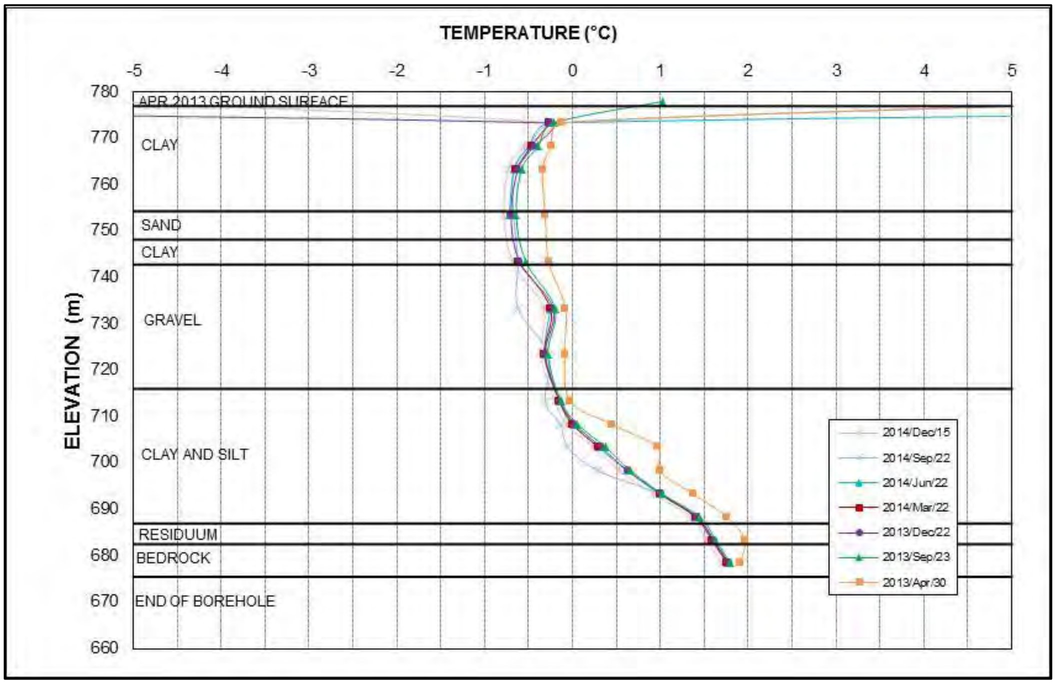


Figure 5-101: Thermistor DST-13 (2013-2014)

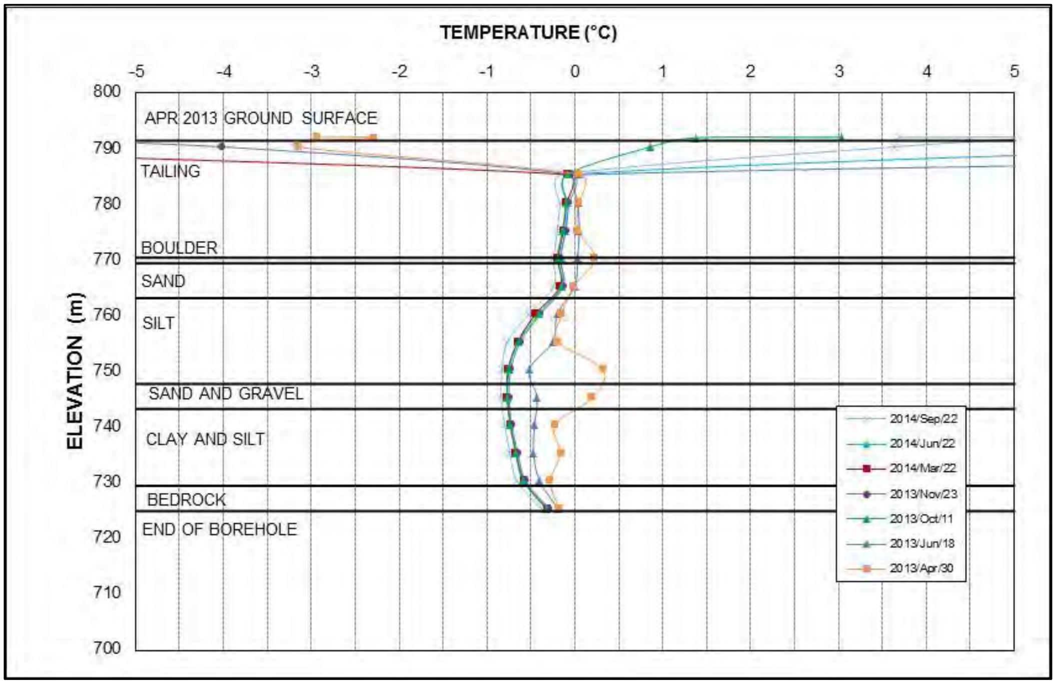


Figure 5-102: Thermistor DST-14 (2013-2014)

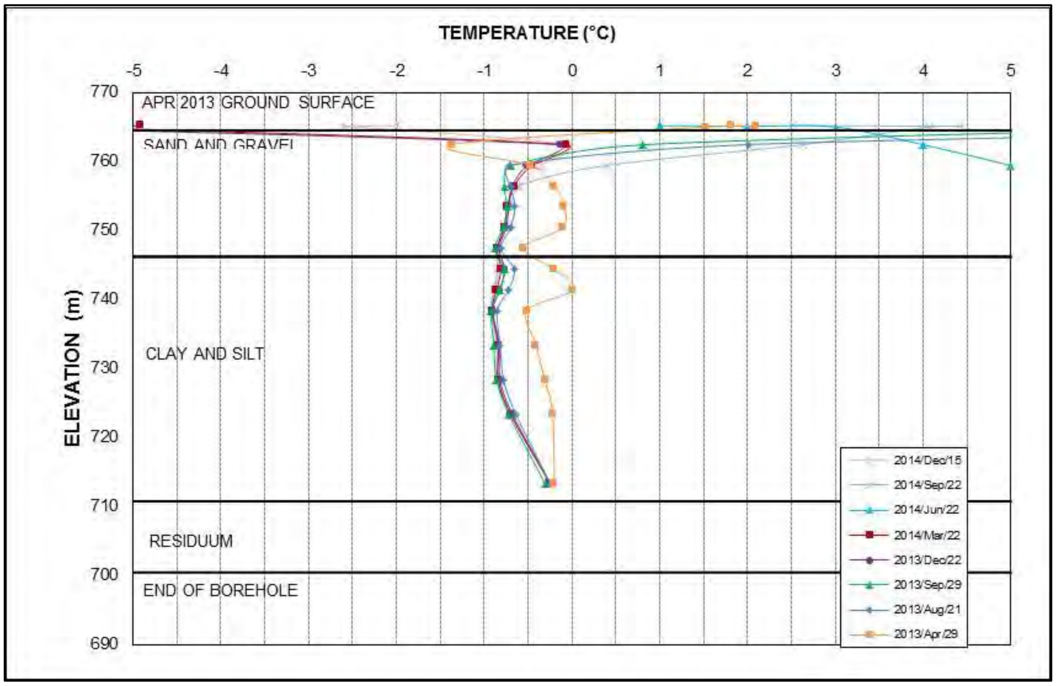


Figure 5-103: Thermistor DST-15 (2013-2014)

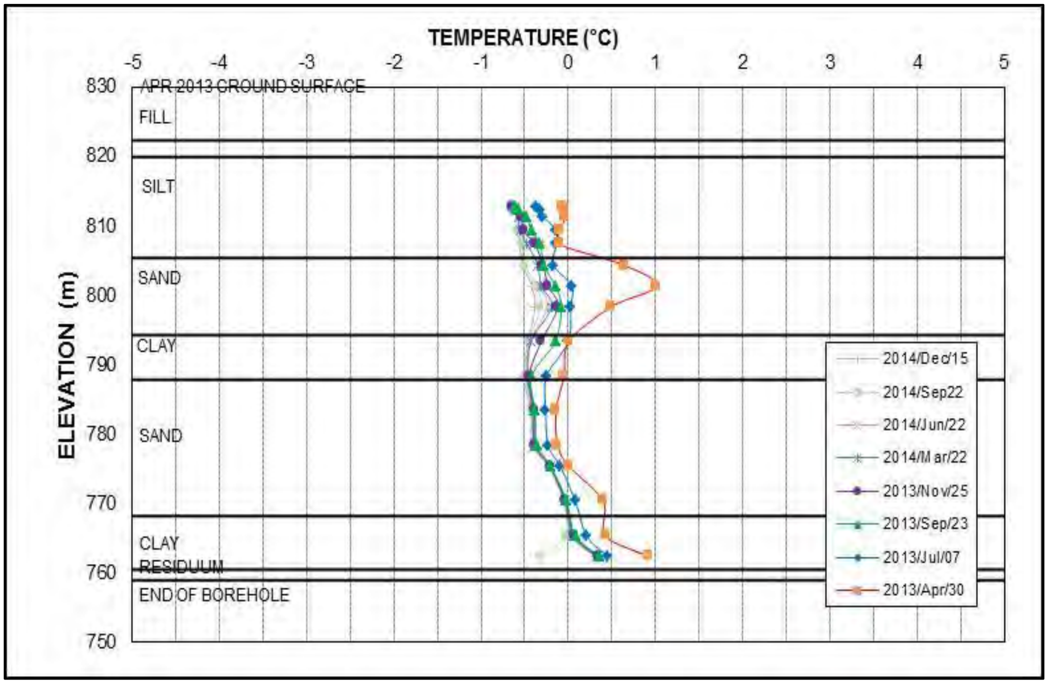


Figure 5-104: Thermistor AT2-1 (2013-2014)

5.17.3.2 Mill Water Pond Thermistors

Data collected from Mill Water Pond thermistors are presented in Figure 5-105 and Figure 5-106. Data are collected quarterly. No major changes to ground temperatures at the Mill Water Pond were observed in 2014.

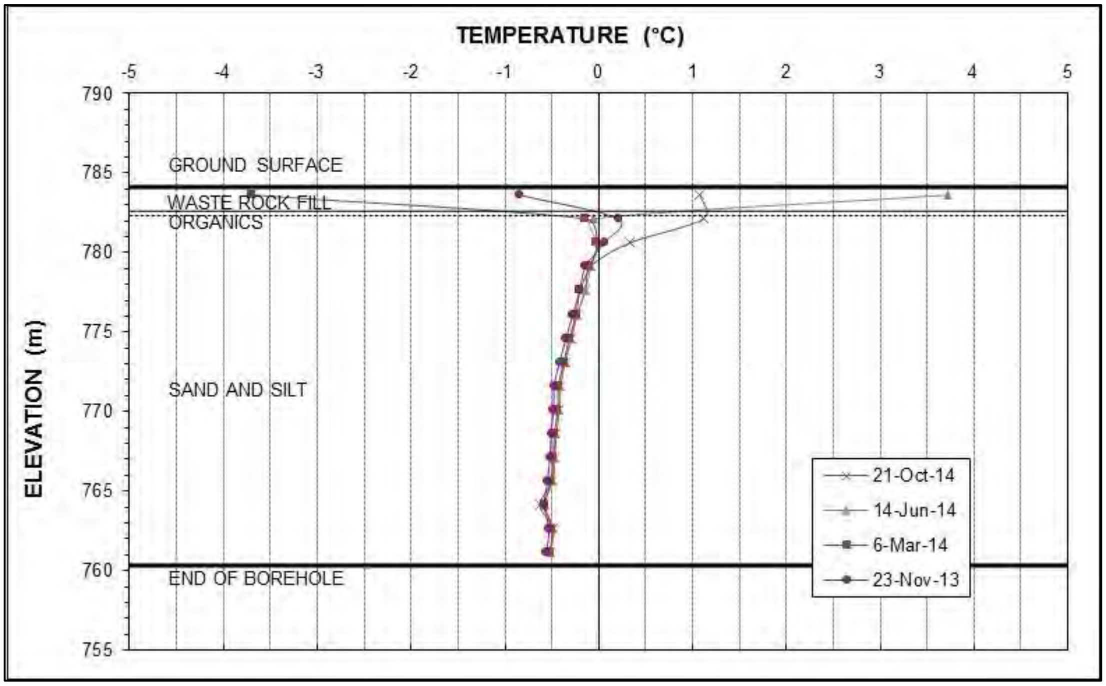


Figure 5-105: Thermistor MWPT-1 (2013-2014)

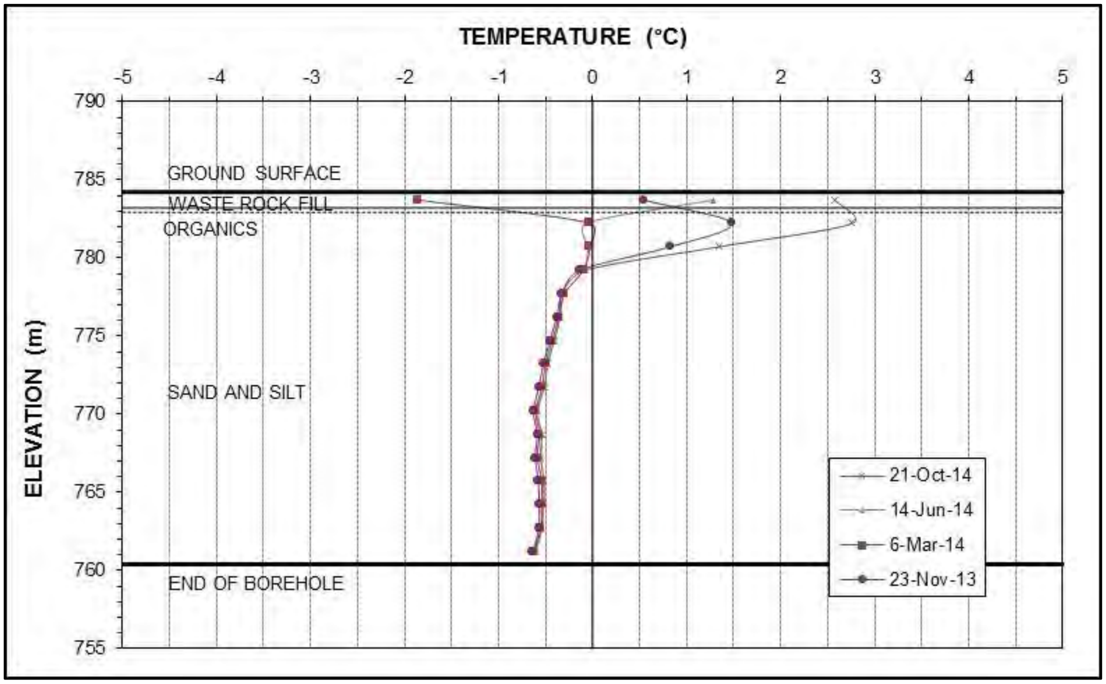


Figure 5-106: Thermistor MWPT-2 (2013-2014)

5.17.3.3 Southwest Dump Thermistors

Data collected from SWD thermistors are presented in Figure 5-107 through Figure 5-110. Data are collected monthly (only quarterly data are shown in the figures for clarity). No major changes to ground temperatures at the SWD were observed in 2014.

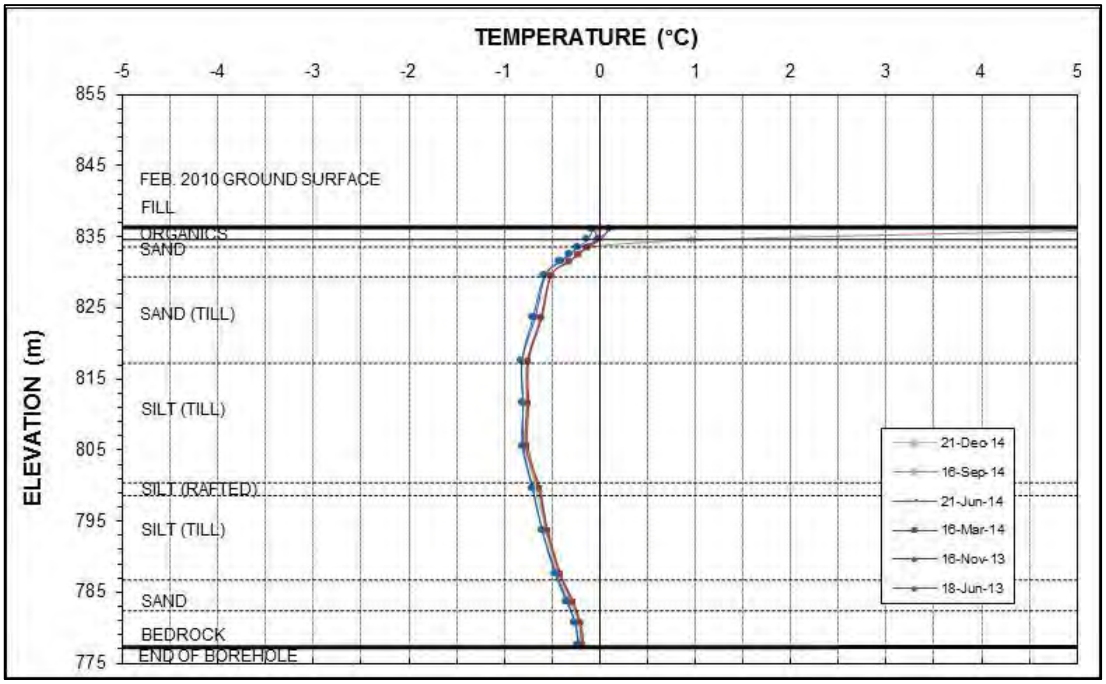


Figure 5-107: Thermistor SDT-1 (2013-2014)

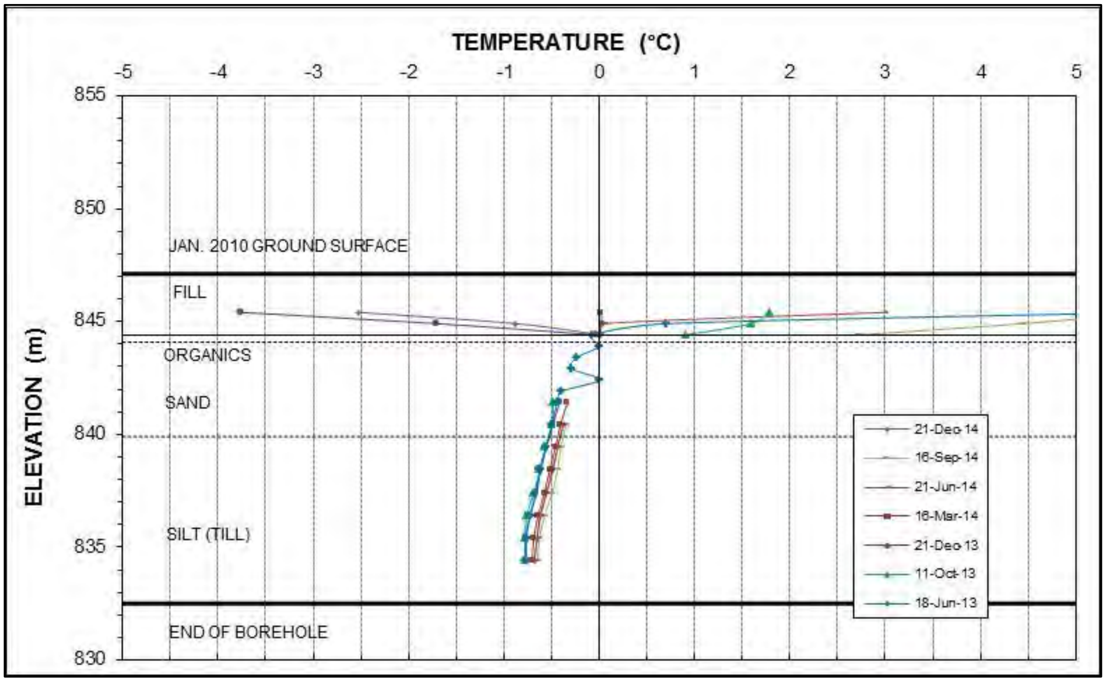


Figure 5-108: Thermistor SDT-2 (2013-2014)

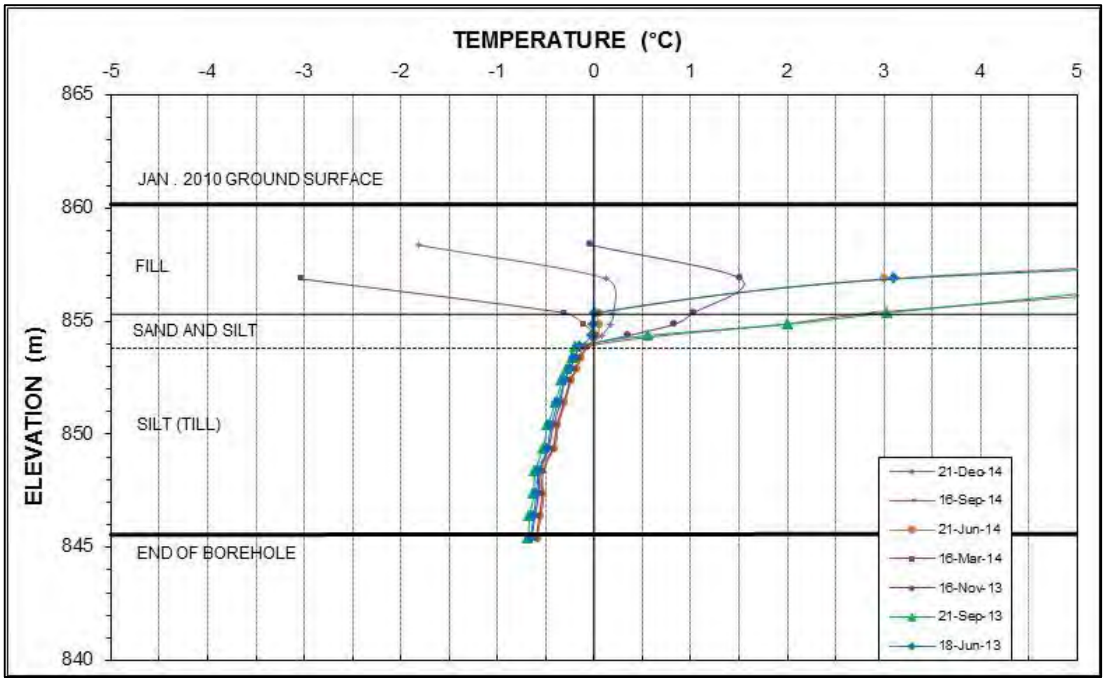


Figure 5-109: Thermistor SDT-3 (2013-2014)

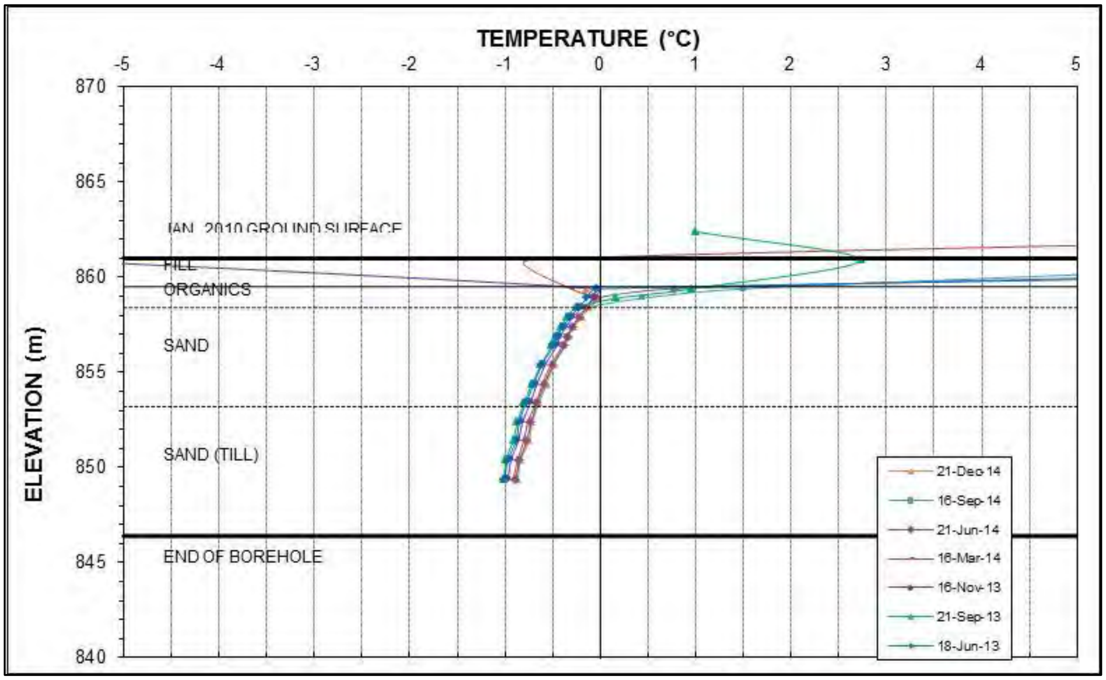


Figure 5-110: Thermistor SDT-4 (2013-2014)

5.17.3.4 Water Storage Pond Dam Thermistors

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

5.18 Waste Rock Verification Program

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

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

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

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

Between July and September of 2014, thirty-four samples of Low Grade Waste (LGW) were collected from the SWD, and twenty-four samples of Medium Grade Waste (MGW) were collected from the SWD dump. All waste material placed in these dumps during this period consisted of exclusively of LGW and MGW from the Area 118 Pit. As there was no placement of waste in either of the dumps after the completion of the Area 118 Pit in October 2014, no verification samples were taken for the remainder of 2014.

Of the sixty-two samples taken, sixty met the pass criteria based on the NP/AP segregation criteria. As the two failures were determined to be isolated events, no further sampling was required. The average monthly values of the Acid-Base Accounting (ABA) parameters for each dump location are summarized in Table 5-56, below. For a complete summary of the sample results, please refer to Appendix N.

Table 5-56: Waste Rock Management Verification Program Summary (2014)

Average ABA Parameter Values: Month By Location								
Location	**Month**	**Waste Type**	**Cu%**	**C% (Tot)**	**S% (Tot)**	**NP**	**AP**	**NP/AP**
SWD	Jul	LGW	0.133	0.253	0.030	21.04	0.94	272
	Aug	LGW	0.030	0.225	0.001	18.72	0.03	599
	Sep	LGW	0.066	0.269	0.030	22.44	0.94	131
SWD	Jul	MGW	0.210	0.293	0.086	24.37	2.68	71
	Aug	MGW	0.164	0.354	0.082	29.46	2.56	364
	Sep	MGW	0.207	0.338	0.129	28.13	4.04	28

5.19 Acid-Base Accounting Program

Appendix 6 of the WUL requires submission of the results of the ABA Program that was conducted during the reporting year. The ABA program determines the Neutralizing Potential Ratio ((defined as Neutralizing Potential divided by Acid Potential [NP/AP]) (NPR)) for overburden and waste rock to confirm that the NPR is greater than three. An NPR value of three or greater is generally considered indication of non-acid generating material. A separate, parallel program was initiated to determine the NPR of the tailings solids.

The following is a summary of results from the ABA program for the monitoring period January to December 2014. The second 2014 semi-annual report is provided in Appendix O while the first semi-annual report was submitted in September 2014.

A total of 186 samples were collected from the Area 2 Pit and Area 118 Pit and sent to the accredited laboratory (SGS CEMI Ltd.) during the 2014 monitoring period. The samples were analyzed according to the BC Research Standard Method as required by the WUL. The mean NPR results for waste rock samples was 5.3 for the duration of the monitoring period.

Twenty samples during the 2014 monitoring period were below the NPR threshold of three. Paste pH values were all above the required threshold of 5 with a mean value of 8.56. The mean sulphide sulphur (SS) content for waste rock samples during the 2014 monitoring period was 0.12%. In 2014, twenty samples were above the SS content for construction grade waste (waste grading Cu <0.1%, NPR>3, SS<0.3%).

Tailings samples analyzed in this period had a mean NPR of 18.6. All tailings samples were within the required limits (NPR >4). All twelve samples of tailings were also compliant in Paste pH and SS content.

In 2015, Minto Mine will continue with the waste rock dispatching system implemented in 2012.

5.20 Physical Monitoring Program

Minto's physical monitoring program consists of a combination of instrumentation and visual inspections. Site wide inspections are carried out quarterly, three of which are completed internally by Minto's geotechnical engineer and one by an external geotechnical engineering consultant in accordance with Clause 13.2 of the QML. As specified in the WUL and *Minto Physical Monitoring Plan*, the following regular inspections are also performed:

- Waste rock and overburden dumps – daily during construction; following precipitation events with greater than 25 mm in a 24 hour period;
- Diversion ditch – daily during water conveyance;
- WSP dam – weekly (seepage), monthly (stability); and
- Mill water pond – weekly (seepage).

Deformation monitoring instrumentation includes survey hubs and borehole inclinometers, described in the following sections. A layout of physical monitoring instrumentation is provided in Figure 5-111, below.

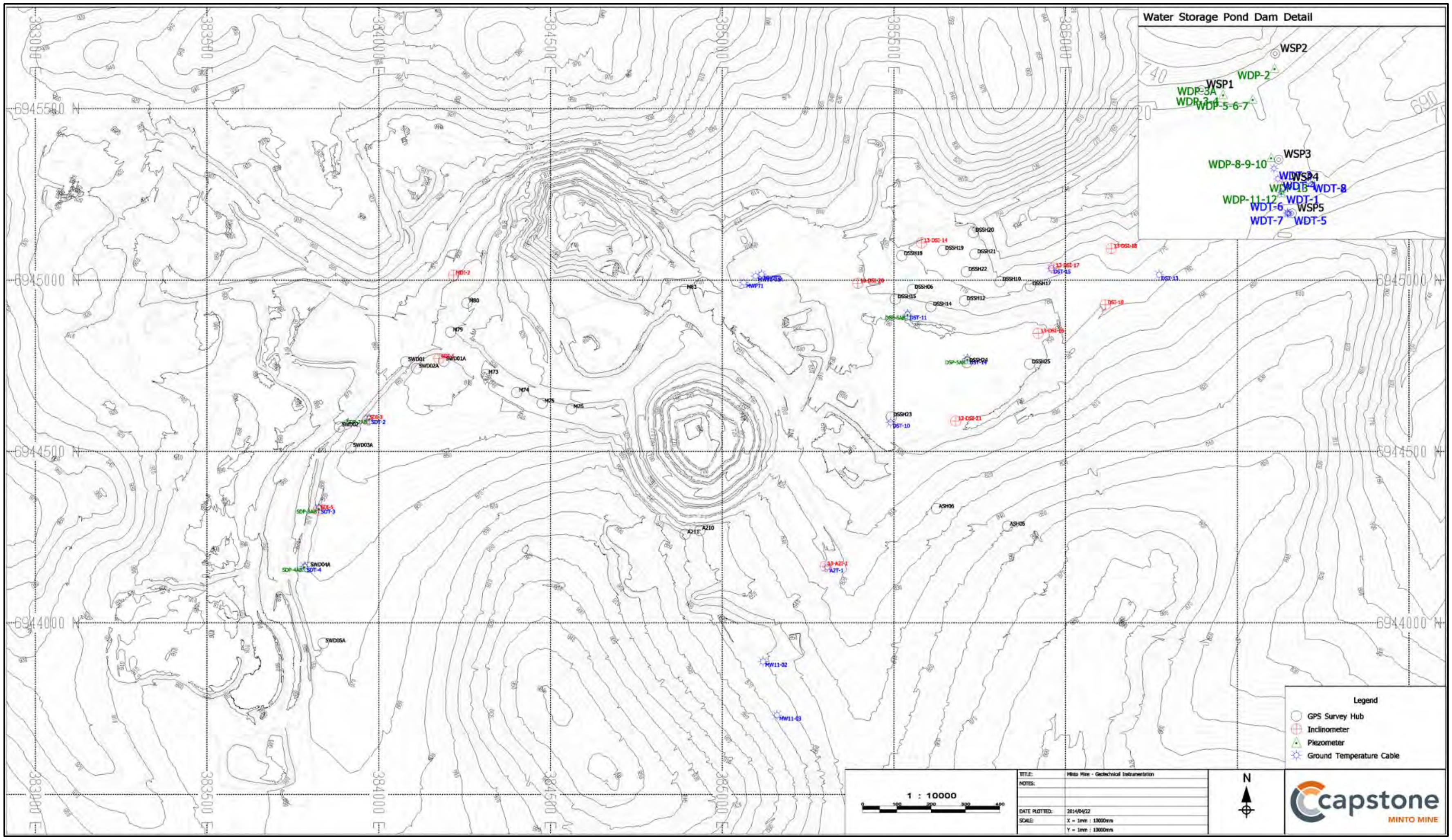


Figure 5-111: Physical Monitoring Program Installation (2014)

5.21 Physical Deformation Monitoring Instrumentation

5.21.1 Survey Hubs

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

5.21.1.1 Main Pit/South Wall Buttress Survey Hubs

There are currently eight operating survey hubs on the Main Pit south wall buttress. There was no change to the operational status of any the hubs in 2014. Data collected are presented in Figure 5-112. Data are currently collected bi-weekly. In general the movement rates continued a gradual decrease in 2014, with rates now nearing zero movement in some of the hubs.

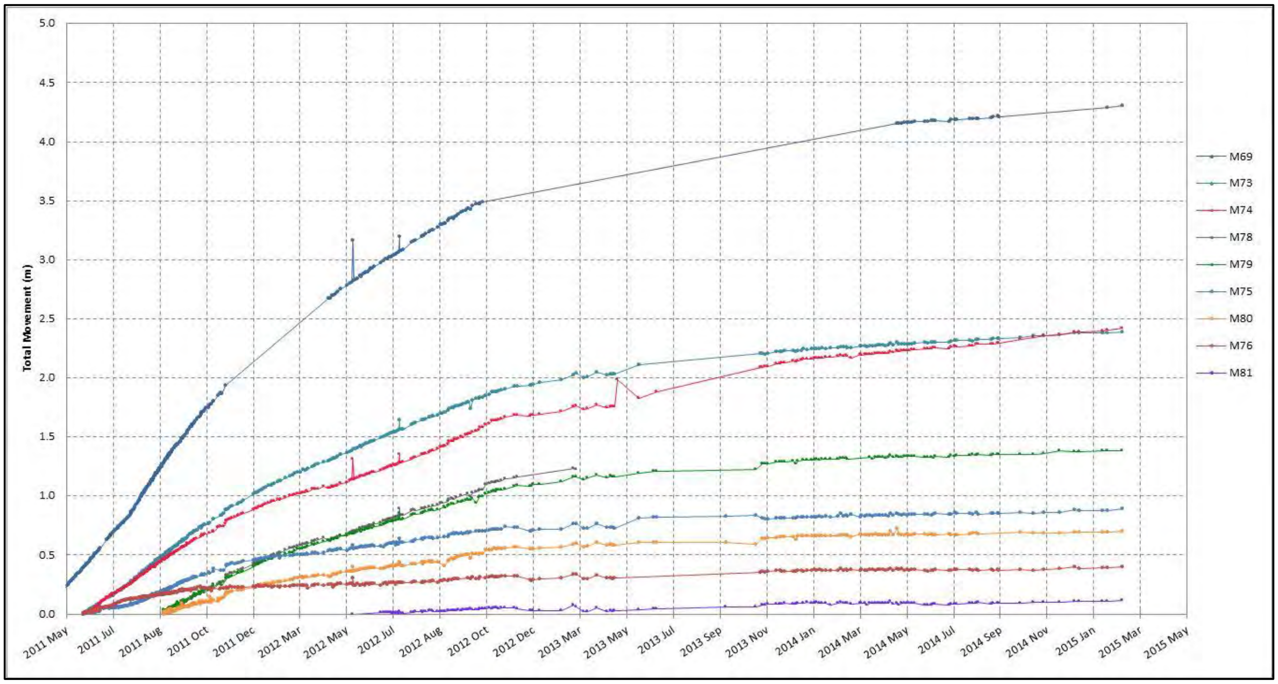


Figure 5-112: Main Pit/South Wall Buttress Survey Hub Data (2011-2014)

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

There are currently fourteen operating survey hubs on the DSTSF and MVF. Eight of these, DSSH-18 to DSSH-25 were installed in 2014. Data collected are presented in Figure 5-113. Data are collected weekly. All hubs indicated a continued very gradual decrease in movement rates in 2014.

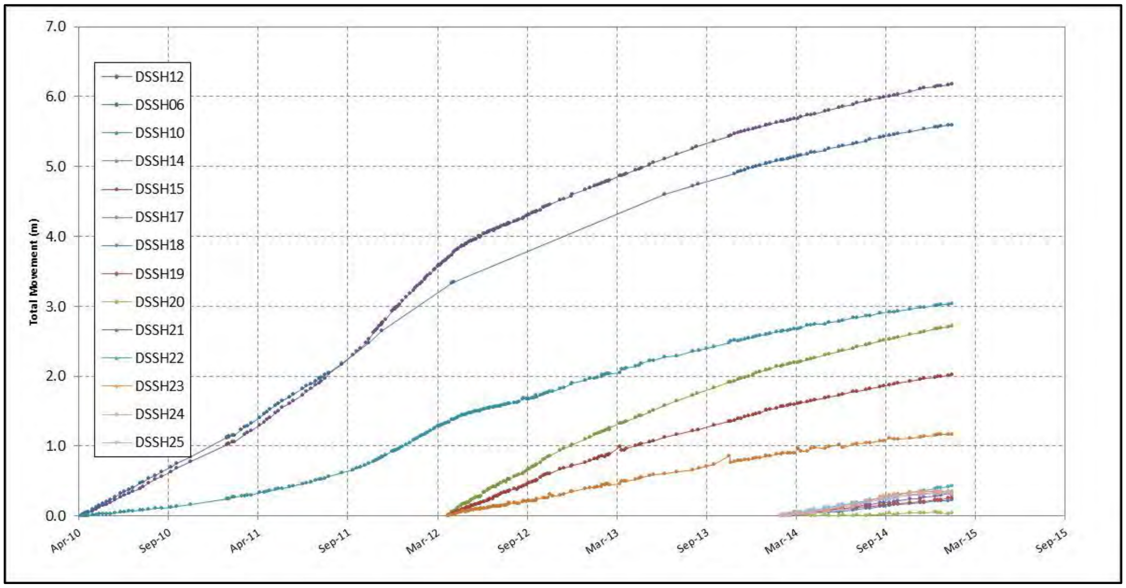


Figure 5-113: DSTSF Survey Hub Data (2010-2014)

5.21.1.3 Southwest Dump Survey Hubs

There are currently five operating survey hubs on the SWD. SWD-03A and SWD-05A are loose in the ground and not considered reliable and have not been included. Data collected are presented in Figure 5-114. Data are collected monthly. Hubs indicated relatively consistent movement rates in 2014.

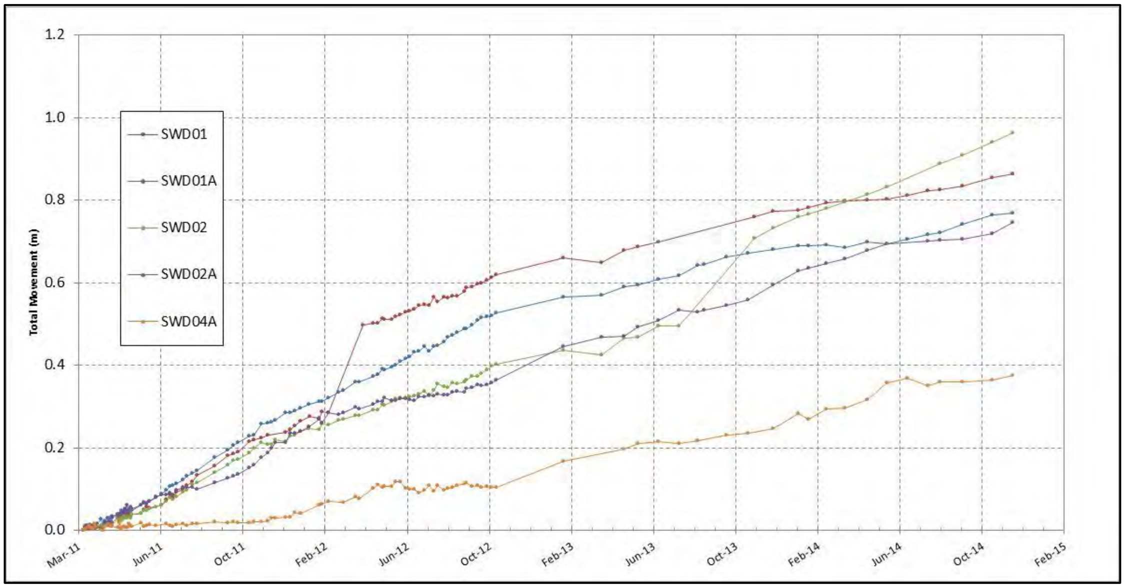


Figure 5-114: SWD Survey Hub Data (2011-2014)

5.21.1.4 *Water Storage Pond Dam Survey Hubs*

There are currently four operating survey hubs on the WSP dam. There was no change to the operational status of any the hubs in 2014. Data collected are presented in Figure 5-115. Data are collected monthly. Data continue to indicate no movement of the dam.

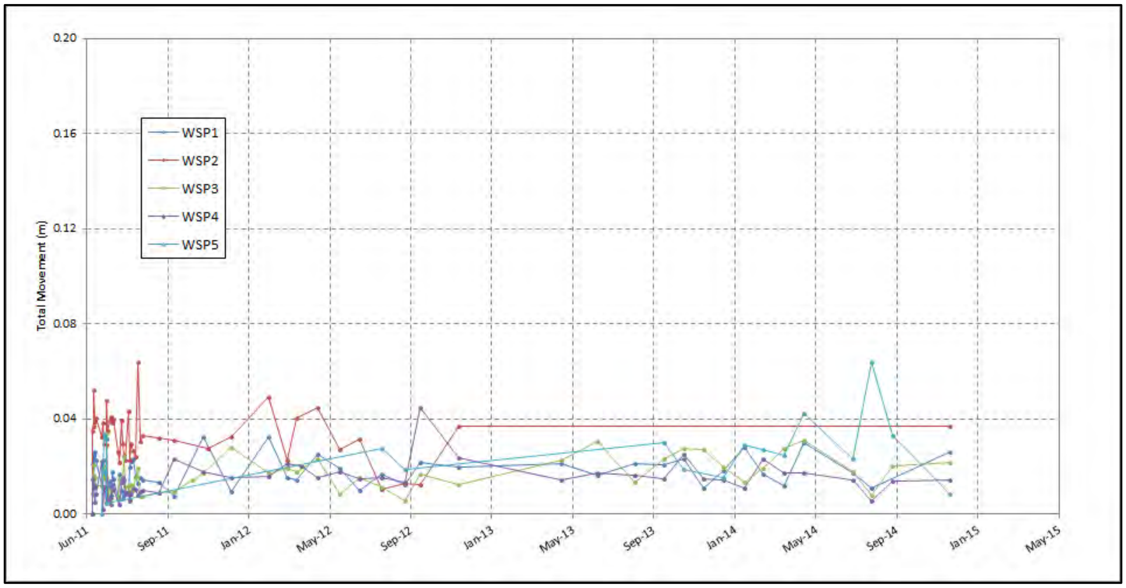


Figure 5-115: Water Retention Dam Survey Hub Data (2011-2014)

5.21.2 Inclinometers

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

5.21.2.1 *DSTSF Inclinometers*

There are currently four operating inclinometers in the DSTSF area. Data collected for the most recent surveys in 2014 relative to the original surveys are presented in Figure 5-116 through Figure 5-119. DSI-14 and DSI-21 are monitored bi-weekly; DSI-10 is monitored bi-monthly; and A2I-1 is monitored quarterly. Only one reading for DSI-10 was taken due to access issues in 2014.

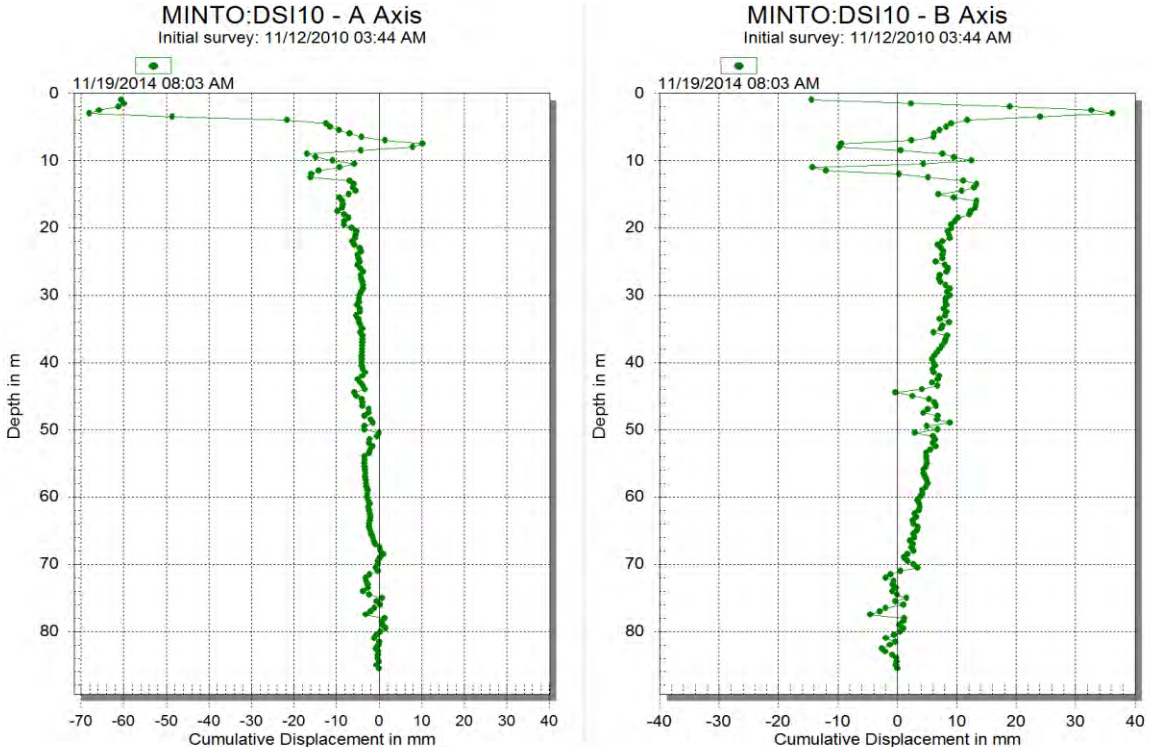


Figure 5-116: DSTSF Inclinometer DSI-10 (2014)

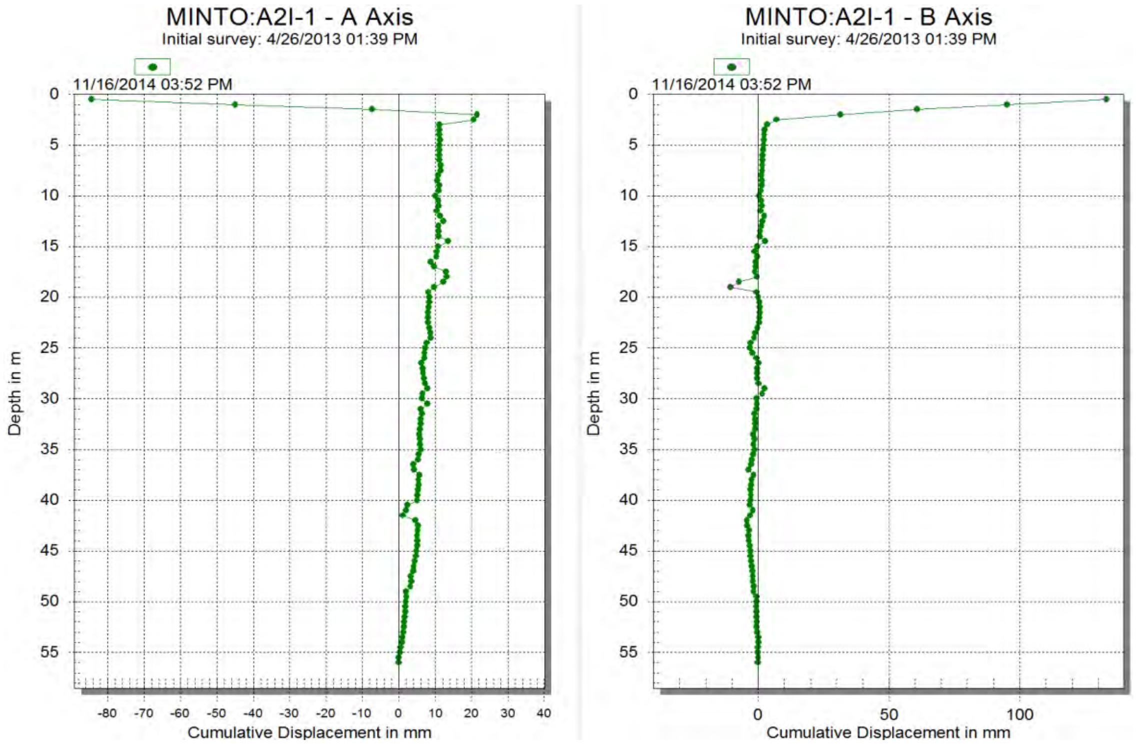


Figure 5-117: DSTSF Inclinometer A2I-1 (2014)

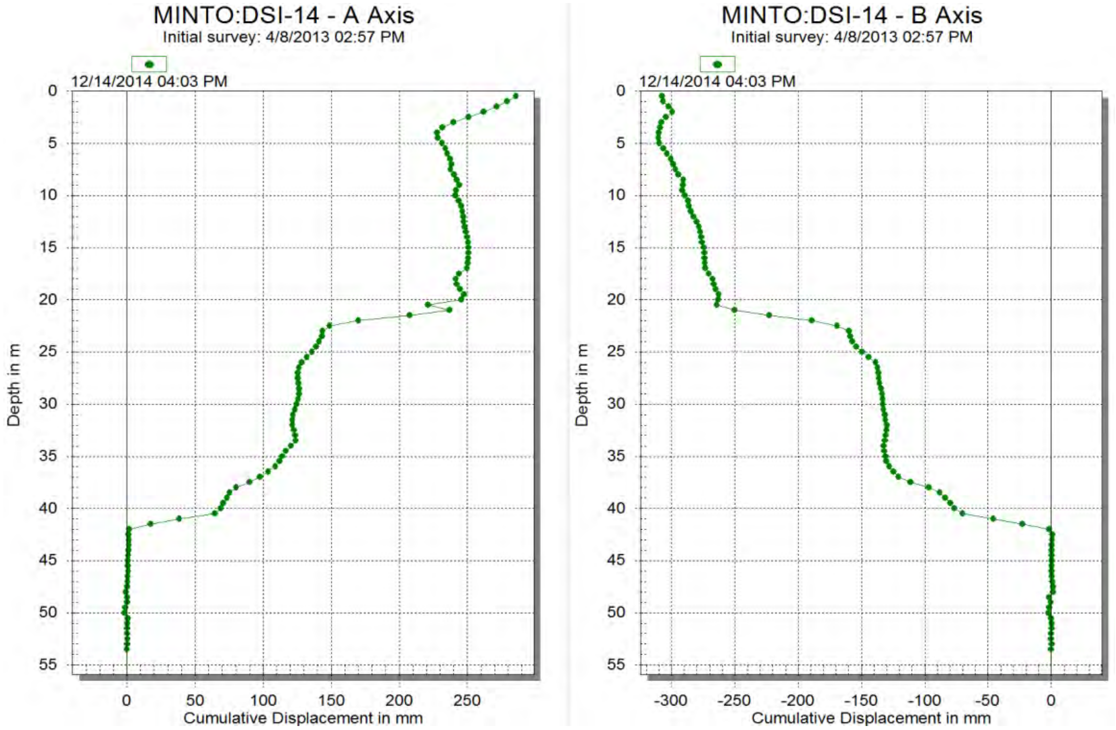


Figure 5-118: DSTSF Inclinometer DSI-14 (2014)

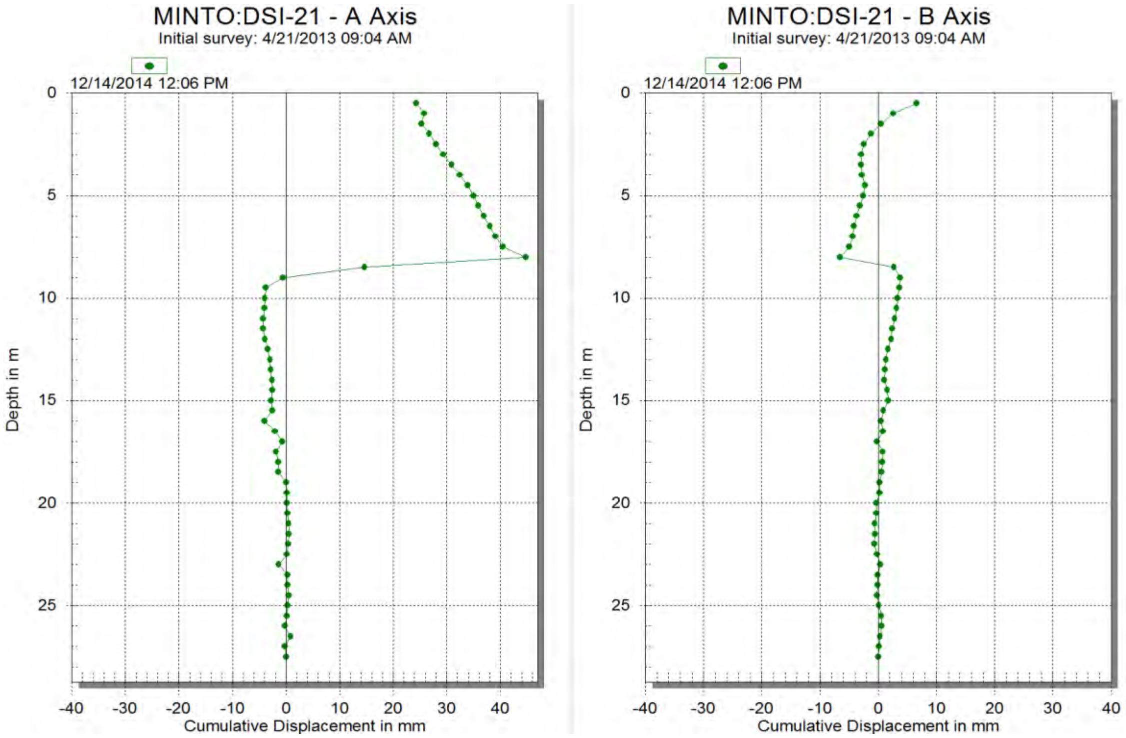


Figure 5-119: DSTSF Inclinometer DSI-21 (2014)

5.21.2.2 Main Pit Inclinometers

There is currently one operating inclinometer in the Main Pit west/south wall area. Readings re-commenced in October 2013 after not having been recorded since November 2012. Data are now collected monthly. Data collected for the most recent survey are presented in Figure 5-120.

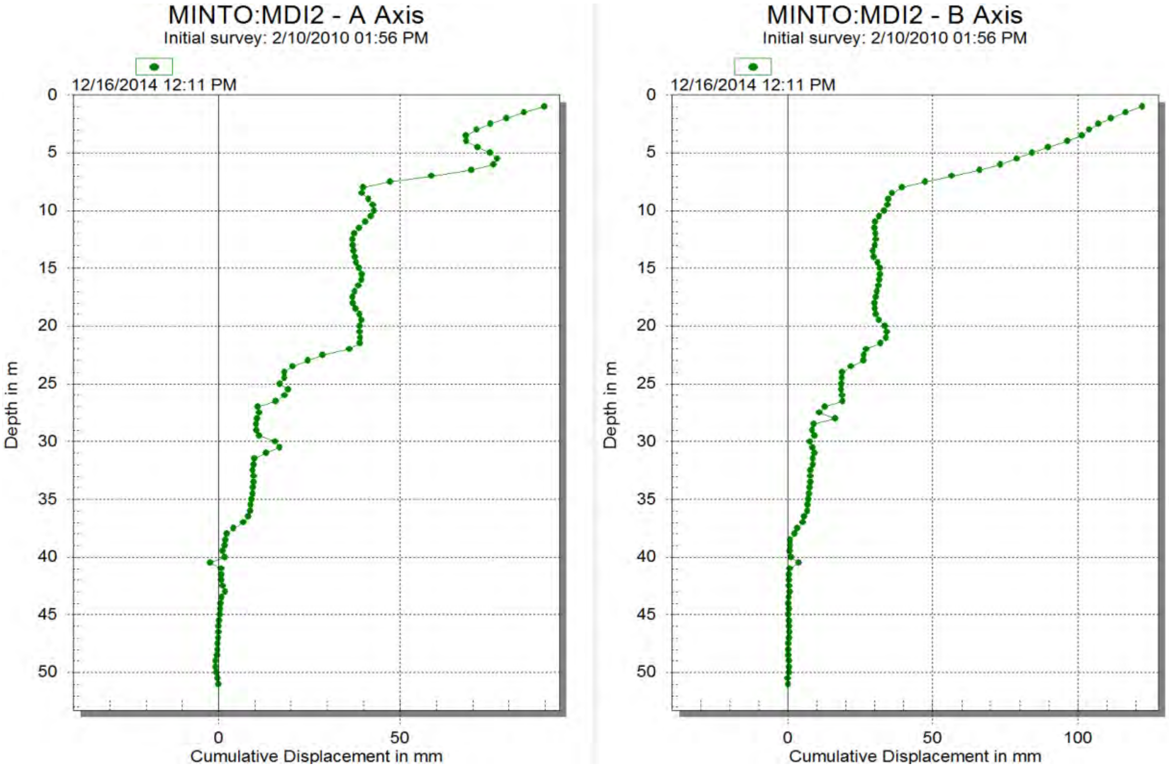


Figure 5-120: Main Pit Inclinometer MDI-2 (2014)

5.22 Engineer's Annual Physical Inspection Reports

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

- Big Creek Bridge;
- Mill and Camp;
- DSTSF;
- Fuel Containment Facility;
- MWD;
- MCDS;
- Mill Water Pond;
- ROD;
- SDD; and
- SWD;
- WSP Dam.

Table 5-57 summarizes the recommendations from the most recent external inspection in November 2014 and the associated planned actions.

Table 5-57: Annual Physical Inspection Report Summary (2014)

Area	Recommendation	Action
General	The condition of all survey hubs on site should be reviewed. Hubs experiencing frost heave should be noted and replaced with hubs that are not susceptible to frost heave. Alternate installation methods could include grouting a hub mount to a large boulder, using a deeper post, and/or welding a base plate (1 m x 1 m) to the base of the post and placing in a deep pit excavation backfilled with compacted, non-frost susceptible materials.	Survey hubs were inspected and photographed in November, 2014. Replacement hubs for those deemed unreliable will be installed in spring 2015.
DSTSF & MVFE	Re-grade the DSTSF overburden surface to promote runoff once the final cover design has been determined and cover the remaining areas of exposed tailings on the south edge of the facility.	Currently a temporary 1 m thick nominal overburden cover has been installed on the DSTSF, meeting the requirements of the Phase IV water licence. The area is relatively large and though the initial design had grade to it, it was insufficient to be achieved in practice and has resulted in spots that pond water. Final cover construction (addition of a much thicker cover) and re-grading will be completed using overburden from Area 2 Stage 3 open pit mining, currently scheduled for 2016 as part of a short haul in the Phase V/VI waste management plan. There is a section of the DSTSF along the south side which requires filling with overburden as well - currently water

Area	Recommendation	Action
		collects along the full extent of the south edge of the DSTSF and seeps into the tailings. The fill required for this is fairly significant and material from Area 2 Stage 3 is planned to be used to complete this.
	Continue to monitor the 2013 crack and settlement area in the MVFE.	Visual inspections are carried out as part of the quarterly geotechnical site inspections.
	Continue to monitor the 2014 crack and install two survey nails/pins (one on each side of the crack) to measure the relative displacement. Consider spray painting lines across the crack to aid in monitoring any future displacement.	Cracks are now covered in snow so will not be painted until the summer. Monitoring instrumentation will be installed in Spring, 2015 when the crack is exposed.
MWD	None	None
SWD	Complete reading of the survey hub and slope inclinometers on at least a monthly and bi-monthly basis, respectively, and continue monitoring ground movement rates. Notify SRK Consulting of any other observations or increases in movement that indicate a significant change in dump performance or dump stability.	Survey hubs are currently read monthly and inclinometers are read bi-weekly. Geotechnical inspections are carried out quarterly.
	The tension crack area at the north end of the SWD should be re-graded to lessen the dump slope if the north access ramp is to be re-opened to traffic. Re-grading of this area is planned as part of the upcoming re-grading of the SWD.	Re-grading for closure is currently underway.
	The survey hubs at the toe of the dump should be replaced and installed using a different methodology that will mitigate against frost heave. Placement of replacement hubs should consider avoiding areas of fine sediments prone to pile heaving due to frost action, and re-grading of the SWD.	New/replacement survey hubs will be installed once final re-grading for closure is completed, expected to be mid to late 2015. Current hubs will continue to be monitored until that time.
	Continue to monitor erosion at the culvert outlet located near the W15 Detention Structure and maintain a photographic record to inspect for changes in condition.	Monitoring, including photographs, is carried out quarterly as part of the site geotechnical inspections.
	Continue to monitor sediment accumulation in the culvert at the inlet and outlet. Maintain a photographic record to inspect for changes in condition.	Monitoring, including photographs, is carried out quarterly as part of the site geotechnical inspections.
ROD	Continue to monitor the slope failure area for further signs of movement or instability.	Monitoring, including photographs, is carried out quarterly as part of the site geotechnical inspections.

Area	Recommendation	Action
Mill and Camp Site	Continue to monitor the retaining wall near the mill's apron feeder tunnel and maintain a photographic record of its condition.	Monitoring, including photographs, is carried out quarterly as part of the site geotechnical inspections.
	Re-grade the area above the erosion channels on the camp pad to promote runoff away from these areas.	A work plan will be developed for the spring to re-grade where possible (note this may be limited due to extensive infrastructure in this area).
	In addition to the surface re-grading, fill the channel by the carpenter's shop with rip-rap or a half culvert to provide a path for the water to drain. In place of the surface grading, consider constructing a small ditch near the slope crest to direct runoff to the drop channel or half culvert.	See above, a work plan will be developed for the spring which will combine ditching and half culverts or HDPE pipe to direct the water to controlled areas and prevent further erosion of the slope.
Mill Water Pond	Re-establish survey hubs and collect monthly data until results are consistent. Reduce monitoring frequency to biannual thereafter.	The Mill Water Pond is no longer in use and plans to fill the pond to increase stockpile space near the crusher have been proposed.
	If the Mill Water Pond is to be brought back into service the following actions are recommended: • Patch tears in the liner system. • Fill the voids under the tears before patching. • Clean out sediments accumulated in the surface runoff ponds and culverts	The Mill Water Pond is no longer in use and plans to fill the pond to increase stockpile space near the crusher have been proposed.
SDD	Cover the exposed liner as per the channel design.	The exposure is now covered in snow. When exposed in the spring it will be covered. It is very small and near the top of the slope so it is not expected to affect ditch performance prior to repair.
MCDS	Continue annual monitoring for further signs of instability or seepage on the downstream slope of the MCDS.	Regular monitoring is carried out by the Environmental Department. Quarterly monitoring is carried out as part of the site geotechnical inspections.
WSP Dam	Continue regular monitoring of the dam, noting specifically the clarity of the seepage and flow exiting the stilling basin and the seepage rate through the weir.	Dam inspections are carried out monthly by Minto's Geotechnical Engineer. Inspection reports are stored in the Mine Technical Building.
	The discharge point of the water (from the pit, water treatment plant, etc.) influences the seepage pump data at W3 in the seepage pump house. Options to	This recommendation should refer to W17, not W3. The discharge point was extended further past W17 in November 2014.

Area	Recommendation	Action
	obtain accurate seepage measurements should be explored such as moving the discharge point a further downstream of the pump house. The issue should be resolved prior to 2015 spring melt.	
Big Creek Bridge	Continue regular annual monitoring of sediment accumulation in the culverts. If sediments continue to accumulate, clean them out.	Quarterly monitoring is carried out as part of the site geotechnical inspections.
South Wall Buttress	The tension crack area in the In-Pit Dump should continue to be monitored. A photographic record should be maintained to inspect for changes in condition. Following completion of the buttress, additional survey hubs should be installed along the crest to monitor movement.	Note this recommendation refers to the in-pit dump which is not part of the designed and built south wall buttress. Three survey hubs, M82, M83 and M84 were installed along the crest referred to in January 2015. Monitoring, including photographs, is carried out quarterly as part of the site geotechnical inspections.
	Additional survey hubs should be installed along the South Wall Buttress crest to monitor movement.	Additional hubs will be installed in spring 2015.

6 Reclamation

Reclamation at Minto Mine progressed throughout the monitoring period. The *Minto Mine Phase V/VI Reclamation and Closure Plan* (submitted June, 2014) currently guides the reclamation efforts on-site. The primary focus for progressive reclamation in 2014 included:

- Completion of the DSTSF cover;
- SWD Recontouring; and
- Reclamation Research.

6.1 Dry Stack Tailings Storage Facility Cover

The DSTSF was covered with an initial overburden cover in 2013 and at that time was 92% complete. The remaining 8% that required cover was revaluated in 2014 and was then completed. Clause 37 of the WUL is now fulfilled. Once the final cover design is determined, consideration will be given to the final closure cover of the DSTSF. Figure 6-1, below, identifies the area that was covered in 2014.

Figure 6-1: DSTSF with Highlighted Section Indicating Area Covered in (2014)

6.2 Southwest Dump Recontouring

With the completion of the Area 118 Pit, the SWD was no longer required for waste rock storage as there is no plan to use the SWD in Phase V/VI operations. With the completion of the SWD, the first opportunity, since the MWD, to begin reclamation on a major structure was available. In May 2014, Minto procured the services of SRK Consulting to develop a closure landform design for the SWD. Using information collected from an onsite investigation and operations surveys, SRK Consulting was able to develop a closure landform design incorporating the following goals: ensure slopes are geotechnically stable while avoiding large uniform slopes; and ensure slopes are hydrotechnically stable by reducing or impeding concentrated flow of water and reducing erosion pathways for both water and wind. The preliminary design has slope angles ranging from 3:1 to 13:1 with built in flexibility to allow operations to produce slopes that will vary in slope angle while still meeting design criteria.

In early November 2014, Pelly Construction began recontouring the low grade waste portion of the SWD. Approximately 63,000 m^3 of material was bulldozed in a cut and fill situation which resulted in the completion of recontouring slopes for the low grade waste portion SWD. For the low grade waste portion of the SWD, an estimated average slope angle ratio of 6:1 was achieved. Figure 6-2 shows an as built image of the low grade waste area after recontouring was complete. Figure 6-3 through Figure 6-7 are cross sections of the slopes which show the slope angle of the given cross section.

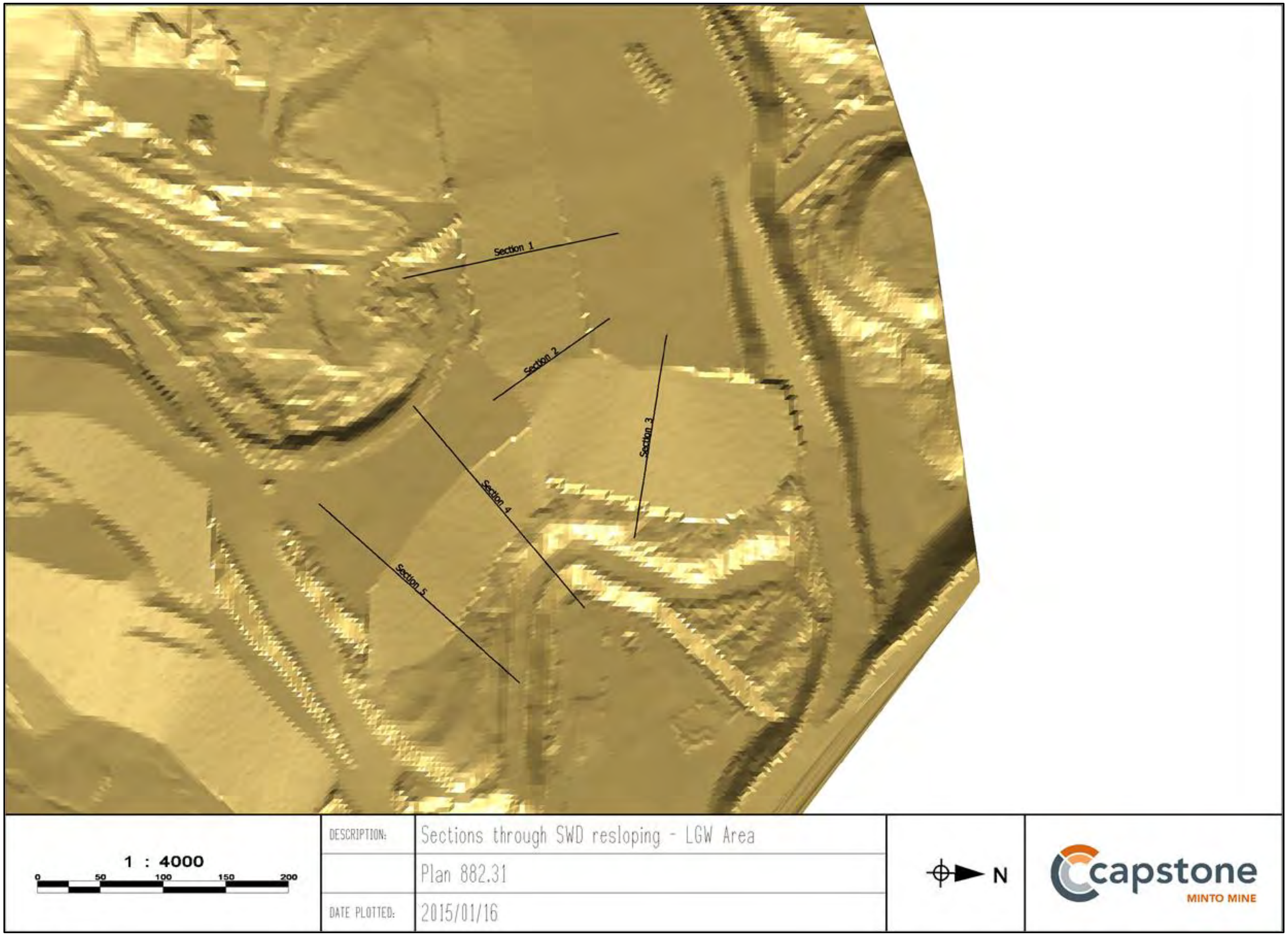


Figure 6-2: As Built Image of the Low Grade Waste Area of the SWD, Depicting 5 Cross Sections

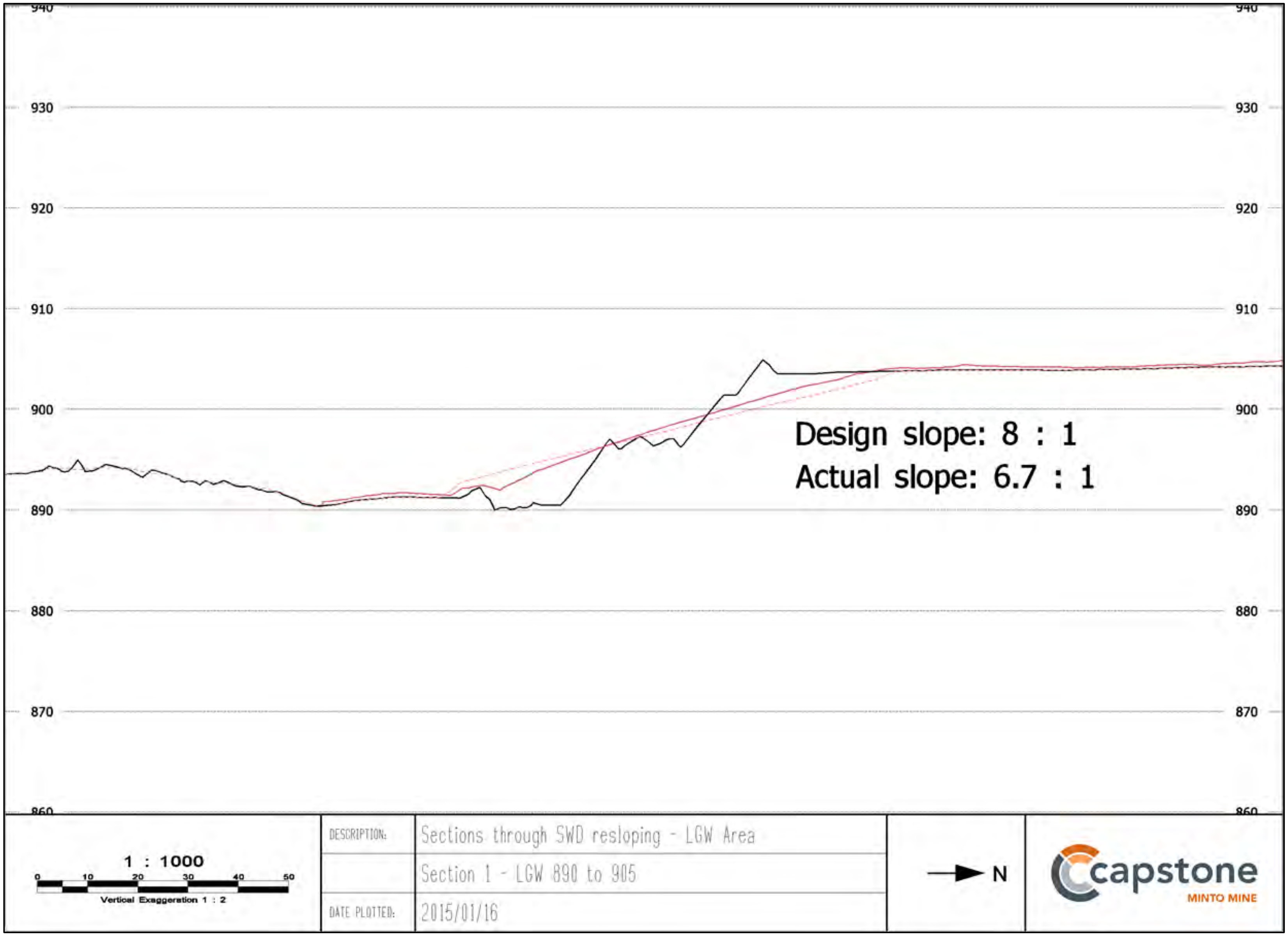


Figure 6-3: Cross Section 1 – South Slope of the Low Grade Waste Area of the SWD

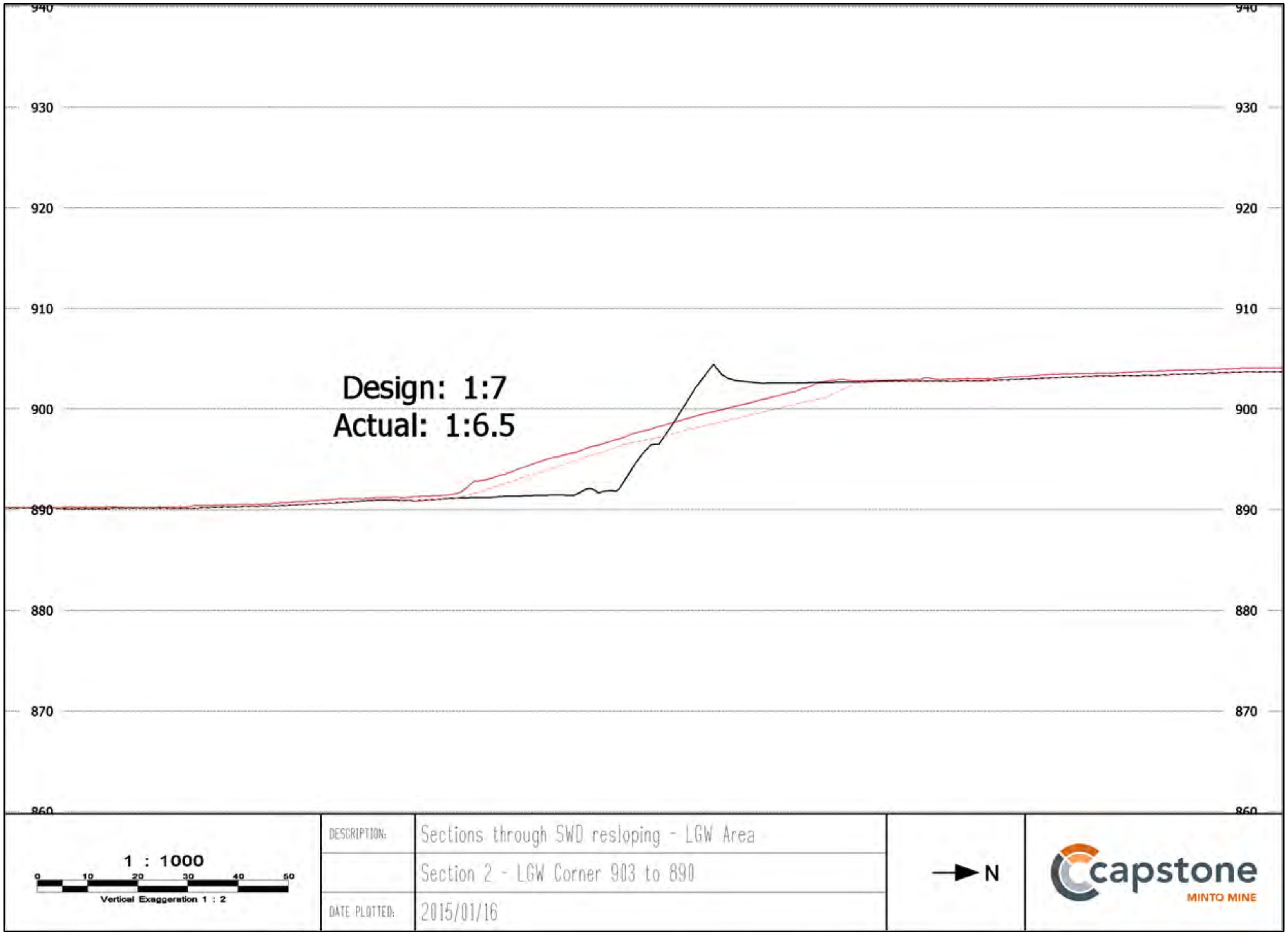


Figure 6-4: Cross Section 2 – South Slope of the Low Grade Waste Area of the SWD

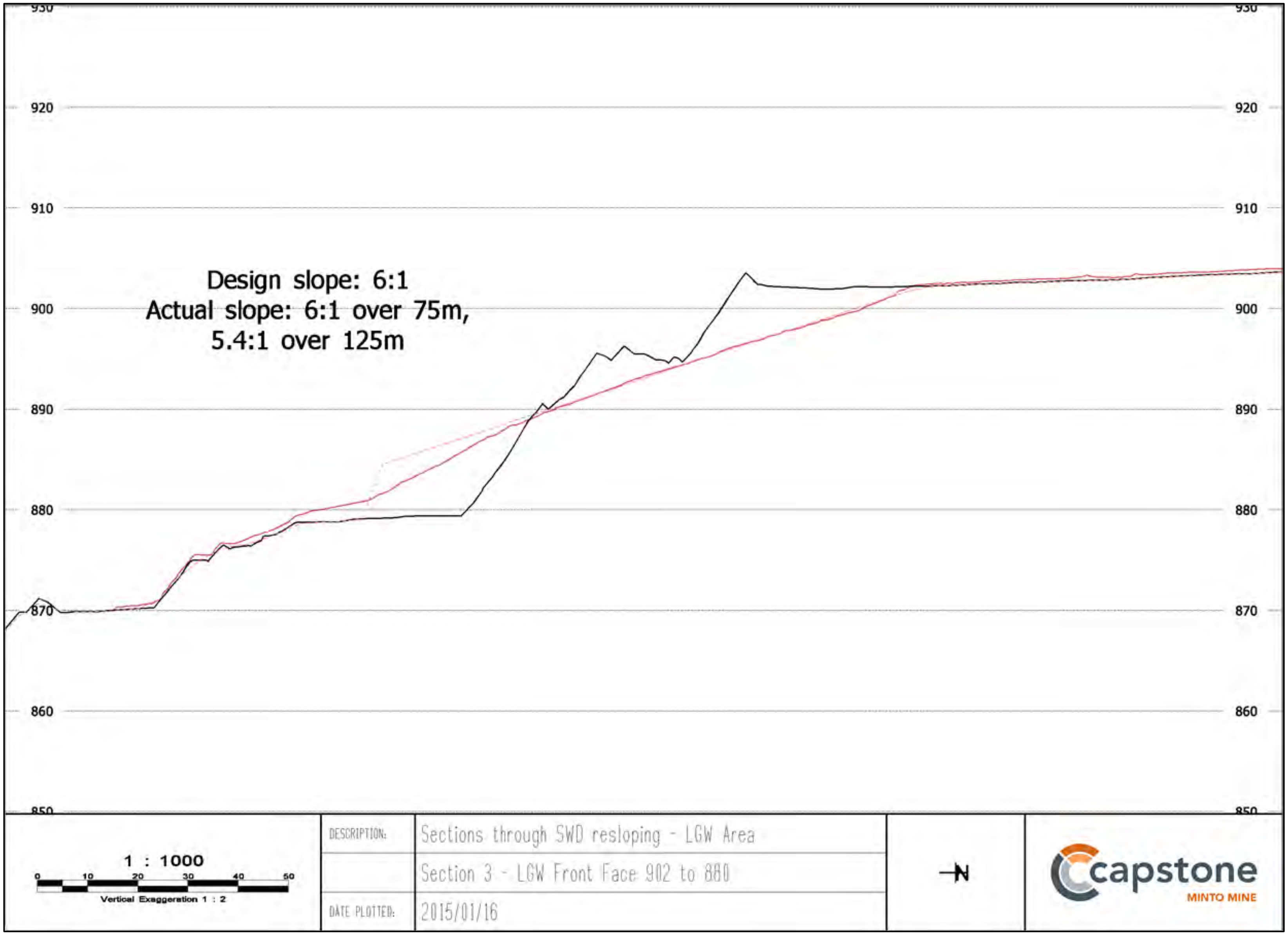


Figure 6-5: Cross Section 3 – East Slope of the Low Grade Waste Area of the SWD

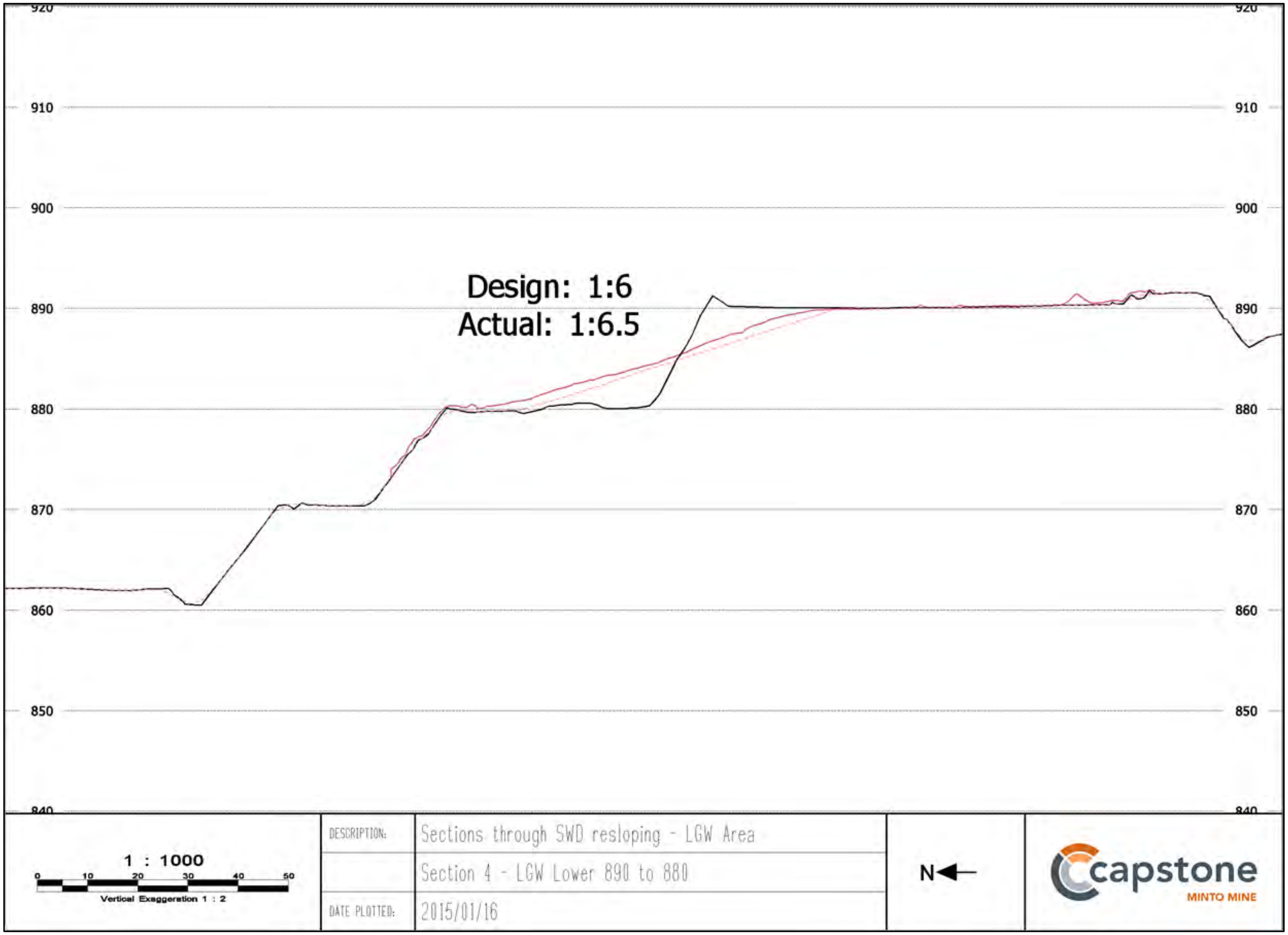


Figure 6-6: Cross Section 4 – North East Slope of the Low Grade Waste Area of the SWD

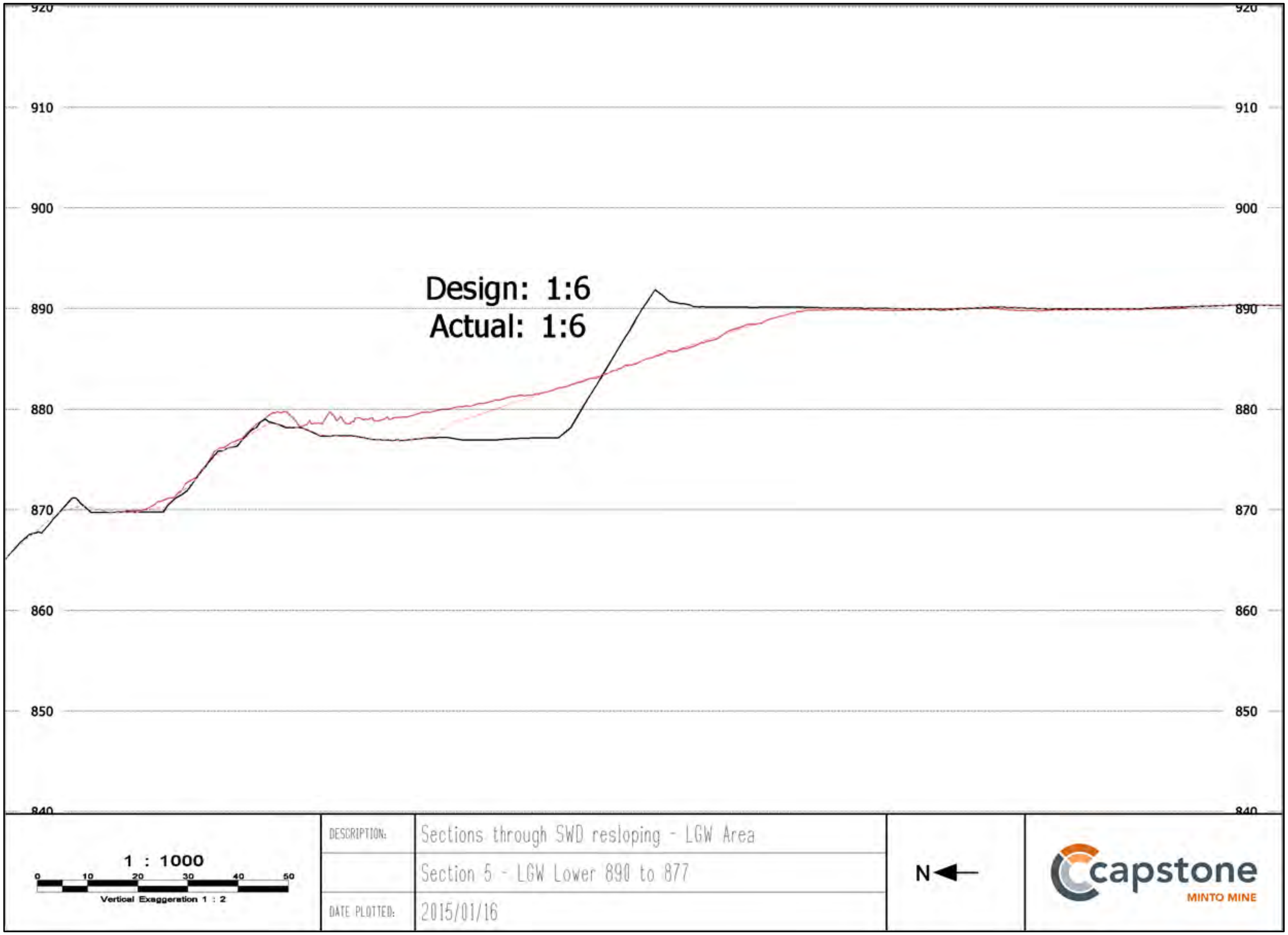


Figure 6-7: Cross Section 5 – North East Slope of the Low Grade Waste Area of the SWD

6.3 2014 Reclamation Research

Reclamation research in 2014 focused on the carryover of research from previous years. Large scale reclamation research included vegetation surveys on the MWD, cover design study, and passive water treatment research.

6.3.1 Main Waste Dump Vegetation Survey

The MWD was seeded in 2012 as a large scale trial plot project (see Photograph 6-1), with the intention of acquiring a better understanding of erosion rates, soil amendments and vegetation dominance in the mine site area. Since 2012, a vegetation survey has been completed in the fall of each growing season. In conjunction with surveying species dominance and percent coverage, general notes are taken on site conditions such as erosion and natural regeneration.

Photograph 6-1: MWD on September 13, 2014

In the fall of 2013, grass morphology was at, or past maturity. Without florets or seeds, grasses were difficult to identify and as a result there was an expected higher margin of error in the 2013 survey. The lower slope of the MWD was planted late in 2012 and after two years of growth there was still very little vegetation present. In the 2013 vegetation survey, in areas where the vegetation had not yet established, only a percent cover was recorded. Typically, this was in areas with less than 5% cover.

The 2014 survey was completed in August, a month earlier than the previous year. By completing the survey earlier in the season it allowed grasses to be intact (florets and seed present) and therefore the grasses were more easily identifiable. With the 2014 survey being completed in August as opposed to September in the previous year there is a greater degree in confidence with the 2014 results over the 2013 results. Species identification was completed in all plot areas on the upper slope, with the exception of control areas, as they typically had less than 0.5% cover. Transects were established for each plot area and the same quadrats have been used in each year of the survey.

Table 6-1, below, describes the plots on the upper MWD. Each plot area consisted of ten 50cm x 50cm quadrates running diagonally across the plot area. Species were recorded in order of dominance from 1 to 6. As not all plot areas had full species representation, only the three most dominant species are included in Table 6-1. In 2014, *Festuca saximontana* was the most dominant species in all but one plot area which and this result was consistent with the 2013 results.

Table 6-1: Upper MWD Vegetation Survey, Percent Cover and Order of Dominance (2014)

Plot Name	Percent Cover	Dominant Species		
		1	2	3
Upper West Slope Plot C (Control)	>1	*Festuca saximontana*	*	*
Upper West Slope Plot OR	38	*Festuca saximontana*	*Poa glaucous*	*Festuca filiformis*
Upper West Slope Plot A	30	*Festuca saximontana*	*Festuca filiformis*	*Deschampsia cespitosa ssp.*
Upper West Slope Plot B	24.5	*Festuca saximontana*	*Festuca filiformis*	*Elymus trachycaulus*
Upper West Slope Plot D	29.5	*Festuca saximontana*	*Festuca filiformis*	*Deschampsia cespitosa ssp.*
Upper East Slope Plot A	N/A	*	*	*
Upper East Slope Plot B	44	*Festuca saximontana*	*Festuca filiformis*	*Deschampsia cespitosa ssp.*
Upper East Slope Plot C	>0.5	*Poa glaucous*	*	*

Plants for root and shoots measurement were gathered from just outside of the established quadrate area, so not to disturb the composition in the quadrates. Table 6-2 outlines the root and shoot comparison of *Festuca saximontana*, the most dominant species identified during the 2014 vegetation survey. In an effort to see if there were any variations in plant composition based on elevation, the quadrates were split into lower, middle and upper sections within the plot area.

Table 6-2: Upper MWD Vegetation Survey, Average Root and Shoot Lengths (2014)

Plot Name	Average Root Length (cm)			Average Shoot Length (cm)		
	Festuca saximontana					
	Lower Slope	Mid Slope	Upper slope	Lower Slope	Mid slope	Upper slope
Upper West Slope Plot C (Control)	N/A	N/A	N/A	N/A	N/A	N/A
Upper West Slope Plot OR	20	14.7	20.3	65.3	42.3	80
Upper West Slope Plot A	16	15	13	57	52.7	59
Upper West Slope Plot B	*	*	*	*	*	*
Upper West Slope Plot D	17.7	23.7	17	47	57	54.3
Upper East Slope Plot A	*	*	*	*	*	*
Upper East Slope Plot B	11.3	16.3	14.3	55	56.3	37.3
Upper East Slope Plot C	*	*	*	*	*	*

The lower slopes (lower bench) of the MWD are only sparsely covered and grasses were generally small and without florets or seed, making distinguishing species difficult. Therefore it was determined that a percent cover would be sufficient on the lower portion of the MWD for the 2014 survey. Three exceptions are the LWS 1B, LES 4A and LES 4B plot areas. Although these plot areas had thick, robust vegetation cover, the initial fertilizer rates are unfeasible for any large scale reclamation and growth rates are expected to diminish over time. Therefore these areas were also included in the percent cover. Table 6-3, below, displays the results from the lower slopes of the MWD.

Table 6-3: Lower MWD Vegetation Survey, Percent Cover (2014)

Plot Area	Average Percent Cover
LWS 3C	4.6
LWS 3B	5.3
LWS 3A	0
LWS 2A	4.3
LWS 2B	6.1
LWS 2C	0
LWS 1C	5
LWS 1B	2.2
LWS 1A	43.5
LES 4A	46.5
LES 4B	25.5
LES 4C	0

6.3.2 Cover Design

A combined environmental and geology drilling program was completed in late 2014. The environmental portion of the drilling program was intended to determine the soil characteristic expected to be released in the mining of the Area 2 Stage 3 mining. Soil from all nineteen holes drilled in 2014 were logged and sampled. The information compiled from the program will inform Minto of the soil characteristics expected as well as estimated volumes in Area 2 Stage 3. At the time of this report the information was not readily available and therefore will not be included.

6.3.3 Passive Water Treatment

Section 6.3.3 describes the Passive Water Treatment activities during the reporting period.

6.3.3.1 Pilot Scale Passive Constructed Wetland Treatment System

A pilot scale passive Constructed Wetland Treatment System (CWTS) using local hydrosoils and wetland plants was tested under various operating conditions to measure the effectiveness of metal and nutrient removal. The CWTS was operated over the course of thirty-seven weeks starting in October 2013 and running through July 2014. Three pilot CWTS were constructed, in duplicate, to evaluate the performance of different designs for selenium and copper treatment (see Photograph 6-2). The CWTS were planted with either Sedge (*Carex aquatilis*), or Sedge (*Carex aquatilis*) and aquatic moss as follows:

- System 1 and 2: *Carex aquatilis*;
- System 3 and 4: *Carex aquatilis and* Moss; and
- System 5 and 6: *Carex aquatilis and* Moss, with biochar amendment in soil.

Photograph 6-2: Pilot CWTS Set Up Including Systems 1-6

All systems performed to reduce contaminant loads, however the hybrid bioreactor-CWTS design (including addition of a carbon source) resulted in the lowest copper and selenium concentrations of the study. In summary, the range of conditions required for effective copper and selenium treatment were achieved for this site-specific CWTS design, highlighting the robustness and adaptability of the design and providing a range of conditions under which the system will function.

Detailed findings of the Pilot Scale Study are included in Appendix P.

6.3.3.2 Demonstration Scale Constructed Wetland Treatment System

Upon completion and following the results of the pilot scale CWTS, Minto constructed a demonstration scale CWTS system on site. The demonstration scale CWTS includes two systems in parallel with two cells in each series and a final catchment basin that both systems flow into (see Figure 6-8 and Photograph 6-3). A stable foundation on waste rock fill was prepared and selected for the CWTS and a base of residuum (sandy gravel) material was placed in compacted lifts to allow for shaping of the structure to design specifications. The two parallel systems serve as a replicate for data analysis.

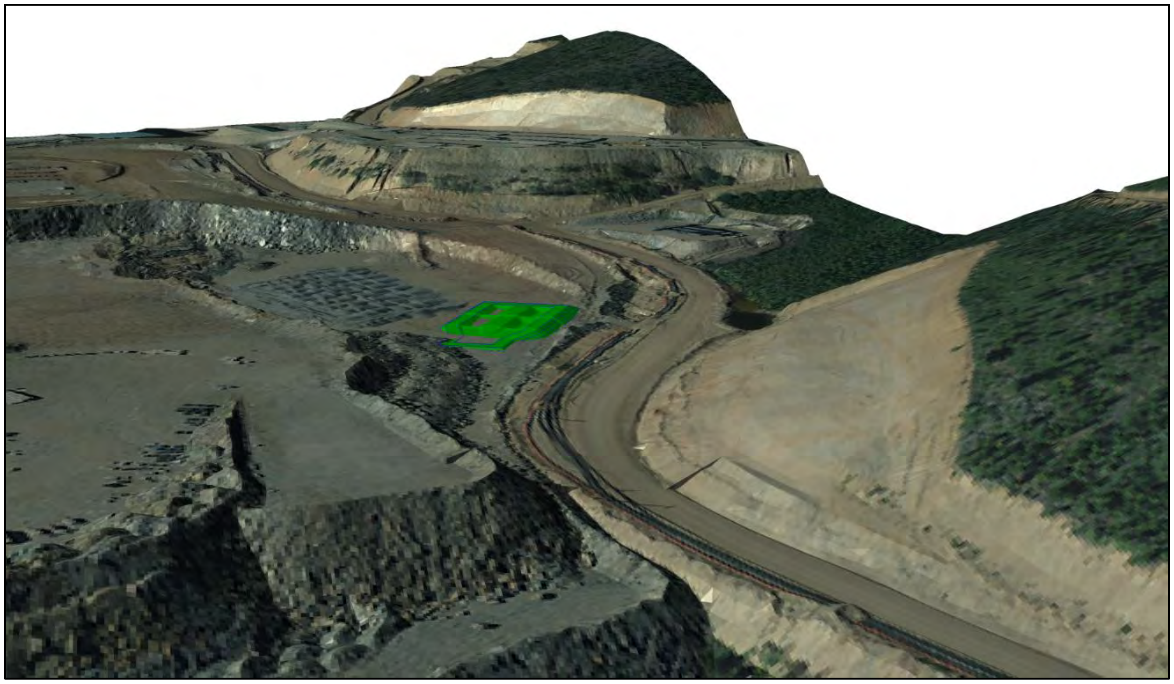


Figure 6-8: Layout Design and Location of the Demonstration Scale CWTS

Photograph 6-3: Demonstration Scale CWTS showing the redox probes and newly planted sedges

A detailed study design and construction report of the Demonstration Scale Study is included in Appendix P.

6.4 Proposed Reclamation for 2015

The proposed reclamation for 2015 includes final cover design for the majority of the SWD (high grade waste section excluded); final recontouring of the SWD; and potentially contouring the tailings cover surface and the proposed MVFE Phase 2.

The final cover design for the SWD needs to be determined before stripping of the Area 2 Stage 3 Pit as the soil released from the stripping can be directly placed on the SWD. It is expected that a final cover design will be determined and included in the submission of the next *Reclamation and Closure Plan* (December 18th, 2015).

The bulk of the final recontouring of the SWD is planned to be completed in 2015 so that the surface is prepared to accept soil material from the Area 2 Stage 3 stripping. Roadways will be left in place for accessing all areas of the dump for hauling soil and will be contoured as the cover material is placed. Final design of the SWD will be included in the next submission of the *Reclamation and Closure Plan* as the design was not finalized in time to be included in this report.

The top surface of the DSTSF may be contoured in preparation for the final closure cover; however, this action will be time dependent as the sloping of the SWD will be priority. Also, it is Minto's intention to wait for the completion of the MVFE Phase 2 before completing the reclamation work on the DSTSF.

In 2015, the CWTS will be allowed to continue to mature, with plants becoming more established and abundant, and microbial communities accordingly acclimating to the targeted conditions. Influent and effluent metal and nutrient loads will be measured as a key performance indicator along with various other parameters to predict, promote and optimize the system.

7 Water Management and Water Balance

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

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

7.1 Water treatment

Surface runoff that did not meet the WUL discharge standards was directed to the Main Pit through the W15 Pipeline, W35 SDD, or via the W36 MCDS pump back.

Minto has the option of treating for:

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

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

7.1.1 Operations Overview

The water treatment system operated for 277 days, and discharged 243,368 m^3 of water which was conveyed to the WSP. The RO units operated for 3,561 hours producing 216,112 m^3 of permeate water. RO removal efficiency decreased throughout the operating season as a result of calcium and other contaminant build up in the RO membranes. This resulted in several hours of down time in order to wash the membranes. Table 7-1 and Table 7-2 summarize the 2014 water treatment operations statistics, reagent consumption and contaminant removal efficiency.

Table 7-1: WTP Operating Statistics (2014)

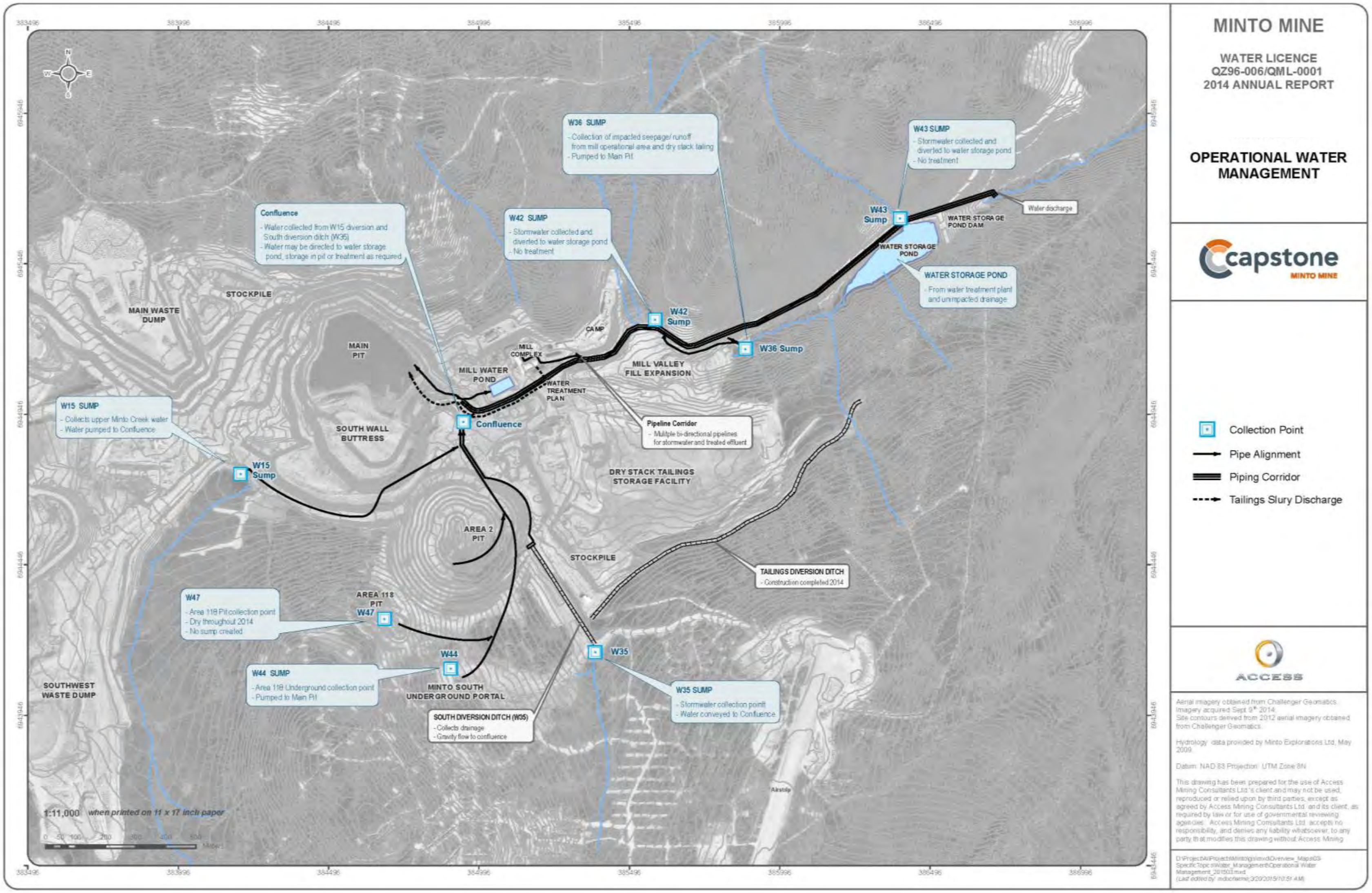
WTP Statistics 2014	
Plant Feed (m^3)	497,385
RO Treated (m^3)	216,112
Discharged to WSP (including blending) (m^3)	243,368
Runtime (hour) (Discharge hours)	3,560
Recovery (%)	69
Yardney psi	35
Reagent Consumption	
Polyclear 2528 (floc) bags	25
Flowrate floc (average ml/min)	1,297
Aluminex5/Hydrex (totes)	33
Flowrate ALX (average ml/min)	136
TMT liters	1
Flowrate TMT (average ml/min)	0
Actisand (microsand) kg	3,725
Sodium Bicarbonate bags	156
Antiscalant liters	3,900
1 micron filters each	5,162
RO	254
CUNO	920

Table 7-2: WTP Constituent Removal Summary (2014)

Parameter	Units	Average WTP Feed	Average WTP Product
pH-L	pH units	8.2	7.7
Cond-L	µS/cm	939	337
TDS	mg/L	638	218
TSS	mg/L	8.3	1.8
Ammonia	mg/L	1.39	0.58
N-NO2	mg/L	0.20	0.13
N-NO3	mg/L	13.53	5.33
Al-T	mg/L	0.2	0.1
Cd-T	mg/L	0.000023	0.000011
Cr-T	mg/L	0.001	0.001
Cu-T	mg/L	0.017	0.002
Fe-T	mg/L	0.2	0.1
Pb-T	mg/L	0.00020	0.00020
Mo-T	mg/L	0.059	0.019
Ni-T	mg/L	0.0025	0.0012
Se-T	mg/L	0.0056	0.0019
Zn-T	mg/L	0.0061	0.0085

7.2 Water Storage and Conveyance Network

There were no major changes to the management of water storage or conveyance structures in 2014. The strategy for managing the mine water inventory was unchanged in 2014, and the water conveyance network is illustrated in Figure 7-1. Compliant (clean) surface water was collected and diverted to the WSP, and subsequently discharged to Minto Creek. Runoff from developed mine areas (mine water) was collected and stored in the Main Pit and was used for ore processing, deposition of tailings and feed water for the Water Treatment Plant.



MINTO MINE

WATER LICENCE
QZ96-006/QML-0001
2014 ANNUAL REPORT

OPERATIONAL WATER MANAGEMENT

Aerial imagery obtained from Challenger Geomatics. Imagery acquired Sept 9th 2014.
Site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Hydrology: data provided by Minto Explorations Ltd, May 2009.

Datum: NAD 83 Projection: UTM Zone 8N

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(Last edited by: mducharme;3/20/2015/10:51 AM)

Figure 7-1: Minto Mine Water Conveyance Network (2014)

7.3 Water Storage Volumes Movement and Tracking

The main water balance components are summarized in Table 7-3 and include the volumes of water stored at the Minto Mine, and the volume discharge to Minto Creek in 2014. Table 7-4 provides a summary of water volumes moved by conveyance structure but is not reconciled against the water balance.

Table 7-3: Minto Mine Water Balance Summary (2014)

Storage Location	Units	Volume
Pit Volume Increase 2014	m^3	660,000
Tailings to Main Pit, total	BCM	530,000
SAT, deposited sub-aqueously in Main Pit	BCM	0
Main Pit Water Volume Increase 2014	m^3	220,000
WSP Net Water Volume Increase 2014	m^3	20,000
Water stored in DSTSF tailings	m^3	0
Water Discharged to Minto Creek in 2014	m^3	488,000
Estimated groundwater inflow to Area 2 Pit	m^3	120,000
Total Surface Runoff Above WSP in 2014	**m^3**	**610,000**

Table 7-4: Volume of Water Moved by Conveyance Structure (2014)

Station	Conveyed to WSP (m3)	Conveyed to Main Pit (m3)	Total Conveyed (m3)
W35	18,999		18,999
W15	83,742		83,742
W45		216,088	216,088
W44		105,597	105,597
WSP reclaim	109,789		109,789
W36		83,648	83,648
Total	**212,531**	**405,333**	**617,864**

Please note that approximately 76, 500 m³ reports directly to the Main Pit and is not captured by flow monitoring devices above. Additionally, approximately 140, 850 m³ reports directly to the WSP and is not captured by flow monitoring devices above.

7.3.1 Water Conveyance Tracking

Diversion of W35 water (SDD): Water was diverted from the south catchment (collected at station W35) to the WSP. An estimated total of 18,999 m^3 moved through this structure in 2014 as measured by a Mace FloSeries® 3 open pipe flow measuring device. This value is considerably lower than the predicted 20% of total runoff for the Minto Mine catchment. This could be related to poor early season measurements. Additionally, the interception of the SDD water by the 118 UG workings, roadways and rerouting to the Area 2 Pit may further account for the difference in the predicted versus actual 2014 SDD flow measurement . The Mace Flo Series device was calibrated to ensure the unit was measuring accurately.

Diversion of W15 water: The W15 sump collects surface runoff from adjacent undisturbed catchments, the SWD and part of the MWD. A total of 83,742 m^3 was conveyed through the W15 conveyance structure in 2014. The W15 flows were measured and recorded using a Seametrics® mag flow meter with digital head relay module. The 2014 conveyance volumes were considerably lower than the predicted 25% to 30% of total runoff for the Minto Mine catchment. Possible causes for the discrepancy are the very gradual increase in ambient temperatures, low snowpack and incidental diversion of water to the Main Pit.

Pump Back of W36 water (MCDS): Water collected downstream of the mill area, ore stockpiles and DSTSF is collected at the MCDS and pumped back to the Main Pit for treatment. A total of 83,648 m^3 was conveyed through this structure in 2014. The flow volumes were measured and recorded using a Seametrics® mag flow meter with digital head relay module. The 2014 flow volume from the MCDS was lower than predicted based on previous seasons; possible causes for the discrepancy include the lower than expected annual precipitation.

7.3.2 Water Storage Tracking

Main Pit: The Main Pit was used as a reservoir to support the following: water use for the Mill process; collection of impacted runoff; and supply feed water to the water treatment plant. Water quality dictates that all water reporting to this location must undergo treatment prior to discharge. A total of 405,333 m^3 of water was conveyed to the Main Pit in 2014 (Table 7-4).

WSP: The WSP worked effectively as a storage location for un-impacted water and maintained the water quality below discharge criteria. A total of 212,531 m^3 of water was conveyed to the WSP in 2014 (Table 7-4).

7.3.3 Water Balance and Water Quality Predictions Modeling

As per the WUL Clause 78, Minto is required to update the Water Balance and Water Quality Model. Minto retained SRK Consulting to complete a 2014 site water balance and water quality prediction update, provided in Appendix K.

7.3.4 Water Conveyance Construction

2014 water conveyance construction activities at the Minto Mine are discussed in Section 7.3.4.

7.3.4.1 W3 Flume

During the spring of 2013, erosion at the intake of the W3 flume eroded the backfill placed under and around the sides of the existing Palmer-Bowles fiberglass flume. To regain functionality of the W3 Flume, in late September 2014, SRK Consulting and Territorial Contracting rehabilitated the structure to incorporate a compacted foundation, upstream concrete slab footing and a wing wall entrance section with upstream and downstream riprap erosion protection (see Photograph 7-1). The full as-built report is presented in Appendix Q.

Photograph 7-1: Wing Wall and Footing Construction for W3 Flume Rebuild

7.3.4.2 Tailings Diversion Ditch

Between June and September 2014, improvements to the TDD at the Minto Mine were completed to alleviate poor drainage (pooling), seepage and poor integrity. Over the course of the construction period, the following improvements were made (see Photograph 7-2 and Photograph 7-3):

- Installation of embankment fill (construction grade waste rock) ;
- Grading of the overall ditch and sloping the walls to 2:1;
- Installation of a Bentofix GCL to line the embankment fill;
- Installation of a bucket packed 0.6 m nominal thickness layer of silt/clay fines over the GCL; and
- Installation of a 12 oz. geotextile and rip rap along the entire length.

The as-built construction report was delivered to the YWB in October 2014 and is attached to this report as Appendix B.

Photograph 7-2: TDD Shaped and Graded Ditch Segment Showing GCL and Geotextile Cloth

Photograph 7-3: TDD - Completed Section of Ditch Showing Rip Rap Coverage and Grade

No other major water conveyance structure modifications were undertaken in 2014.

8 Closure

Minto trusts this document fulfills the 2014 annual reporting requirements of Minto Mine’s WUL and QML.

References

ASTM. 2007. Standard Guide for Sampling Ground-Water Monitoring Wells. Designation: D4448-01 (Reapproved 2007)

British Columbia, Ministry of Environment (BC MOE). 1985. British Columbia Water Quality Guideline.

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

Minnow (Minnow Environmental Inc.). 2009. Minto Mine Water Use Licence Benthic Invertebrate Community Survey Results. Letter Report prepared for the Access Consulting Group and Minto Explorations Ltd, January 2009.

Minnow (Minnow Environmental Inc.). 2011. Minto Creek Sediment and Benthic Invertebrate Community Assessment – 2010. Prepared for Minto Explorations Ltd., June 2011.

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

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

Minnow (Minnow Environmental Inc.). 2013b. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2012. Prepared for Minto Explorations Ltd, March 2013.

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

Minnow (Minnow Environmental Inc.). 2014b. Capstone Mining Corp. Minto Mine Phase 3 EEM Study Design - Investigation of Cause. Prepared for Capstone Mining Corp. March 2014.

Appendix A – South Diversion Ditch Construction

capstone
MINTO MINE

South Diversion Ditch Construction

Prepared by:
Minto Explorations Ltd.
Minto Mine

September, 2014

Table of Contents

List of Appendices

1 Purpose

As required by clause 53 of the Water Use Licence QZ96-006, Minto mine is required to submit as-constructed plans and drawings of all structures authorized by the licence within 60 days of completion of the construction. This document serves to meet the requirements of the water use licence as well as serve as a construction record for future reference.

2 Introduction

The South Diversion Ditch (SDD) conveys water from upper Minto Creek to the Confluence area. The Area 2 Stage 2 pit eastern expansion cut into a section of the previously existing ditch requiring realignment of that section.

EBA Engineering Consultants Ltd. issued designs for review in May 2012 consisting of an inlet berm upstream of the Area 2 pit, a 24” pipeline navigating around the pit at a 2.2% grade and a spillway directing water into the Area 2 pit in case of a pipe overflow event. The inlet ditch design required compacted residuum, a geosynthetic clay liner, geotextile and a layer of rip-rap.

SRK Consulting Ltd. reviewed the EBA design and issued the drawings for construction in late 2012. The only major change to the plan was to add a 16” pipe in parallel with the 24” pipe system.

In anticipation of 2013 freshet, the piping system was installed in December 2012 and spillway construction was completed in May 2013. Final construction of the ditch was completed in August 2014; minor adjustments were made to ensure that the SDD met design requirements. These modifications included; brushing out vegetation, removing boulders that may have impeded flow and widening of the spillway.

Figure 1 – South Diversion Ditch conveyance from Minto Creek.

3 Design Details

SRK Consulting Ltd. prepared a hydraulic assessment to ensure the system would be adequate for up to a 100 year, 24 hour duration storm. Runoff data was gathered from Environment Canada which shows maximum daily peak flows from 34 stations in the Yukon. The hydraulic model estimated a maximum peak flow of 13.30 m^3/s and SRK concluded that the design could sufficiently convey the maximum peak flow.

The Design requirements of the SDD realignment are summarized below:

- Two pipelines consisting of a 24” DR32 and 16” DR11 HDPE line;
- Pipeline inlet structure located as close as practical to the Area 2 Stage 2 pit rim;
- Pipeline extended from inlet structure to existing stilling basin/chamber known as “the Confluence”;
- Pipeline aligned to specifications indicated in the EBA Issued for Review design document;
- Flow in excess of the pipelines’ capacity routed to the Area 2 pit via an appropriately sized overflow structure;
- A berm is required at the outlet of the overflow structure and along the pit ramp road to convey flow to bedrock where flow can then be directed down the pit face.
- The minimum combined capacity of the overflow structure and the pipelines must be equal to the maximum capacity of the upstream component of the SDD;
- Seepage minimized at the pipe inlet; and
- Haul truck vehicle access maintained along the underground portal access road.

4 Pipe Inlet and Spillway Construction

The 24” and 16” pipes were buried at the south east end of the Area 2 pit below the construction of the overflow spillway. The pipe inlet at the end of the ditch was lined with geotextile as shown by Figure 2.

The spillway is designed to convey 12.2 m3/s of water with a 0.2 m freeboard to account for the possibility of pipe blockage due to ice. The spillway was constructed across the road with a spillway elevation of 813 across the road, shown in Figure 4. The channel is 15 m wide at the center of the road with a depth of about 0.6m and sloping westward across the road is about 2.6%; greater than the 2% minimum required as per design.

The spillway slopes down the Area 2 pit bench where water would then flow down the wall and into the pit. The slope from the edge of the road down the pit bench is about 6%; greater than the 2% minimum design specification.

Figure 2 – Installation of geotextile at SDD inlet ditch.

Figure 3 – Completed SDD inlet ditch.

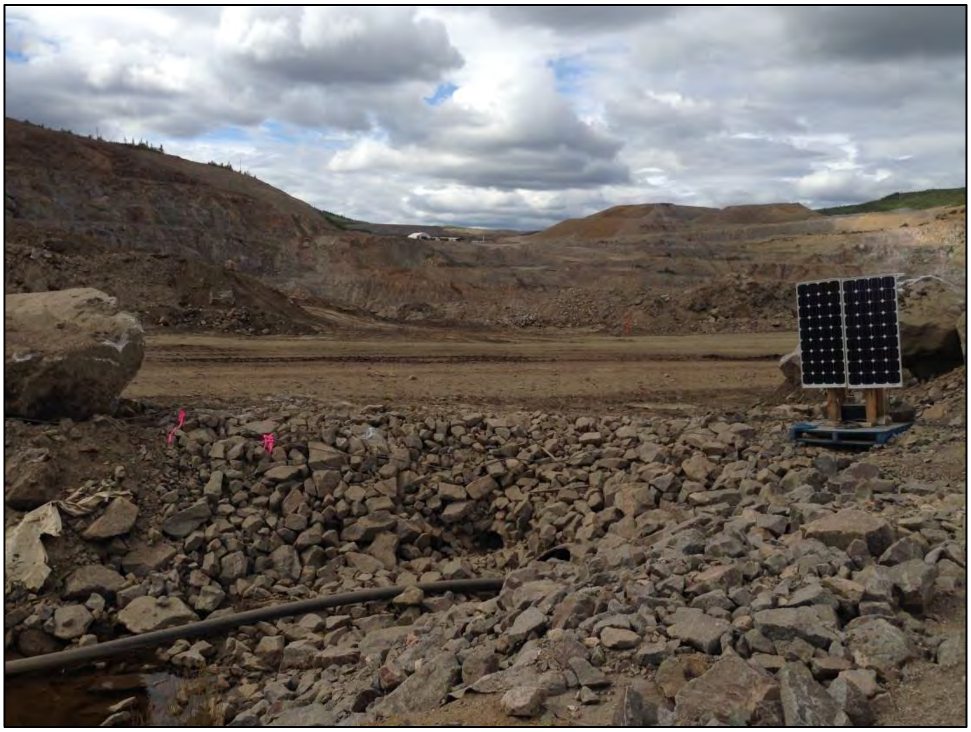


Figure 4 – Spillway across haul road – northeast facing

Figure 5 – Spillway across haul road – northeast facing

5 Piping

The piping system is designed to convey about 1.1 m³/s of water. Piping was installed from the previously existing diversion ditch, under the swale, around the Area 2 pit and into the Confluence. The piping system has an average grade of 3.1%, slightly more than the minimum grade design stipulation of 2.2%. Both the 24” and 16” pipes connect from the edge of the ditch inlet to the Confluence.

Figure 6 – 24” and 16” piping navigating around the Area 2 pit to the Confluence

This report, South Diversion Ditch Construction, Minto Mine, YT", was prepared by

Original Signed

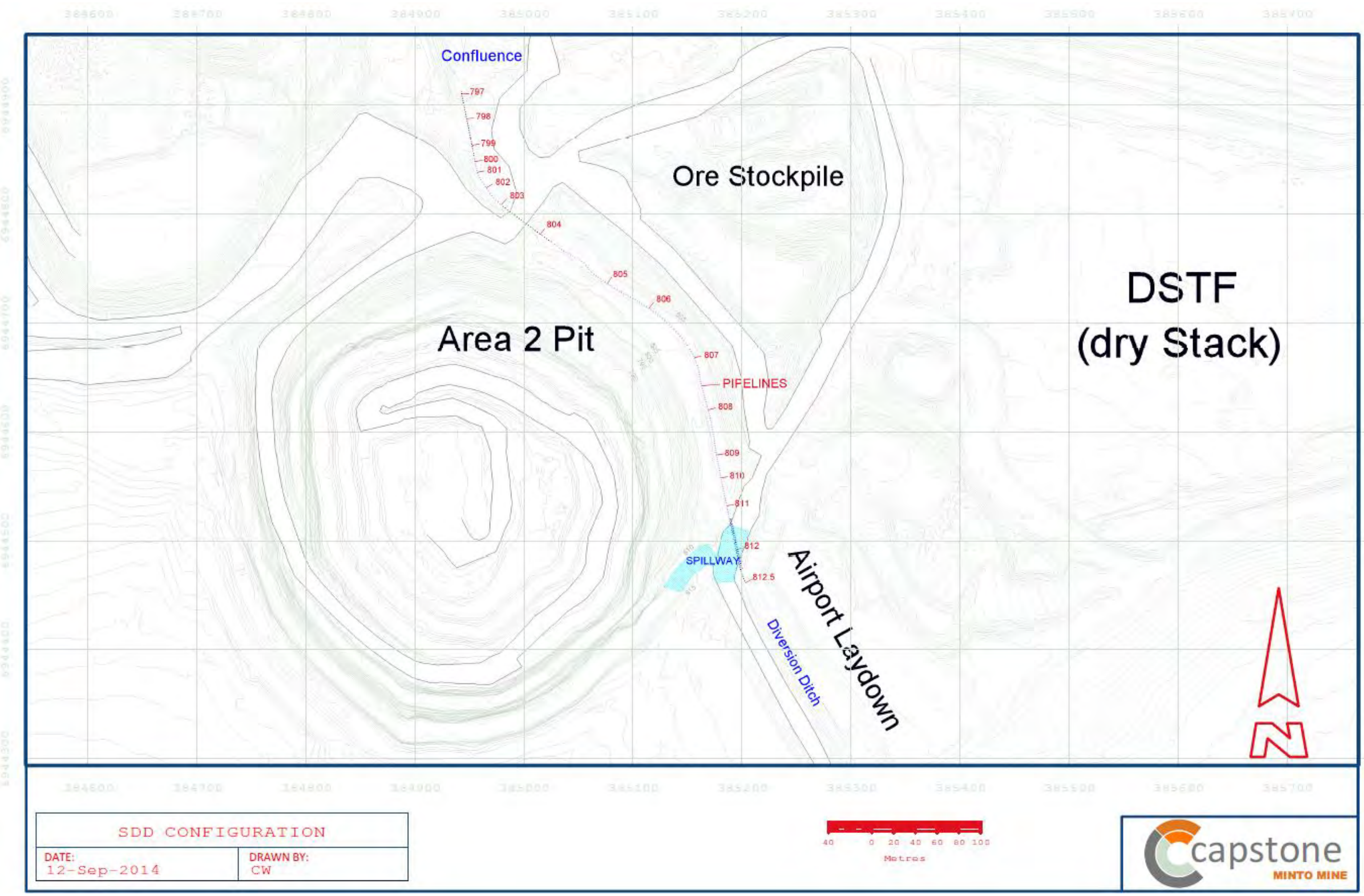
Curtis Wettstein, P.Eng
Minto Explorations Ltd.

Reviewed by:

Original Stamped and Signed	Original Stamped and Signed
Sebastien Tolgyesi, P.Eng	Pooya Mohseni, P.Eng
Mine Manager, Minto Explorations Ltd.	Chief Engineer, Minto Explorations Ltd.

All data used as source material plus the text, tables, figures, and attachments of this document have been reviewed and prepared in accordance with generally accepted professional engineering and environmental practices.

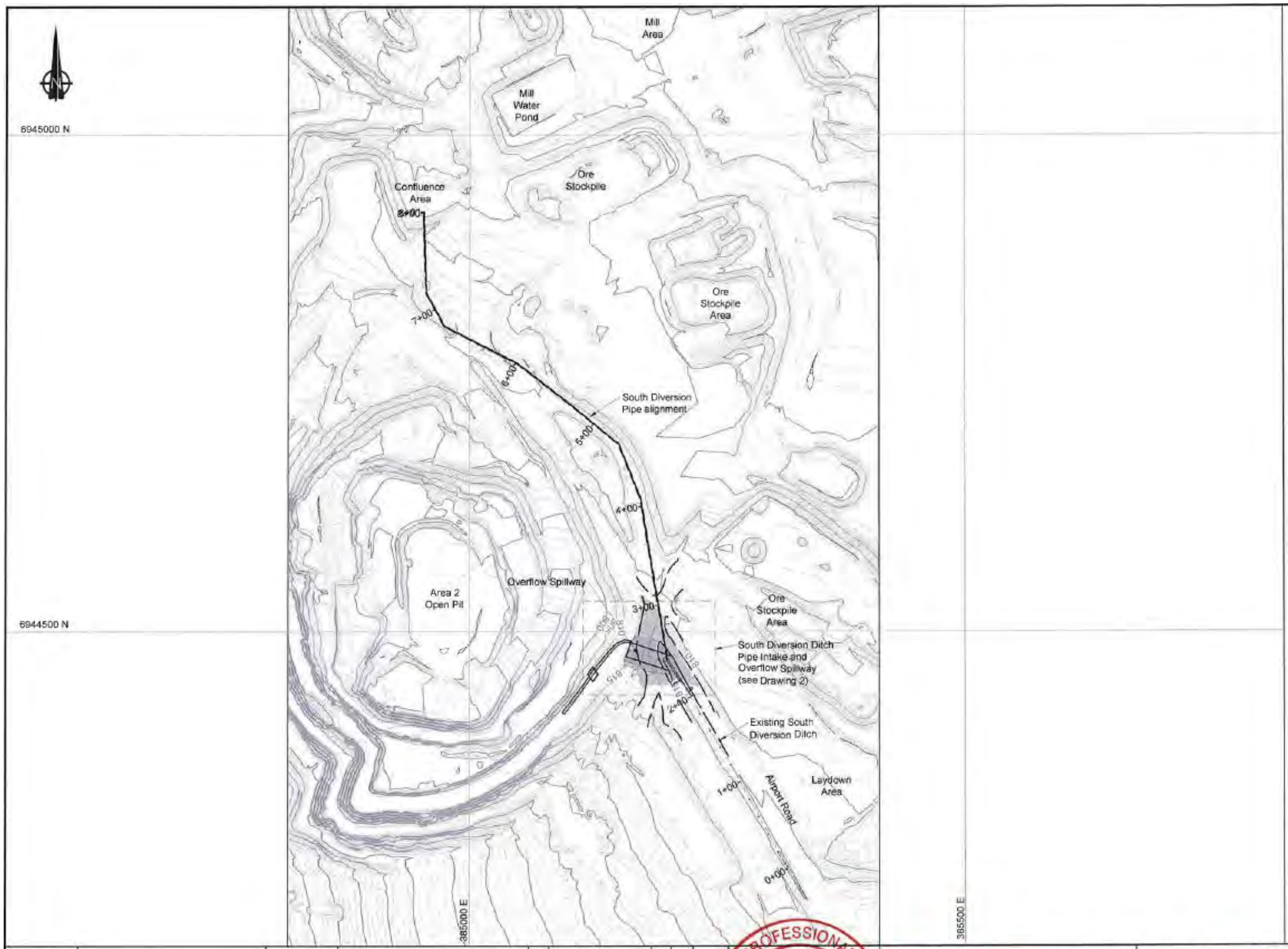
Appendix A: As-Built Drawings



Drawing 1 - As-built topographic view of SDD pipeline and spillway location.

Drawing 2 – Spillway cross sectional view

Appendix B: Design Drawings



LEGEND

▨	New Infrastructure
─	Minor Contours
──	Major Contours
- - - -	Pipes

NOTES

1. Survey control is based on the UTM projection NAD83, Zone 8. Contour interval is 1m. Elevations are relative to mean sea level.
2. Topographic contours were provided by Minto in September 2012.

SDD Alignment Stakeout Table		
Station	Easting	Northing
0+00	385321.35	6944260.06
0+60	385292.21	6944312.45
1+11	385268.58	6944357.56
1+91	385227.48	6944426.29
2+44	385199.55	6944471.86
4+09	385172.15	6944634.12
4+67	385150.42	6944688.34
5+30	385102.13	6944727.58
5+98	385048.23	6944769.81
6+81	384974.68	6944807.13
7+19	384956.38	6944840.96
8+01	384953.63	6944922.91

0 20 40 60 80 100
Scale in Metres

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE
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REFERENCE DRAWINGS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
0	Issued for Construction	DM	PM	1Feb13
A	Issued for Review	DM	PM	16Jan13

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PETER [illegible] MIKES
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FILE NAME: 1CM002.006–Site Plan–20130115.dwg

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Minto Explorations Ltd.

SRK JOB NO.: 1CM002.006.200

South Diversion Ditch

DRAWING TITLE:
General Site Plan

DRAWING NO.	SHEET	REVISION NO.
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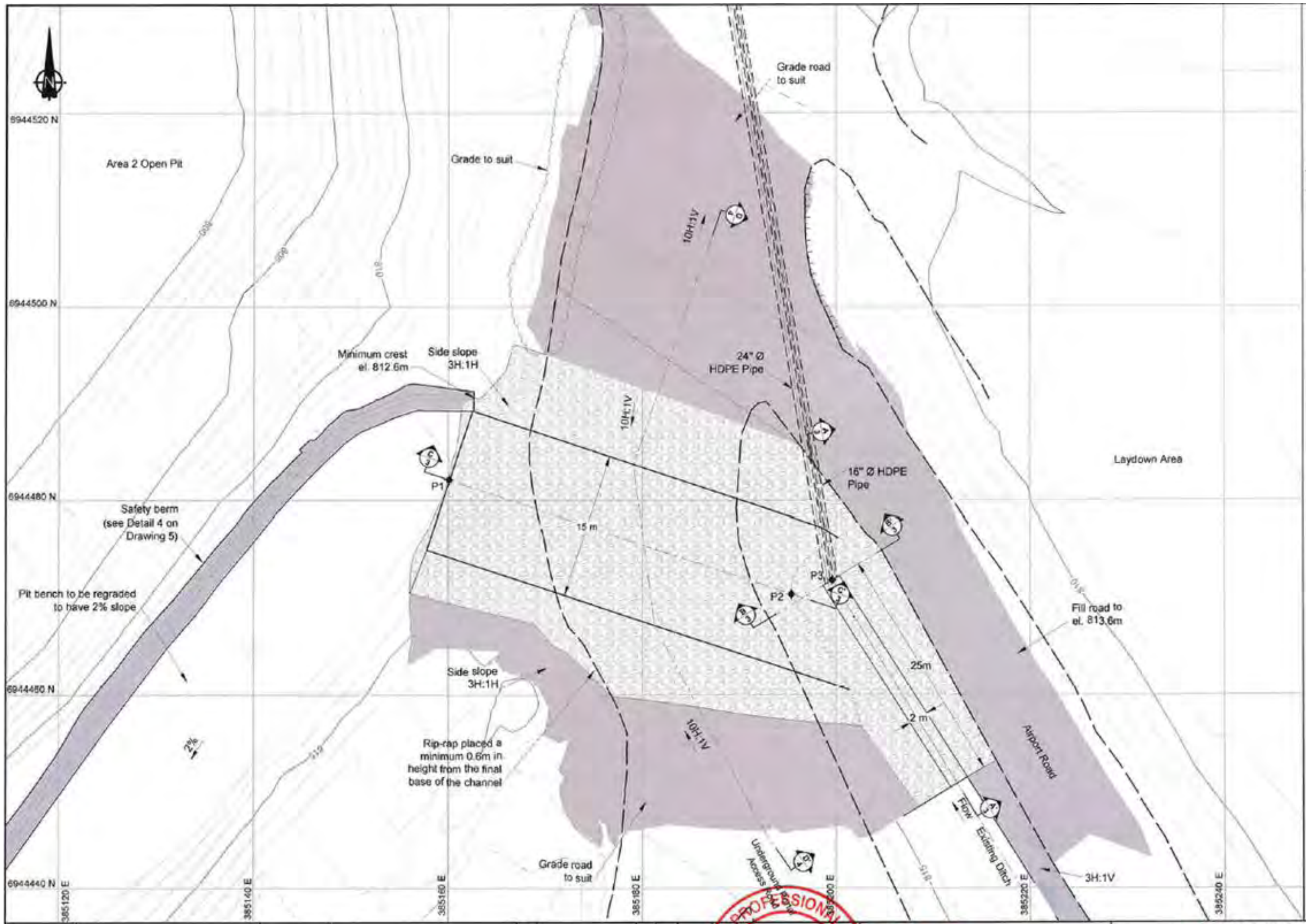

LEGEND

◆ Stake-out Point
▨ Rip-rap
■ New Infrastructure
Minor Contours
Major Contours
Proposed Crest
Edge of Road
Pipe
Liner Limits

NOTES

1. Survey control is based on UTM projection NAD83, Zone 8. Contour interval is 1m. Elevations are relative to mean sea level.
2. Topographic contours were provided by Minto in September 2012.
3. All construction slopes are to be 3H:1V unless otherwise noted.
4. All subgrade is to be firm, unyielding and free of deleterious materials, voids, standing water, ice, and snow.
5. Overflow spillway to have a minimum 1% slope, and 0.6m depth.
6. Airport Road to be filled to an elevation of 813.6m
7. Surfacing material may be placed over the spillway rip-rap at to improve trafficability provided that the channel depth remains at least 0.6 m deep.
8. The spillway channel side-slopes may be altered to suit field conditions provided that the slopes remains 3H:1V or flatter.
9. Rip-rap to consist of durable waste rock material with a median particle size of 200mm.

STAKEOUT POINTS			
Point #	Easting	Northing	Elevation
P1	385159.47	6944482.17	812.00
P2	385196.33	6944470.45	813.00
P3	385199.55	6944471.86	811.95

0 2 4 6 8 10
Scale in Metres

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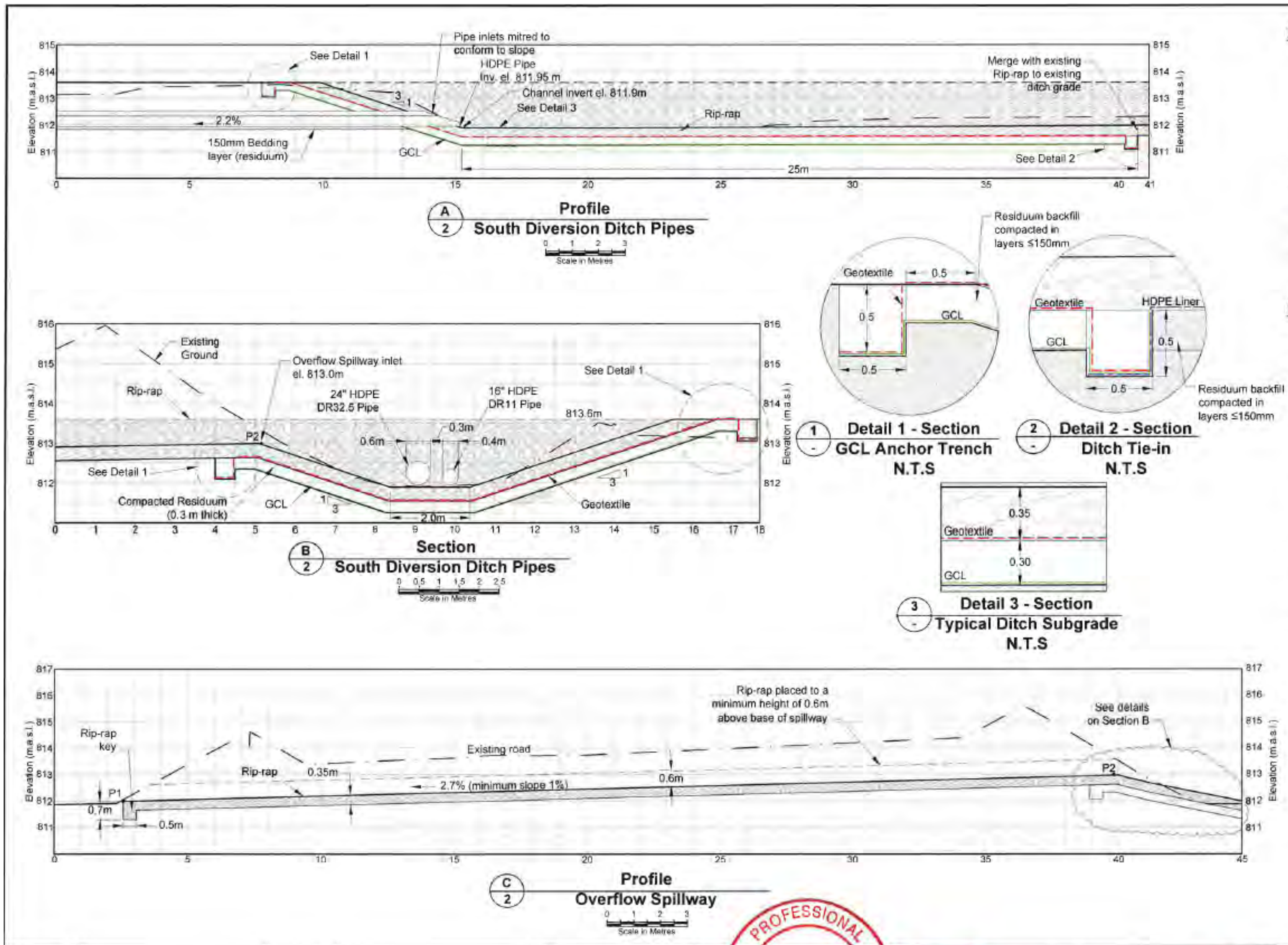
South Diversion Ditch

DRAWING TITLE:
Pipe Intake and
Overflow Spillway Plan

DRAWING NO.	SHEET	REVISION NO.
2	3 OF 5	0



LEGEND

☐	HDPE Pipe
▨	Rip-rap
☐	Compacted Residuum
▨	Subgrade
— - —	Original Ground
——	Design Surface
——	GCL
- - - -	Geotextile
——	Existing HDPE Liner
- - - -	Top of Rip-rap

NOTES

1. Survey control is based on UTM projection NAD83, Zone 8. Elevations are relative to mean sea level.
2. Topographic contours are provided by Minto in September 2012.
3. All construction slopes are to be 3H:1V unless otherwise noted.
4. All subgrade is to be firm, unyielding and free of deleterious materials, voids, standing water, ice, and snow.
5. Overflow spillway to have a minimum 1% slope, 0.6m depth.
6. Surfacing material may be placed over the spillway rip-rap at to improve trafficability provided that the channel.depth remains at least 0.6 m deep.
7. The spillway channel.side-slopes may be altered to suit field conditions provided that the slopes remains 3H:1V or flatter.
8. Surfacing material may be placed over the spillway rip-rap provided that a minimum channel.depth of 0.6 m is maintained.
9. Rip-rap to consist of durable waste rock material with a median particle size of 200mm.
10. In the vicinity of the pipe, Rip-rap is to be placed in a way that does not damage the HDPE pipe.
11. GCL to be covered with a minimum 300 mm of residuum.
12. Residuum to have a maximum particle size of 25mm.
13. Not heavy equipment is to be driven on top of GCL unless a minimum 600mm cover is in place.
14. There shall be a minimum 300mm overlap between GCL panels. Panel.overlap shall be orientated perpendicular to the streamflow direction and have a shingle - type overlap towards the downstream direction.
15. GCL is not to be left exposed overnight.
16. GCL should be stored in a heated building and not allowed to freeze prior to installation.

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Minto Explorations Ltd

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South Diversion Ditch

DRAWING TITLE:
Sections A-A', B-B', C-C' and Ditch Details

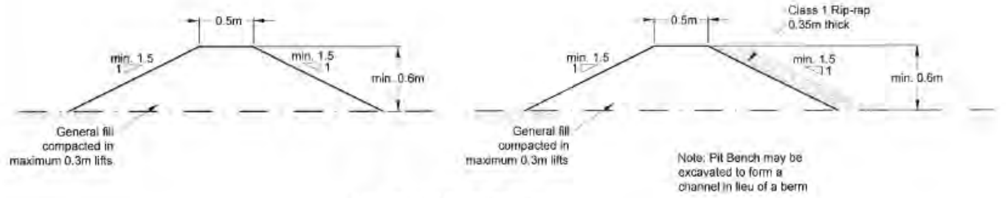
DRAWING NO.: 3
SHEET: 4 OF 5
REVISION NO.: A

LEGEND

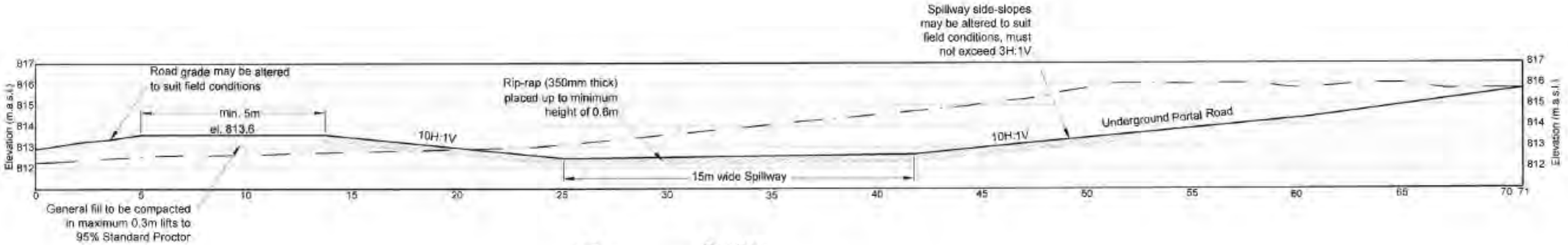
▨	Rip-rap
▨	Subgrade
☐	General Fill
— · —	Original Ground
——	Design Surface

NOTES

1. Survey control is based on UTM projection NAD83, Zone 8. Elevations are relative to mean sea level.
2. Topographic contours were provided by Minto in September 2012.
3. All construction slopes are to be 3H:1V unless otherwise noted.
4. All subgrade is to be firm, unyielding and free of deleterious materials, voids, standing water, ice, and snow.
5. Overflow spillway to have a minimum 1% slope, 0.6m depth.
6. Surfacing material may be placed over the spillway rip-rap at to improve trafficability provided that the channel depth remains at least 0.6 m deep.
7. The spillway channel side-slopes may be altered to suit field conditions provided that the slopes remains 3H:1V or flatter.
8. Surfacing material may be placed over the spillway rip-rap provided that a minimum channel depth of 0.6 m is maintained.
9. Rip-rap to consist of durable waste rock material with a median particle size of 200mm.



4/2 Detail 4 - Section Safety Berm



D/2 Section Overflow Spillway

NO.	DESCRIPTION	CHK'D	APP'D	DATE
A	Issued for Construction	DM	PM	1Feb13
A	Issued for Review	DM	PM	16Jan13

REVISIONS

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PETER H. MIKES

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CHECKED: DM	APPROVED: PM	DATE: February 1, 2013

FILE NAME: 1CM002.006–Site Plan–20130115.dwg

CAPSTONE MINING CORP. MINTO MINE

Minto Explorations Ltd.

SRK JOB NO.: 1CM002.006.200

South Diversion Ditch

DRAWING TITLE: Section D-D' and Safety Berm Details

DRAWING NO. 4 SHEET 5 OF 5 REVISION NO. 0

Appendix B – Tailings Diversion Ditch As-Built

capstone
MINTO MINE

TO: Sebastien Tolgyesi, P.Eng, P.Geo, Minto Mine Manager

FROM: Eamon Mauer, P.Eng, PMP, General Supervisor – Project Engineering

SUBJECT: Tailings Diversion Ditch Construction 2014 – As Built

DATE: Oct 11, 2014

Between June and Sept 2014 improvements to the Tailings Diversion Ditch at the Minto Mine were completed based on EBA Dry Stack Surface Water Diversion System drawings Figure 6 and 7 as per the Technical Memo: *Minto Project – Upstream Water Management for the Mill Valley Fill Expansion and Dry Stack Tailings Storage Facility* dated Oct 25, 2011.

Work was constructed on land identified to be within the Jan 1, 2013 Lease Amendment Agreement (Block D) owned by the Selkirk First Nation and leased by Minto Explorations Ltd.

Detailed as built construction drawings can be found within Appendix A with the EBA design drawings located in Appendix B and a photographic log of construction provided in Appendix C. Documentation identifying the zero grade rip rap utilized within the ditch is provided in Appendix D.

A summary of work completed includes:

- Installation of embankment fill (construction grade waste rock) along Segment C (EBA Figure 6)
- Grading of the ditch overall and sloping all ditch walls to 2:1
- Installing a Bentofix geosynthetic clay liner to line the embankment fill within Segment C and part of Segment B
- Installation of a bucket packed, 0.6m nominal thickness layer of silt/clay fines over the GCL
- Installation of 12oz Geotextile within Segment A and a portion of Segment B up to a transition location where GCL was used
- Installing zero grade rip rap to line the full length of ditch within the work area

Permafrost conditions were noted at two locations within Segment B and, as a result, care was taken not to disturb the thermal mat (organics, moss) within Segment C. Instead of digging into the mat the GCL was placed on top of the moss and scrub. To mitigate the permafrost noted within Segment B rock was placed to pad into the zones to increase bearing strength such that a layer of geotextile and rip rap could be installed. It is anticipated that this will allow pore water to escape while keeping fines in place and providing buttressing to the affected zones.

Nominal grades between -1.5 to -3.5% for the majority of the dich line were achieved with a maximum of -8% near the end of the ditch.

Three variances from the EBA design prints occurred:

- A Bentofix GCL was utilized to cap the embankment fill for Segments B and C identified in EBA Figure 6, in addition to 0.6m of silt / clay material, prior to placement of rip rap
- 12oz Geotextile was used to line the ditch in Segment A identified in EBA Figure 6, prior to rip rap being installed

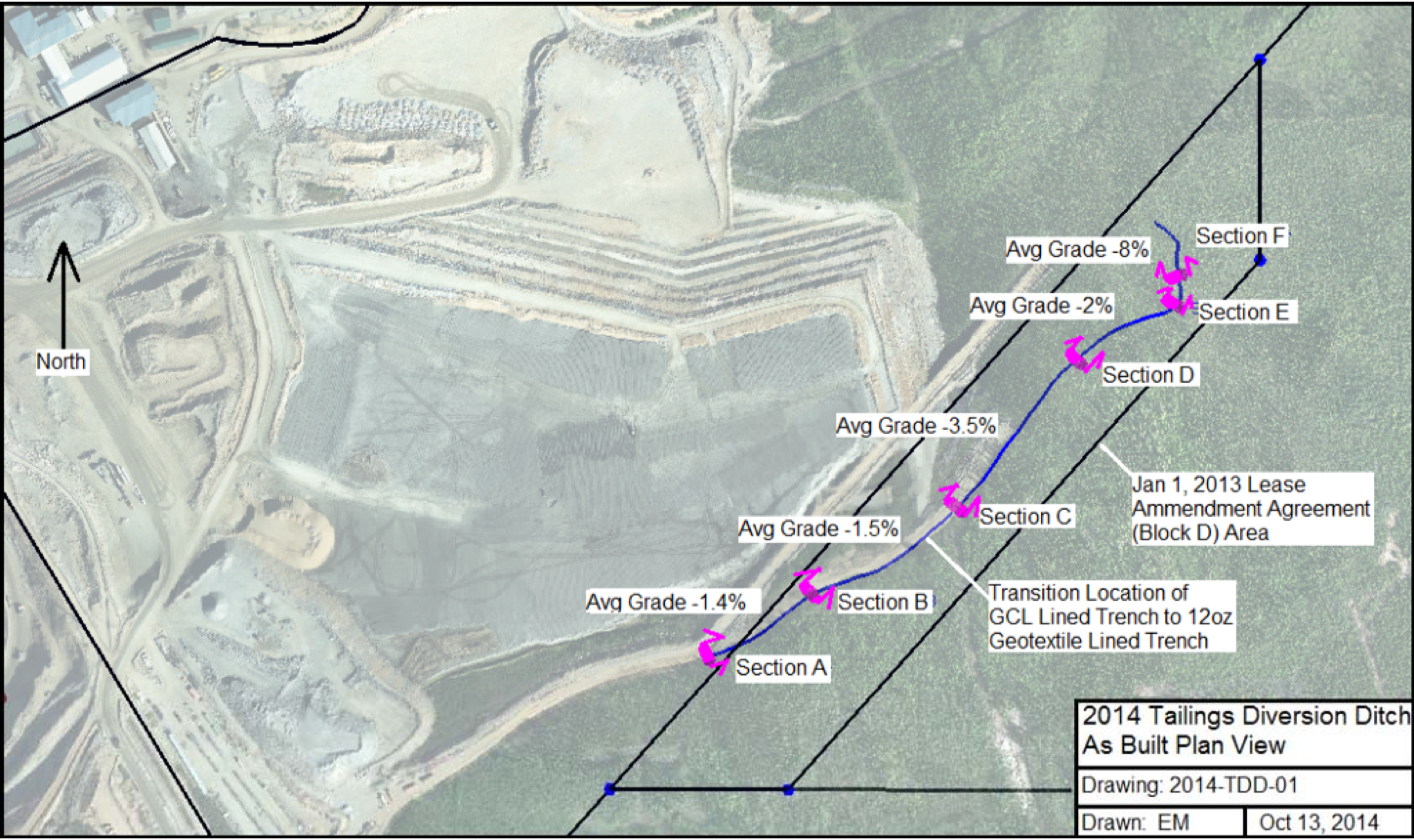
- The proposed buttress identified in cross section B/6 on EBA Figure 7 was installed but is not currently sloped to 3:1 as an extension of the Tailings Diversion Ditch to the Water Storage Pond, from the end of the current works, has been proposed within the Phase 5, 6 mining application and resloping the rock fill to 3:1 at present would remove the access (roadway) to construct the future works.

OCT 14, 2014

EAMON MAUER

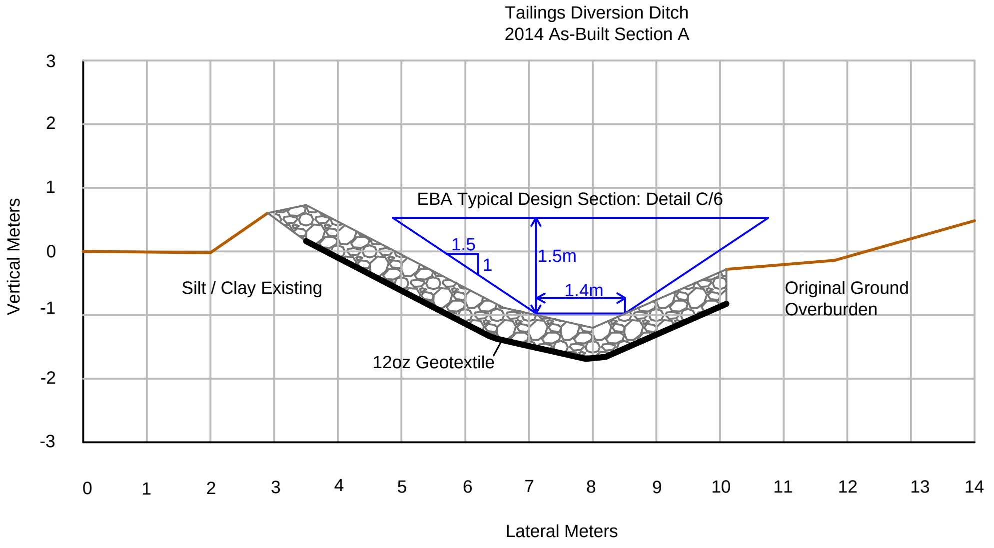
Eamon Mauer, P.Eng, PMP
General Supervisor – Project Engineering
Minto Mine

Appendix A: As Built Drawings

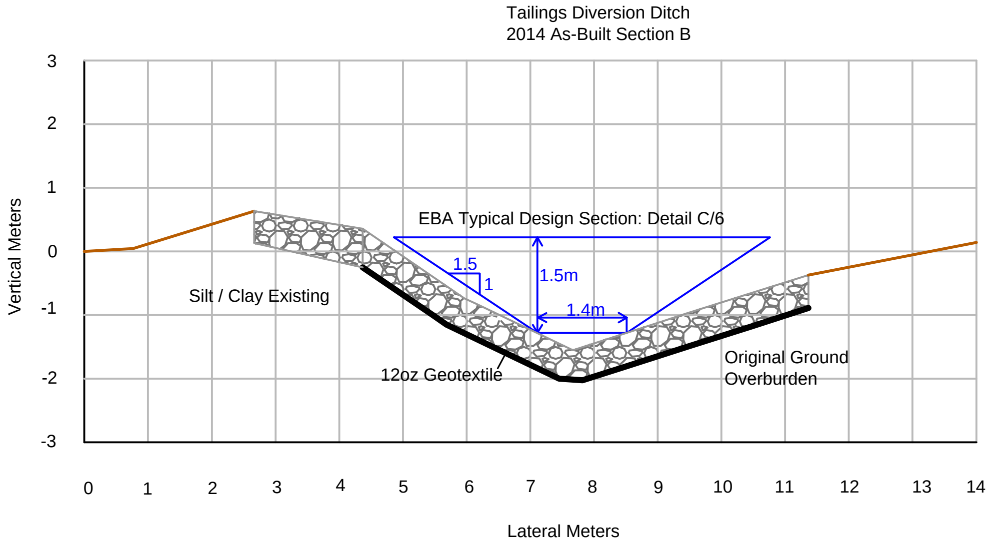


2014 Tailings Diversion Ditch As Built Plan View

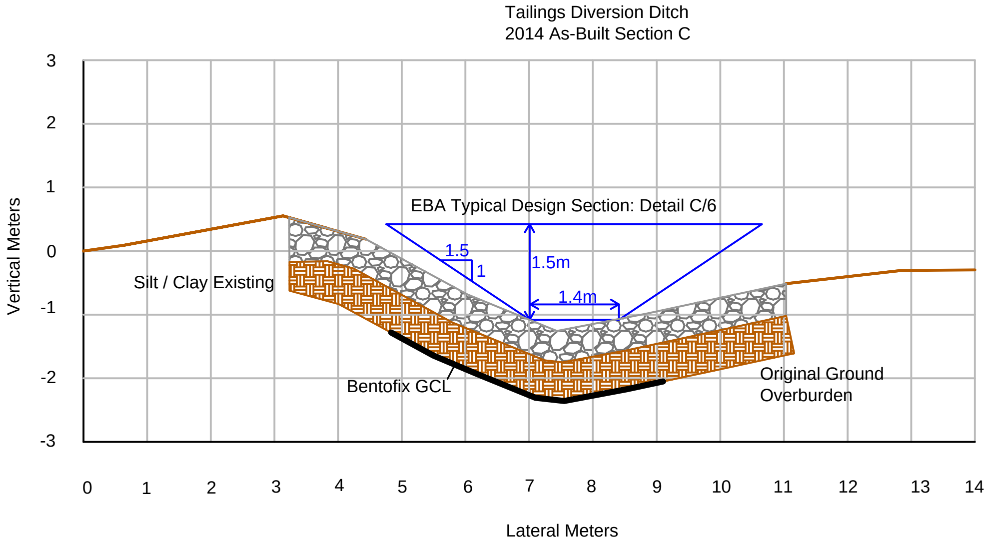
Drawing: 2014-TDD-01	
Drawn: EM	Oct 13, 2014



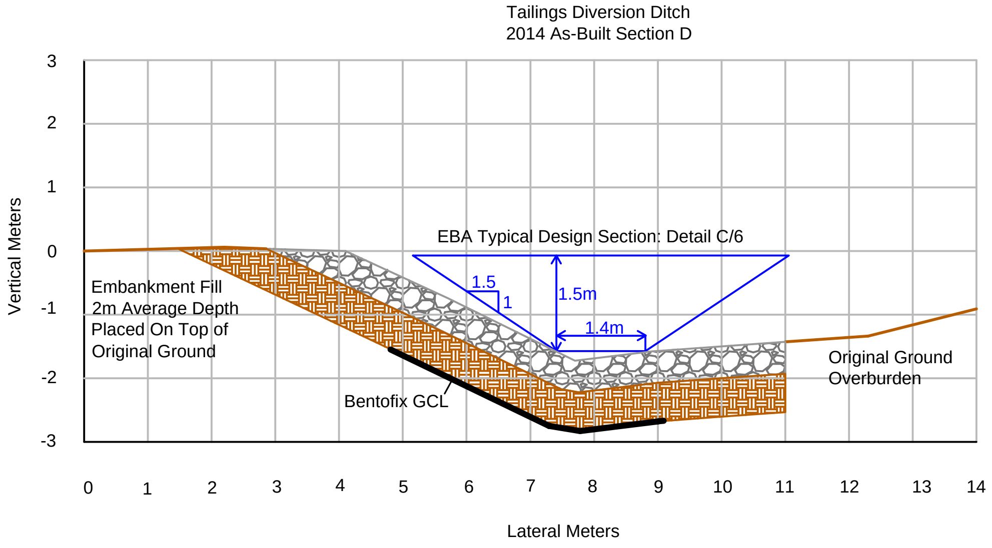
Tailings Diversion Ditch
2014 As-Built Section A



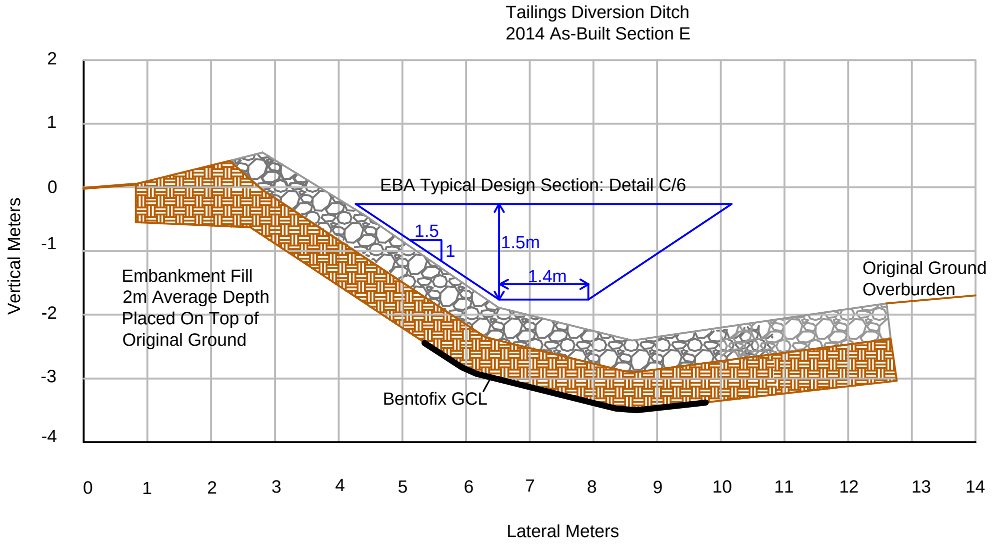
Tailings Diversion Ditch
2014 As-Built Section B



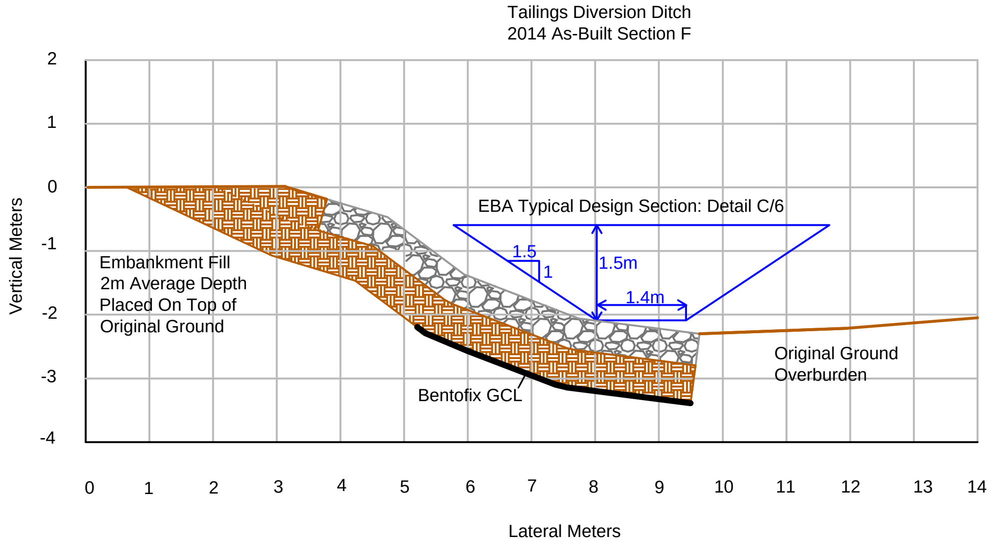
Tailings Diversion Ditch
2014 As-Built Section C



Tailings Diversion Ditch
2014 As-Built Section D



Tailings Diversion Ditch
2014 As-Built Section E



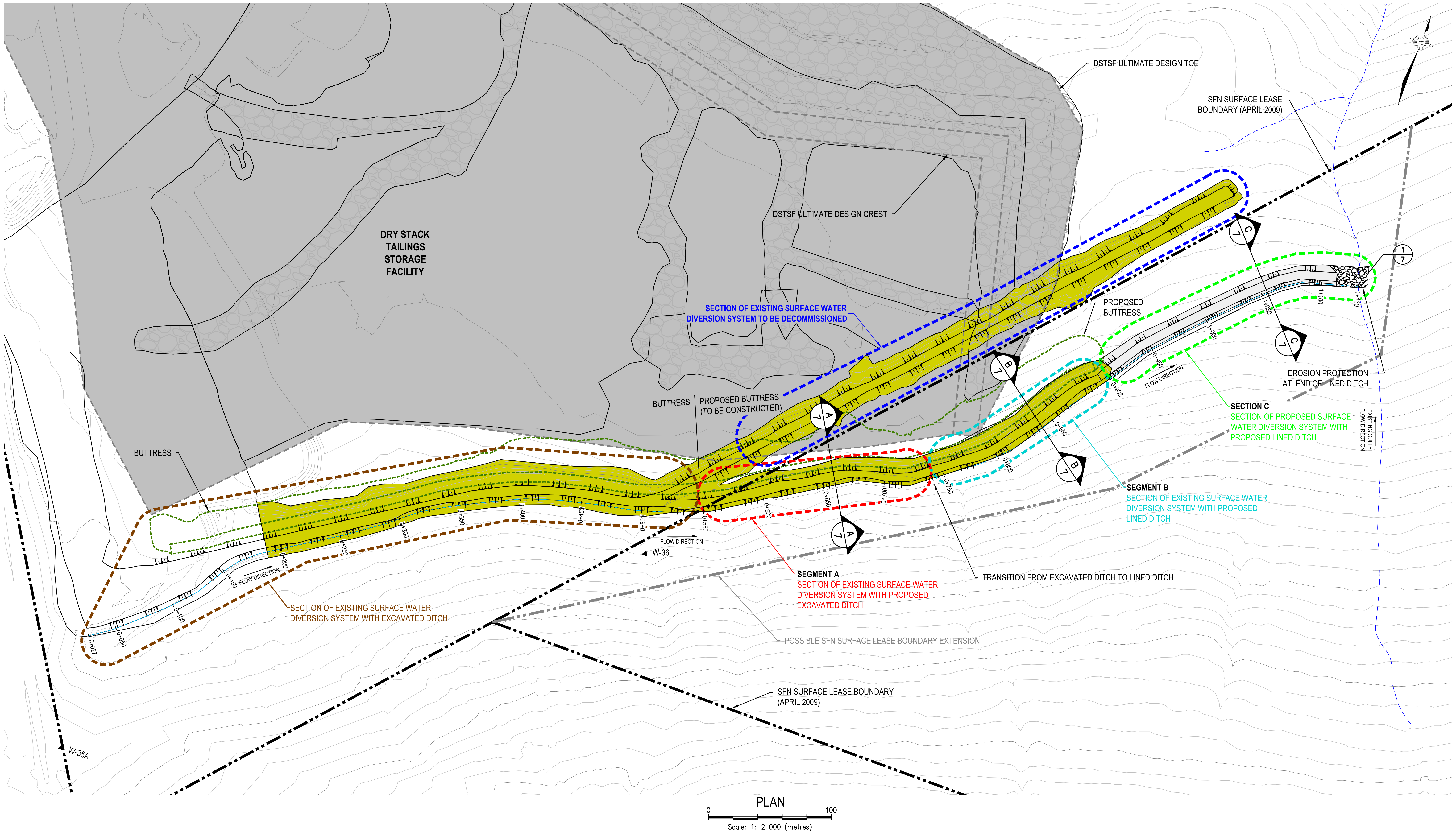
Tailings Diversion Ditch
2014 As-Built Section F

2014 Tailings Diversion Ditch
As Built Cross Sections

Drawing: 2014-TDD-02

Drawn: EM	Oct 13, 2014

Appendix B: EBA Design Drawings



LEGEND

☐	PLACED TAILINGS FOR DIVERSION SYSTEM
🟨	EXISTING SURFACE WATER DIVERSION BERMS
– – – –	WATERCOURSE

MATERIAL TYPES

EMBANKMENT FILL:
EMBANKMENT FILL WILL BE WELL GRADED MINED WASTE ROCK.
EMBANKMENT FILL WILL BE NOMINALLY COMPACTED BY SPREADING EQUIPMENT.

RIPRAP:
RIPRAP WILL BE GRADE BIN 0.0 COARSE GRADED MINED WASTE ROCK WITH MINIMAL FINES. CARE SHALL BE TAKEN TO ENSURE THAT MATERIAL USED FOR RIPRAP CONTAINS LITTLE FINES AND NO EXCESSIVE VISIBLE OXIDIZATION.

NOTES

1. THIS DRAWING PRESENTS TEMPORARY MEASURES TO ALLOW FOR SURFACE RUN-ON WATER TO BE COLLECTED UPGRADIENT OF THE DSTSF AND DIVERTED AROUND THE FACILITY. MAINTENANCE ISSUES ARE EXPECTED AND WILL NEED TO BE ADDRESSED THROUGHOUT ITS USE.
2. REGULAR INSPECTION WILL BE REQUIRED BY MINE STAFF TO IDENTIFY MAINTENANCE REQUIREMENTS. INSPECTIONS SHOULD BE CONDUCTED DAILY DURING FRESHET, BIMONTHLY DURING SUMMER MONTHS AND DURING AND AFTER SIGNIFICANT RAINFALL EVENTS.
3. SOME PERMAFROST DEGRADATION IS EXPECTED DURING THE OPERATIONAL LIFE OF THE DITCH. THE DEGRADATION IS EXPECTED TO BE MINOR AND WILL BE MITIGATED THROUGH REGULAR MAINTENANCE.
4. 2 m MINOR AND 10 m INDEX CONTOURS SHOWN BASED ON JUNE 2011 SURVEY DATA PROVIDED BY MINTO

STATUS
ISSUED FOR USE

CLIENT
MINTO EXPLORATIONS LTD.

DRY STACK TAILINGS STORAGE FACILITY
MINTO MINE, YUKON

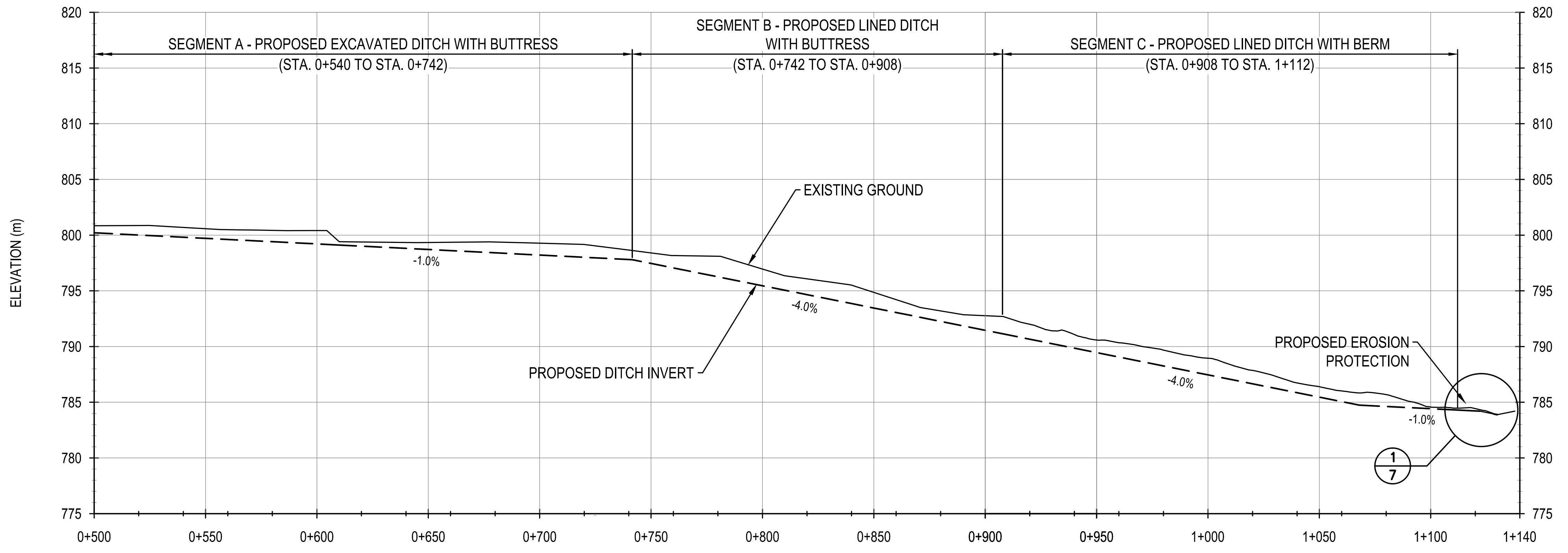
DRY STACK SURFACE WATER DIVERSION SYSTEM
PLAN VIEW

eba
A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
W14101068	CB/JAB	BJC/ML	4

OFFICE	DATE
EBA-WHSE	October 25, 2011

Figure 6

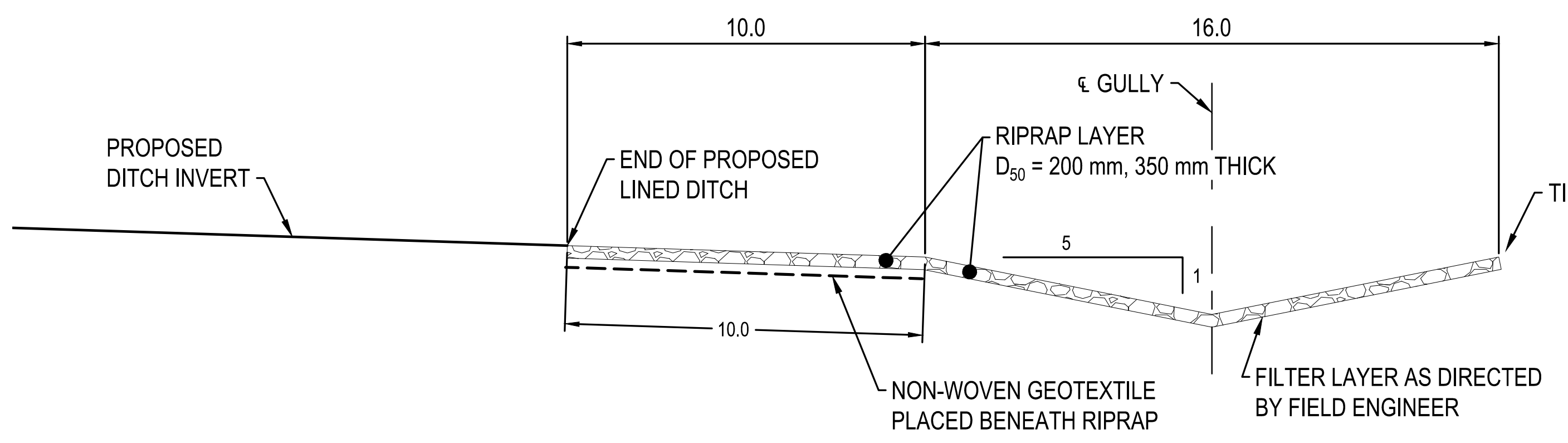


PROPOSED DITCH PROFILE

5X VERTICAL EXAGGERATION

0 100

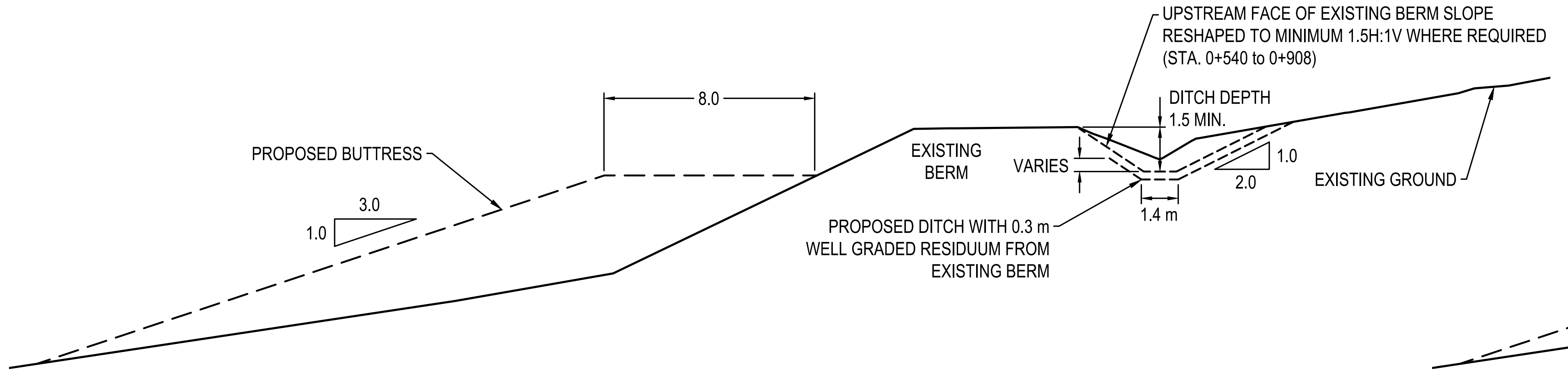
Scale: 1: 2 000 (metres)



1
7
PROPOSED EROSION PROTECTION RIPRAP APRON

0 10

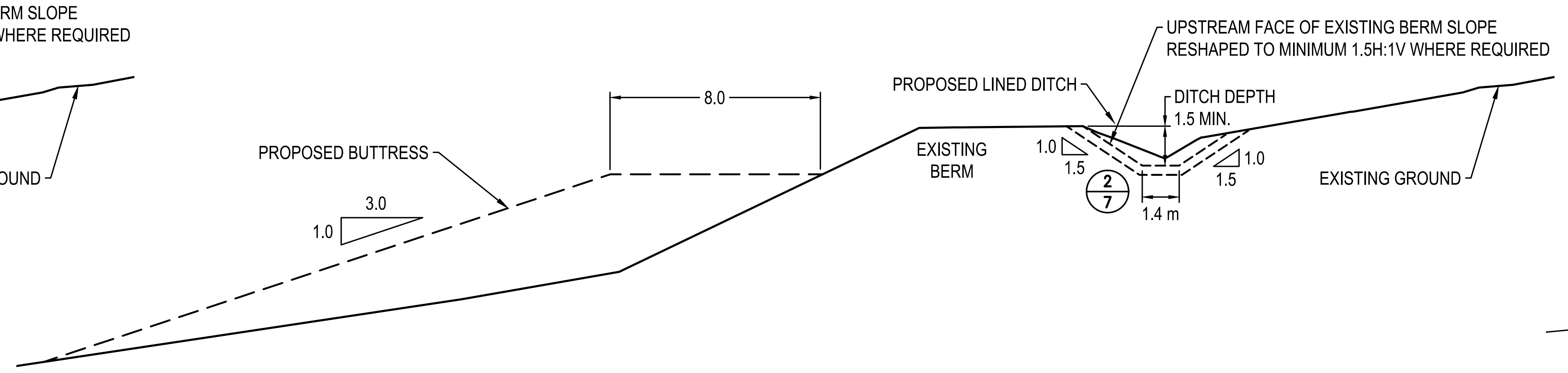
Scale: 1: 200 (metres)



A
6
PROPOSED BUTTRESS AND EXCAVATED DITCH
TO BE CONSTRUCTED ALONG SEGMENT A (TYPICAL)

0 10

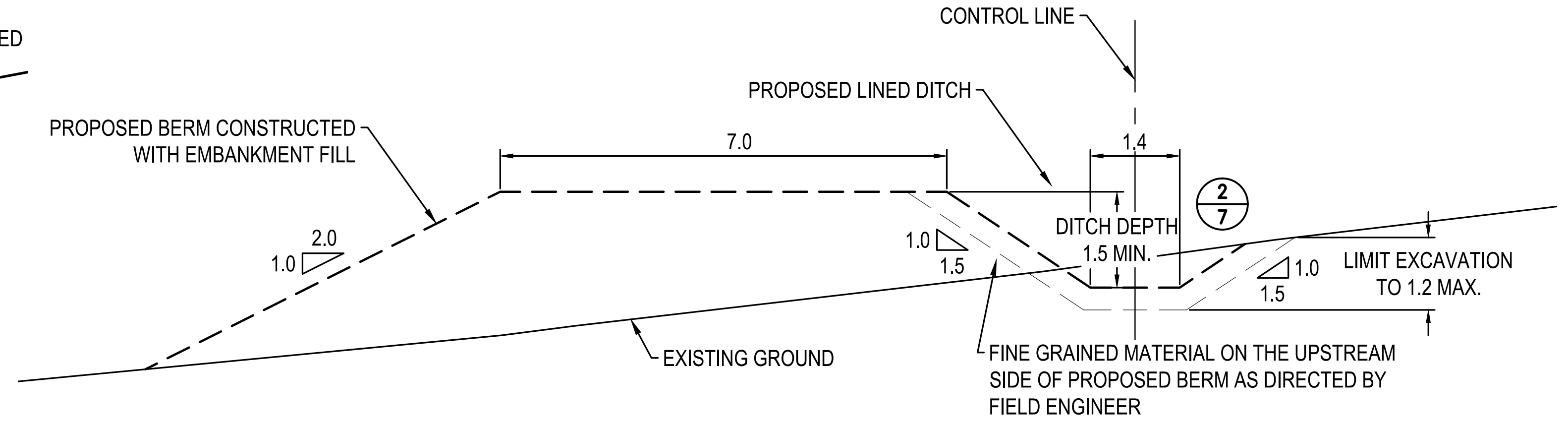
Scale: 1: 200 (metres)



B
6
PROPOSED BUTTRESS AND LINED DITCH
TO BE CONSTRUCTED ALONG SEGMENT B (TYPICAL)

0 10

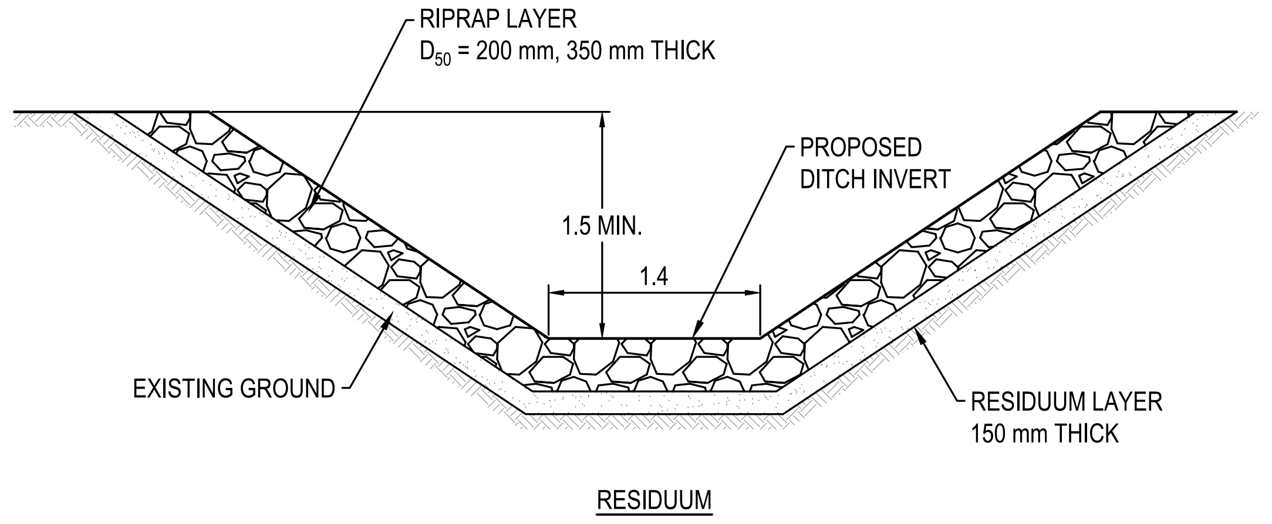
Scale: 1: 200 (metres)



C
6
PROPOSED BERM AND LINED DITCH
TO BE CONSTRUCTED ALONG SEGMENT C (TYPICAL)

0 5

Scale: 1: 100 (metres)



2
7
PROPOSED LINED DITCH DETAILS
FOR SECTIONS B & C

SCALE 1:50

MATERIAL TYPES

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STATUS
ISSUED FOR USE

CLIENT
MINTO EXPLORATIONS LTD.

DRY STACK TAILINGS STORAGE FACILITY
MINTO MINE, YUKON

DRY STACK SURFACE WATER DIVERSION SYSTEM
PROFILE AND SECTION VIEWS

A TETRA TECH COMPANY

PROJECT NO.	DWN	CKD	REV
W14101068	CB/JAB	BJC/ML	3

OFFICE	DATE
EBA-WHSE	October 25, 2011

Figure 7

CAPSTONE MINING CORP.
MINTO MINE SITE

Appendix C: Photos of Construction

Figure 1: Between Section C and D Looking East, April 19th, 2014

Figure 2: Between Section C and D Looking West, April 19th, 2014

Figure 3: Between Section E and D Looking West, June 20th, 2014

Figure 4: Section E Looking West, June 20th, 2014

Figure 5: Section D Looking East, June 21st, 2014

Figure 6: Section D Looking West, June 21st, 2014

Figure 7: Between Section C and D Looking East, June 23rd, 2014

Figure 8: Section C Looking East with Overburden Placed On Top Of Geosynthetic Clay Liner

Figure 9: Near Section A Looking East, Sept 4th, 2014

Figure 10: Near Section A Looking West, Sept 4th, 2014

Figure 11: Transition Zone GCL to 12oz Geotextile, Sept 4th, 2014

Figure 12: Section B Looking East, Sept 5th, 2014

Figure 13: Section B Looking East, Sept 7th, 2014

Figure 14: Section C Looking West, Sept 16th, 2014

Figure 15: Section A Looking West, Oct 6th, 2014

Figure 16: Section C Looking West, Oct 6th, 2014

Figure 17: Section D Looking East, Oct 6th, 2014

Figure 18: Temporary End Ditch Discharge, Future Works Proposed In Phase 5,6 Mine Plan

CAPSTONE
MINING CORP.
MINTO MINE SITE

Appendix D: Zero Grade Rip Rap Documentation

James Spencer

From: Douglas McIlveen
Sent: Monday, April 28, 2014 6:20 PM
To: Eamon Mauer
Cc: Gary Paarup
Subject: Samples Collected Along Tailings Diversion Ditch
Attachments: TDD 14-04-28 -complete.xlsm

Attached are the assay results from the samples we collected earlier today along the edge of the tailings diversion ditch. All samples returned below detectable limits (<0.01%) Cu and consistently show a high NP/AP ratio. This material is suitable for use as rip-rap.

Douglas McIlveen, **P.Geo.** | Chief Geologist
CAPSTONE MINING CORP.
MINTO MINE
13-151 industrial Road,Whitehorse,Yukon Canada, Y1A 2V3
Main 604-759-0860 ext. 6635 | Fax 604-759-0861 douglasm@mintomine.com

James Spencer

From:	Matthew Skanes
Sent:	Monday, September 15, 2014 2:12 PM
To:	Eamon Mauer
Subject:	FW: Info for construction material from the 844-06
Attachments:	844-06_Figure_5.PNG; 844-06_Figure_6.PNG; 844-06_Figure_7.PNG; 844-06_Figure_8.PNG; 844-06_Figure_1.PNG; 844-06_Figure_2.PNG; 844-06_Figure_3.PNG; 844-06_Figure_4.PNG

From: Matthew Skanes
Sent: September-12-14 10:34 AM
To: Eamon Mauer
Cc: Douglas McIlveen; Gary Paarup
Subject: Info for construction material from the 844-06

Hi Eamon,

Please let me know of this information and attached screenshots from Vulcan (Grade Control package) is satisfactory:

Material mucked as construction material from the 844-06 was from a region that returned complaint data for all blast holes within the designated region.

Figure 1 shows a plan view of the entire 844-06 blast with all (4) material divisions. Each material polygon displays the:
-Material type
-Cu %
-Volume (BCM)
And,
- NP/AP ratio

For example, in the upper right of figure 1, the 'Zero Grade Waste (construction)' material, containing an average of 0.01% Cu, having a volume of 1852 BCM, and an NP/AP ratio of 284.690 is clearly seen.
Any 'construction' material that was needed for projects was derived from ONLY this region.

Figure 2 shows the survey numbers of all blast holes from the 844-06.

Figure 3 shows the entire 844-06 in relation to the as-built of the 118 pit (scan taken on Aug 31, 2014)

Figure 4 shows a close-up of the 'Zero Grade Waste (construction)' material polygon with blastholes (drillholes) color coded by Cu % (Green = <0.01% Cu, and Blue = 0.01-0.1% Cu)

Figure 5 shows the entire 844-06 blast with blastholes color coded to Cu %.

Figure 6 shows the entire 844-06 blast with blastholes color coded to NP/AP ratio (Green = >3, and Red = <3)

Figure 7 shows a close-up of the 'Zero Grade Waste (construction)' material polygon with blastholes color coded to NP/AP ratio from figure 6.

Figure 8 shows the entire 844-06 blast with blastholes color coded to Sulphur % ratio (Green = <0.3, and Red = >0.3)

Please let me know if you have any further questions or concerns.

Thanks,

Matt Skanes | Mine Geologist
CAPSTONE MINING CORP.
MINTO MINE
13-151 Industrial Road, Whitehorse, Yukon, Canada, Y1A 2V3
Phone 604-759-0860 ext. 6631| Fax 604-759-0861

Appendix C - South Wall Buttress As-Built

capstone
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

South Wall Buttress
As-built Report

January 2015

Table of Contents

1 Introduction

This report presents as-built drawings and performance measurements of the South Wall Buttress, built to stabilize the Main Pit's south wall following a significant slope failure in April 2011.

The Main Pit was Minto Mine's sole source of ore from startup in 2007 through its completion in April 2011. The pit was mined in five stages, each enlarging it to access deeper ore. The south wall of the pit intersected a paleochannel of permafrost soil overburden with significant ice content. Each stage of mining (except for Stage 4) pushed the southern extent of the pit further, increasing the height of the exposed overburden slope: at the completion of Stage 5, it measured 67m high at its deepest point.

In their design report for the South Wall Buttress, EBA provided the following description of the slope:

> *The south wall consists of between 50 and 70 m of soil overlying bedrock. The following general stratigraphy is extrapolated from available borehole information:*
>
> - *0 to 5 m depth - Various fill materials, and native Silt (Till-like) material;*
> - *5 m to 45m depth – Silt/Sand (Till-like) soils;*
> - *45-50 m depth – Ice-rich Permafrost Clay, observed to contain substantial warm segregated ground ice;*
> - *50-55 m depth – Sand derived from weathered bedrock (Residuum);*
> - *55 m depth – Granodiorite Bedrock*
>
> *Based on movement data, failure is confined to a relatively weak zone within the overburden located at a depth of about 40 m to 50 m. This weak zone correlates with a layer of ice-rich permafrost clay. The inclinometer data indicates that a large block of the overburden above this weak zone is creeping slowly towards the pit. The mechanism of failure is analogous to ice near its melting point at the base of a glacier.*

1.1 Background

Movement along a plane above the overburden / bedrock contact had been observed during the mining of the Stage 3 pushback in April of 2009; this movement eventually led to a failure of the south wall on May 5, 2009.

After the completion of Stage 3 in March 2010, a small (approx. 210,000 m^3) buttress was dumped in up to the 766m elevation to prevent movement near the toe of the overburden layer. This interim measure, having successfully stabilized the Stage 3 wall, was removed in the course of Stage 5 mining.

With the failure of the south wall during the mining of Stage 3, the Stage 5 pushback design was created with a large unloading cut at the 810m elevation and 30° slopes in overburden. Mining of Stage 5 began in summer of 2010 and finished in April 2011.

Prior to mining, it was recognized that the Stage 5 south wall would need to be supported by a buttress of 850,000 m^3, which would have formed a layer of approximately 40m thickness over the slope. This was intended to prevent localized failure of the overburden layer. Several variations on this design were created, with some, such as that appearing in the *Preliminary Phase IV Waste Management Plan* submitted as part of the Phase IV environmental assessment application, measuring as much as 1.30 Mm^3.

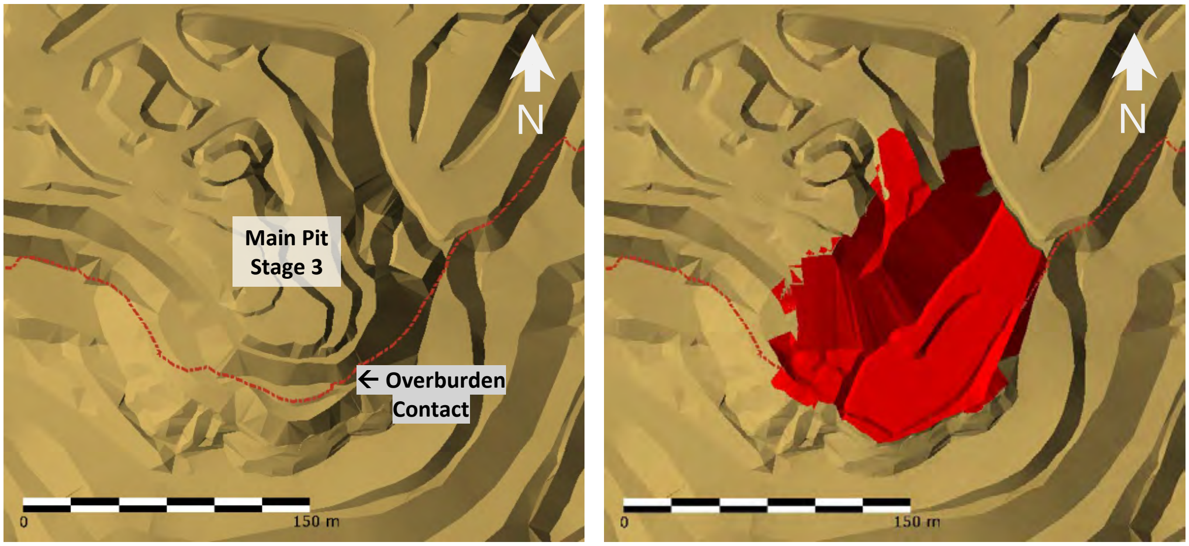


Figure 1-1: Completed Stage 3 pushback (left) and temporary buttress constructed to stabilize the slope (right).

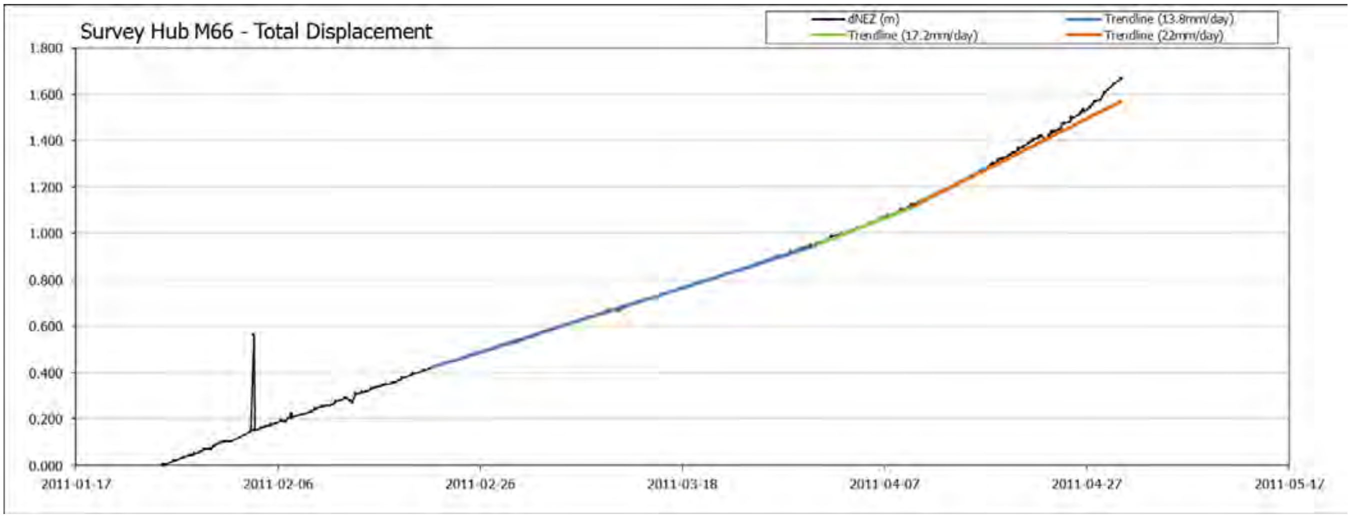
Figure 1-2: Movement along failure plane in overburden, south wall, Main pit, Stage 3 pushback, April 2009.

Figure 1-3: Displacement along the plane of movement: south wall, Main pit, Stage 3 pushback, April 2009.

Figure 1-4: Main pit, Stage 3, May 2009 south wall failure. Looking south-southwest, camera positioned at bottom of pit.

Figure 1-5: South wall failure, Main pit, April 2011. Aerial photo, looking southwest. Start of buttress construction visible at bottom left corner of the photo.

Monitoring via inclinometers and survey hubs during the mining of Stage 5 in the winter of 2010/2011 suggested a larger-scale translational failure. The graph below shows movement data for one such survey hub.



Analysis showed that the bulk of a 50m-thick silty / sandy overburden layer was sliding into the pit along a thin layer of ice-rich permafrost clay. After several months of accelerating movement, this translational failure resulted in a substantial piece of the slope sliding into the pit on April 30, 2011, bounded at the back by a large tension crack. This created an over-steepened overburden face that underwent a progressive failure, sloughing continuously throughout the summer of 2011 until winter conditions halted further degradation of the slope.

The volume of the failure initially measured 83,000 m^3; by the end of the summer, the volume lost from the South Wall had increased to 302,000 m^3. The following, quoted from EBA's *Area 1 South Wall Buttress Design Report*, describes the material that comprised the failure:

> *The majority of the in-situ overburden was in a permafrost condition and the failed material included significant remnant chunks of frozen material. Following the initial failure and subsequent failures, the resulting run-out of the failed material extended approximately 150 m from the toe of the original slope. Depending on the level of thaw, the material was deposited at an angle of between 10 and 15 degrees. Subsequent observations indicated that the failed material has continued to melt and the angle of the run-out material has further decreased.*

Construction of the buttress to the original design began shortly before the slope failure and continued until May 30, 2011, at which time the buttress advanced to a point where it could not be safely constructed using the original design. This, and concerns about the ability of the design to stabilize the slope, necessitated a new analysis of the data and a new design, which EBA performed in July of 2011.

This analysis showed that a buttress considerably larger than the original design would be required to halt the movement of the overburden slope.

2 Buttress Design

EBA's analysis concluded that a 2.65 Mm^3 buttress with a 4:1 front face slope, the toe of which would butt up against existing rockfill in the pit, would stabilize the south wall. The side slope of the buttress was designed at 1.5:1 H:V. The figure below shows an overview of the design; sections are available in the Section 4 of this document and in EBA's design report.

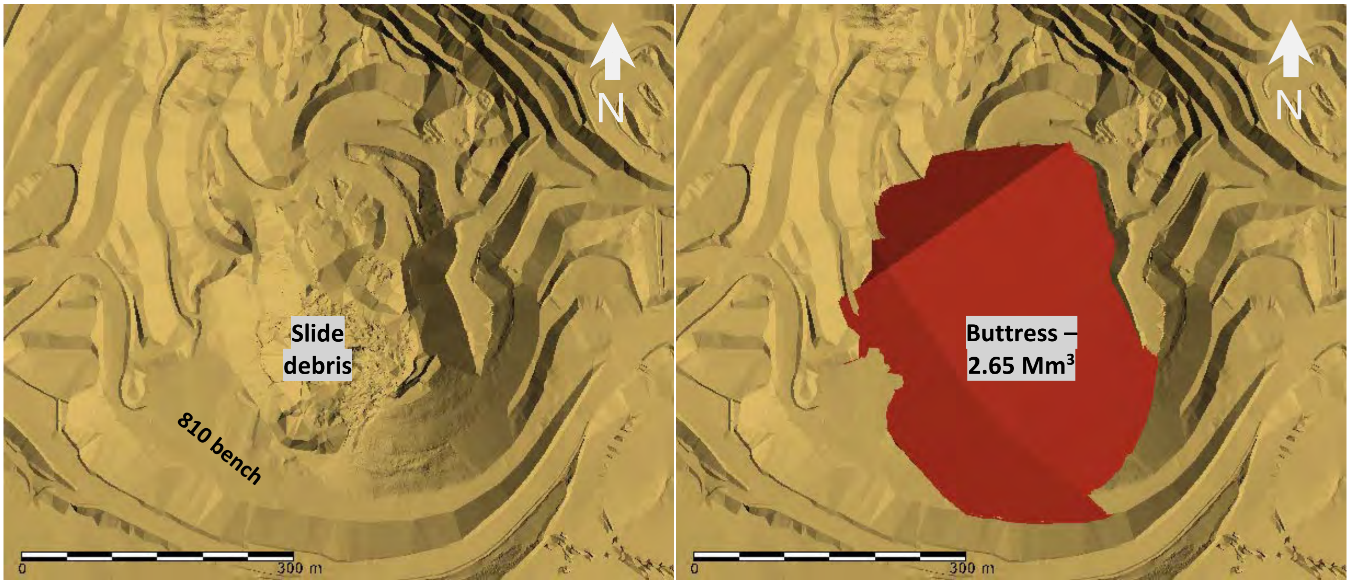


Figure 2-1: Post-failure survey of the Main pit (left) and final buttress design for the south wall of the Main pit (right).

The intersection of the overburden contact with the final pre-failure as-built of the south wall is shown in Figure 4. It can be seen that the overburden contact intersects the south wall as low as 740m at the south corner of the pit, and as high as the 770m elevation at the west corner of the pushback.

This is also illustrated in a section view of the buttress, shown in Figure 5.

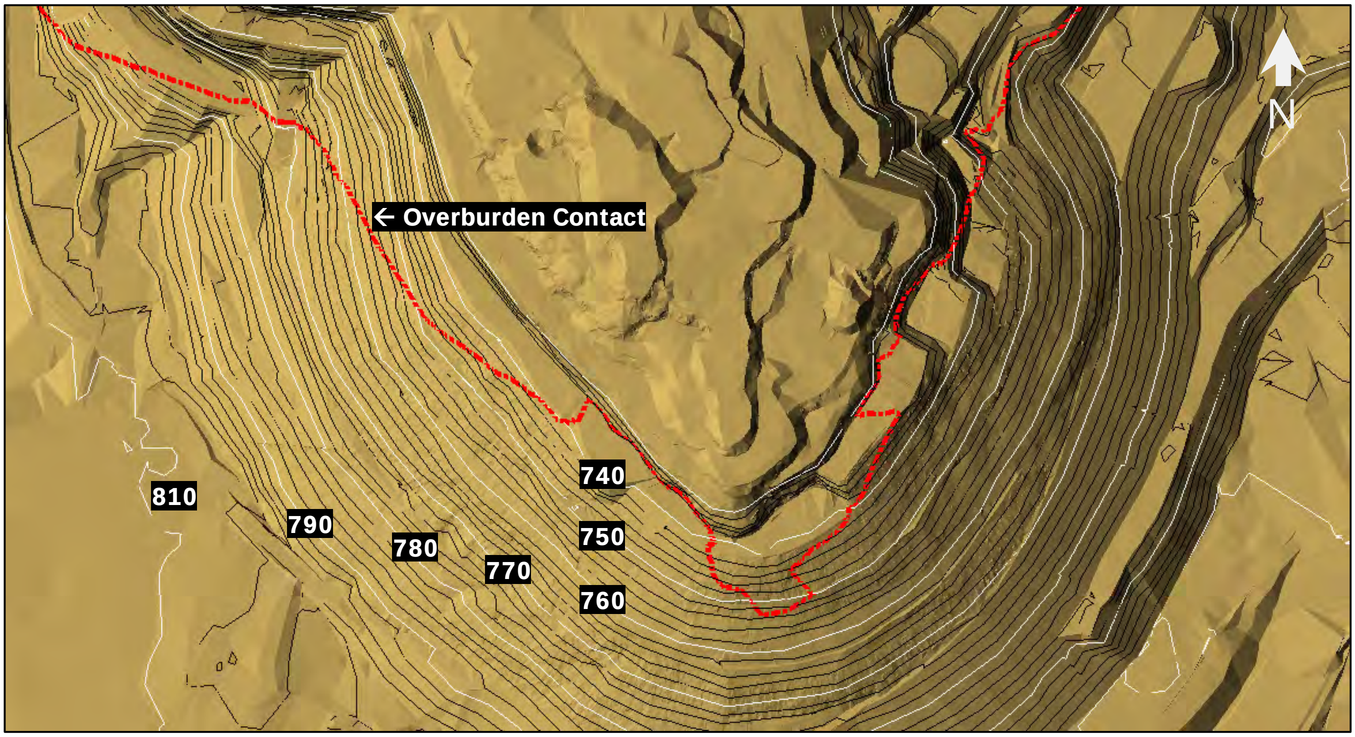


Figure 2-2: Overburden contact (red) where it intersects the final pre-failure as-built of the south wall.

Figure 2-3: Section (0° azimuth) through centerline of buttress, looking west.

3 Construction Sequence

Dumping of material as per the original pre-failure buttress design began on May 28, 2011, shortly before the wall failure, by end-dumping from the 765 elevation. The photo below shows this initial dumping as of June 15. Dumping continued until June 2, at which time the toe was largely resting upon the slide debris and it was no longer considered safe to proceed. Minto contracted EBA to carry out a redesign of the buttress at this time.

Figure 3-1: Main Pit, looking southeast, June 15. Dumping based on the original wraparound buttress design is shown.

Dumping resumed on July 11 based on the new design. The construction plan called for three stages, the first of which was a toe berm across the pit on ground considered likely to be beyond the toe of the slide debris (due to the water level in the pit and Minto's inability to discharge water at that time, this could not be verified). This served to provide a stable toe for the buttress and to contain slide debris. The toe berm was dumped from the 754m elevation, which was chosen to ensure that natural segregation would leave coarse material at the toe of the structure, and to stay safely above the level of the slide debris. The water level in the pit was also a significant factor, being at approximately 750-753m elevation during the construction Stage 1.

The three sections shown in Figures 3-2 through 3-4 show the planned construction sequence.

Stage 2 padded over the slide debris from two separate faces. This approach was chosen so that dumping could advance from a stable base to cover the slide debris while maintaining sufficient dump height to permit safe travel of haul trucks on the dump surface. Stage 2, as well as the completed Stage 1 toe berm, are shown in Figures 3-5 and 3-6.

Following the completion of Stage 2, further construction took place in lifts of 2m thickness, each of which was compacted using a vibratory smooth-drum compactor, until the buttress reached the 784 elevation in March 2012. At this time, effort shifted to the Mill Valley Fill Extension.

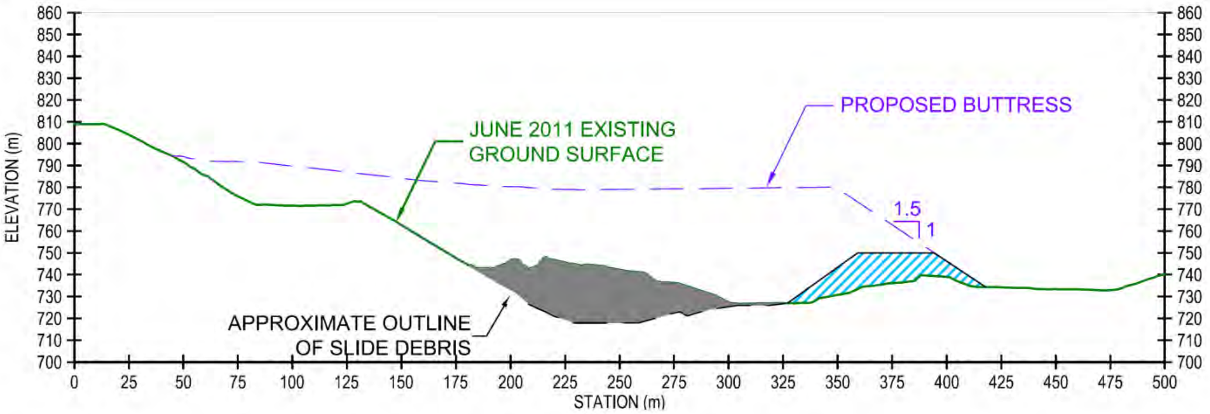


Figure 3-2: Stage 1 of buttress construction, shown hatched in blue.

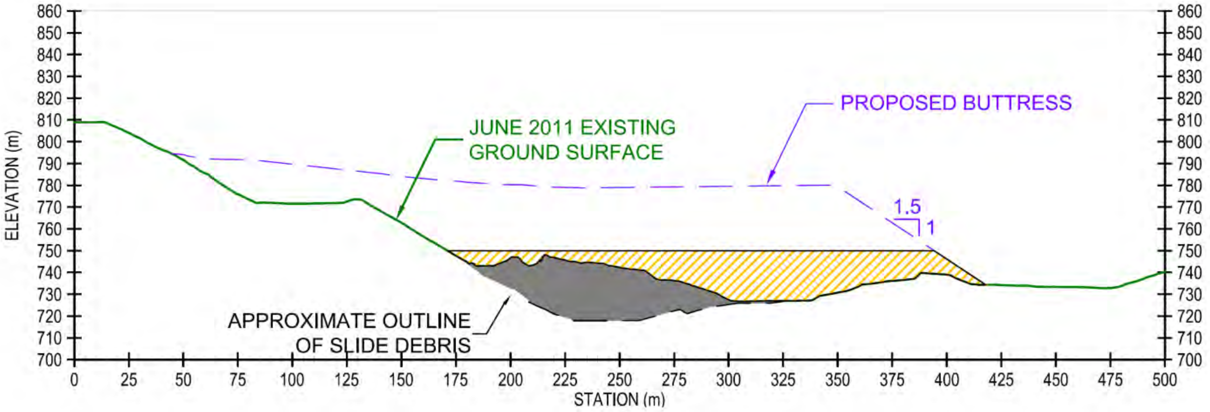


Figure 3-3: Stage 2 of buttress construction, advancing the buttress flat to pad over slide debris.

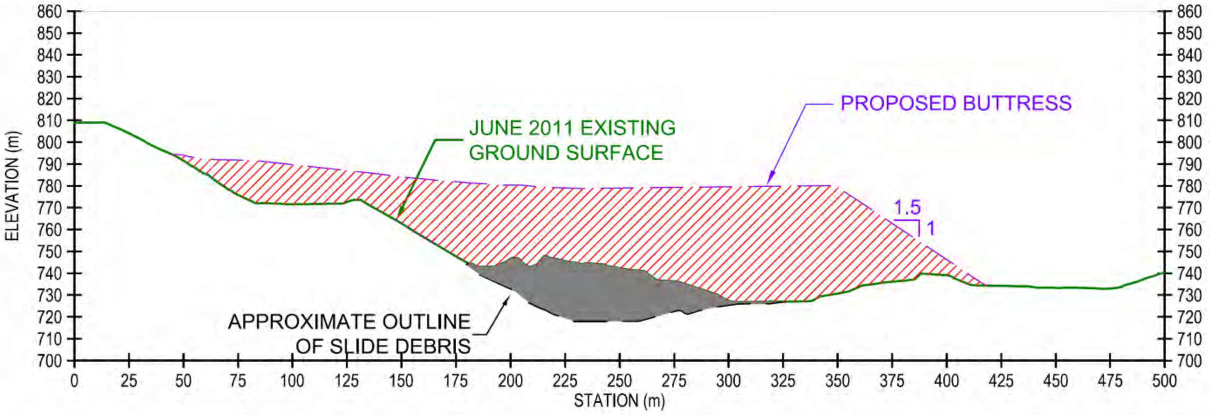


Figure 3-4: Stage 3 of buttress construction: bulk fill.

Figure 3-5: Photo showing Stages 1 and 2 of buttress development. September 17, 2011, looking S-SE.

Figure 3-6: Buttress development, October 2, 2011, looking E-SE.

Figure 3-7: Aerial ortho-photo of South Wall Buttress, August 14, 2012.

Figure 3-8: Aerial ortho-photo of South Wall Buttress, August 11, 2013.

Figure 3-9: Aerial ortho-photo of South Wall Buttress, September 9, 2014.

Work resumed in September 2012 by dumping a road on top of the South Wall Buttress's front face; this expanded the dump beyond the original EBA design and was intended to serve as a bench along which a tailings line would run.

The development of this additional bench coincided with Minto's decision to separate so-called "SAT waste" from the Area 2 pit, this being waste rock with an NP:AP ratio less than 3.0, a sulfide sulfur content greater than 0.30%, or a paste pH of less than 5.0. It was determined that this material should be stored under saturated conditions after the closure of the mine. To minimize re-handling costs at closure, dumping of SAT waste rock from the 786m elevation, beyond the design of the South Wall Buttress and beneath the spill elevation of the pit, began at this time and continued until April 2013.

To conserve pit volume for the mine's water and tailings storage needs, dumping of SAT waste then began on top of the buttress pad.

Simultaneously, a new haul road was built from low-grade waste rock to compensate for the loss of the previous haul road mined out by the northwest corner of the Area 2 pit (see Figure 3-8). The thawing overburden on the 810 bench was covered: this low-grade waste rock fill was only partly within the buttress footprint. Finally, work resumed on raising the lower pad of the South Wall Buttress in lifts until it reached its present level at the 800m elevation.

4 As-Built Drawings and Volumes

As-built drawings are shown in the following figures. The sections were chosen to approximately match those in Figure 4 of EBA's design report.

In some section views, the profile of the slide debris shows vertical discontinuities, as it was created as a composite of several surveys taken over a period of months. As the south wall overburden thawed and sloughed, the volume of slide debris in the pit increased, flowing over the fill being placed at the time. Simultaneously, rock fill was being placed on top of slide debris. The point at which the slide debris met the rock fill was observable on each survey surface, but it was not possible to determine the nature of the contact beneath. The contact point on surface was therefore projected downward.

4.1 Volumes

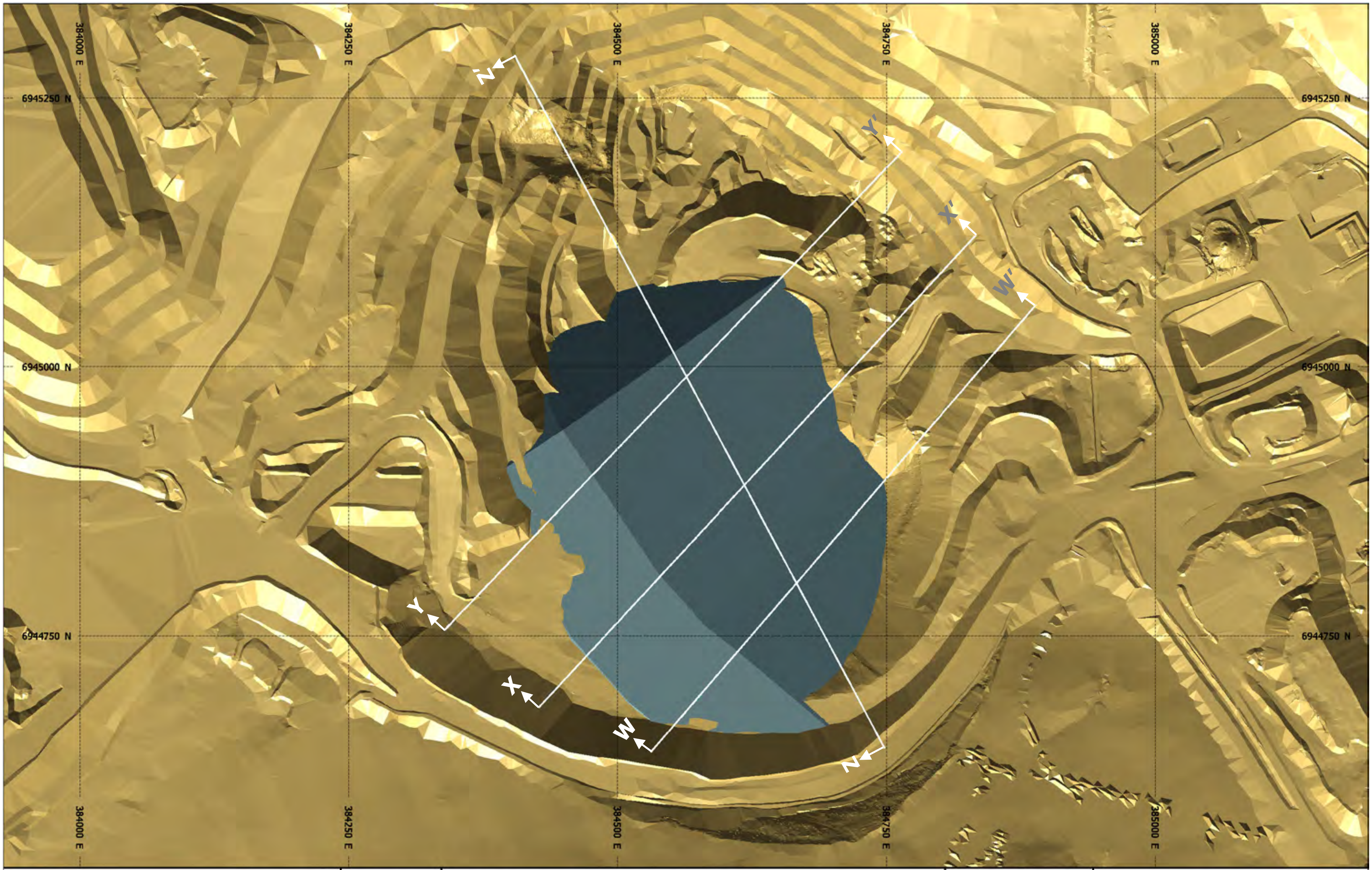
The combination of the South Wall Buttress, the in-pit SAT dump, and the dumping completed to establish the new east-west haul road (shown in Figure 3-7) measures 4.63 Mm^3 (as of October 2014).

There are a few small areas in which the South Wall Buttress was not dumped out to the design crest; the volume of these under-built areas measures 53,000 m^3.

4.2 SAT Volume

The following table describes the quantity of SAT waste present below a given elevation.

From	To	SAT Volume Within Interval (m^3)	Cumulative SAT Volume Below Elevation (m^3)
811	812	2390	2390
810	811	5460	7850
809	810	10637	18487
808	809	12439	30926
807	808	12747	43673
806	807	13232	56905
805	806	13805	70710
804	805	14357	85067
803	804	14884	99951
802	803	15439	115390
801	802	16603	131993
800	801	21206	153199
799	800	34753	187952
798	799	48997	236949
797	798	52350	289299
796	797	52278	341577
795	796	52344	393921
794	795	55821	449742
793	794	57993	507735
792	793	58193	565928
791	792	58034	623962
790	791	57698	681660



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DESCRIPTION:	South Wall Buttress design superimposed upon April 2011
	site as-built survey
DATE PLOTTED:	2015/01/17

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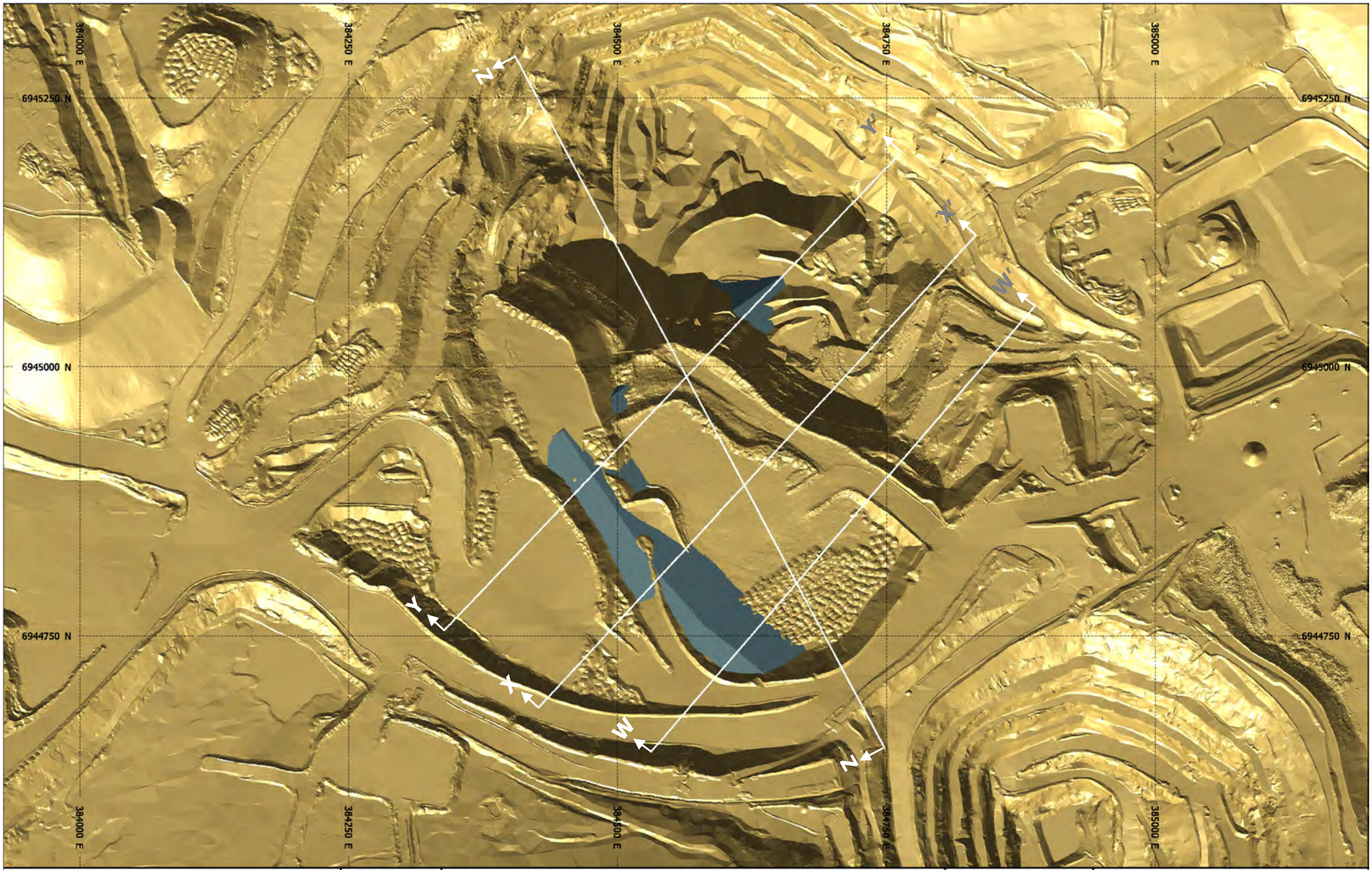

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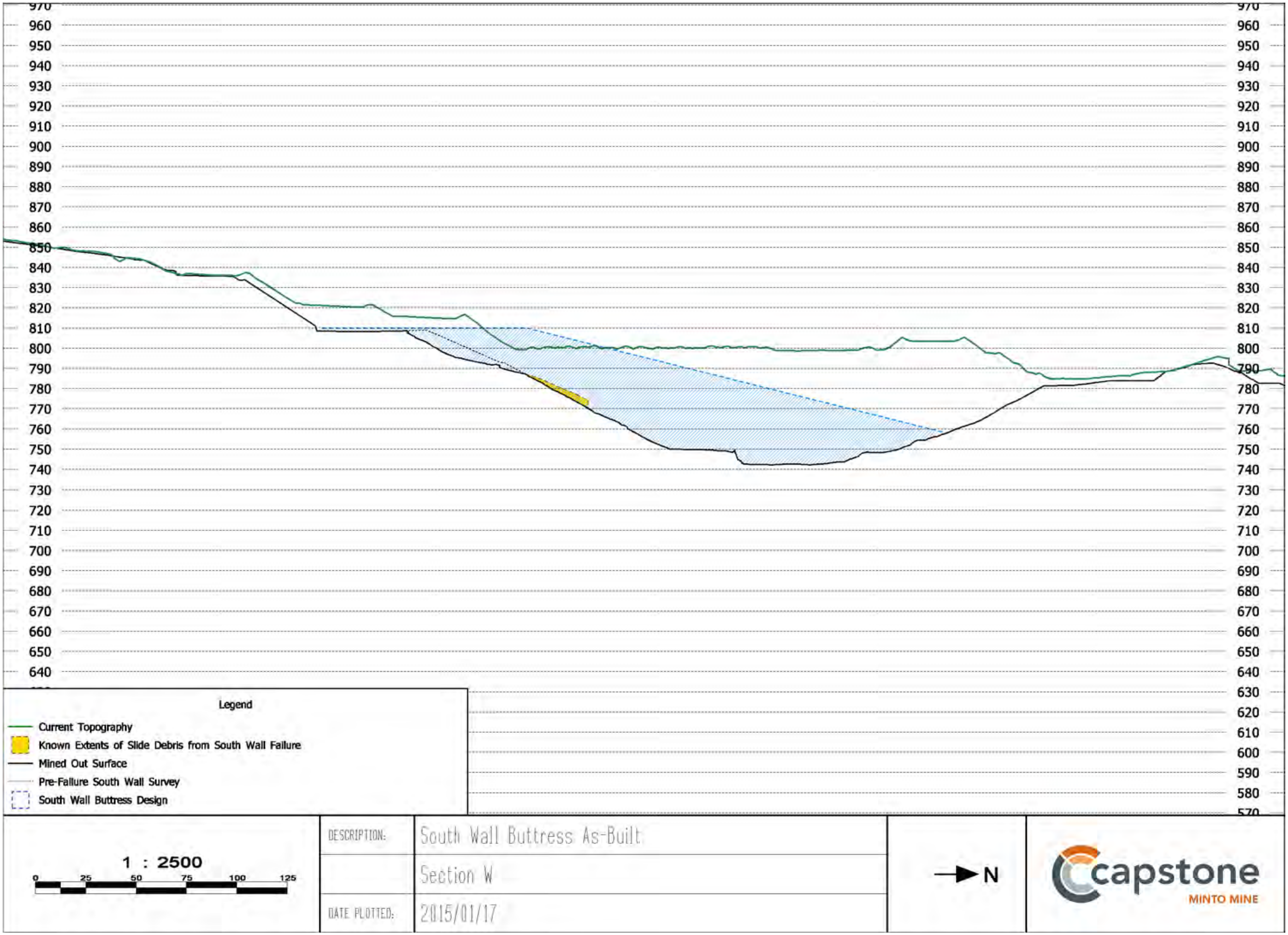
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South Wall Buttress Design
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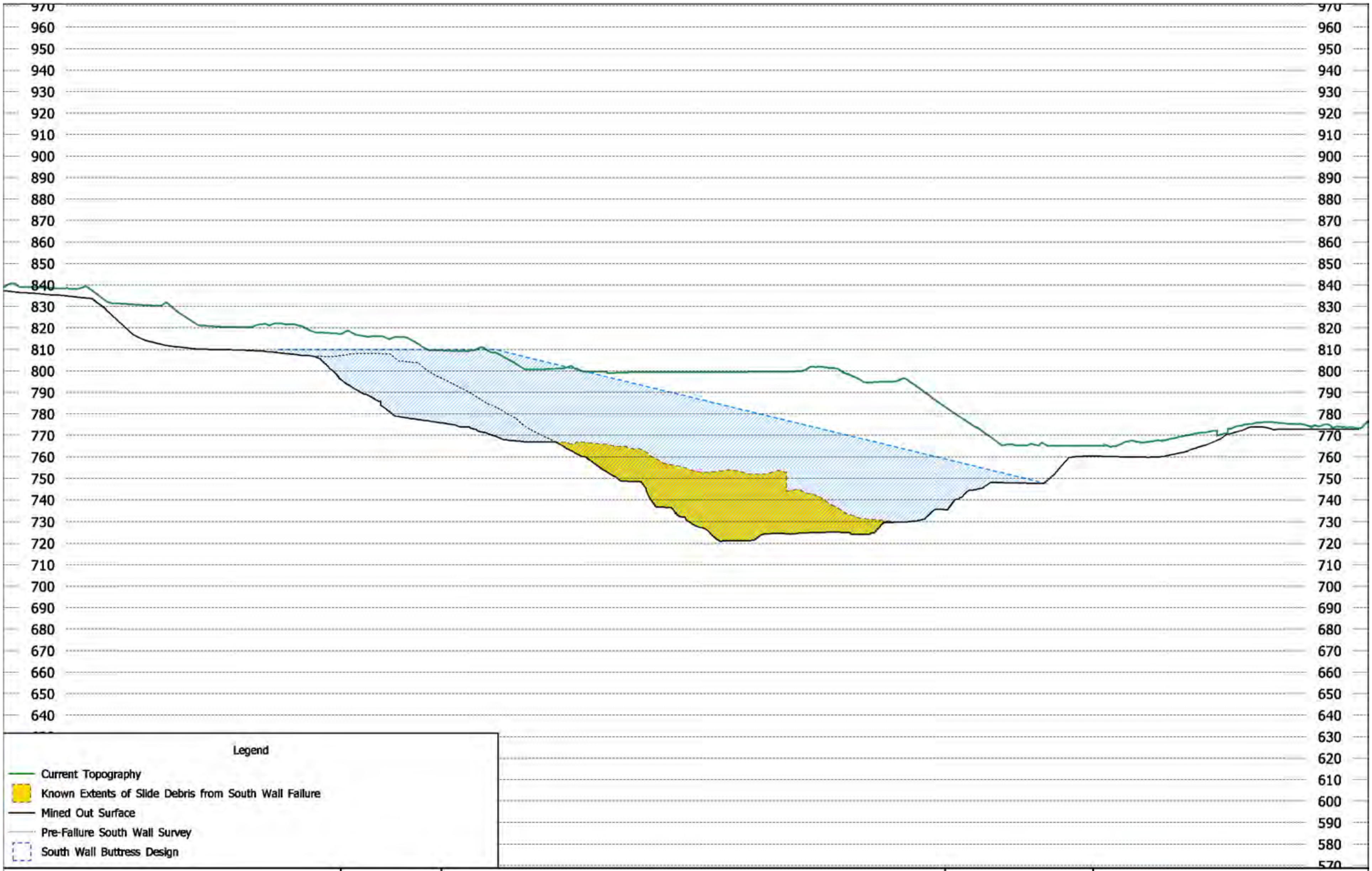

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Pre-Failure South Wall Survey
South Wall Buttress Design
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Mined Out Surface
Pre-Failure South Wall Survey
South Wall Buttress Design
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DESCRIPTION:
South Wall Buttress As-Built
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5 Buttress Performance and Monitoring

Monitoring of the buttress consists of a combination of surface instrumentation and visual inspections. Inspections of the pit and buttress are carried out quarterly as part of site wide geotechnical reviews. Three of the quarterly inspections are done internally by Minto's geotechnical engineers and one is done by an external geotechnical engineering consultant.

Instrumentation consists of series of survey hubs around the south perimeter of the pit/buttress, shown in Figure 5-2, which have been surveyed regularly since the start of dumping in early 2011. Hubs are constructed by drilling holes in the rock fill of the dump, inserting steel posts approximately 2m into the ground, and cementing them into place. Affixed to each post is a base plate on which an RTK-corrected GPS instrument is attached. At the time of this report, readings are taken bi-weekly.

Movement rates, shown in Figure 5-1, indicate gradually decreasing movement during construction of the buttress in 2011 and 2012. By mid to late 2013, movement had decreased significantly, at which point construction of the buttress had been completed nearly to design. At the time of this report, movement has essentially stopped, with the exception of small movement (<1 mm/day) rates still recorded in mid to late 2014 on the west side of the buttress (hubs M69, M73 and M74). Hub M74 in particular has been damaged by frost heaving and there is some question if the movement being recorded is representative of ground movement or heaving/leaning of the hub post. A replacement hub is planned for this location to verify the results of M74.

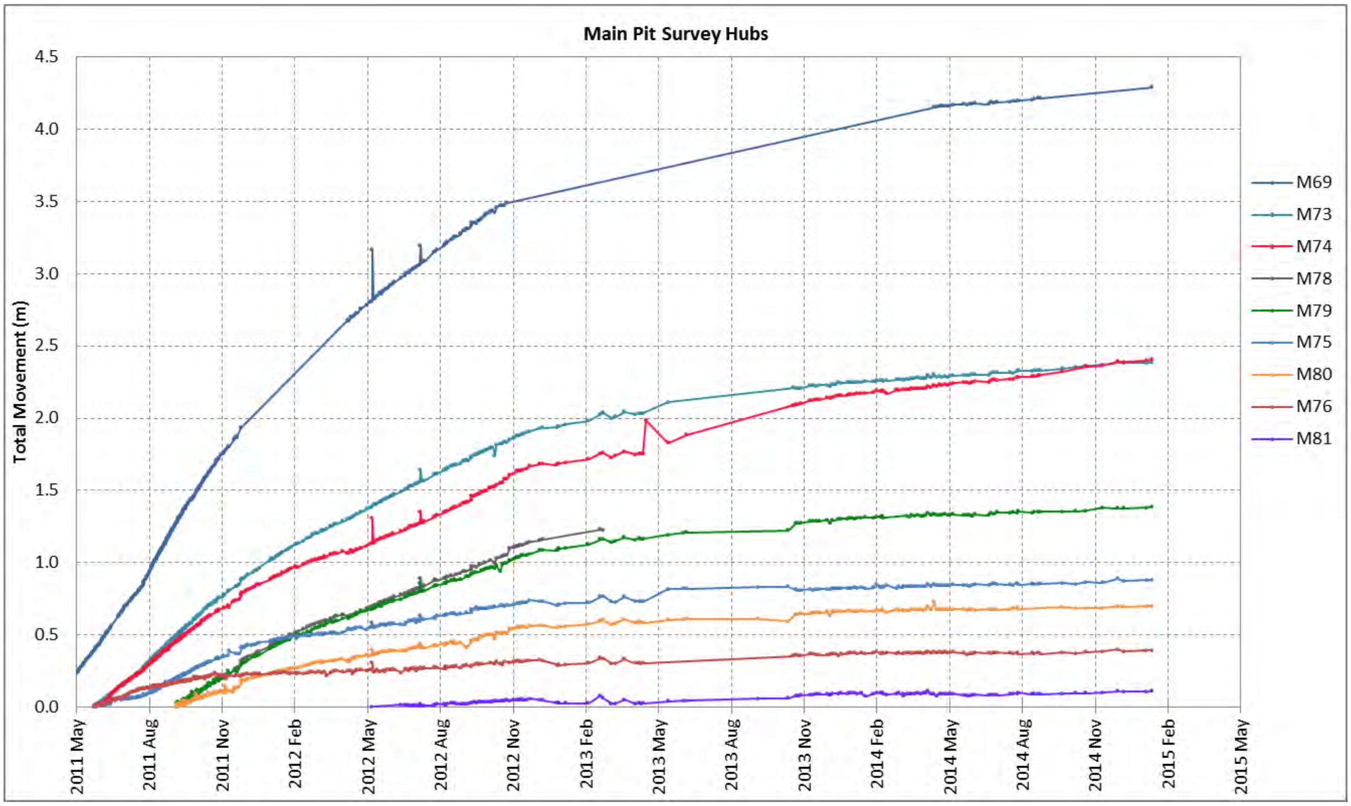

Figure 5-1: Main Pit survey hub total displacement data.

In January 2015, three additional hubs, M82 (behind tension cracks), M83 and M84 (near crest within tension cracked area at the northwest corner) were installed on the west side of the buttress to monitor tension cracking on the 810 bench of the in-pit dump. Although data is only available for a short time period, early results indicate movement is no longer occurring, or is very marginal.

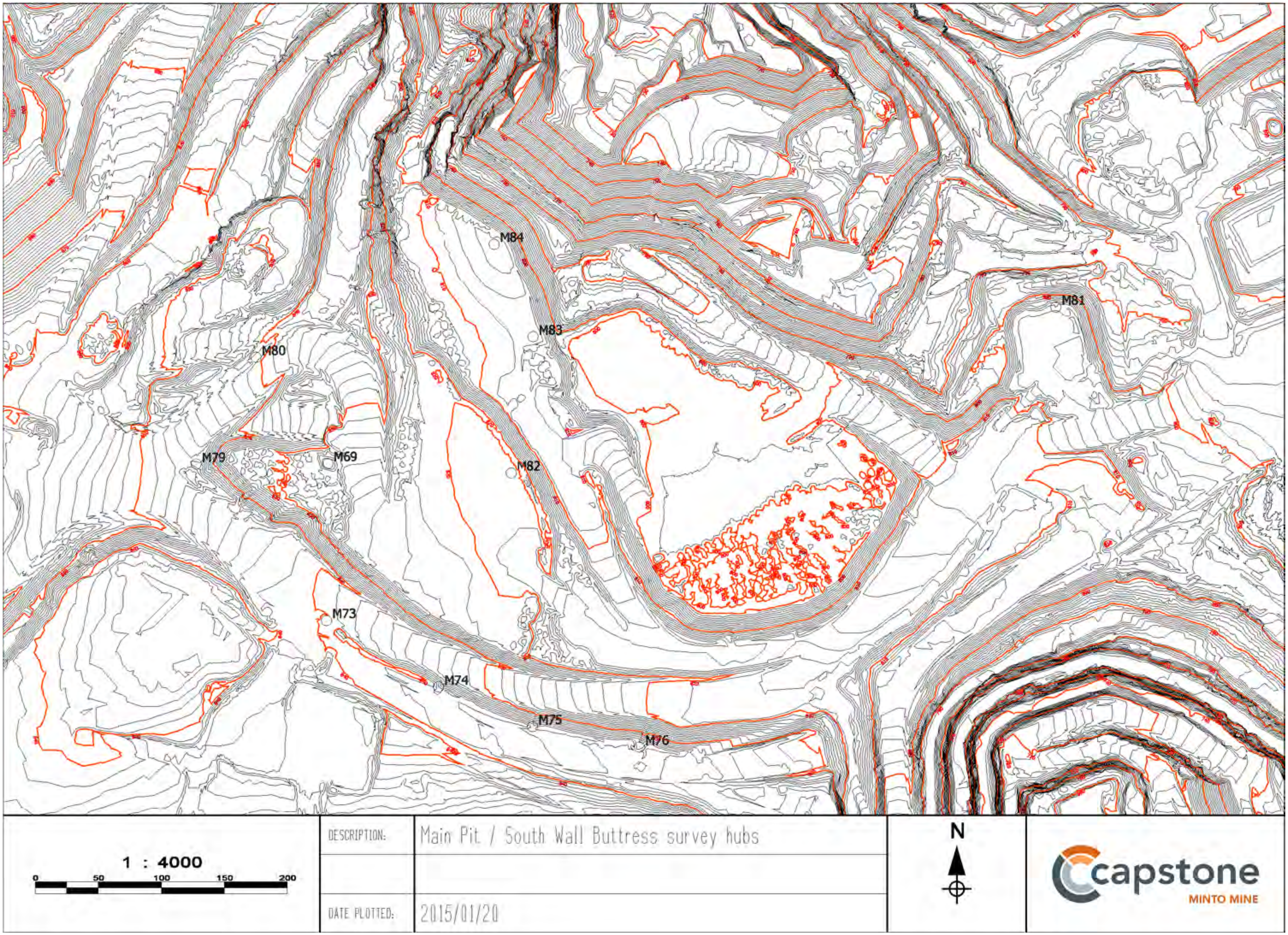

Figure 5-2: South Wall Buttress survey hubs

Appendix D – Minto Mine Spill Contingency Plan

Minto Mine

2015 Spill Contingency Plan

Prepared by:

Minto Explorations Ltd.

Minto Mine

March 2015

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Appendix D: Tug and Barge Emergency Contingency Plan

1 Introduction

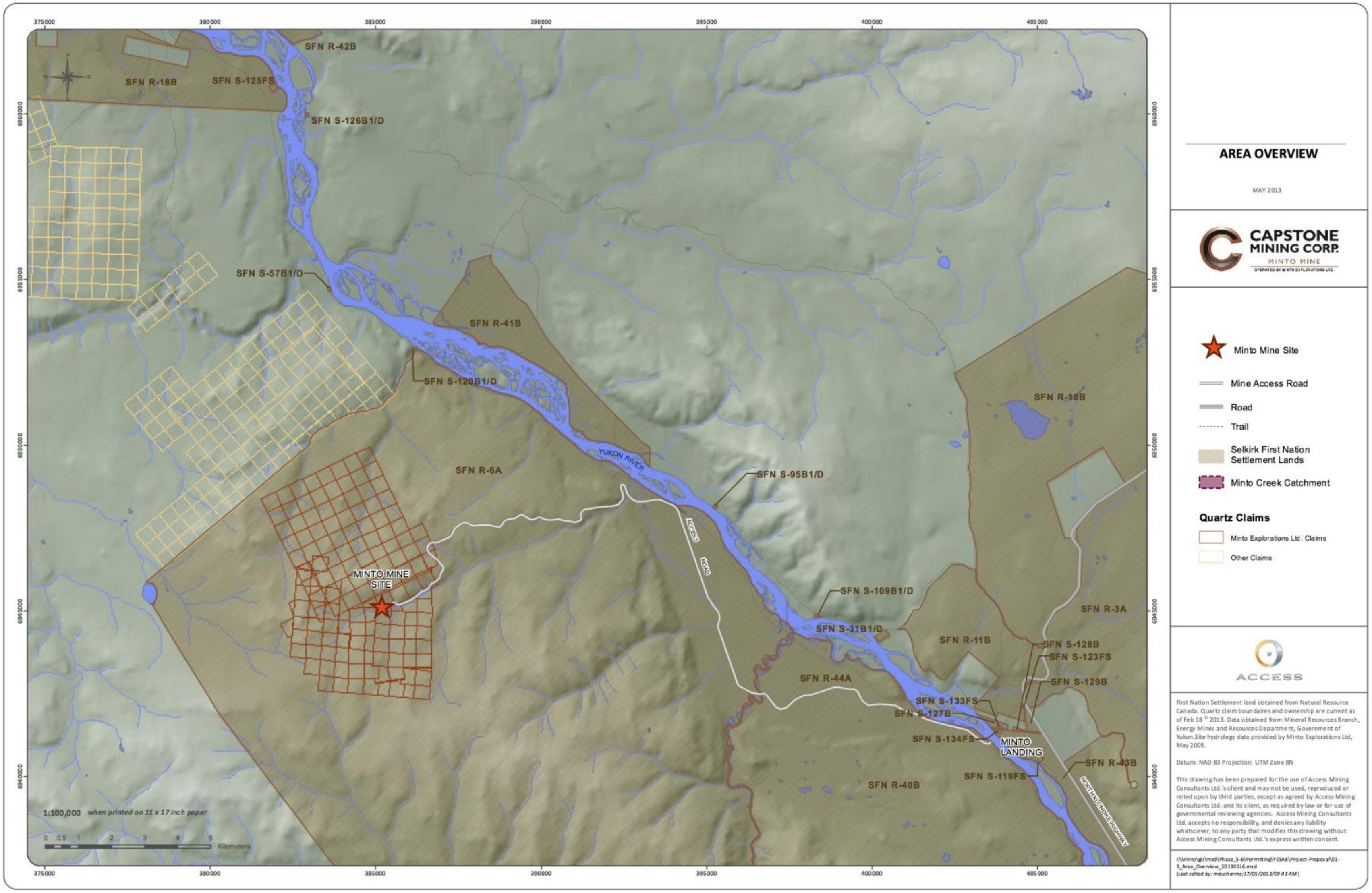
Minto Mine (administered by Minto Explorations Ltd. (Minto)) is a high-grade copper and gold mine that is located 240 km north of Whitehorse, Yukon. Operations are ongoing at this time and began in October 2007. The mineral deposits mined at the site were identified during exploration programs occurring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

This Spill Contingency Plan (SCP) is an update to the previous SCP, submitted in March 2014. The content of this SCP is derived from the *Plan Requirement Guidance for Quartz Mining Projects* (Yukon Government, 2013). The SCP has been updated annually and submitted as part of Minto's Water Use Licence and Quartz Mining Licence annual reports.

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

1.1 Project Description

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



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

Datum: NAD 83 Projection: UTM Zone 8N

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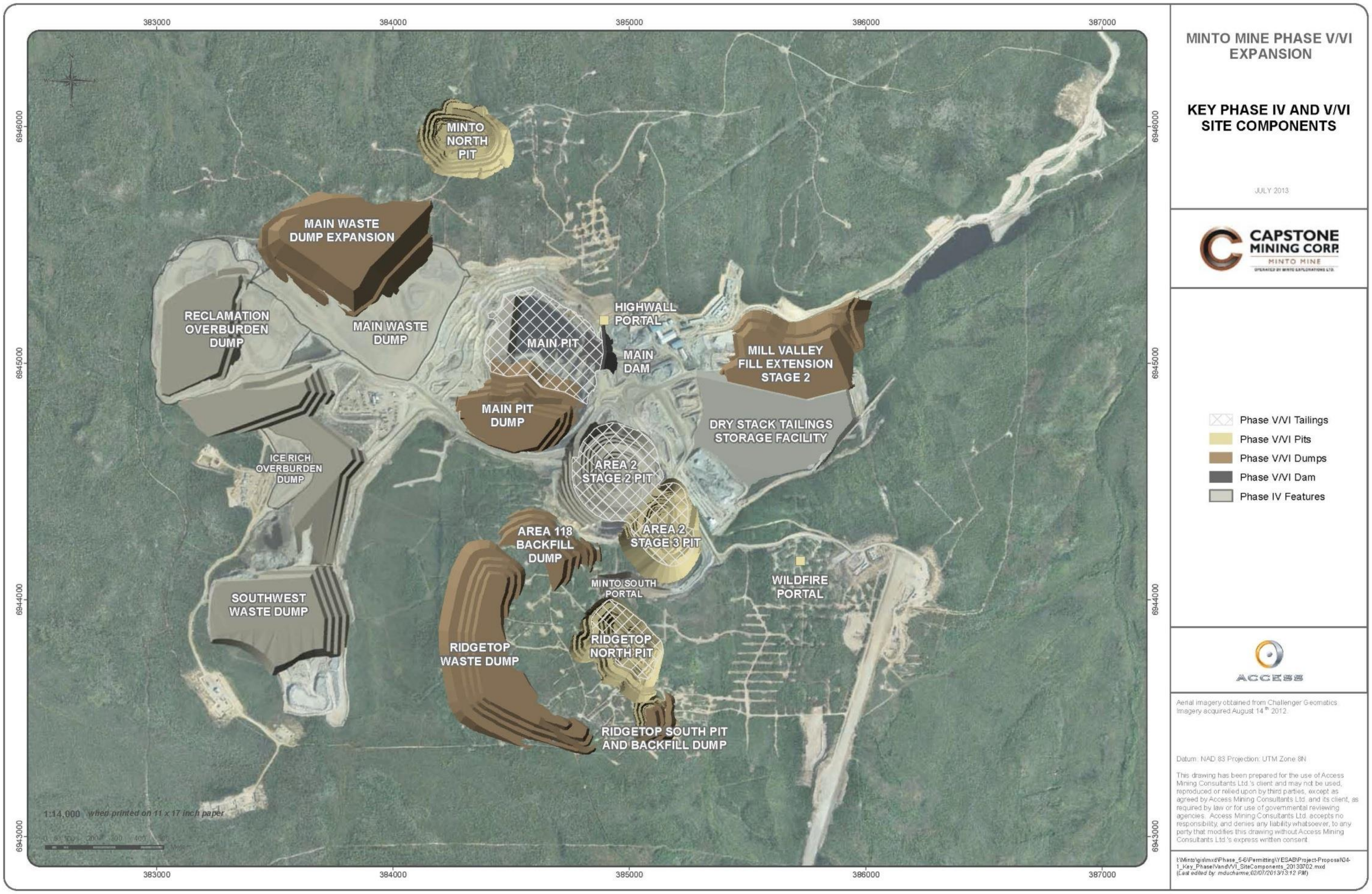
Figure 1-1: Minto Mine Area Overview



Aerial imagery obtained from Challenger Geomatics Imagery acquired August 14th 2012.

Datum: NAD 83 Projection: UTM Zone 8N

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

2 Definitions

The following definitions apply to the components of the Spill Contingency Plan outlined herein.

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

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

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

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

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

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

3 Purpose and Scope

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

This Spill Contingency Plan (SCP) is prepared in accordance with Minto Mine's Type "A" Water Use License QZ96-006 (WUL), which states that:

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

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

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

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

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

And finally to satisfy the requirements of the Quartz Mining License QML-0001 Schedule B, that requires "*a plan that describes the measures designed to minimize the potential impact to the environment following a fuel or chemical spill."*

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

3.1 Purpose

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

This document also addresses opportunities to improve spill preparedness, response, and mitigation for Deposits Out of the Normal Course of Events (DONCE) that have the potential to impact the Yukon River and its tributaries within the project site.

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

3.2 Scope

The objectives of the SCP are to:

- identify potentially hazardous materials located on site;

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

The *Minto Mine Emergency Response Plan* (Minto, 2014) contains other information that relates to Emergency spill procedures. The Emergency Response Team (ERT) and members of the Environmental Department have been training on responding to Hazmat Spills. It is beyond the scope of this document to define the specific Spill Response Procedures and decision loops involved in an ERT response. Any details pertaining to a response from ERT to APCC at a spill incident is the responsibility of the Site Safety Department. General procedures for spill response procedures to emergency spills will be detailed herein.

3.2.1 Hardcopy Locations

Copies of the SCP are kept on-site at all times in the following locations: Mill Control Room; Site Safety Office; Environmental Office; General Manager's Office; Site Services Office; and on the Copper Queen Tug. Contact information is provided in Table 4-2.

4 Communication and Spill Reporting

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

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

Table 4-1: Reportable Spill Thresholds

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

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

4.1 Internal Reporting (All Spills)

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

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

4.2 External Reporting (Reportable Spills Only)

Under federal and territorial regulations, the environmental lead will call the 24-hour Yukon Spill Report line should a spill of a reportable quantity occur (Table 4-1). Although several government agencies at the federal, territorial and municipal levels may ultimately be informed, only the Yukon 24-Hour Emergency Spill Response Number is required for reporting purposes. The Environmental Lead will ensure that the appropriate information is collected before reporting to the Spill Report line. Any spill of an amount greater than those listed in Table 4-1 or a spill of any amount that enters the Yukon River or a tributary of the river is a "reportable spill".

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

- Name
- Phone number
- Product spilled
- Quantity spilled
- Quality of product (thin, viscous etc.)
- Location of spill
- Distance to water
- Distance to drinking water wells
- What happened
- Responsible party
- Actions to contain the spill
- Obtain the Environment Yukon Spill Reporting Number and first/last name of the person whom the report has been made to (in the event of a reporting discrepancy it's always good to know this information).

Minto will also contact: the Selkirk First Nation Lands Director; Energy Mines and Resources Client Services and Inspections; and Environment Canada via email or phone after discovery of a reportable spill. A detailed written report will be submitted to the regulatory authorities within 10 days after the event. The contact information for the various Minto Mine employees, emergency response and external reporting personnel is provided in Table 4-2.

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

Resource	Email	Contact Number
Minto Mine Internal Communications Contact Info		
Health and Safety Department	safety@mintomine.com	604 759-0860 ext. 4644
Environmental Department	minto_environment@mintomine.com	604 759-0860 ext. 4659
Ron Light, General Manager	ronl@mintomine.com	604 759-0860 ext. 4639
Jennie Gjertsen, Environmental Manager	jennieg@mintomine.com	604 759-0860 ext. 4634
Emergency Phone Contacts		
Yukon 24- Hour Spill Line		867 667-7244
CANUTEC-Dangerous Goods Help		0-613-996-6666

Resource	Email	Contact Number
(Transport Canada)		
Fire Department – Pelly (Emergency)		867 537-3000
Police – Pelly		867 537-5555
Hospital – Whitehorse		867 667-8700
Fire Department – Whitehorse		867 668-8699 or 867 668-2462
Police – Whitehorse		867 667-5555
YG Department of Environment, Water Resources Branch		867 667-3227
YG Environmental Protection Branch		867 667-3436
Selkirk First Nations, William Sydney, Lands Director		867 537-3331
YG EMR, Client Services and Inspections		867 667-3199
External Reporting and Contacts for Submission of Spill Reports		
YG EMR, Steve Colp, Natural Resources Officer - Mining	Steve.Colp@gov.yk.ca	867 456-3839
YG EMR, Sevn Bohnet, Senior Natural Resources Officer - Mining	Sevn.Bohnet@gov.yk.ca	867 456-3884
Selkirk First Nation, William Sydney, SFN Lands Director	sydneyw@selkirkfn.com	867 537-3331 ext. 257
YG Environmental Health Services, Craig Vanlankveld, Environmental Health Officer	craig.vanlankveld@gov.yk.ca	867 667-8316
Environment Canada, Travis Teele, Enforcement Officer	Travis.Teel@ec.gc.ca	867-393-6705

5 Spill Action Plan

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

5.1 Spill Response Procedures: Non-Emergency

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

Major contractors have personnel trained to NFPA 472 Awareness level and are able to respond to non-emergency spills. A complete inventory of Dangerous Goods stored and used at the Minto Mine, including; details on material handling and clean-up, reporting thresholds, special precautions, PPE requirements, and disposal methods is provided for reference during spill response activities (Appendix B).

5.2 Spill Response Procedures: Emergency

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

Once called via a "Code 1" the Safety Coordinator/Medic will respond to the scene and conduct an initial assessment and assume command of the scene. If the Safety Coordinator/Medic is required to treat patients, command is transferred to the Health and Safety Superintendent/Officer or Emergency Response Team Captain. Unified Command Structure will be initiated once the General Manager, Area Manager, or Environmental Lead is on scene. The Unified Command Structure is a cooperative effort command between the General Manager, Health and Safety Superintendent/Officer, Area Manager of involved Department and the Environmental Lead. Transfer of command includes a detailed verbal report of the incident and activities conducted and underway.

A "Code 1" Protocol initiated by an emergency spill will trigger the Specific Spill Response Procedure based on the product type, quantity and environmental and safety conditions.

Initial spill response will be conducted in accordance to *Transport Canada's 2012 Emergency Response Guidebook* (Transport Canada, 2012). This Guidebook will assist Incident Command with information to identify the material, use the guide to reference potential hazards, public safety and emergency response information. The *Table of Initial Isolation and Protective Action Distances* will be used to dictate isolation and protection for large and small spills. However, this is not a comprehensive spill mitigation and response document and will only assist responders in making initial decisions upon arriving at the scene of a dangerous goods incident. It should not be considered as a substitute for emergency response training, knowledge or sound judgment. The *Emergency Response Guidebook* does not address all possible circumstances that may be associated with a dangerous goods incident. The ERT (Appendix C) has additional specific procedures for responding to the most commonly transported and hazardous materials including Nitric Acid, Gasoline, Diesel, Ammonium Nitrate, Sodium Sulfide and Propane.

In addition to on-site response, Minto Mine, through its carriers of dangerous goods, has contracts in place with spill responders. These are full service response agencies that have commitments to mobilize fully trained emergency response teams and equipment 24 hours a day 7 days a week.

5.2.1 CANUTEC Transport Canada

In the event that a spill requires additional technical resources Minto Mine is registered with CANUTEC, a division of Transport Canada, for 24 hour Spill Response support and information to deal with emergency situations. If a spill occurs beyond the boundaries of the Minto property, the owner of the transportation firm and the owner or consignor of the dangerous goods will communicate with the regulators, however for incidents that occur on the Minto property, the Environmental Department will ensure reporting to regulators is performed appropriately.

5.2.2 Surrounding and Downstream Communities

Notification of downstream water users of a spill, if required, is the responsibility of the Yukon Government, Environmental Protection Branch. Minto Mine will also notify the authorities including police and fire departments and the Selkirk First Nation community of Pelly Crossing.

5.2.3 Public Relations

The General Manager is the designated spokesman for Minto Mine. The General Manager may delegate his responsibility for public relations if required to do so by the scale of the incident.

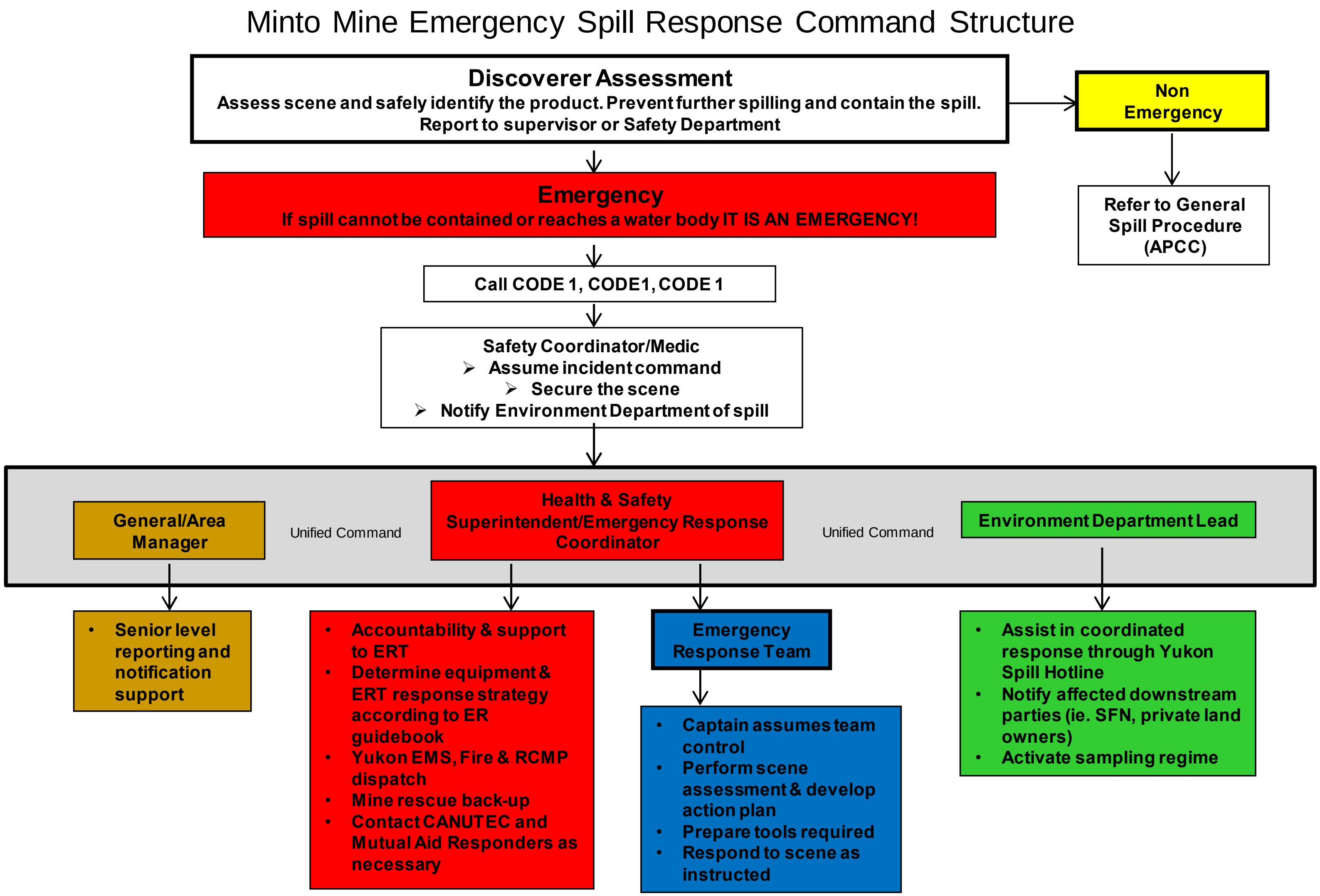
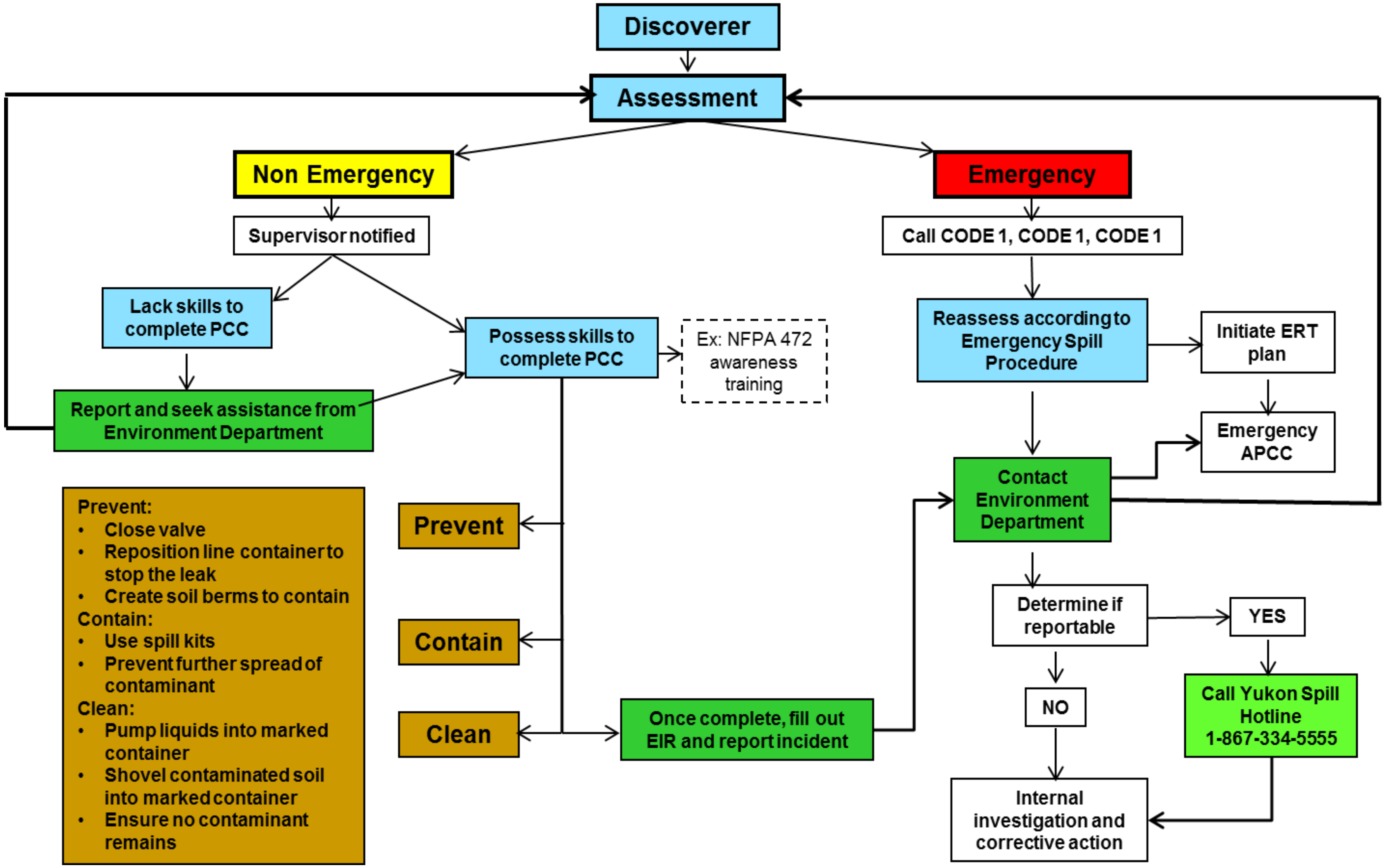


Figure 5-1: Minto Mine Emergency Spill Response Command Structure

Minto Mine General Spill Procedure
(Assessment Prevention Containment Clean-up)



Prevent:
- Close valve
- Reposition line container to stop the leak
- Create soil berms to contain

Contain:
- Use spill kits
- Prevent further spread of contaminant

Clean:
- Pump liquids into marked container
- Shovel contaminated soil into marked container
- Ensure no contaminant remains

Figure 5-2: Minto Mine General Spill Procedure

5.3 Disposal and clean-up

Disposal and treatment methods of contaminated material are outlined below, and are further detailed in the *Minto Mine Spill Response Procedure: Non-emergency spills on soil* and the *Minto Mine Land Treatment Facility Standard Operating Procedure* documents which are both updated frequently by the Environmental Department. The Minto Mine Site has a Land Treatment Facility to accept incoming contaminated material from hydrocarbon and petroleum hydrocarbon spills. Depending on the state and substrate of the surface material, the clean-up and disposal location will differ. Brief practical descriptions of the clean-up procedures are summarized in Table 5-1.

Table 5-1: Disposal and Movement of Contaminated Material from Spill Sites

WASTE TYPE	DESCRIPTION	MOVEMENT OF MATERIAL FROM SPILLS
Oil or Glycol Contaminated Soil	Soil, Organics, and granular material (avoid coarse rock) contaminated as a result of a hydrocarbon or glycol spill	Contaminated soil will be transferred to the Land Treatment Facility. Contaminated soil will first be placed in a holding cell and labelled to be later categorized and farmed. Contact Environment dept. before dropping off material in the Land Treatment Facility. Small spills will be stored in a composite pile in the staging area. Larger spills will be stored separately in staging while waiting for lab results.
Oil or Glycol Contaminated Rock	Blasted rock and coarse material and/or bedrock, contaminated as result of a hydrocarbon spill or glycol spill	If blasted rock contains ore and has been cleared by Mill operations ore will be processed through the mill. Non-ore containing rock will be placed in the main pit and in-situ bioremediation will be applied to the pile.
Oil or Glycol Contaminated Snow/ Ice/Water	Snow, Ice, and/or Water that has been contaminated as a result of a hydrocarbon spill or glycol spill	Contaminated snow/water will be transferred to the Main Pit or shipped off site at the discretion of the Environmental Lead

**** Any amount of material that has more than 30000 ppm oil or glycol is considered special waste and must be disposed of off-site to a Special Waste Facility**

6 Spill Response Supplies

Spill kits (yellow and blue drums) are located throughout the Minto Mine Property at locations indicated in Figure 6-2. Additionally, there are blue barrels located at the km 12 gravel pit, Minto Creek and at the east and west terminals of Minto Landing. The contents of the yellow and blue barrels are summarized in Table 6-1. Spill kits are also supplied for each heavy and light truck at the Minto Mine. Contractor supervisor trucks have spill kits permanently affixed to the truck body. All contract trucking agencies coming to the mine are required to carry spill kits within or affixed to the truck.

Table 6-1: Spill Kit Contents

Spill Kit Item	Yellow Barrel	Blue Barrel	Yellow Truck Bag
Tyvek splash suits	2	2	
Chemical master gloves	2	2	1
Garbage bags with ties	10	5	3
Oil only booms (5” x 10’)	4	2	1
Oil only mats (16” x 20”)	100	100	
Universal sorbent mat	20	20	10
Sorbent socks	20	20	
Sorbent pads (pillows)	10	10	
Absorb-all pellet bags	2	2	
Tarp	2	1	
Duct tape	1	1	
Utility knife	1	1	
Field notebook and pencil	1	1	
Rake	1		
Pick axe	1		
Aluminum scoop shovels	2	2	
Instruction binder	1	1	1

Heavy machinery at the mine site is available for use in spill response and clean up, as required under contract. Additionally, Minto Mine has a 1991 Chevrolet Top Kick Fire truck with a 3200 L/min pump with 3800 liter supply tank and 3000L drop tank. This truck can support all spill response activities with SCBA, Class A and B foam capabilities, decontamination needs, as well as fire suppression/protection tools and equipment common to a truck of this nature. All ERT members are competent with the operation of this fire truck and related equipment in accordance with NFPA standards.

In 2013, Minto Mine, on advice from Emergency Response Action Plan (ERAP) providers, procured a 20’ Hazmat trailer and a helicopter-portable In-Viro-Drum vacuum unit (Figure 6-1) capable of being transported to locations not reachable with a vacuum truck. It has a liquid cooled three cylinder Kubota diesel engine and 250 CFM non-sparking blower, which makes it safe to vacuum flammable liquids and solids from water or dry land. It comes with a Double Port Vac Drum that allows for transfer of product from the drum to one of our 9500 Liter bladders, while the drum continues to be filled. This system allows for quick, efficient and effective clean-up of hazardous products from hard to reach locations.

Figure 6-1: In-Viro Drum and vacuum unit and 24’ Packman vessel for spill response operations

Further training and skill development will take place in Spill Response Evolutions to be staged in 2014.

Minto Mine also recently acquired a 24’ Packman man boat, which is described, further in the “Barge Emergency Contingency Plan” (Appendix D).

Spill contingency equipment and earth moving equipment located at Minto Mine are listed in Table 6-2. All contractor equipment is available for use in spills and clean-up operations.

Table 6-2: Spill contingency equipment located at Minto Mine

Quantity of Units	Equipment		Quantity of Units	Equipment
1	416 Backhoe		1	Assorted Wooden Plugs
1	3800 Liter Vacuum Truck		4	773DTruck
Various	Dozers, Excavator, Loaders		9	777 Truck
1	In-Viro Drum Portable Vacuum unit		1	Hazmat trailer 20’
2	9500 Liter bladders		1	Top Kick fire truck
1	24’ Packman Response Vessel		500’	Sorbent Boom (various sizes)
2	10000 Liter Fuel Trucks		1	Storage Sea Can at Landing
1	Roll Over Kit		3	Trash pumps
1	Pipe Plug kit			

Figure 6-2: Minto Mine Area Overview – Hazmat Storage and Spill Supplies

7 Spill Prevention and Response Training

Education and training are critical to the success of any site-wide initiative, and the most important tool to ensuring the success of the SCP. Minto has a comprehensive training program in place that ensures all workers and supervisors are aware of their responsibilities and the practices that personnel and contractors must adhere to. Records are kept of the names of all employees or contractors that receive training, tracked though the Simply Safety software program. Annual re-training is scheduled for all Minto and major contractor employees.

7.1 Existing Spill Prevention and Response Training

In 2012, Hazmat and Transportation of Dangerous Goods training was carried out to the National Fire Protection Association (NFPA) 472 Awareness Level for all departments and major contractors. Employees are trained to understand the potentially hazardous situations that spills can create with respect to the health and safety of workers and the environment. They are trained to understand responsibilities as employees to Assess, Prevent, Contain, and Cleanup as well as to report any spills. The SCP is made available to all employees and employees will be advised of revisions or changes to the SCP.

7.1.1 Orientation

Employees and visitors are required to sign off on the environmental policy as part of the employee, contractor and visitor orientations that include a summary of the response required when a spill has occurred. The orientation has a strong focus on ensure proper reporting of spills, so that the appropriate response and clean up can occur.

7.1.2 "Big 6" Training

As part of the orientation, all Minto employees and major contractors receive further training that is a computer based PowerPoint presentation, followed by a written test. Prior to 2013, the "Big 5" package was focused on some of the most common safety training required for site, which included WHMIS (Workplace Hazardous Material Information System), fall protection, confined spaces, lock out and hot work training. In early 2013, a sixth component to the program was added that is specifically focussed on Environmental Awareness training. One module is dedicated to Spill Response and covers reporting and basic steps for APCC.

7.1.3 Targeted Practical Training

Training sessions are put on by the Environmental Department, and efforts are made to tailor the training to the attending group (i.e. underground miners, surface contractors, site services, etc.). Smaller groups are identified and targeted for specialised spill prevention training that is more job-specific.

These include, but are not be limited to; maintenance personnel (mechanics), waste and water truck operators, fuelling personnel, and warehouse workers. Training in smaller groups will focus on spill prevention techniques.

7.1.4 Training for Fuel Handling Employees

Currently there are Safe Work Practices (SWP) designed for bulk fuelling at the fuel farm and for fueling of equipment in the field. These SWPs include descriptions of the stepwise procedure for safely performing the task and also includes steps to take for emergency shut-off. Both the procedure and the equipment are audited during Workplace Inspections and Planned Job Observations by immediate supervisors and the Environmental department.

7.1.5 ERT Training

An Emergency Response Team (ERT) has been established to, among other duties, respond to emergency spills. The Emergency Response Team periodically receives training to the NFPA 472 Operations Level Responder and are required to thoroughly understand this document in order to respond to spills or incidents of a specific nature. This training is required as a foundation to develop site specific contingency planning for response tactics in areas specific to the Minto Mine associated activities that present a risk to the Yukon River and its tributaries.

7.1.6 Emergency Spill Response drills

Table top and/or field drills will help to prepare the ERT and other mine staff to respond to a major spill safely by identifying any deficiencies in the equipment or processes in place. On October 26th, 2014 a combined field and table top exercise took place with the following objectives:

- Help individuals become more knowledgeable with the ERP and SCP
- Identify gaps in the plan
- Improve communication between stakeholders and departments
- Learn new ways and better ways to execute the plan

The announced exercise was initiated to test part of the Emergency Response Plan as it applies to Spills and the SCP. It focused on the crisis, interaction and escalation of problems within:

- Administrative
- Operational
- Managerial
- Facilities

The scenario was as follows:

- A tanker truck with pup and trailer of diesel overturns on Oct 26th on icy roads at 3:20pm at south end of Big Creek, still dark and is a Sunday and roads are icy and snowing lightly.

The exercise lasted approximately 2 hours and involved management staff onsite and offsite, the ERT, major contractors, The Yukon Spill Hotline, CANUTEC, Transnorth Helicopters, WCB, Parkland Fuel, and Quantum Murray. A post –incident debrief revealed both opportunities and successes at the field operations and management level.

7.1.7 KPIs and Scheduled Re-Training

Individuals who receive training are tracked, and training numbers are used as a key performance indicator (KPI) with annual targets. In addition, tracking is used to ensure annual retraining is delivered and statistics measured against key performance indicators.

8 Routine Maintenance and Monitoring

The Fuel Farm is inspected twice monthly for any leakages and, through the Human Machine Interface (HMI) readout, regular inventory is tracked daily to identify any incidental losses. An overfill protection system is installed on the two main diesel tanks using a visual indicator and a relay to the control room that will alarm on the HMI to alert maintenance personnel. The area also receives inspections by a qualified engineer and recommendations are recorded and deficiencies corrected as per the *CCME Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products* (Canadian Council of Ministers of the Environment, 2003).

The tug and barge receive frequent inventory inspections for spill equipment and have had major overhauls in the last few years to ensure that the operation is continually improving. Maintenance activities are also carried out regularly and systems are inspected as per Transport Canada Regulations. The daily start-up procedure includes checking for leaks and ensuring all systems are performing to specifications. Annual maintenance activities have included the following: prop repairs, controls work, system checks and repairs. Substantive refits have included: cylinder heads, exhaust manifold seals, motor mounts, transmission mounts and water pumps replaced. A new transmission, propulsion seals and propellers have been installed and aligned. Other improvements have included welding reinforcements on the bow of the barge for landings, electrical upgrades, and the installation of an anchor with hawser.

The open pit mining equipment is outfitted with Wiggins Fast Fuel Systems on newer contractor open equipment that is a fail-safe system for overflow protection. All fuel trucks receive a daily walk-around inspection to ensure emergency shutoffs and hatches and tank valves are operating properly and are free of leaks. These are recorded daily.

The Waste Management Area (WMA) is restricted to access between 1-3 pm daily by an attendant familiar with the protocols for waste segregation, incineration, special waste handling and landfilling. The attendant will inspect all loads that come into the WMA to ensure that waste has been properly sorted before any material is off loaded. The Environmental Department is directly responsible for the administration, compliance and procedures associated with the management of waste. They are also responsible for providing support and manpower to prepare shipments for backhauling and to ensure the WMA is maintained in accordance with the Waste Management Permit (# 81-005). The Environmental Monitors are responsible for conducting weekly inspections to ensure that the WMA is in compliance.

9 References

Canadian Council of Ministers of the Environment. (2003). *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.* Winnipeg: CCME.

Government of Canada. (1985, January 18). Transporation of Dangerous Goods Act SOR/85/77.

Government of Yukon. (1996). Spills Regulation. *Environment Act: Spills Regulation O.I.C. 1996/193*.

Government of Yukon. (2002). Environment Act. *Revised Statutes of the Yukon: Environment Act, RSY 2002, c.76*.

Minto. (2014). *Emergency Response Plan.*

Transport Canada. (2012). 2012 Emergency Response Guidebook. *A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Transportation INcident*.

Yukon Government. (2013, August). *Plan Requirement Guidance for Quartz Mining Projects.* Retrieved from http://www.yukonwaterboard.ca/forms/quartz/Plan%20Requirement%20Guideline%20for%20Quartz%20Mining%20Projects%20-%20August%202013-kh.pdf

Appendix A: Spill Report and Environmental Incident Report Forms

Spill Report Form

capstone
MINTO MINE

Spill Name:	

General Report Information: (To be completed by the supervisor of responsible department or company)

EIR #:		Location of Incident:	
Date of Incident:		Time of Incident:	
Contaminant Type:		Volume of Spill (L):	
Equipment (Type):		Equipment (#):	
Company or Department:		Supervisor	
Hours since last PM:		Proximity to nearest waterbody:	
Previous indication of leak (i.e. Prior Drip) (Yes/No):		Estimated cost of spill:	

Failure of Mechanism: (Check one box below)

Blown Hose		Failed Hose Connection		Human Error	
Unforseen		Blown or Leaking Seal		Unknown	
Other					

Brief Description of Cause: (conditions at time of spill, what was happening at the time, specific direct cause of spill, etc.)

Clean Up Actions Undertaken:

Land Treatment Facility Information: (To be filled out by Environment Department)

Material Moved to LTF (Yes/No):		Material Sampled (Yes/No):		Quantity (m^3):	

Notes:	

Corrective Actions: (Must fill out for all reportable and preventable spills)

Action Item #	Responsible Department	Corrective Action	Due Date

Reporting Sequence:

First Observer:
Name | Company | Date/Time

Reported To:
Name | Company | Date/Time

Reported To Environmental:
Name | Company | Date/Time

Reported To General Manager:
Name | Company | Date/Time

Regulatory Tracking: (To be completed by Environment Department)

24 Hour Spill Hotline (867) 667-7244:

Reported By:		Reported To:		Date/Time:	

Selkirk First Nation Lands Director (867)-537-3331

Reported By:		Reported To:		Date/Time:	

EMR - Client services and Inspections (867) 456-3882: (or site inspectors)

Reported By:		Reported To:		Date/Time:	

Environment Canada in the event of a discharge to a waterway (867)-667-3400

Reported By:		Reported To:		Date/Time:	

Detailed written report and MSDS to YWB, EMR, EC and SFN (Required within 10 days of spill):

Submitted By:		Date of Submission:	

Photos:

Appendix B: Reporting Threshold, Special Precautions, PPE Requirements, and Cleanup and Disposal Methods

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Acetone	2-Propanone	Anachemia	Liquid	3	B-2, D-2B	1, 3, 0	200 L	Solvent	Extremely Flammable	Goggles, gloves. SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant foam. Do not allow into waterway or drains. Contain spread of spill and soak up with absorb all, absorbant pads. Clear up using non-sparking tools. Place liquid and absorbents into tighly sealed container, label clearly and dispose of as hazardous waste offsite.
Acetylene	C_2H_2	AIRGAS INC	Pressurized gas dissolved	2.1	A, B-1, F	1, 4, 3	any if container larger than 100 L	Welding/cutting gas	Extremely flammable, pressurized gas dissolved in an extremely flammable liquid (Acetone)	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition, if possible without risk, shut off bottles. If bottle is ruptured after the gas has been expelled, the bottle will release the Acetone. At that point treat as an Acetone spill.
AERO 6493 Promoter	Alkyl hydroxamate	Cytec Canada	Liquid above 15C	9		2, 1, 2		Metal flotation in mill			Soak up with absorbent (do NOT use sawdust. Use PLASTIC tools). In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Place recovered spilt liquid in labelled drums for disposal as Special waste. Incinerate used absorbent pads.
AERO MX-5149	Modified Thionocarbamate 15-40%Xanthate esther 40-70%	Cytec Canada	Liquid	3				Metal flotation in mill	Flammable		
Aerodri 100 Dewatering Agent		Cytec Canada	Liquid	3	B-2, D-2A	2, 3, 0	200 L		Avoid contact with strong oxidizers or acids.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste. Soak up with absorbent materials and dispose of offsite in clearly labeled containers
Alconox		Anachemia	solid	not regulated	D-2B	1, 0, 0	50 kg			Safety Glasses, Gloves	Clean up uncontaminated material for reuse. Incinerate waste.
ALIQUAT 336	Methytrioctyl-ammonium Chloride	Sigma-Aldrich Canada	Liquid	6	D-2B	2, 1, 1	5 kg		Toxic if swallowed. Very corrosive. Will burn skin and eyes. Avoid contact with strong oxidizers. Hygroscopic: avoid contact with moist air.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
AlphaSolve II	>50% Sodium Hydroxide <50% Silicate	Alpha Resources	Solid						Avoid contact with strong oxidizers.	Safety Glasses, Impervious Gloves.	Highly caustic. Will produce heat and steam on contact with water. May boil and spatter. May generate hydrogen gas on contact with metals. Sweep or vaccum and, if not re-useable, send offsite as hazardous waste, in tightly closed, well labeled containers.
Aluminex 5	Aluminum Chloride Hydroxide Sulphate 15%	NALCO	Liquid					Coagulant		Safety Glasses, Gloves	Soak up with absorbent materials. These can be incinerated. Any remaining spilt liquid should be stored in closed container, labelled and disposed of off-site as Special Waste.
Aluminum Standard - AA		Anachemia	Liquid	8	E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
AM28 Flotation Reagent	Mixture of Potassium Hydroxide Alkyl hydroxamate	Australian Metallurgical Services	Liquid	not regulated	D-2B	1, 0, 0				Safety Glasses, Gloves	Soak up with absorbent (do NOT use sawdust. Use PLASTIC tools). In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Place recovered spilt liquid in labelled drums for disposal as Special waste. Incinerate used absorbent pads.
Amco Clear Turbidity Standard		GFS Chemicals	Liquid	not regulated	not regulated					Safety Glasses, Gloves	Contain spill. Incinerate waste or place in landfill
Ammonia, Refrigerant	Ammonia, Anhydrous	GT&S, INC	Liquefied Gas	2.3, 8	does not appear classified??	3, 0, 0	any amount		Liquefied gas, will produce extreme cold when released. Death has occurred at 5000ppm exposure for 5 minutes. Evacuate release area upwind and avoid low areas.	Goggles, gloves. SCBA.	Toxic gas and will react with a large number of substances, many in a violent manner, Gas will dissipate quickly in air. Small spills can be dissolved in water at ratio of 1:10 Not very flamable. Do not attempt to neutralise.
Ammonium Nitrate prill	Ammonium Nitrate										

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Ammonium Nitrate Emulsion	Ammonium Nitrate Emulsion										
Arsenic Standard - AA		Anachemia	Liquid	8	D-2A, E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Ascorbic Acid	L-Ascorbic Acid (Vitamin C)	Anachemia	solid	not regulated	not regulated	1, 1, 1			also known as Vitamin C	Safety Glasses, Gloves	Contain spill. Incinerate waste or place in landfill
Brake & Parts Kleen	CO_2 aerosol of Heptane and Isopropyl alcohol	Kleen-Flo Tumbler Industries	aerosol	Consumer Commodity	A, B5, D2-B	1, 3, 0			Highly flammable	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Buffer Solution pH 10		Anachemia	Liquid	not regulated	D-2A	1, 0, 0			Dilute Sodium Hydroxide	Safety Glasses, Gloves	Contain spill. Absorb with sand, vermiculite or sorbal. Incinerate waste.
Buffer Solution pH 4		Anachemia	Liquid	not regulated	not regulated	1, 0, 0				Safety Glasses, Gloves	Contain spill. Absorb with sand, vermiculite or sorbal. Incinerate waste.
Buffer Solution pH 7		Anachemia	Liquid	not regulated	not regulated	1, 0, 0				Safety Glasses, Gloves	Contain spill. Absorb with sand, vermiculite or sorbal. Incinerate waste.
Cadmium Standard - AA		Anachemia	Liquid	8	D-2A, E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use flooding quantities of water. Contributes to combustion of other materials. Neutralize with soda ash or lime. Contain spill, keep from entering ground water. Neutralized spill can be pumped to the pit or tailings system.
Calcium Chloride		J.T. Baker	solid	not regulated		1, 0, 2, 3			Road Salt, will corrode metals	Safety Glasses, Gloves	Sweep up spilled material and it my be deposed of in dilute form to the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Carbon Dioxide in Argon		Mittler Supply Inc.	Pressurized gas	2.2	A, D-2B	1, 0, 0	any if container larger then 100 L		Non-Flammable but will replace the O_2 in confined space	Goggles, gloves. SCBA if in confined space	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Caustic Soda (solid)	Sodium Hydroxide	Fisher Scientific	solid	8	E	3, 0, 1	5 kg		very corrosive solid	Safety Glasses, Gloves	Sweep up spilled material for reuse. In case of fire use appropriate measures for the surrounding fire. Minimise direct water spray on material. This material melts and 318°C and when molten reacts violently with water. Neutralize the residue with a dilute solution of acetic acid. Neutralized solution can be disposed of in the pit or tailings system.
Caustic Soda (solution)		DOW	Liquid	8	E	3, 0, 1	5 L		very corrosive liquid	Safety Glasses, Gloves	Contain spill and pump to plastic barrel for re-use. In case of fire use appropriate measures for the surrounding fire. Neutralize the residue with a dilute solution of acetic acid. Neutralized solution can be disposed of in the pit or tailings system.
Caustic Potash	Potassium Hydroxide	Brenntag Canada	Solid		D-1B, E						
Chevron 2-Cycle Oil		Chevron Lubricants Canada	Liquid	not regulated	B-3	1, 2, 0			flammable oil for 2-storke fuel	Safety Glasses, Gloves	contain spill and use absorbent and incinerate waste
Chevron ATF+3 Automatic Transmission Fluid		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Automatic Transmission Fluid MD-3		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Clarity Synthetic Machine Oil		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Compressor Oil 260		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Coupling Grease	Grease	Chevron Lubricants Canada	Semi-Solid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Chevron Delo 300 Motor Oil		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Delo Grease EP	Grease	Chevron Lubricants Canada	Semi-Solid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chevron Diesel Engine Oil Delo 6170 CFO		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Drive Train Fluid HD		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron ECO Hydraulic Oil AW		Chevron Lubricants Canada	Liquid	not regulated	not regulated	0, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Gas Engine Oil 930 and 940		Chevron Lubricants Canada	Liquid	not regulated	not regulated	0, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Mid-grade unleaded gasoline		Chevron Products	Liquid	3	B-2, D-2A, D-2B	2, 3, 0	200 L		Extremely Flammable, Vapours are harmful and they may be explosive. Non-sparking tools required. Vapours will collect in low areas and travel along the ground to an ignition source.	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Dike the spill and pump to containers for recycling. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Allow waste absorbent to evaporate and then Incinerate waste.
Chevron NWS Manual Transmission Fluid 6044GR		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron RPM Universal Gear Lubricant		Chevron Lubricants Canada	Liquid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Chevron Supreme Antifreeze/Coolant	Ethylene Glycol	Chevron Lubricants Canada	Liquid	not regulated under 5000 lb.	D-2A	1, 1, 0			may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chevron Ulti-Plex® Grease EP		Chevron Lubricants Canada	Semi-Solid	not regulated	not regulated	1, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Chloramine T	Chloramine-T trihydrate	Fisher	solid	8	D-2A, E	3, 1, 1			Container may explode under fire conditions. Will release toxic fumes with fire or when mixed with strong oxidizers or acids	Goggles, gloves. SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. In case of fire. Material by itself is non-flammable, may decompose violently $>100^{\circ}C$, use dry chemical, CO_2 foam or water spray. DISPOSAL mix with flammable solvent and incinerate.
Chromium Standard - AA		Anachemia	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Citric Acid	Citric Acid, Monohydrate	Anachemia	solid	not regulated	E	2, 1, 0			Will cause severe eye damage. Avoid oxidizers, acids, bases and bleach.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. In case of fire, use flooding quantities of water. Will decompose at high temperatures and emit acrid smoke and fumes.
Copper Standard - AA		Anachemia	Liquid	8	E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Crystal 78	Sodium Silicate	Quadra Chemicals	Liquid	not regulated	D-2B				Caustic solution. Avoid mixing with strong acids. Contact with metals such as aluminum, tin, lead and zinc generates hydrogen gas.	Goggles, gloves. Respirator	solution can be pumped into plastic drum and possibly recycled in mill circuit, or shipped off site. In case of fire use appropriate measures for surrounding fire.
Cyquest DP-6	Sodium polyacrylate in water	Cytec Canada	Liquid	not regulated				Mill reagent	Slippery	Goggles, Impervious gloves	Soak up with absorbent materials. These can be incinerated. Any remaining spilt liquid should be stored in closed container, labelled and disposed of off-site as Special Waste.

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Delo Diesel Fuel System Cleaner		Chevron Lubricants Canada	Liquid	3	B-3, D-2A, D-2B		200 L			Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Diesel Fuel No. 2		Chevron Products Company	Liquid	3	B-3, D-2A, D-2B	0, 2, 0	200 L			Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
DIISOBUTYL KETONE	2,6-Dimethyl-4-heptanone	J.T. Baker	Liquid	3	B-2, D-2A	2, 2, 0	200 L		Avoid contact with strong oxidizers or acids.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Drierite, indicating		Anachemia	solid	not regulated	D-2A	1, 0, 1				Safety Glasses, Gloves	Eliminate all sources of ignition. In case of fire use measures dictated by surrounding fire. Will decompose at 1450°C liberating Cl_2 and SO_2. This product can be dried and reused, recycled.
FLEET CHARGE 50/50 Antifreeze	Ethylene Glycol	OLD WORLD INDUSTRIES	Liquid	not regulated under 5000 lb.	D-2A	1, 1, 0			may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Fleet Charge PG Antifreeze/Coolant	Propylene Glycol	OLD WORLD INDUSTRIES	Liquid	not regulated	not regulated	0, 1, 0				Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Flomin C 3505 Collector	Potassium amyl xanthate (PAX)	Flomin Inc.	solid	4	not regulated	2, 2, 1	25 kg		Product is spontaneously combustible. Avoid contact with heat, moist air, and water.	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. Solutions of product my be deposed of on the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Flomin F 500 Frother	4-METHYL-2-PENTANOL (Methyl isobutyl carbinol - MIBC)	Flomin Inc.	Liquid	3	B-2, D-2B	2, 2, 0	200 L		Acids, acid chlorides, alkalis, oxidizing agents. Will attack some forms of plastics, rubber and coatings	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Floran Catalyst	Proprietary Inorganic Peroxide Blend	Floran Technologies	Liquid	5	C, D-2B	2, 0, 1, OX	50 L		Non-Flammable but will aid combustion of other materials	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use flooding quantities of water. Contributes to combustion of other materials. Contain spill, keep from entering ground water. Absorbed pill can be disposed in the pit or tailings system.
Frost Killer (Tannergas)	Methyl alcohol	TANNER SYSTEMS, INC.	Liquid	3, 6.1	B-2, D-1B, D-2A,D-2B	1, 3, 0	200 L		Extremely Flammable, Vapours are harmful and solution is poisonous	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
FUEL INJECTOR CLEANER		Radiator Specialty Co	Liquid	3	B-3, D-2A, D-2B		200 L			Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Gasoline, Unleaded		Petro-Canada	Liquid	3	B-2, D-2A, D-2B	2, 3, 0	200 L		Extremely Flammable, Vapours are harmful and they may be explosive. Non-sparking tools required. Vapours will collect in low areas and travel along the ground to an ignition source.	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Dike the spill and pump to containers for recycling. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Allow waste absorbent to evaporate and then Incinerate waste.
Havoline DEX-COOL Extended Life 50/50 Anti-Freeze/Coolant	Ethylene Glycol	Chevron Lubricants Canada	Liquid	not regulated	D-1b, D-2A	2, 0, 0			may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
HAVOLINE DEX-COOL extended life anti-freeze/coolant-B	Ethylene Glycol	Chevron Lubricants Canada	Liquid	not regulated	D-1b, D-2A	2, 1, 0			may be fatal by ingestion	Safety Glasses, Gloves	contain spill. Can be pumped, filtered and reused. Small amounts can use absorbent and incinerate waste. Larger absorbent material in plastic drums and shipped off site for disposal.
Havoline Power Steering Fluid		Chevron Products	Liquid	not regulated	not regulated	0, 1, 0				Safety Glasses, Gloves	contain spill. Small amounts can use absorbent and incinerate waste. Larger material pumped into plastic drums and used in a waste oil heating system.
Hot 4-in-1 Heating Oil Treatment	Proprietary Blend	FPPF Chemical Company, Inc.	Liquid	3	B-3, D-1A, D-2A, D-2B	3, 2, 0	200 L		Fuel Additive, fumes will collect in low area's.	Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Hydrated Lime	$Ca(OH)_2$	Chemical Lime Company of Canada Inc.	Solid		D-2A, E				Will cause severe caustic burns. Avoid strong acids, and aluminum	Safety Glasses, Gloves	sweep up uncontaminated material for reuse. Neutralize with dilute acid and may be disposed of in pit or tailings system.

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Hydraulic Oil SAE 10W		EXXON MOBIL	Liquid	not regulated	not regulated	0, 1, 0				Safety Glasses, Gloves	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
Hydrochloric Acid		Anachemia	Liquid	8	D-1A, E	3, 0, 1	5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind	Goggles, gloves. Respirator or SCBA if in confined space	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Hydrofluoric acid, 47 - 51%		Fisher	Liquid	8, 6.1	D-1A, D-2A, E	4, 0, 1	5 L		**Extremely corrosive and Toxic acid. Causes very severe acid burns with symptoms being delayed. Skin contact of <10% can be fatal from cardio-pulmonary problems. IMMEDIATE medical attention is required for all exposures.**	**Goggles, gloves. Respirator or SCBA if in confined space (Actually SCBA should be used anywhere unless spill is in a fumehood)**	Neutralize with soda ash. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to a plastic barrel and then disposed of in the pit or tailings system.
IPAC 6832		Quadra Chemicals	Liquid	not regulated	not regulated				water soluble	Safety Glasses, Gloves	No special clean up procedures,
Iron Standard - AA		Anachemia	Liquid	8	E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Javex Liquid Bleach		Colgate Palmolive	Liquid								
KOPR-KOTE	Graphite, Cu & MoS$_2$ mixture	Jet-Lube of Canada	paste	not regulated	not regulated					Safety Glasses, Gloves	Wipe up spill with rages and incinerate waste.
Lead Standard - AA		Anachemia	Liquid	8	D-2A, E	4, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Lime		Chemical Lime Company of Canada Inc.	powder	not regulated	E	3, 0, 1			Will cause severe caustic burns. Avoid strong acids, and aluminum	Safety Glasses, Gloves	sweep up uncontaminated material for reuse. Neutralize with dilute acid and may be disposed of in pit or tailings system.
Liquid Nitrogen	Nitrogen	Praxair Canada Inc.	Liquefied Gas	2.2 Non-flammable gas	A	3, 0, 2	any if container larger then 100 L		Use air supplied respirator when working in confined space, Loose-fitting cryogenic gloves, Metatarsal shoes for cylinder handling. Protective clothing where needed. Cuff less trousers should be worn outside of shoes	Extremely cold liquefied gas, Will cause severe frost bite Use SCBA when working in confined space,	Evacuate all personnel from danger area. Allow spilled liquid to evaporate. Use self-contained breathing apparatus where needed. Shut off flow if you can do so without risk. Ventilate area or move cylinder to a well-ventilated area. Test for sufficient oxygen, especially in confined spaces, before allowing re-entry
LIQUID WRENCH SUPER LUBRICANT (AEROSOL)	Proprietary Blend	Radiator Specialty Co	aerosol	2.1	A, B5, D-1A, D2-B		any if container larger then 100 L		containers may rupture if exposed to high temperatures.	Safety Glasses, Gloves	Allow container to completely discharge while eliminating ignitions sources. Wipe up spill with rages and incinerate waste.
Loctite Belt Dressing	Proprietary Blend t	Henkel Canada, Inc.	aerosol	2.2	A, D-2A, D-2B		any if container larger then 100 L		containers may rupture if exposed to high temperatures.	Safety Glasses, Gloves	Allow container to completely discharge Wipe up spill with rags and incinerate waste.
LPS 2 Spray Lubricant	Proprietary Blend	LPS Laboratories	aerosol	2.2	A, D-2A, D-2B		any if container larger then 100 L		containers may rupture if exposed to high temperatures.	Safety Glasses, Gloves	Allow container to completely discharge Wipe up spill with rages and incinerate waste.
Magnesium Nitrate Matrix Modifier		Spex CertiPrep	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
MAXGOLD™ 900 Promoter	Proprietary Blend	Cytec Canada	Liquid	3	B-3, D-2A	3, 2, 0	200 L		slightly yellow liquid that has a slight sulphur smell. In confined space use respirator with organic vapour cartridges	Goggles, gloves. Respirator or SCBA if in confined space	eliminate ignition sources, use absorbent on small spills, for large spill pump to plastic drum for shipment off site. In case of fire use dry chemical extinguisher, CO$_2$ or foam. Water likely not effective.
MERCSORB Mercury Amalgamation Powder		NPS Corporation	solid	4		0, 1, 1	25 kg		Dry zinc dust will not ignite spontaneously, but once ignited, it may burn readily in air	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. In case of fire use appropriate measures for surrounding fire.

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Mercury Indicator Powder	Proprietary Blend	NPS Corporation	solid	not regulated		2, 1, 0			Odorless, yellowish-tan to gray powder. Dust may form a flammable or explosive mixture in air. When heated to decomposition, toxic fumes of sulfur oxides are produced	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. In case of fire use appropriate measures for surrounding fire. This product in itself is considered to be non-hazardous.
Mercury Standard - AA		Anachemia	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Mercury Vapor Suppressor	Proprietary Blend	NPS Corporation	solid	not regulated		2, 1, 0			Odorless, black, irregular, dry granular solid. Wet activated carbon removes oxygen from the air causing a severe hazard to workers in confined space.	Safety Glasses, Gloves	Sweep up spilled material and place in closed container for reuse. Contaminated waste can be incinerated. In case of fire use appropriate measures for surrounding fire. This product in itself is considered to be non-hazardous.
Methanol		Anachemia	Liquid	3, 6.1	B-2, D-1B, D-2A,D-2B	1, 3, 0	200 L		Extremely Flammable, Vapours are harmful and solution is poisonous	Goggles, gloves. Respirator or SCBA if in confined space	Eliminate all sources of ignition. Ventilate area if required. Use absorbent. In case of fire, use dry chemical, CO2, Alcohol-resistant Foam or water spray. Incinerate waste.
MIBK	4-Methyl-2-pentanone	Fisher Scientific	Liquid	3	B-2	2, 3, 0	200 L		clear liquid that has a slightly sweet smell. In confined space use respirator with organic vapour cartridges	Safety Glasses, Gloves	Clear liquid that is immiscible with water. Use absorbent for small spills and incinerate waste. Large spills, eliminate ignitions sources and pump to plastic drum for shipment off site.
Molybdenum Standard - AA		Anachemia	Liquid	not regulated	not regulated	0, 0, 0				Safety Glasses, Gloves	Contain spill. Incinerate waste or place in landfill
Mucasol universal detergent		Sigma-Aldrich Canada	Liquid	not regulated	D-2B	2, 0, 0				Safety Glasses, Gloves	
Nickel Standard - AA		Anachemia	Liquid	8	D-2A, E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Nitric Acid		Anachemia	Liquid	8	C, D-1A, E	4, 0, 0, OX	5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind. **Strong Oxidizer**	Goggles, gloves. Respirator or SCBA if in confined space	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Nitric Acid 40%		Quadra Chemicals	Liquid	8	C, D-1A, E	4, 0, 0, OX	5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind. **Strong Oxidizer**	Goggles, gloves. Respirator or SCBA if in confined space	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Oxygen		BOC Canada Limited (Linde)	Pressurized gas	2.2	A, C	0, 3, 0, OX	any if container larger then 100 L		Strong Oxidizer will Contribute to combustion of other materials.	Safety Glasses, Gloves	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Oxygen Refrigerant		Air Liquide Canada	Liquefied Gas	2.2	A, C	0, 3, 0, OX	any if container larger then 100 L		Strong Oxidizer will Contribute to combustion of other materials. Liquefied gas, will produce extreme cold when released.	Safety Glasses, Gloves	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Palladium Nitrate Matrix Modifier		Spex CertiPrep	Liquid	8	D-2A, E	3, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Phosphoric acid		Sigma-Aldrich Canada	Liquid	8	D-1A, D-2B, E		5 L		Concentrated acid, Extremely corrosive. Ventilate or stay upwind.	Goggles, gloves. Respirator	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.
Polyclear 2528	Polyclear Floc	QUADRA CHEMICALS	solid	not regulated	not regulated				concentrated solution is extremely slippery, use caution	Safety Glasses, Gloves	Sweep up spilled material and it my be deposed of in dilute form to the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
Potassium hydroxide	KOH	Science lab	Solid	8	D-1B	3, 0, 1	5 kg		very corrosive solid	Safety Glasses, Gloves	Use appropriate tools to put the spilled solid in a convenient waste disposal container. If necessary: Neutralize the residue with a dilute solution of acetic acid.
Potassium Iodide		Anachemia	solid	not regulated	D-2A	1, 1, 1			light and water exposure will cause breakdown	Safety Glasses, Gloves	Eliminate all sources of ignition. In case of fire use measures dictated by surrounding fire. Will decompose at high temperatures and emit toxic I_2 fumes. Use appropriate SCBA.
Potassium permanganate		CAIROX	Solid	5.1	C, E	1, 0, 0, OX	50 kg		corrosive solid. Oxidizing solid	Safety Glasses, Gloves	Sweep up solid spill for possible reuse. If necessary reduce material in aqueous solution with sodium thiosulfate (hypo), In case of fire use flooding quantities of water, material will contribute to combustion.
Propane		Superior Propane	Liquefied Gas	2.1	A, B-1		any if container larger then 100 L		Extremely flammable. Liquefied gas, will produce extreme cold when released.	Goggles, gloves. SCBA if in confined space	close valve if possible without risk, or allow the vent. In case of fire use any media suitable for surrounding fire. Use water spray to cool fire exposed containers.
Selenium Standard - AA		Anachemia	Liquid	8	E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.

Common Name (Synonyms)	Chemical Name	Manufacture / Supplier	Phase	TDG Class	WHMIS Class	NFPA Rating	Reporting Threshold	Use	Special Precautions	PPE Required	Special Cleanup and Disposal Info
Sodium Borohydride		Anachemia	solid	4.3	B-6, B-4, D-1B, E	3, 1, 2	25 kg		Flammable solid. Reacts violently with water and acids to produce flammable H_2 gas. Strong reducing agent.	Safety Glasses, Gloves	Eliminate ignition sources, sweep up dry material. In case of fire use only dry chemical extinguisher, DO NOT USE WATER OR CO_2
Sodium Hydroxide Solutions (various strengths)	NaOH (The Anachemia MSDS is current, treat all solutions in the same manner regardless of strength.)	Various Suppliers	Liquid	8	E	3, 0, 1	5 L		Caustic solution. Avoid mixing with strong acids. Contact with metals such as aluminum, tin, lead and zinc generates hydrogen gas.	Safety Glasses, Gloves	Neutralize the residue with a dilute solution of acetic acid. Neutralized solution can be disposed of in the pit or tailings system.
Sodium Nitrite		Anachemia	solid	5.1, 6.1	C, D-1B, D-2A	3, 0, 2, OX	50 kg		**Strong Oxidizer** will Contribute to combustion of other materials.	Safety Glasses, Gloves	Eliminate all sources of ignition. In case of fire, use flooding quantities of water. Will decompose at high temperatures and emit acrid smoke. Strong oxidizer, may form compound that are sensitive to shock, friction. Sweep up solid spill for disposal. Dispose of contaminated solution in the pit or tailings system.
sodium sulphide Flakes	Sodium sulphide Hydrated	Quadra Chemicals	solid	8	D-1B, E		5 kg		caustic, very corrosive solid	Goggles, gloves. And a respirator, avoid creating dust and avoid any acids. Contact with acids liberate toxic H_2S	Sweep up spilled material an place in plastic sealed container for shipment off site.
TMT 15%		Quadra Chemicals	Liquid	not regulated	D-2B				water soluble	Safety Glasses, Gloves	No special clean up procedures,
Urea		Anachemia	solid	not regulated	not regulated	1, 0, 0			Avoid contact with strong oxidizers. In fire conditions it can produce oxides of nitrogen. Also ammonia, and HCN	Safety Glasses, Gloves	Sweep up spilled material and it my be deposed of in dilute form to the pit or tailings system. In case of fire use appropriate measures for surrounding fire.
VARSOL 3139 SOLVENT	Petroleum Hydrocarbons	Imperial Oil Chemicals	Liquid	3	B-3, D-2B	1, 2, 0	200 L		Flammable solvent	Safety Glasses, Gloves	Clean up uncontaminated material for reuse. Incinerate waste.
VoltEsso 35		Imperial Oil Chemicals	Liquid	not regulated	not regulated	1, 1, 0			electrical insulating oil	Safety Glasses, Gloves	Clean up uncontaminated material for reuse. Incinerate waste.
Zinc Standard - AA		Anachemia	Liquid	8	E	1, 0, 0	5 L		Dilute Nitric Acid <5%	Safety Glasses, Gloves	Neutralize with soda ash or lime. Contain spill, **do not** allow un-neutralized acid to enter water systems. Neutralized spill can be pumped to the pit or tailings system.

Appendix C: ERT Response to HazMat Spills

ERT Response to Hazmat Spill

Spill Contact: Yukon Territory Spill Line 1-867-667-7244

Canutec: 1-613-996-6666 Cell: *666

1. **Site Management and control**

   Initial responders will :

   - Approach the scene from uphill and upwind.
   - Establish command uphill and upwind of spill at an appropriate distance.
   - Establish 2 isolation perimeters: one that separates the hot zone from the warm zone and another that separates the warm zone from the cold zone. Emergency Response Guide or Canutec shall be referenced for perimeter size.
   - Evacuate affected area or 'protect in place', as req'd. Emergency Response Guide or Canutec shall be referenced for evacuation zone.
   - Identify contaminated persons and ensure they remain isolated until they can be decontaminated.
   - Establish a staging area.
   - Designate an information officer.
   - Possible unification of command.

2. **Identification of the problem**

   I/C will identify the:

   - Spilled product, as per witness testimony, placards, labels, bill of lading, type of container, etc. If product cannot be identified from command position, then a recon team will be tasked with identification.
   - Size of container.
   - Size and nature of release.
   - Conditions and # of victims at accident site.
   - Topography of area, and exposures threatened.

3. **Hazard & Risk Evaluation**

   A risk evaluation will be conducted, taking into consideration:

   - Product hazards
   - Access & Egress

- Size of Spill
- Condition of container
- Proximity of exposures
- Personnel available to perform operations, and their level of training/experience
- Information from MSDS, ERG, Canutec, etc., minimum 3 sources

4. Personal Protective Equipment

PPE will be selected for Ops, RIT, and Decon teams, considering:

- Flammability/explosiveness of product
- Toxicity of product
- Route of entry of product
- Permeation rate of PPE
- Breakthrough time of PPE
- Availability of PPE
- Visibility and workability while wearing PPE

5. Information management and resource coordination

The information officer will begin to gather information about the product once it has been identified. The information officer can use the MSDS, ERG, Canutec, or many other resources to gather information, such as:

- Properties of the product
- Hazards of the product
- Expected travel of product released
- Populations/ environment in jeopardy
- PPE req'd by responders
- Decontamination requirements

Command will prioritize the information and ensure that the correct people receive the correct information.

6. Implementing Response Objectives

Command will develop an overall strategy, which may be offensive (entry of hot zone to gain quick control), defensive (contain from the cold zone to prevent spread), or passive (isolate only, and wait for incident to run its course), considering:

- Life safety
- Incident stabilization
- Environmental protection
- Property salvage

Command will delegate tactics to operations teams, such as:

- Reconnaissance for unknown product
- Evacuation for toxic gas leak, fire, or explosive hazard
- Fire control for flammable gas, flammable liquid, or oxidizer
- Search and rescue
- Leak control
- Neutralization of corrosives
- Deployment of boom, drain covers, etc.
- Building of dams, dykes, etc.

To follow: specific tactic options will be discussed in more detail, pertaining to hazardous materials that are commonly found in large quantities at the Minto Mine.

Entry teams will enter with a clear objective, but must assess for the next team's objective. For example, the 1st entry team may be tasked with rescuing the driver of a fuel truck that rolled down a bank and is spilling fuel. Although their objective is to rescue, while they are on scene they should observe where the leak is, consider what could be used to stop it, where the fuel is going, and what is needed to contain it. They should bring a camera, so that pictures can be brought back to command. This will give command crucial information and better prepare the next team for their task.

7. Decontamination

Considerations for decontamination should begin at the outset of the incident. A decontamination construct will exist in the warm zone prior to any team entering the hot zone. It will typically consist of a large berm fashioned out of a large chemical resistant tarp, wrapped over a charged 2 ½" hose-line. There will be a charged 1 ½" hose-line nearby for emergency decontamination. Within the berm, there will be a series of smaller berms, in which, personnel will stand while being decontaminated. Personnel conducting the decontamination will be wearing the appropriate PPE (typically 1 class below ops) and will use detergent and water to gently scrub and rinse ops personnel and rescuees as they exit the hot zone. Tools and anything else exiting the hot zone will be decontaminated as well.

Once decontamination is complete, all product collected by the berms, will be handled as per the MSDS.

8. Termination

Once emergency operations are complete, the scene will be handed over to clean-up & recovery operations. Command will ensure that the hand-off includes all pertinent information about the spilled product:

- Properties
- Hazards
- Location
- Safe-handling
- Exposure signs and symptoms
- Req'd PPE
- Disposal procedures

Command will conduct an on-site debrief. As well, a more formal debrief will be conducted, with all parties involved, at a later time. The incident will be documented, including exposure records for all personnel that entered the warm and/or hot zones.

Nitric Acid 40%

Note: when it comes to corrosives such as Nitric Acid, the solution to pollution is NOT dilution. For a spill of 1   45 gal drum, it would take over 450,000 gal of pure water to make the solution habitable for fish. It would take over 45,000,000 gal of pure water to neutralize it.

Site management and control

- Set up perimeter with at least 50m radius.
- Command, staging, & decon shall be positioned uphill.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product Carrier (if spill occurs during delivery to mine).

Identification

- UN# 2031
- Liquid state
- Colourless to yellow
- Transported in 45 gallon drums
- # of 45 gal drums possibly damaged will help estimate size of spill.
- What is downhill from spill? Could acid reach a stream?

Hazard & risk evaluation

- Strong acid, very corrosive.
- Severely hazardous to eyes and skin
- Ingestion could cause death
- Inhalation hazard, although low vapour pressure 1.3kPa (wants to be a liquid).
- Could be devastating to stream life.
- Strong oxidizer, could have explosive reaction with organic or combustible materials

PPE

- If there is a fire situation, PPE will consist of full turn-out gear and SCBA.
  Otherwise
- Know and heed permeability rate and breakthrough times of all PPE.
- Acid resistant, class B suit with hood.
- Full-face respirator with appropriate chemical cartridges.
- Chemical resistant gloves & boots
- Chemical resistant tape used to seal between boots/suit, gloves/suit, and mask/hood.

Information management and resource coordination

- See MSDS for product information.
- Know the product's route of travel.
- Was anyone exposed?
- Will non-human life be exposed?
- Standard decon set-up will be constructed.
- Have tools cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is enough neutralizing agent at the site to complete the task. ***See below for chart***
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured/exposed personnel.
- Prevent from entering streams
- Prevent from contacting combustibles and organics.
- If possible, stop the leak.
- If possible, contain by covering drains/culverts, damming, diverting to a berm, etc.
- Use over-pack to contain leaking drums that still contain product.
- Neutralize spilled product with weak caustic – primary neutralizing agent is Ansul Spill X-A, alternatively hydrated lime or baking soda (if available). Be cautious of chemical reaction.
- Use Litmus paper to test for pH when neutralizing with lime or baking soda.
- Site Services Vac-truck is an option for cleaning up product before or after neutralized, as necessary.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, vac-truck can be utilized to clean up solution contained with the decon berms.
- Safe and proper disposal of all spent PPE.

- Transition of command.
- Debrief

Quick Access Chart for Estimating Amount of Caustic Req'd to Neutralize 40% Nitric Acid

For **Spill X-A**, use 1:1 ratio by volume, or 10lbs Spill X-A per 1 gal Nitric Acid.

Amount of Nitric Acid Spilled (in Gal.)	Amount of Baking Soda Req'd (in Lbs.)
1	5.6
2	11
5	28
10	56
20	110
45	252
90	504
135	756
180	1,008

Amount of Nitric Acid Spilled (in Gal.)	Amount of Lime Req'd (in Lbs.)
1	2.4
2	4.8
5	12
10	24
20	48
45	108
90	216
135	324
180	432

Charts derived from formulas below

Specific Gravity Nitric Acid: 1.2455

Concentration: 40%

1 gal HNO_3 x 1.24 x 8.34 lbs/gal x 0.40 = 4.14 lbs HNO_3

$HNO_3 + NaHCO_3 \rightarrow NaNO_3 + H_2O + CO_2$ Therefore 1 mol Nitric Acid per 1 mol Sodium Bicarb (Baking Soda)

$2HNO_3 + Ca(OH)_2 \rightarrow Ca(NO_3)_2 + 2H_2O$ Therefore 2 mol Nitric Acid per 1 mol Calcium Hydroxide (Lime)

HNO3 = 63 amu

NaHCO3 = 85 amu

Ca(NO3)2 = 74 amu

(4.14 lbs HNO3/63 amu-HNO3) x 85 amu-NaHCO3 = 5.6 lbs NaHCO3

Therefore 1 gallon of Nitric Acid req's 5.6 lbs of baking soda

(4.14 lbs HNO3/2(63) amu-HNO3) x 74 amu-Ca(OH)2 = 2.4lbs Ca(NO3)2

Neutralization Formulas and Quick Access Charts **Formulas**

The key to effective and efficient neutralization, is knowing how to use the following formulas.

1. The first formula indicates how much acid is spilled in weight.

Step #1- Determine the quantity of acid spilled, usually in gallons.
Step #2- Determine the specific gravity of the acid usually provided in MSDS.
Step #3- Determine the concentration of the acid spilled usually in %.
Step #4- The weight of water is 8.34 pounds per gallon.

After the above figures are known plug them into the following formula.

Quantity of spill X specific gravity X weight of water X concentration = weight of the spill

Example
One gallon of sulfuric X 1.84 X 8.34 X 98% = 15.04 pounds of sulfuric

2. The second formula will determine the quantity of the neutralizer needed. The type of neutralizer needs to be selected based on costs and availability. Plug numbers into the following formula.
3.

Weight of the acid spilled X number in the chart for the selected neutralizer.

Example

15.04 pounds of sulfuric X 1.06 for Soda Ash = 15.94 pounds of Soda Ash

Determination through Chemistry

To calculate the amount of neutralization agent needed the balanced chemical reaction must be written and the equivalent weights of acid and base determined.

Example: 1,000 gallons of 38% hydrochloric acid will be neutralized with lime.

Step #1 – Write the complete balanced neutralization reaction:
$2HCl + CaO \rightarrow CaCl_2 + H_2O$
This equation shows that 2 moles of HCl are required in the reaction with one mole of calcium oxide (lime).

Step #2 – Calculate the molecular weight of each compound:
HCl – H = 1, Cl = 35.5, Total = 36.5 amu
CaO – Ca = 40, O = 16, Total = 56

Step #3 – Calculate the weight of the HCl spill:
1,000 gallons X 1.20 X 8.34 X 0.38 = 3,803.04 pounds of HCl
Step #4 – Calculate the amount of neutralizer needed:
From Step #1 it was found that 2 moles of HCl are needed to react with 1 mole of CaO. From Step #2 it was found that 1 mole of HCl weighs 36.5 amu's so 2 moles weigh 73.0 amu's. The formula is**; weight of acid/formula weight of acid X formula weight of base = pounds of the neutralizer needed.**
3,803.04/73 X 56 = 2,917.4 pounds of lime

Finer Points

The final amount is an approximation and in actual practice more neutralizing agent should be obtained. The neutralization process needs to be checked at several spots to assure pH levels are acceptable and uniform.

Neutralization Precautions

Remember, the neutralization process is exothermic and it may involve splashing of product. Safety is paramount and proper protective equipment is very important. Also, the neutralizer is hazardous in its own right and needs to be handled with care. Consider expense and availability in selecting neutralizer. Other weak bases that may be used and their molecular weights are; sodium bicarbonate ($NaHCO_3$)- 85, and magnesium hydroxide ($Mg(OH)_2$)-58.

Neutralization Chart Information

Acids

Hydrochloric Acid, HCl, MW = 36.5, density/specific gravity is 1.19, weight of a gallon is 3.77 pounds at 38% concentration. Synonyms are chlorohydric acid and muriatic acid.

Nitric Acid, HNO_3, MW = 63, density/specific gravity is 1.41, weight of a gallon is 8.23 pounds at 70% concentration. Synonyms are Aqua Fortis and Azotic Acid. (Aqua Regia is a mixture of nitric and hydrochloric acids).

Phosphoric Acid, H_3PO_4, MW = 98, density/specific gravity is 1.69, weight of a gallon is 11.98 pounds at 85% concentration. Synonyms are orthophosphoric acid.

Sulfuric Acid, H_2SO_4, MW = 98, density/specific gravity is 1.84, weight of a gallon is 15.04 pounds at 98% concentration. Synonyms are Oil of vitriol and “oleum” is fuming sulfuric acid.

Bases

Ammonium hydroxide, NH_4OH, MW = 35, clear solution, synonyms are ammonia solution and aqua ammonia. Strong ammonia odor evolves from liquid. High vapor pressure.

Calcium carbonate, $CaCO_3$, MW = 100, white powder, synonyms are crushed limestone and dolomite. Low heat of reaction that gives off carbon dioxide gas.

Calcium hydroxide, $Ca(OH)_2$, MW = 74, white powder, synonyms are slaked lime, hydrated lime, and calcium hydrate.

Calcium oxide, CaO, MW = 56, white powder, synonyms are quicklime, lime, and unslaked lime. Most economical, lowest cost, neutralizer. **Best choice!** Maximum pH is 12.45 at 25C.

Magnesium carbonate, $MgCO_3$, MW = 84, synonyms are magnesia alba and carbonate magnesium.

Magnesium hydroxide, $Mg(OH)_2$, MW = 58, white powder, synonyms are milk of magnesia and magnesia hydrate. Good neutralization agent. Maximum pH is 10.6 at 25C.

Potassium hydroxide, KOH, MW = 56, white flakes, synonyms are caustic potash. High heat of reaction with toxic fumes. Maximum pH is 14 at 25C.

Sodium bicarbonate, $NaHCO_3$, MW = 85, white powder, synonyms are baking soda and sodium acid carbonate. Low heat of reaction with carbon dioxide gas evolution.

Sodium Carbonate, Na_2CO_3, MW = 106, white powder, synonyms are soda ash. **Second most economical neutralization agent next to lime.** Maximum pH is approximately 11 at 25C.

Sodium hydroxide, NaOH, MW = 40, white powder, synonyms are caustic soda, soda lye, caustic, and lye. High heat of reaction with toxic fumes. Maximum pH is 14 at 25C.

Quick Access Charts

Sulfuric Acid neutralization using Baking Soda (Sodium Bicarbonate)

Amount of Sulfuric Acid spilled	Amount of Baking Soda needed in pounds
1 gallon	25.6
2 gallons	51.2
3 gallons	76.8
4 gallons	102.4
5 gallons	128.0
10 gallons	256.0
50 gallons	1280.0
55 gallons	1408.0
100 gallons	2560.0

Hydrochloric Acid neutralization using Baking Soda

Amount of Hydrochloric Acid spilled	Amount of Baking Soda needed in pounds
1 gallon	5.5
2 gallons	11.0
3 gallons	16.5
4 gallons	22.0
5 gallons	27.5
10 gallons	55.0

50 gallons	275.0
55 gallons	302.5
100 gallons	550.0

Nitric Acid neutralization using Baking Soda

Amount of Nitric Acid spilled	**Amount of Baking Soda needed in pounds**
1 gallon	7.4
2 gallons	14.8
3 gallons	22.2
4 gallons	29.6
5 gallons	37.0
10 gallons	74.0
50 gallons	370.0
55 gallons	407.0
100 gallons	740.0

Sodium Sulfide

Site management and control

- Set up perimeter with at least 50m radius if water introduced, or 25m if solid.
- Command, staging, & decon shall be position upwind and uphill.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1849
- Solid state
- Yellow
- Smell sulfurous or like rotten eggs with introduction of moisture.
- Transported in 1000 Kg ‘Super-Sacks’.
- # of super-sacks possibly damaged, will help estimate size of spill.
- Is water being introduced to the spill? If so, what is downhill form the spill? Could run-off reach a stream?
- Are corrosives being introduced to spill? If so, what is downwind?

Hazard & risk evaluation

- Strong caustic.

- Severely corrosive to digestive tract, respiratory system, eyes, and skin.
- Dust is powerful systemic poison. Inhalation could cause headache, dizziness, unconsciousness, pulmonary edema, asphyxiation, death.
- Contact with acid releases toxic and flammable Hydrogen Sulfide.
- Routes of entry include absorption, inhalation, and ingestion.
- Keep spilled product dry
- If water introduced, avoid run-off, contact with soil, waterways.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear and SCBA.

Otherwise

- Know and heed permeability rate and breakthrough times of all PPE.
- SCBA if significant H2S release, otherwise, full-face respirator & OV cartridges with pre-filter.
- Corrosive resistant, class B suit with hood.
- Chemical resistant gloves & boots
- Chemical resistant tape used to seal between boots/suit, gloves/suit, and mask/suit.

Information management and resource coordination

- See MSDS for product information.
- Was anyone exposed?
- Will non-human life be exposed?
- Standard decon set-up will be constructed.
- Have tools cribbed for entry team.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req’d
- Have Site Services staged for digging, damming, product extraction, as req’d.

Implementing Response Objectives

- Rescue injured/exposed personnel.
- Keep product dry.
- Monitor atmosphere for H2S and SO2.
- If water introduced, contain run-off by covering drains/culverts, damming, diverting to a berm, etc. Solution collected can be mixed with oxidizing agent, such as hydrogen peroxide or sodium hypochlorite to prevent evolution of H2S.
- If product has entered a stream, consider using over-flow dams to contain product, for extraction.
- Vacuum or sweep up dry product
- Disposal as per Environmental Dept. recommendations

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½” hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, solution in decon berms to be disposed of, as per Environmental recommendations.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief

LPG (Propane)

Note: Minto gas detectors are calibrated to methane, and must be corrected to propane prior to use, during propane leak mitigation.

Site management and control

- Set up initial perimeter of at least 100m. For large tank where there is fire, set up perimeter of at least 1600m.
- Command, staging, & decon shall be positioned uphill and upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1075
- Colourless liquid and vapour while stored under pressure.
- Colourless and odourless gas in natural state at any concentration.
- Commercial propane has an odorant added which is commonly ethyl.
- Transported by tanker truck.
- Stored in 12,000L tank at ramp to camp and twin 18,000L tanks at Km 0 of the access road.

- What is downhill from spill?
- Is there threat to life?
- Is there threat to a stream?

Hazard & risk evaluation

- Extremely flammable gas.
- Vapour could be ignited by any source of ignition.
- Vapour is heavier than air and may travel considerable distance to an ignition source, and flash back.
- Stored under pressure, as a liquid.
- Product extraction methods could create static if not bonded/grounded, and serve as an ignition source.
- Massive explosion hazard where flame impingement on tank.

PPE

- Full turn-out gear with SCBA.

` **Information management and resource coordination**

- See MSDS for product information.
- Consider contacting Canutec.
- Know the product's route of travel.
- Ensure tools are cribbed for entry teams.
-
- Have fire truck at scene and ambulance in staging area, as req'd

Implementing Response Objectives Leak in an enclosed space

  - Evacuate structure.
  - Close supply valve remotely if possible.
  - Eliminate any source of ignition.
  - Use positive pressure to ventilate space, ensure that it is exhausting to safe location.

If no remote isolation valve:

  - Entry team (2 ERT members) & RIT team (2 ERT members) will don full turn-out gear & SCBA.
  - Any electronic equipment being carried, such as radio or gas detector, must be intrinsically safe.
  - Entry team will enter with charged 1 ½" hose-line and gas detector equipped with LEL sensor, while RIT stages in the cold zone .

- Once entry team is at ‘reach of stream’ distance from the leak, the nozzleman (Entry member 1) will set-up, with nozzle fixed on Entry member 2. Entry member 2 will continue toward valve, with gas detector.

  If LEL sensor rises above 20%, entry team will retreat until ventilation can be made adequate.

- Once Entry member 2 reaches the valve, he will close the valve, then back away until he reaches entry member 1.
- Entry team will exit the structure, until it has been adequately ventilated.
- Once adequately ventilated, ERT members, wearing appropriate PPE, will sweep the structure with gas detector(s), to ensure there are no pockets of gas, before deeming the structure ‘safe to enter’.

LPG line on fire, with no impingement

Note: a propane leak that is burning is safer than one that is not burning, as long as there is no impingement on a tank or structure. Therefore, in this scenario, gas will be allowed to burn until the valve can be shut off.

- Evacuate immediate area.
- If possible, close isolation valve from remote location.

  If no remote isolation valve:

- Eliminate any further source of ignition.
- 2 or more ERT members in full turn-out gear & SCBA will be on 1 ½” hose-line.
- Nozzle will be turned to full fog, which will create a water-curtain between the fire and the fire fighters.
- The fire team will approach the isolation valve, keeping the water-curtain between themselves and the fire at all times, being careful not to put the fire out with the stream
- When the valve is reached by the team, the 2nd member on the line will let go of the hose and approach the valve, while the nozzleman maintains the water-curtain between the fire and the valve/fire team.
- The 2nd member will close the valve then back away from the fire until he regains his position on the hose.
- The team will maintain the water-curtain while they back away from the damaged gas-line.
- Once the team is at a safe distance, a 45 degree pattern can be fixed on the broken gas-line to cool it, and disperse any residual gases.

LPG leak, not enclosed, not on fire

Note: LPG has a very high vapour pressure (1013 kPa) so it wants to be a gas, a high vapour density (1.52) so it's heavier than air, and a low flash point (-103.4 C). This combination means that it can form an explosive gas cloud that will stay close to the ground, may linger in incident area, or migrate downwind and/or downhill, possibly settling in low lying areas.

- Evacuate immediate area as well as areas downwind/downhill as per ERG recommendations.
- If possible, close isolation valve from remote location.
- From 'reach of stream', set up ground monitor and fix a 45 degree fog pattern on area of concern. This will push gas cloud away from area and disperse it. Be sure to push it to a safe location.

If no remote isolation valve:

- Entry team (2 ERT members) & RIT team (2 ERT members) will don full turn-out gear & SCBA.
- Any electronic equipment being carried, such as radio or gas detector, must be intrinsically safe.
- Entry team will enter with charged 1 ½" hose-line and gas detector equipped with LEL sensor, while RIT stages in the cold zone.
- While ground monitor continues to 'make it rain' in the hot zone, nozzleman (entry member 1) will fix nozzle on entry member 2, as entry member 2 approaches the isolation valve, with gas detector.

If LEL sensor rises above 20%, entry team will retreat until water stream can be made more effective

- Once Entry member 2 reaches the valve, he will close the valve, then back away until he reaches entry member 1.
- Entry team will retreat to the cold zone until gases are adequately dispersed
- Once the gas is adequately dispersed, ERT members, wearing appropriate PPE, will sweep the area with gas detector(s), including low-lying areas where gas may have migrated to, before deeming the area 'safe to enter'.

Fire where there is flame impingement on LPG tank

- Evacuate all non-ERT members for at least 1,800 m where there is flame impingement on either the 12,000 L tank or the tandem 18,000 L tanks.
- Command will know and understand the signs of imminent BLEVE.
- If Command witnesses signs of imminent BLEVE from an upright tank, there shall be no attempt made to cool tanks, rather, all focus shall be on a rapid evacuation of all personnel, at least 1,800m.
- If tank has been knocked over, there may be little or no warning signs of BLEVE, therefore no attempt shall be made to cool, rather, all focus shall be on a rapid evacuation of all personnel, at least 1,800m.
- If a BLEVE is not imminent, an attempt will be made to connect a ground monitor to the stand-pipe at the Tailings bldg.
- A narrow fog stream will be fixed on the tank at the area of flame impingement.
- The monitor will be left unmanned and the remaining ERT will evacuate at least 1,800m.

Where a tanker truck carrying propane has over-turned on the access road, causing damage to the tank trailer and subsequent rapid release of propane, the strategy for the hazmat portion of the incident response, will be passive and conducted from an upwind/uphill location, at a safe distance, as per the ERG. Transfer of residual product for the scenario, will be conducted by outside resource.

Decontamination

- 1 ½" charged hose-line, as emergency decon

Termination

- Debrief

BW GasAlert Micro 5 is intrinsically safe, as per: *http://directories.csa-international.org/xml_transform.asp?xml=certxml%5C080259_0_000-4828-82.xml&xsl=xsl/certrec.xsl*

- GasAlert Micro 5 Portable Gas Detector, Model M5-xwt1t2-r-p-d-a-b-cc & M5PID-xwt1t2-r-p-d-a-b-cc; utilizing electrochemical, catalytic bead and photo-ionization sensors; Intrinsically Safe when powered by one of the following AA Size Batteries /

Battery Pack
- Duracell MN1500; T-Code T4; Ambient -20 to +40°C; T-Code 139.8°C (T3C); Ambient -20 to +50°C
- Energizer E91; T-Code 153°C(T3C); Ambient -20 to +40°C; T-Code 163°C (T3B); Ambient -20 to +50°C
- NiMH Rechargeable Battery Pack "M5-BAT01"; T-code T4; Ambient -20 to +50°C
- Lithium Polymer Rechargeable Battery pack “M5-BAT07B”; T-Code T4; Ambient -20 to +50°C

Diesel, Kerosene, CFE 150

Note: LEL sensor will not detect presence of long-chain hydrocarbon vapour. Photo-ionization detector (PID) should be used, if available.

Site management and control

- Set up perimeter with at least 50m radius.
- Command, staging, & decon shall be positioned uphill and upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept, Dyno Nobel (if spilled product is CFE 150), product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1202.
- Liquid state.
- Colour varies.
- Petroleum odour.
- Transported by B-train, tidy-tanks.
- Stored in tanks at fuel farm.
- What is downhill from spill??
- Is there threat to life?
- Is there threat to a stream?

Hazard & risk evaluation

- Combustible liquid.
- Vapour could be ignited by any source of ignition.
- Extraction methods could create static if not bonded/grounded, and serve as an ignition source.
- Ambient temperature relevant.

- Irritant to eyes and skin
- Ingestion and inhalation hazard
- Toxic to aquatic life.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear with SCBA.
  Otherwise
- For offensive strategies, such as rescue or plugging, full turn-out gear with SCBA
- For defensive strategies, such as diverting, damming, booming, diking, class B suit.
- Respirator with OV cartridges.
- Oil resistant gloves & boots

Information management and resource coordination

- See MSDS for product information.
- Know the product's route of travel.
- Standard decon set-up will be constructed.
- Ensure tools are cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd.
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured personnel.
- Consider using fog stream to protect rescuers.
- Fire-fighting: Use dry chemical, CO2, Class B foam, or water with fog pattern.
- If using fog, considering increased run-off hazard
- Prevent from entering streams.
- If possible, stop the leak: close valves, use plugs, plug n' dyke, gaskets, straps, jacks, cribbing, etc.
- Containment berm at source, 'Surrey Condom'.
- If possible, contain by covering drains/culverts, diking, diverting to a berm, absorbing, etc.
- If product has entered a stream, use booms, hydrocarbon-only absorbent socks and pads, under-flow dams, diversion-booms, skimmers to contain and extract, as per instructions found later in this document.
- If transfer of product req'd, ensure entire system is bonded/grounded.
- Use non-sparking tools, such as pneumatics.
- Site Services Vac-truck is an option for cleaning up product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½” hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, vac-truck can be utilized to clean up solution contained with the decon berms.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief

Gasoline

Note: Minto gas detectors are calibrated to methane and must be corrected to gasoline, or alternatively pentane, prior to use during gasoline spill mitigation

Site management and control

- Set up perimeter. Consider radius up to 800m depending on amount of product and level of explosion hazard.
- Command, staging, & decon shall be positioned uphill and upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept., product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1203.
- Liquid state.
- Colourless to slightly yellow.
- Recognizable odour.

- Transported by B-train, tidy-tanks.
- Stored in tank at fuel farm.
- What is downhill from spill??
- Is there threat to life?
- Is there threat to a stream?

Hazard & risk evaluation

- Flammable liquid. Extremely flammable in presence of ignition source, at nearly any temperature.
- Vapour could be ignited by any source of ignition.
- Vapour is heavier than air and may travel considerable distance to an ignition source, and flash back.
- Product extraction methods could create static if not bonded/grounded, and serve as an ignition source.
- Explosion hazard where flame impingement on tank.
- Irritant to eyes.
- Ingestion and inhalation hazard
- Toxic to aquatic life.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear with SCBA.

  Otherwise
- For offensive strategies, such as rescue or plugging, full turn-out gear with SCBA
- For defensive strategies, such as diverting, damming, booming, diking, fire resistant class B suit.
- Respirator with OV cartridges, only if LEL's are being monitored, otherwise, do not dampen sense of smell. Rather, move upwind of product vapour.

Information management and resource coordination

- See MSDS for product information.
- Know the product's route of travel.
- Standard decon set-up will be constructed.
- Ensure tools are cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Offensive tactics for rescue of injured personnel only.
- Consider blanketing affected area with class B foam, prior to rescuers entering hot zone.

- Use fog stream to suppress vapours and protect rescuers.
- Rescuers will carry intrinsically-safe radios and gas-detector.
- Prevent from entering streams
- If possible, stop the leak.
- If possible, contain by covering drains/culverts, diking, diverting to a berm, absorbing, etc.
- If product can or has has entered a stream, use booms, hydrocarbon-only absorbent socks and pads, under-flow dams, diversion-booms, as per instructions found later in this document.
- Safe handling and disposal of all waste product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, safe disposal of decon berm contents
- Safe and proper disposal of all spent PPE
- Hand-over command of operation to Environmental Dept.
- Debrief

Ammonium Nitrate

Site management and control

- Set up perimeter with at least 25m radius.
- Command, staging, & decon shall be positioned upwind.

- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept, Dyno Nobel, product carrier (if spill occurs during delivery to mine).

Identification

- UN# 1942.
- Solid state. Prills or granules.
- White.
- Odorless.
- Is there threat to a stream?

Hazard & risk evaluation

- Oxidizer .
- Exposure to high heat may evolve toxic, flammable gases.
- Explosive when confined and exposed to high heat.
- Ingestion and inhalation hazard.
- Toxic to aquatic life.

PPE

- If there is a fire situation, PPE will consist of full turn-out gear with SCBA.

Otherwise

- Class C suit with long sleeves.
- Dust mask.
- Oil resistant gloves & boots

Information management and resource coordination

- See MSDS for product information.
- Work closely with Dyno.
- Standard decon set-up will be constructed.
- Have tools cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req’d
- Have Site Services staged for digging, damming, product extraction, as req’d.

Implementing Response Objectives

- Rescue injured personnel.
- Fire-fighting: If flame impingement on tank, use unmanned ground monitor to supply flooding quantities of water via straight-stream, to cool tank. Then, evacuate area 800m in all directions. If signs of imminent explosion are present prior to setting up ground monitor, do not attempt to set it up, just evacuate for 800m in all directions.
- Prevent from entering streams.
- Once in stream, may be unrecoverable. Underflow dams should be constructed, and surface can be skimmed.
- If possible, stop anymore product from being spilled.
- Follow Dyno's recommendations for recovery and clean-up of product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, vac-truck can be utilized to clean up solution contained with the decon berms.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief.

Emulsion

Site management and control

- Consider initial perimeter of 800m.

- Command, staging, & decon shall be positioned upwind.
- Eliminate sources of ignition.
- Unify command with Safety Superintendent, Mine Manager, Environmental Dept, Dyno Nobel, product carrier (if spill occurs during delivery to mine).

Identification

- UN# 0332.
- Viscous liquid.
- Pink, opaque.
- Slight fuel oil odour.
- Shipped in bulk by tanker truck.

Hazard & risk evaluation

- Emulsion explosives.
- Stable under normal conditions.
- May explode under fire conditions.
- Eye & skin irritant.
- Slight ingestion & inhalation hazard.
- Avoid contact with corrosives.
- Is there threat to a stream?

PPE

- Class C suit with long sleeves.
- Standard PPE

Information management and resource coordination

- See MSDS for product information.
- Work closely with Dyno.
- Standard decon set-up will be constructed.
- Have tools cribbed for entry teams.
- Ensure there is enough PPE at the site to complete the task.
- Ensure there is drinking water for responders.
- Have hazmat trailer, ambulance & fire truck in staging area, as req'd
- Have Site Services staged for digging, damming, product extraction, as req'd.

Implementing Response Objectives

- Rescue injured personnel.
- Fire-fighting: If fire reaches cargo, DO NOT ATTEMPT TO FIGHT FIRE. Cargo may explode. Evacuate in all directions for 1600m.
- Prevent from entering streams.
- If possible, stop anymore product from being spilled.
- Follow Dyno's recommendations for recovery and clean-up of product.

Decontamination

Standard decon set-up will be utilized in warm zone:

- Large berm fashioned out of large chemical resistant tarp, wrapped over charged 2 ½" hose-line, 2 small berms, will be in series, within the large berm.
- Decon personnel shall don class C suits without need for respiratory or splash protection, other than safety glasses.
- Ensure all personnel that entered hot zone are properly decontaminated.
- Ensure that all tools that entered the hot zone are properly decontaminated.

Termination

- Once operation complete, clean out berms under direction of Dyno.
- Safe and proper disposal of all spent PPE.
- Transition of command.
- Debrief.

Appendix D: Tug and Barge Emergency Contingency Plan

MINTO MINE

Tug and Barge Emergency Contingency Plan

VERSION 2013-01

Prepared by:
Capstone Mining Corporation
Minto Mine
January 15, 2013

1.0 Introduction

Minto Mine (Minto) a subsidiary of Capstone Mining Corporation is pleased to submit the following contingency plan (plan) as per requirements of the access and land use permit “Minto Landing Ice Bridge and Marshalling Area and West Side Barge Landing and Marshalling Area” (the permit). It is Minto’s intention that this plan will fulfill the requirement as stated in Schedule 2, Section 9.0 Contingency Plan of the permit. It is not Minto’s objective for this plan to mitigate all possible accidents or malfunction in regards to the in stream operation of the Copper Queen tug and barge.

The SCP as prepared is adaptive and will be amended as is practicable. This plan is intended to deliver the best possible means of mitigating an accident or malfunction of the loading/unloading or in-stream operation of the tug and barge with the resources available at Minto. Preventing such an occurrence requires a combination of: procedural and engineering controls, based on an awareness of at risk conditions. These documents exist in the form of the Spill Contingency Plan, Emergency Response Plan, any procedures or plans on the tug or barge from Site Services. This document serves as a contingency plan in the event that an accident or malfunction occurs when loading, unloading, and in-stream operations of the Copper Queen tug and barge (CQTB).

2.0 General Procedures

Any Response to an Emergency condition will be based on a priority sequence of Life, Environment and Property. Therefore every event will be regarded with these priorities in mind. Initial on scene assessment of the accident or malfunction will be called out on channel one as a “Code 1”. The Emergency Response Team will be dispatched, communication established and the barge operator and deckhand will respond to control the scene.

Deckhands will mitigate all emergencies on the barge to the best of their ability given the resources available. General procedure in the event of an emergency would have the barge move to the west landing if possible or practical unless otherwise communicated to the barge captain. To mitigate an emergency in offloading or loading vehicles onto the barge the deckhand will utilize the anchor points on both landings. Slack will be left in the rope to ensure the barge captain is able to maneuver when docked at the landing. Tying off to the anchor points will mitigate complete catastrophe if the barge loses power during loading and offloading and will be discussed further under the specific procedures section of this plan.

Minto is currently in discussion with JDS about a mutual aid agreement. It is Minto's intention to have the agreement in place before the 2013 barge operating season. The mutual aid agreement will be for assistance on the east side landing (equipment, manpower etc.) as well as in-stream support. To mitigate the risk of losing control of the barge downstream Minto will be installing an anchor on the barge. In the event of an emergency the deckhand would be able to deploy the anchor allowing the barge a safety contingency if control was lost.

3.0 Specific Procedures

Below is a list of the current on site procedures for dealing with various emergencies in regards to the CQTB at Minto Mine.

1. Emergency Response to Sinking
2. Emergency Response to Loss of Power or Control
3. Emergency Response to Fire Onboard
4. Emergency Response to Man Overboard
5. Emergency Response to Freight or Vehicle Overboard
6. Emergency Response to Medical Emergency on Board of the Barge
7. Emergency Response to Spill Response

3.1 Emergency Response to Sinking of CQTB

1. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
2. Captain and deckhand will deploy Canadian Coast Guard approved life rafts.
3. As per Emergency Response Plan, Incident command (IC) will communicate with Deckhand by radio to determine any further details of events, number of injured or trapped people, risks to property and environment.

4. IC will respond to scene in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.
5. Incident Accountability will be established and adhered to throughout the operation.
6. IC will determine the need for rescue of people downstream. Option to deploy rescue ropes via launcher considered for KM 12.
7. Alternate access to river to be determined by nature of incident, KM 20 provides a second potential access. All other access would require trail cutting which is possible but would take more time.
8. IC, ERT Captain, and Environmental Lead (Unified Incident Command Support) will assess ongoing situation and need for additional or fewer resources.
9. Alternate man boat (see Appendix A for details on man boat) will be deployed from landing as needed to support rescue and/or to gain more information regarding location of sunken vessel and determine possible plan for retrieval/securing. Man boat operator will work under the direction of IC.
10. If available and a benefit, Minto would exercise the use of the mutual aid agreement with JDS.
11. Once rescued, all patients will be treated as per OFA3/EMR protocols transported as per Yukon EMS dispatch confirmation aligned with Minto Emergency Response Plan.

3.2 Emergency Response to Loss of Power or Control of CQTB

The tug operates on two engines so total loss of power is not likely; however, is still possible and below is the emergency procedure that would be activated in the event that total loss or control of the CQTB was to occur.

12. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response. Captain will also communicate freight details and passenger numbers on board.
13. Passengers and crew will follow instructions from Captain and remaining on board if deemed safe. The Captain and deckhand will follow MED protocol in decision making in regards to passenger safety.
14. Captain and deckhand will deploy Canadian Coast Guard approved life rafts if deemed unsafe to stay on board by Captain.
15. IC will respond to scene or as close to it, in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs and downstream communication and reporting requirements based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.
16. Incident Accountability will be established and adhered to throughout the operation.
17. Captain will navigate to the best of his ability to the safest downstream location possible. Under the direction of the Captain the deckhand may deploy the anchor to assist in stopping the barge and tug.
18. Captain will communicate to IC location and details of condition of vessel and people and assist in determining plans for action.
19. Once vessel is secured to shore or where landed in river, Man boat will be deployed to assist with additional securing and remove non-essential people to location where they can be transferred back to site or alternate safe location.
20. If available and a benefit, Minto would exercise the use of the mutual aid agreement with JDS.
21. Plan for retrieval will be based appropriate to the conditions and location of vessel. Plan to be developed cooperatively through Barge Captain, Minto ECC and Mutual Aid resources.

Equipment and additional resources will be sourced through ECC as per Minto Emergency Response Plan.

3.3 Emergency Response to Fire on the CQTB

22. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
23. If safe to do so, deckhand will attempt to supress fire using equipment on board following Marine Emergency Duty (MED) protocol.
24. Captain and deckhand will deploy Canadian Coast Guard approved life rafts if vessel in immediate danger. If possible and practical the Captain will position barge so that wind is blowing port to star board, to keep smoke/flames away from life raft.
25. If able to do so Barge will cross to West Bank of crossing and continue to use barge supplied fire suppression equipment. All passengers will disembark under direction of deckhand.
26. IC will respond to scene in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.
27. Incident Accountability will be established and adhered to throughout the operation.
28. Once IC on scene and vessel safely secured, fire suppression will be conducted under the direction of the IC following NFPA 1081 standards. Industrial Fire Brigade.
29. Consideration of environmental sensitivity need to be considered by IC in cooperation with the Environmental Lead (unified incident command support).
30. Defensive spill containment methods to be utilized to control run off and releases from firefighting operations. This may include tactics such as extinguishing agent selection, damming and berming on barge, boom placement around vessel, removal of burning equipment once fire controlled, etc.

3.4 Emergency Response to Man Overboard

31. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
32. Captain and deckhand will throw out provided Canadian Coast Guard approved life-rings to all personnel overboard. The response from the barge crew will conducted as per their MED training.
33. If able to successfully rescue person overboard, deckhand will treat person based on marine first aid protocols awaiting response by ERT and site Medic.
34. If unable to successfully achieve rescue, vessel will continue to West landing and man boat deployed for downstream rescue. Communication to IC on Radio Channel 1 must be available at all times. Man boat operation will be conducted under the direction of IC once in place.
35. Captain will communicate to IC of possible downstream rescue requirement.
36. IC will instruct ERT to stage at KM 12 with option to deploy rescue ropes via launcher considered for KM 12.
37. Incident Accountability will be established and adhered to throughout the operation.
38. IC to stage ambulance for patient pick up.
39. IC will communicate the need for mutual aid to ECC who will follow the Minto ERP by contacting local agencies for assistance on East side of river.
40. Once rescued, all patients will be treated as per OFA3/EMR protocols transported as per Yukon EMS dispatch confirmation aligned with Minto Emergency Response Plan.

3.5 Emergency Response to Freight or Vehicle Overboard of the CQTB

41. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response. Captain will also communicate freight details and passenger numbers on board.
42. Passengers and crew will follow instructions from Captain (Captain will respond as per MED training) remaining on board if deemed safe.
43. Captain and deckhand will deploy Canadian Coast Guard approved life rafts if deemed unsafe to stay on board by Captain. If at landing passengers will be offloaded to safe location on shore.

44. IC will respond to scene or as close to it, in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs and downstream communication and reporting requirements based on initial assessment and evaluation by IC will be communicated to the Emergency Communications Center (ECC) as per Emergency Response Plan.
45. Incident Accountability will be established and adhered to throughout the operation.
46. Captain will navigate to the best of his ability to the landing, preferably west landing.
47. Once vessel is secured to shore, man boat will be deployed by deckhand or ERT members to assist with additional securing of vessel and freight, and deployment of containment booms located at landing and on vessel. Man boat operation under the direction of IC once in place.
48. Plan for retrieval of freight will be determined appropriate to the condition and location of freight. Plan developed cooperatively through Barge Captain, Minto ECC and Mutual Aid resources.
49. Equipment and additional resources will be sourced through ECC as per Minto Emergency Response Plan including manpower, expertise, heavy equipment, etc.
50. Special considerations for support in the event of incident occurring on East side of river to include Yukon Emergency Measures Organization, local first responders and alternate equipment operations contractor.

3.6 Emergency Response to Medical Emergency on board CQTB

51. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
52. For serious injury as defined in the ERP, Yukon EMS will be notified immediately.
53. Deckhand will treat patient per Marine Emergency First Aid protocols.
54. Captain will navigate barge to west bank of Yukon River and all vehicles will offload on west bank, giving clear passage for Ambulance.

55. ERT response will include medic, ambulance, fire truck and compliment of team members to assist with patient transfer and packaging.
56. Incident Accountability will be established and adhered to throughout the operation.
57. Yukon EMS dispatch will be updated of situation once history and assessment confirmed.
58. Upon arrival, Minto Medic will take control of scene and advise ERT Captain of resources needed on scene.
59. Upon history and assessment, patient will be treated, packaged and transferred as per OFA3/ERM protocols transported as per Yukon EMS dispatch confirmation aligned with Minto Emergency Response Plan.

3.7 Emergency Response to a Spill

60. Activation of Emergency Protocol onboard CQTB calling code 1 to initiate ERT response.
61. Deckhand will attempt to contain spill using on board spill kit, to prevent spill into Yukon River.
62. IC will respond to scene in one emergency vehicle ahead of remaining ERT. IC will upon arrival to scene provide initial scene assessment and gather any additional information available. Minimum ERT response will include full ERT member compliment, Environmental Lead, Hazardous materials response trailer, fire truck, ambulance and all associated equipment. ERT operations to be under the control of the ERT Captain. Additional response needs, downstream communication, communication with CANUTEC and reporting requirements based on initial assessment and evaluation by IC will be communicated to the ECC as per Emergency Response Plan and Spill Contingency Plan.
63. Incident Accountability will be established and adhered to throughout the operation.
64. If practical the barge captain will navigate the barge to west landing.
65. All passengers will disembark vessel.
66. All vehicles and machinery that is not in the spill zone will disembark.
67. Deckhand and ERT members under the direction of IC will use the man boat to deploy containment booms around the barge.

68. IC with advice from the Environment Lead will develop and implement the SCP for stopping the spill if possible.
69. If the spill cannot be stopped a plan to mitigate the quantity of contaminant spilt to environment will be developed and implemented.
70. If safe and practical to do so Environment Lead will deploy environment staff to sample downstream of spill to measure contamination concentration.
71. IC with advice from the Environment Lead will oversee cleanup of the spill.
72. Special considerations for support in the event of incident occurring on East side of river to access the barge with ERT by man boat.

4.0 Minto Mine Training

The barge crew were trained and certified in Marine Emergency Duties (MED) A1 and A2 in 2012. The MED course meets the standards of training, certification and watchkeeping and is run by Transport Canada. The A1 MED course covers basic safety with a focus on hazards and emergencies awareness, firefighting, emergency response, lifesaving appliances and abandonment, survival and rescue. The A2 MED course covers small passenger-carrying vessel safety with the same focus as A1 with the addition of maintenance and inspection of emergency equipment and passenger control. As well the barge crew is trained in Marine First Aid.

The ERT team and environment staff has been trained in NFPA 472 Hazardous Materials Response Certification, awareness and operations for responders. In 2014 Minto is planning to host a table top and field exercise in regards to Yukon River response. The table top and field exercise will be held in conjunction with ERT, barge crew, environment department, management, and consultants.

Appendix E – Minto and McGinty Creek 2014 Hydrology Update

ACCESS

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Whitehorse, Yukon Y1A 2V3
Phone (867) 668-6463 Fax (867) 633-4882
www.accessconsulting.ca

Memorandum

To: Minto Explorations Ltd.

From: Anthony Bier, Access Consulting Group (ACG)

CC: Scott Keesey

Date: March 25, 2015

Re: Minto and McGinty Creek 2014 Hydrology Update

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1 INTRODUCTION

The Minto Mine (Minto) Environment Department maintains a network of hydrometric stations as part of its regular monitoring of surface water hydrological conditions in Minto and McGinty Creeks (Figure 1). Minto personnel conduct regular discrete discharge measurements and maintenance at the stations where Solinst Levelogger and Barometric Loggers are utilized to capture continuous stage records. Access Consulting Group (ACG) has been retained to process these data into discharge records for the 2014 season, as it has for previous years, utilizing Aquarius Time-Series management software. This memorandum presents the methods of observations and data processing along with the results of the 2014 monitoring program.

In general, 2014 was a challenging water year, especially in McGinty Creek where already small streams were reduced to some of the lowest flows observed since monitoring began. The result was that multiple staff gauges went dry necessitating repositioning some stations. Both Minto and McGinty Creek had lower than average flows in 2014.

2 METHODS

Hydrometric data are collected and managed throughout the open water season by Minto on both Minto and McGinty Creeks. Minto utilizes the Velocity-Area method of discharge calculation and measures velocity using a Hach FH950 handheld electromagnetic flow meter. Minto staff work closely with ACG to ensure they are adhering to best practices. Measurements are conducted manually and paired with staff gauge observations and site photographs. In general, multiple visits per month occur on Minto Creek and monthly visits on McGinty Creek during the open water season.

These data are checked for entry and calculation errors and suspicious measurements by Minto after field personnel have entered measurements into a calculation spreadsheet. Paired Solinst Leveloggers and Barologgers are utilized to collect the continuous stage record. All rating measurements are provided to ACG along with the raw Solinst logger records to be processed.

All measurements are entered into a master spreadsheet and .CSV files are created which include date, time, staff gauge height and discharge measured. These rating measurements are then imported into Aquatic Informatics' Aquarius Time-Series (Aquarius) data management software and a rating curve is built. Suspicious measurements are verified against photos and field notes (e.g. if they differ greatly from the stage-discharge relationship). This can be due to the effects of ice or other changing control conditions. Rating curve development thus considers which measurements should be included and when and where shifts to the rating are appropriate. All measurements within the continuous period are included in the hydrographs (Appendix A). Rating curve shifts are used at some Minto sites where appropriate.

Barometrically compensated Solinst water level data were imported into Aquarius software from .CSV files which are exported from Solinst software following compensation. Aquarius allows for adjustment of the Solinst record to match the staff gauge observations, for development of rating curves with the field data, and for automatic processing of continuous discharge records. This preserves the raw data in an easy to reference format and changes can be made to the data at any time which then cascade through the various time series. For example, at new sites, rating curves may improve after several seasons and alter a previous year's continuous record as high or low ends of the rating curve become well defined. Stage time series are adjusted for drift, offset and erroneous data are deleted or excluded from discharge computation if they are deemed ice affected. The rating curve is automatically applied to the continuous stage record for a specified time period to create the continuous discharge time series.

Data for the 2014 season are presented in this memo. For comparison, where data are available, a summary of recent historic data is included. Hydrographs for 2014 are included in Appendix A while discrete discharge measurements are included in Appendix B.

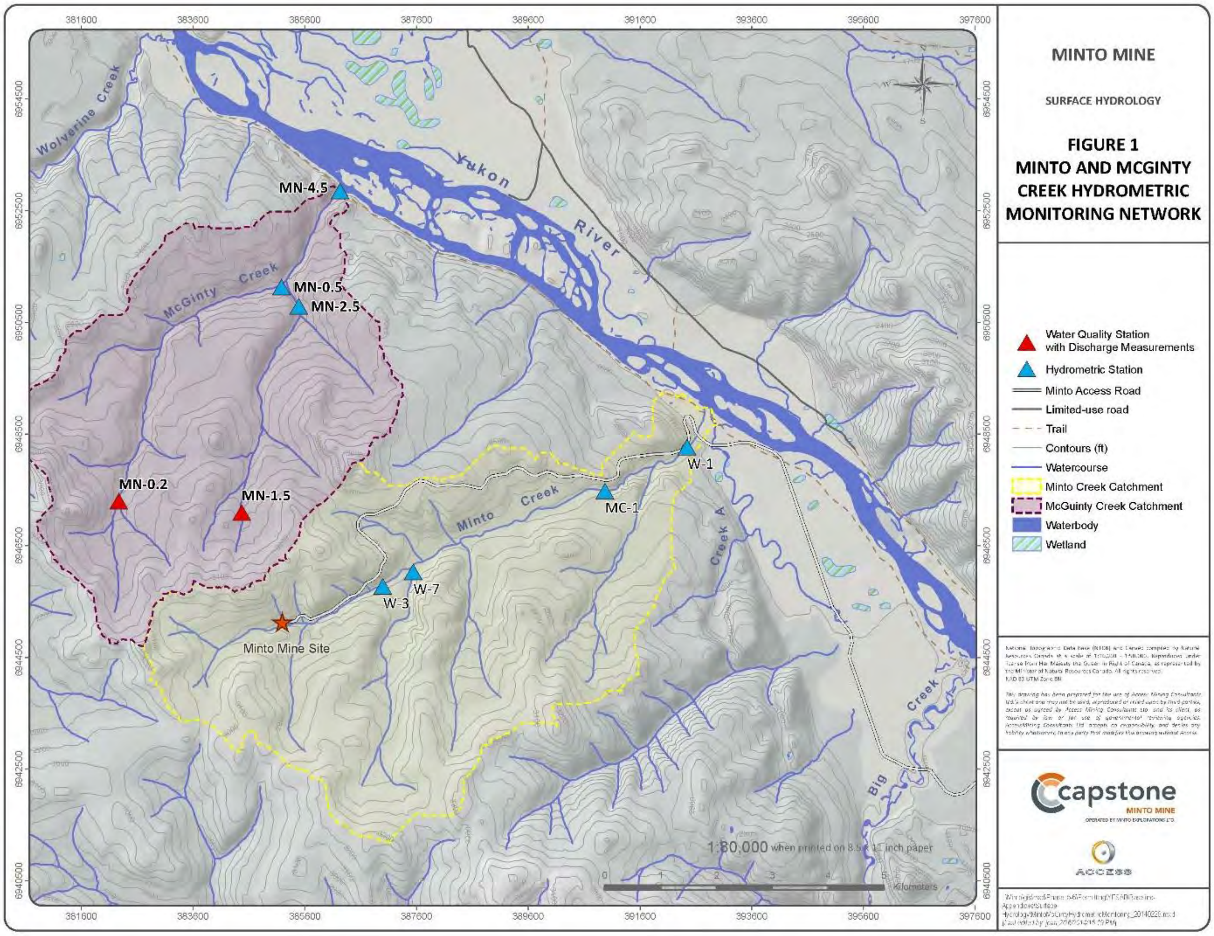

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Figure 1 – Minto and McGinty Creek Surface Hydrology Monitoring sites

3 MINTO CREEK

The Minto Creek hydrological monitoring program includes four hydrometric stations on Minto Creek, three of which are on the main stem (W1, W3 and MC-1) and one on a small tributary, W7 (Figure 1). The W7 station was established on a southern tributary which joins the main creek just below W3. The three main stem monitoring stations are all below the mine site and include W3 (the regulated flume below the Water Storage Pond dam), MC-1 (mid-catchment) and W1 (lower Minto Creek above the road crossing and approximately 1 km upstream of the confluence with the Yukon River) (Figure 1). Mean monthly flows are presented below in separate sections for each station with a brief discussion. The annual hydrographs are included in Appendix A and discrete measurements and observations carried out by the Minto Environmental Team in 2014 are presented in Appendix B.

3.1 STATION W3 - FLUME BELOW WATER STORAGE POND DAM

Water level is continuously monitored in the flume which is approximately 500m from the toe of the Minto Water Storage Pond dam via a Solinst Levelogger in combination with a barometric logger. Frequent observations by Minto staff (minimum weekly) allow for correction of the level logger to the actual height of water in the flume and confirmation of the manufacturer specified stage-discharge relationship. This provides a record with a high degree of accuracy. Figure 2 (Appendix A) shows the hydrograph for the 2014 season and Table 1 summarizes the continuous data as mean monthly flows. Note that for the period in March when there is a large stage peak, the discharge was linearly interpolated as it was reported in the field notes that the flume was backed up and levels were not indicative of the actual discharge. The winter stage record was interpolated using the discrete stage observations.

Table 1 – Mean monthly discharge (m^3/s), Minto Creek at W3

	Month											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2011						0.005	0.005	0.006	0.005			
2012						0.003	0.004	0.004	0.004			
2013						<0.001	<0.001	0.002	0.003	0.003	0.006	0.004
2014	0.003	0.006	0.006	0.057	0.086	0.003	0.003	0.003	0.004			

3.2 STATION MC-1 - MINTO CREEK MID-CATCHMENT

Hydrometric station MC-1 is located between the flume at W3 and is just upstream of the canyon on lower Minto Creek. This site is characterized by shallow channel slope and slower moving water above the control of the canyon. Figure 3 (Appendix A) shows the discharge time series for the 2014 open water season and Table 2 summarizes these data as mean monthly flows.

The mean monthly discharge has been updated for previous years in Table 2 as the rating curve becomes better defined. MC-1 also experiences a later summer shift which is likely due to aggradation of the channel. This seasonal shift from the base rating curve appears consistently, but is not exactly the same from year to year. Minto staff report that MC-1 freezes to ground in winter.

Table 2 – Mean monthly discharge (m^3/s), Minto Creek at MC-1

	Month				
Year	**May**	**Jun**	**Jul**	**Aug**	**Sep**
2012	0.179	0.065	0.052	0.041	0.108
2013	0.358	0.085	0.103	0.044	0.089
2014	0.187	0.028	0.031	0.036	0.038

Note: Grey numbers indicate estimate due to incomplete data.

3.3 STATION W1 – LOWER MINTO CREEK ABOVE ROAD CROSSING

The 2014 continuous discharge record for Minto Creek at W1 extends from late May through early October (Figure 4, Appendix A). The discharge time series was cut off in early October due to daily ice formation causing large fluctuations in stage and inaccurate discharge calculations. Mean monthly flows in 2014 were lower than the previous two years (Table 3). It is suspected that those measurements which do not fall on the time series are due to a changing control with aggradation at low flow. There are not sufficient data to define that shift at this time. It is important to note that May 2014 is calculated from incomplete data (less than 50% coverage).

Table 3 – Mean Monthly Discharge (m^3/s), Minto Creek at W1

	Month				
Year	**May**	**Jun**	**Jul**	**Aug**	**Sep**
2012	0.269	0.073	0.052	0.051	0.078
2013	0.485	0.064	0.065	0.044	0.085
2014	0.138	0.022	0.020	0.014	0.020

Note: Grey numbers indicate estimate due to incomplete data.

3.4 STATION W7 - TRIBUTARY OF MINTO CREEK

A staff gauge was established on this tributary of Minto Creek in the summer of 2013. This site is located on the most upstream of the southern tributaries meeting the main channel of Minto Creek below W3 (Figure 1). W7 had been a regularly monitored surface water quality station for a number of years prior to installation of the hydrometric station. The first staff gauge observation occurred on August 11th, 2013 and there were two rating measurements in 2013, one in August and one in September. The 2013 level record extended from August to late October (at which time it became ice affected). In 2014 the station was found to have been damaged by ice. The stilling well was repositioned in June, but the staff gauge was out of the water for most of the season. Small mountain streams are challenging sites from which to obtain continuous data and this site is a strong candidate for an artificial control such a V-notch weir. The ease of access will allow for the frequent maintenance requirements of artificial controls. Table 4 presents the discrete measurements gathered in 2013 and 2014. The stage record from late June to October is shown in Figure 5 but note that it is adjusted to a single stage observation (Appendix A) and is not comparable to 2013 given that the staff gauge was moved. It is included only to show relative variation.

Table 4 – Discrete measurements at Minto Creek W7 in 2013 and 2014

Date	Time	Stage (m)	Discharge (m^3/s)
Jul-13-2013	14:25	-	0.013
Aug-17-2013	15:57	0.11	-
Aug-24-2013	14:45	0.145	0.031
Sep-06-2013	15:21	0.134	0.019
Oct-21-2013	6:10	0.185	0.006
May-16-2014	12:47	-	0.045
Jun-03-2014	13:30	-0.032	0.042
Jul-26-2014	12:11	-	0.027
Aug-17-2014	12:19	0.11	0.015
Sep-20-2014	12:27	0.166	0.02
10/10/2014	16:10	0.194	0.038

4 MCGINTY CREEK

McGinty Creek has two main sub-catchments which each have two water quality monitoring stations, one just above the confluence and one near the headwaters. MN-4.5 is located on the main stem below the confluence of the tributaries near the mouth; just above the Yukon River (Figure 1). MN-0.5 and MN-0.2 are the lower and upper stations on the west tributary, respectively. MN-2.5 and MN-1.5 are the lower and upper stations on the east tributary, respectively.

4.1 STATION MN-4.5 - MCGINTY CREEK NEAR THE MOUTH

MN-4.5, situated near the mouth of McGinty Creek, is similar in catchment area to Minto Creek, but exhibits consistently higher flows than Minto Creek. Datalogger data from 2014 extends from mid-May to late September when ice formation begins (Figure 6, Appendix A).

Table 5 summarizes the monthly mean values from the continuous record with earlier years values having been refined with further rating development. Discrete measurements conducted in 2014 are also included in Appendix B. It is likely that the true mean flow in June 2014 was much higher, but limited by the data available.

Table 5 – Mean monthly discharge (m^3/s), McGinty Creek at MN-4.5

		Month				
Year	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**
2011	-	0.444	0.093	0.125	0.134	0.068
2012	0.212	0.230	0.180	0.082	0.053	0.165
2013	-	-	0.054	0.103	0.093	0.116
2014		0.230	0.041	0.037	0.026	0.046

Note: Grey numbers indicate estimate due to incomplete data.

4.2 STATION MN-2.5 - EAST TRIBUTARY OF MCGINTY CREEK

The average discrete flow measurement in 2014 at MN-2.5 was 0.016 m^3/s compared to a historical average of 0.024 m^3/s since monitoring began in 2012. The Solinst Levelogger was deployed June 3rd, 2014 and downloaded July 16th, 2014. A subsequent visit found the logger frozen into the stilling well and it was left in place. Rating measurements in 2014 did not appear to fall on previous attempts at creating a rating curve. Photos from June shows substantial ice persists around the staff gauge. With the short record that is potentially ice affected no continuous data is presented. Spot measurements are included below (Table 6Table 6 – Discrete measurements at MN-2.5 2012 to2014). The June-July stage record is shown in Figure 7 (Appendix A).

Given the continued difficulties with this site, ACG recommends that the measurement reach for this station be reassessed and if necessary, that the control be modified or the station be relocated. One approach may be to fly over the creek in early June and identify a stable section of the creek that is expected to become ice free earlier in the season. It may be that continuous discharge is not possible on this creek given the physical and climatic challenges.

Table 6 – Discrete measurements at MN-2.5 2012 to2014

Date	Time	Stage (m)	Discharge (m^3/s)
06-Aug-2012	12:42	-	0.018
07-Sep-2012	12:19	0.335	0.027
07-Oct-2012	13:15	0.486	0.024
27-May-2013	12:40	-	0.079
17-Jun-2013	13:55	0.452	0.026
15-Jul-2013	16:52	0.432	0.009
11-Aug-2013	14:38	0.422	0.019
28-Aug-2013	17:17	0.44	0.027
16-Oct-2013	15:02	0.487	0.028
16-May-2014	14:20	-	0.032
03-Jun-2014	11:58	0.245	0.013

26-Jul-2014	13:05	0.308	0.011
20-Sep-2014	13:20	0.305	0.012
11-Oct-2014	11:35	0.382	0.012

4.3 STATION MN-0.5 - WEST TRIBUTARY OF MCGINTY CREEK

MN-0.5 has similar challenges to MN-2.5 with stage changing drastically and occasionally in an unexpected way. The mean measured discharge in 2014 was 0.031 m^3/s compared with the mean including 2012-2014 of 0.059 m^3/s. The staff gauge was dry in May and June and the station was moved to the wetted part of the channel thereafter. The first stage observation was taken in August.

Table 7 below includes discrete measurements from 2013 and 2014 and a stage hydrograph is included in Appendix A (Figure 8). Similar to other sites, it appears that ice formation begins to affect the stage around September 22nd. Also note that only the August-September level was adjusted and that the period prior to the logger going dry has not been adjusted. The June-July period, then, is included only to show relative changes and event and does not correspond to any staff gauge. The gap in the middle is the period in which the logger was dry preventing alignment with the "new" stage. The data is considered insufficient to derive discharge.

Table 7 – Discrete Measurements at MN-0.5 in 2013 and 2014

Date	Time	Stage (m)	Discharge (m^3/s)
27-May-2013	11:40	-	0.137
17-Jun-2013	12:05	0.4	0.03
15-Jul-2013	16:52	0.091	0.027
11-Aug-2013	13:05	-0.02	0.035
28-Aug-2013	16:20	-	0.057
16-Oct-2013	14:20	0.118	0.031
16-May-2014	12:47	-	0.045
03-Jun-2014	13:30	-0.032	0.042
26-Jul-2014	12:11	-	0.027
17-Aug-2014	12:19	0.11	0.015
20-Sep-2014	12:27	0.166	0.02
10-Oct-2014	16:10	0.194	0.038

4.4 STATION MN-0.2 AND MN-1.5 MCGINTY CREEK HEADWATERS

These sites generally exhibit very low flows; observations for 2014 are included in Appendix B. MN-0.2 is near the headwaters of the west sub-catchment of McGinty Creek and has an average measured flow in the open water season of 0.002 m³/s. MN-1.5 is near the headwaters of the eastern sub-catchment of McGinty Creek and has an average measured flow during the open water season of 0.004 m³/s. The mean flow at MN-0.2 and MN-1.5 were 0.0004 m³/s and 0.0024 m³/s in 2014, respectively. All measurements are included in Appendix B.

At MN-0.2 a measurement of 0.009 m³/s in July was excluded as it was not in line with historic flows and the field notes indicated it was not taken in the same location. It is however included in Appendix B.

5 CLOSURE

ACG trusts that this review of the 2014 hydrometric data collected at Minto meets the needs of Minto Explorations Ltd. ACG is able to provide continuous data in CSV format on any time step which Minto or their consultants may require. This is a quick and easy request for ACG to execute at any time. Lastly, ACG thanks Minto for the opportunity to continue to support your hydrometric monitoring program.

Anthony Bier, MSc, EPt
Hydrologist
Access Consulting Group

APPENDIX A

HYDROGRAPHS 2014

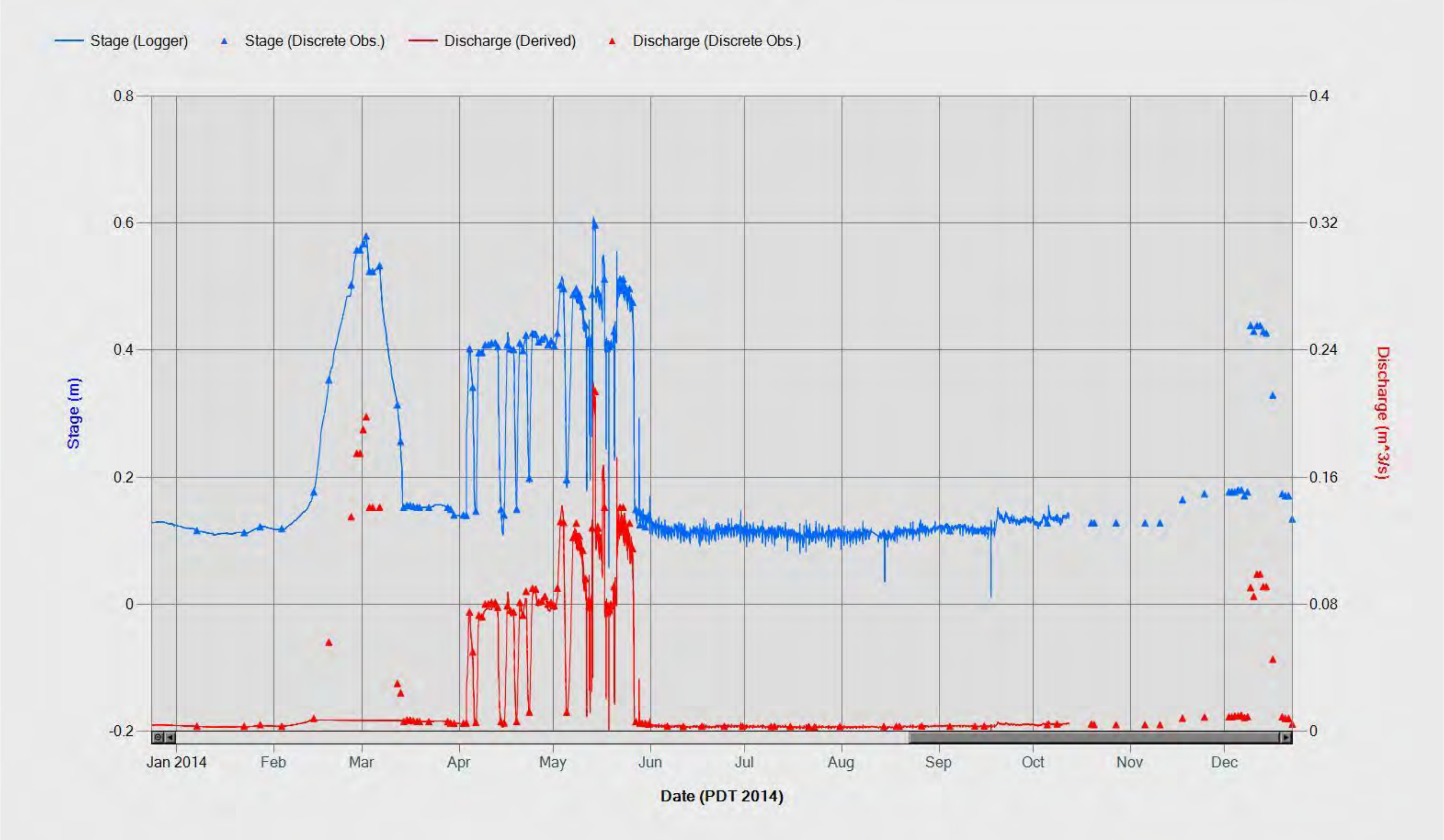

Figure 2 - Flume at W3 2014 hydrograph

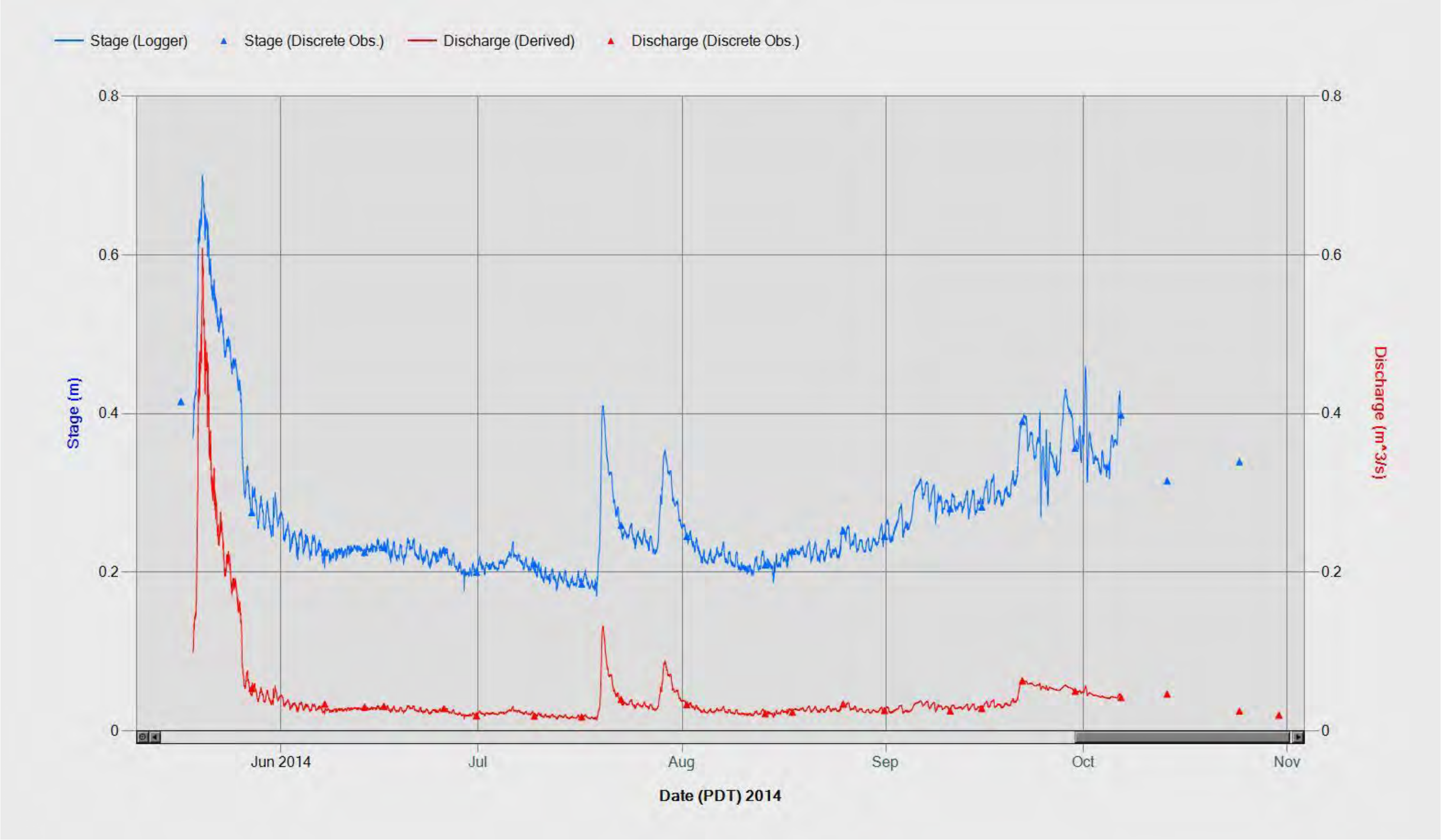

Figure 3 - Minto Creek at MC-1 2014 open water season hydrograph

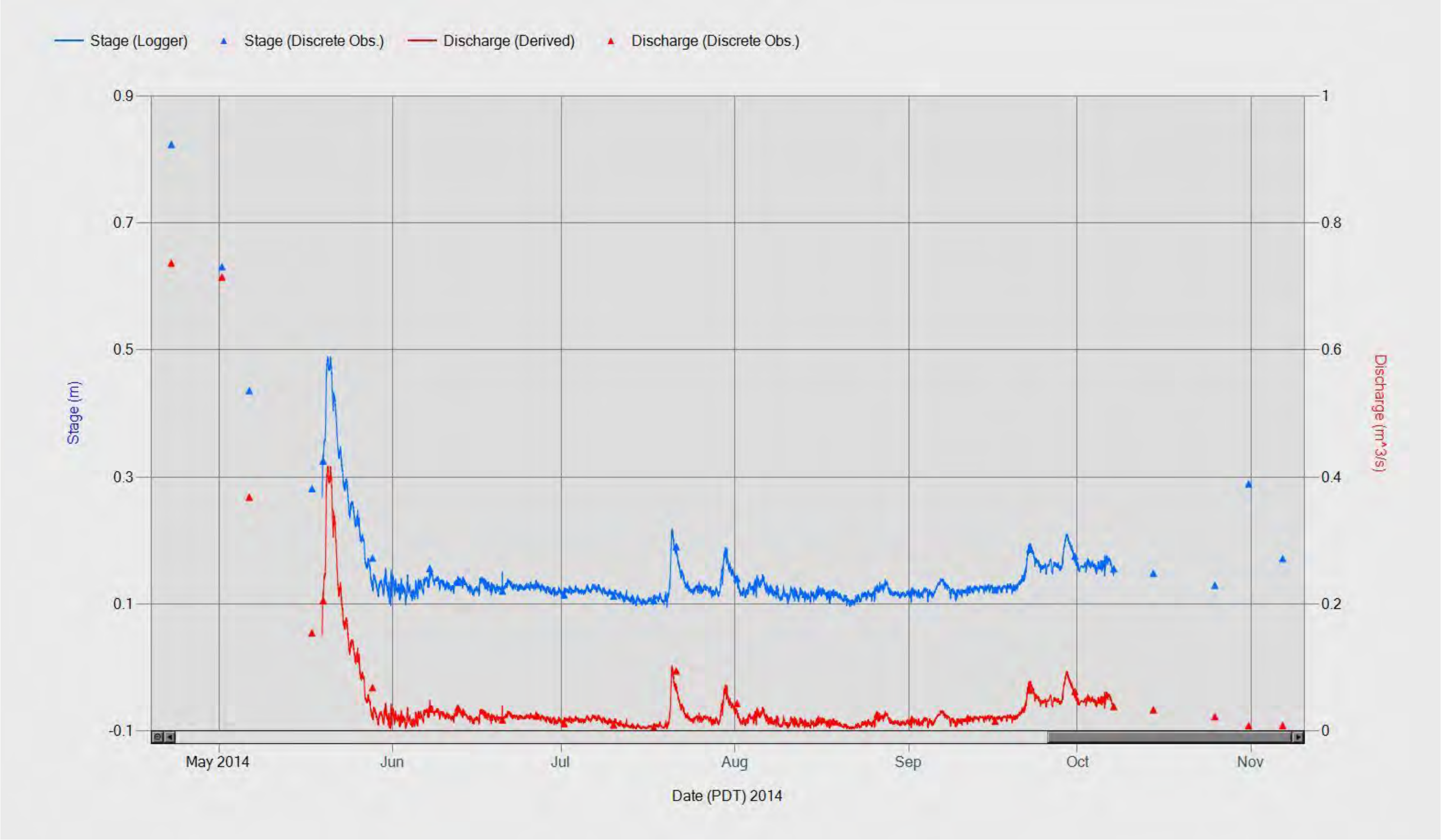

Figure 4 – Minto Creek at W1 2014 open water season hydrograph

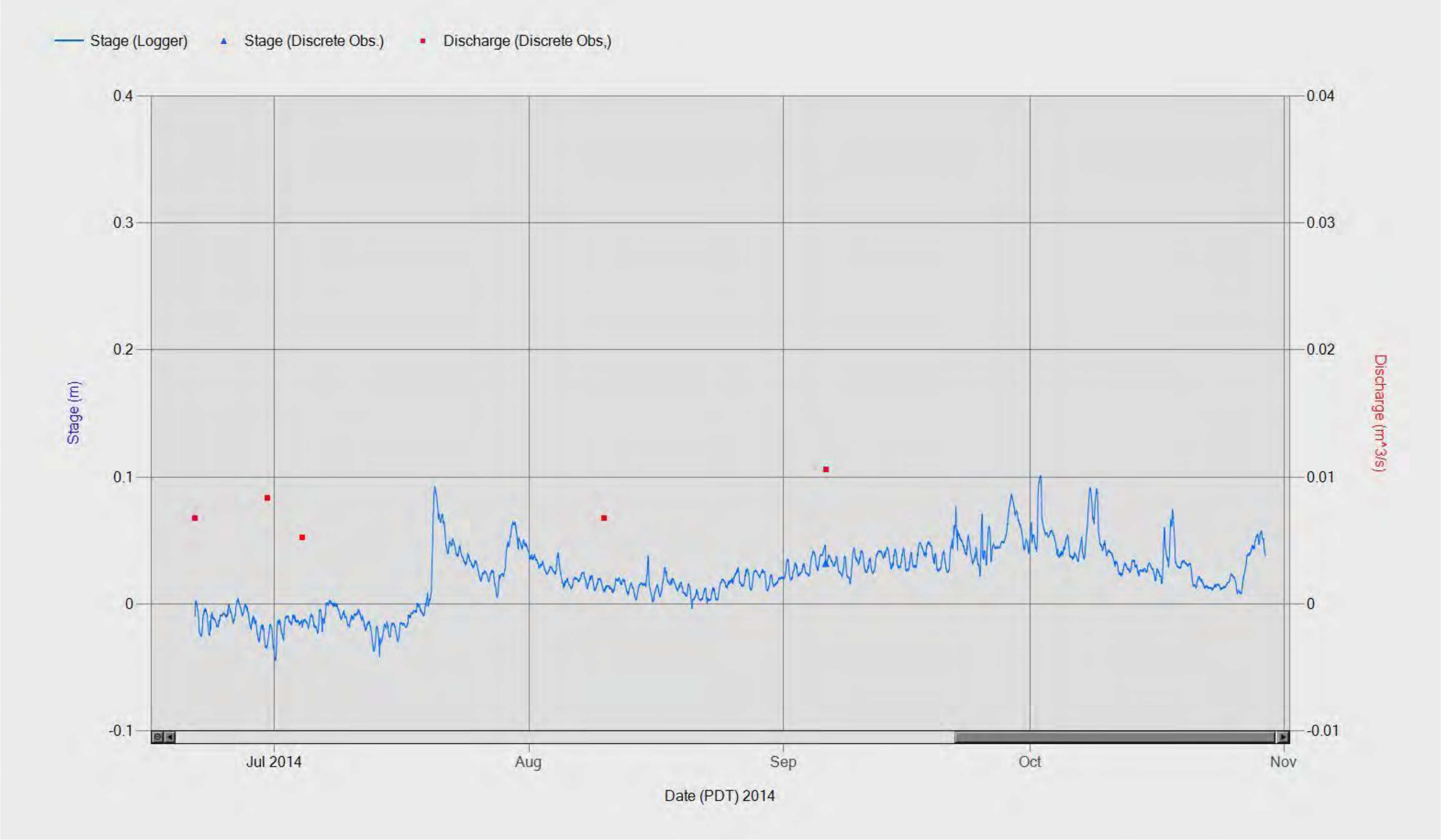

Figure 5 - Minto Creek at W7 2014 open water season hydrograph

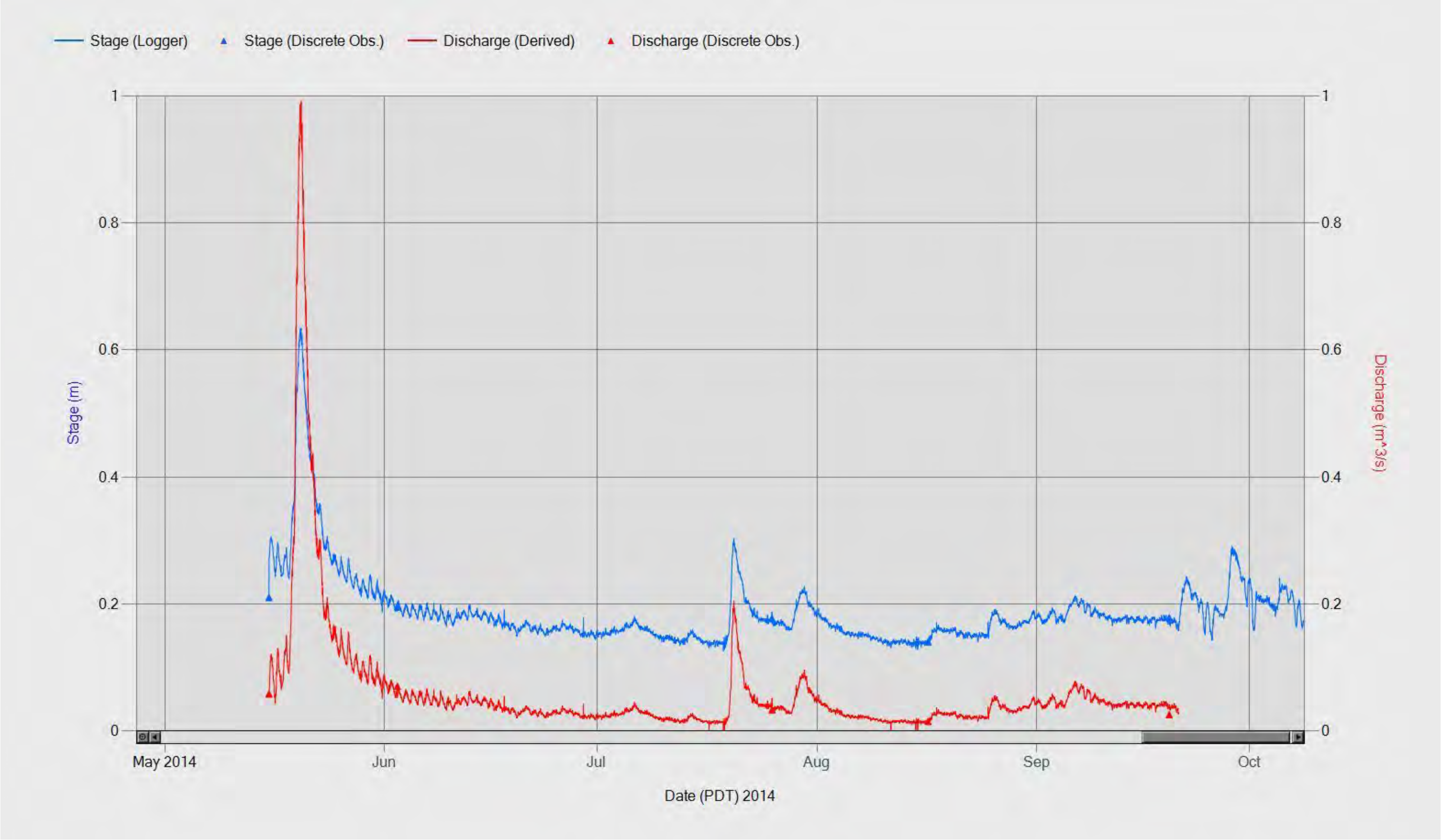

Figure 6 – McGinty Creek at MN-4.5 2014 open water season hydrograph

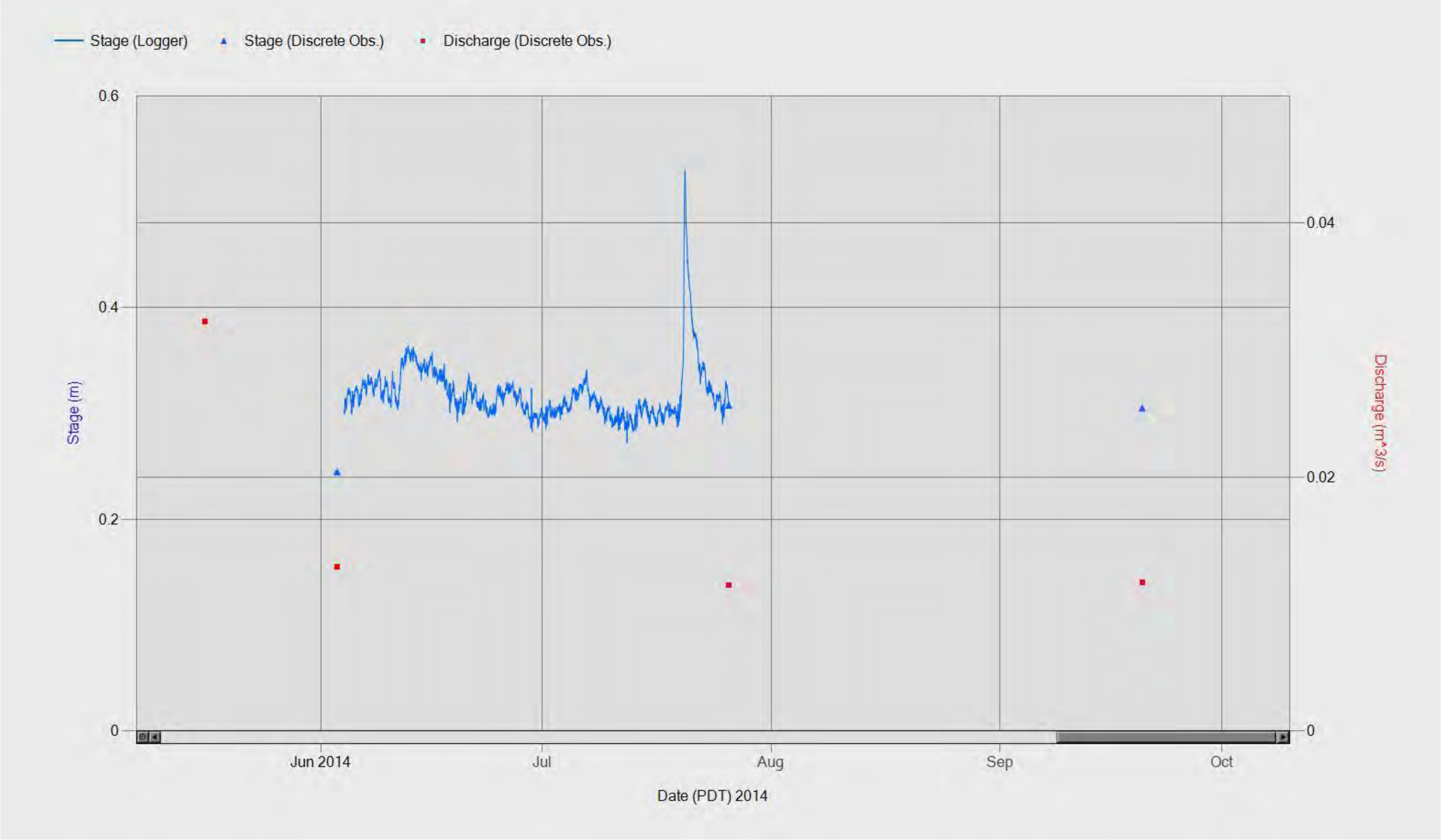

Figure 7 – McGinty Creek at MN-2.5 2014 open water season hydrograph

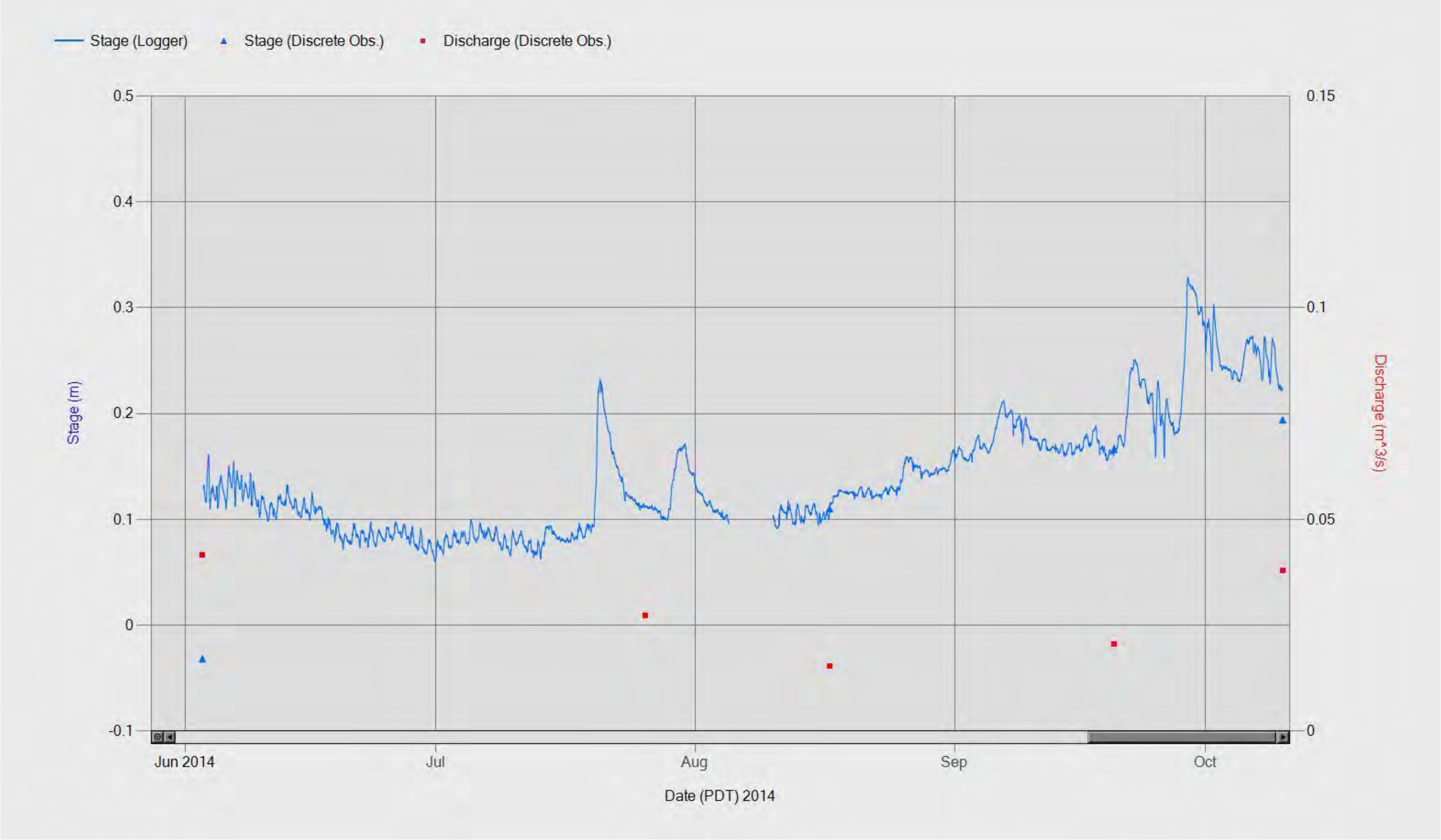

Figure 8 – McGinty Creek at MN-0.5 2014 open water season hydrograph

APPENDIX B

DISCRETE DISCHARGE MEASUREMENTS 2014

W1			
Date	Time	Stage (m)	Discharge (m^3/s)
22/04/2014	14:30	0.825	0.737
01/05/2014	15:07	0.650	0.715
06/05/2014	11:40	0.440	0.368
17/05/2014	16:22	0.295	0.154
19/05/2014	16:00	0.325	0.205
28/05/2014	11:01	0.172	0.068
07/06/2014	15:58	0.141	0.034
12/06/2014	16:48	0.134	0.036
20/06/2014	14:29	0.120	0.017
26/06/2014	15:51	0.130	0.023
01/07/2014	14:46	0.114	0.011
10/07/2014	10:15	0.112	0.009
17/07/2014	14:27	0.150	0.005
21/07/2014	14:27	0.200	0.094
01/08/2014	10:22	0.140	0.043
07/08/2014	10:21	0.125	0.016
13/08/2014	14:07	0.118	0.013
18/08/2014	15:22	0.118	0.014
26/08/2014	9:42	0.128	0.026
01/09/2014	14:32	0.120	0.018
11/09/2014	13:22	0.125	0.020
16/09/2014	10:46	0.128	0.015
22/09/2014	14:40	0.188	0.064
30/09/2014	15:45	0.175	0.062
07/10/2014	14:17	0.155	0.038
14/10/2014	15:26	0.148	0.033
25/10/2014	14:40	0.129	0.022
31/10/2014	14:55	0.289	0.008
06/11/2014	16:33	0.171	0.008
11/11/2014	14:42	0.115	-
12/12/2014	13:00	-	0.038

MC-1			
Date	Time	Stage (m)	Discharge (m^3/s)
17/06/2014	14:05	0.231	0.031
26/06/2014	17:11	0.228	0.028
01/07/2014	16:03	0.2	0.019
10/07/2014	11:39	0.21	0.018

W3			
Date	Time	Stage (m)	Discharge (m^3/s)
07/01/2014	10:40	0.116	0.003
22/01/2014	11:50	0.113	0.003
27/01/2014	14:45	0.122	0.004
03/02/2014	12:00	0.119	0.003
13/02/2014	16:30	0.177	0.008
18/02/2014	12:00	0.354	0.056
24/02/2014	10:30	0.488	0
25/02/2014	9:45	0.488	0
25/02/2014	15:00	0.503	0.135
27/02/2014	9:30	0.558	0.175
28/02/2014	10:30	0.558	0.175
01/03/2014	10:15	0.568	0.19
02/03/2014	10:00	0.580	0.198
03/03/2014	10:30	0.524	0.141
04/03/2014	10:30	0.524	0.141
06/03/2014	16:30	0.533	0.141
12/03/2014	7:30	0.314	0.03
13/03/2014	9:10	0.256	0.024
14/03/2014	8:20	0.152	0.006
15/03/2014	8:50	0.155	0.007
16/03/2014	9:30	0.155	0.007
17/03/2014	9:30	0.154	0.0065
18/03/2014	14:40	0.152	0.006
19/03/2014	10:20	0.152	0.006
22/03/2014	9:15	0.152	0.006
28/03/2014	9:00	0.152	0.006
29/03/2014	7:45	0.149	0.005
30/03/2014	9:30	0.140	0.0049
02/04/2014	8:30	0.140	0.0049
03/04/2014	7:20	0.140	0.0051
04/04/2014	8:05	0.402	0.075
05/04/2014	8:25	0.341	0.05
06/04/2014	8:15	0.146	0.0055
07/04/2014	6:45	0.396	0.073
08/04/2014	7:20	0.396	0.072
09/04/2014	7:45	0.408	0.08
10/04/2014	8:50	0.408	0.08
11/04/2014	8:30	0.411	0.081

17/07/2014	15:58	0.185	0.017
23/07/2014	16:00	0.259	0.039
02/08/2014	15:52	0.245	0.033
14/08/2014	13:57	0.209	0.022
18/08/2014	16:54	0.226	0.023
26/08/2014	10:25	0.252	0.034
01/09/2014	17:22	0.245	0.025
11/09/2014	16:58	0.28	0.025
16/09/2014	12:11	0.282	0.028
22/09/2014	16:06	0.39	0.063
30/09/2014	17:13	0.356	0.050
07/10/2014	16:17	0.398	0.042
14/10/2014	16:42	0.315	0.046
25/10/2014	16:30	0.339	0.025
31/10/2014	17:00		0.020
06/11/2014	18:05	0.263	0.024

W7			
Date	Time	Stage (m)	Discharge (m^3/s)
16/05/2014	12:47	-	0.045
03/06/2014	13:30	-0.032	0.042
26/07/2014	12:11	-	0.027
17/08/2014	12:19	0.11	0.015
20/09/2014	12:27	0.166	0.020
10/10/2014	16:10	0.194	0.038

MN-4.5			
Date	Time	Stage (m)	Discharge (m^3/s)
16/05/2014	11:19	0.21	0.058
03/06/2014	14:17	0.195	0.070
26/07/2014	10:29	0.277	0.033
17/08/2014	10:53	0.14	0.015
20/09/2014	11:07	0.178	0.025
10/10/2014	13:24	0.186	0.046

MN-0.5			
Date	Time	Stage (m)	Discharge (m^3/s)
16/05/2014	12:47	-	0.045

12/04/2014	13:05	0.411	0.081
13/04/2014	8:30	0.405	0.078
14/04/2014	8:40	0.149	0.006
15/04/2014	8:30	0.140	0.0051
16/04/2014	8:30	0.408	0.079
17/04/2014	8:45	0.402	0.076
18/04/2014	9:15	0.401	0.075
19/04/2014	8:30	0.149	0.006
20/04/2014	8:40	0.411	0.081
21/04/2014	8:00	0.399	0.073
22/04/2014	8:00	0.424	0.088
23/04/2014	9:40	0.198	0.012
24/04/2014	10:00	0.427	0.09
25/04/2014	9:55	0.425	0.0895
26/04/2014	8:45	0.413	0.0813
27/04/2014	8:45	0.418	0.082
28/04/2014	8:30	0.421	0.085
29/04/2014	8:15	0.408	0.08
30/04/2014	8:00	0.415	0.081
01/05/2014	8:10	0.407	0.079
02/05/2014	8:15	0.427	0.09
03/05/2014	8:00	0.503	0.132
04/05/2014	8:00	0.497	0.1315
05/05/2014	6:45	0.196	0.012
07/05/2014	7:50	0.488	0.122
08/05/2014	8:20	0.497	0.131
09/05/2014	9:00	0.488	0.123
10/05/2014	10:15	0.469	0.114
11/05/2014	8:35	0.439	0.096
12/05/2014	8:45	0.410	0.079
13/05/2014	9:40	0.488	0.128
14/05/2014	9:35	0.597	0.214
15/05/2014	8:45	0.491	0.128
17/05/2014	8:30	0.512	0.141
18/05/2014	9:05	0.405	0.078
19/05/2014	9:45	0.408	0.08
20/05/2014	8:30	0.430	0.091
22/05/2014	7:30	0.512	0.141

03/06/2014	13:30	-0.032	0.042
26/07/2014	12:11	-	0.027
17/08/2014	12:19	0.11	0.015
20/09/2014	12:27	0.166	0.020
10/10/2014	16:10	0.194	0.038

MN-0.2			
Date	Time	Stage (m)	Discharge (m^3/s)
14/05/2014	17:01	n/a	0.0004
03/06/2014	-	n/a	0.0003
26/07/2014	15:13	n/a	0.0088
17/08/2014	10:19	n/a	0.0006

MN-2.5			
Date	Time	Stage (m)	Discharge (m^3/s)
16/05/2014	14:20	-	0.032
03/06/2014	11:58	0.245	0.013
26/07/2014	13:05	0.308	0.011
20/09/2014	13:20	0.305	0.012
11/10/2014	11:35	0.382	0.012

MN-1.5			
Date	Time	Stage (m)	Discharge (m^3/s)
16/05/2014	15:44	n/a	0.0036
03/06/2014	10:03	n/a	0.0017
26/07/2014	15:16	n/a	0.0026
17/08/2014	15:18	n/a	0.0016
20/09/2014	14:38	n/a	0.0029
11/10/2014	14:22	n/a	0.0021

23/05/2014	7:45	0.512	0.141
24/05/2014	7:45	0.494	0.121
25/05/2014	8:15	0.497	0.131
26/05/2014	8:15	0.475	0.115
27/05/2014	8:15	0.149	0.006
28/05/2014	14:45	0.125	0.005
29/05/2014	8:15	0.137	0.0049
30/05/2014	8:00	0.122	0.0048
31/05/2014	8:45	0.134	0.0043
06/06/2014	9:30	0.116	0.003
11/06/2014	10:45	0.113	0.0029
17/06/2014	9:00	0.116	0.003
24/06/2014	12:43	0.116	0.003
30/06/2014	8:45	0.116	0.003
09/07/2014	11:20	0.116	0.0029
10/07/2014	13:25	0.116	0.003
15/07/2014	14:15	0.113	0.0029
21/07/2014	11:05	0.110	0.0028
23/07/2014	8:05	0.110	0.0026
31/07/2014	9:50	0.113	0.0029
14/08/2014	9:20	0.113	0.0029
18/08/2014	9:00	0.116	0.003
19/08/2014	9:20	0.116	0.003
26/08/2014	11:10	0.119	0.0031
04/09/2014	10:45	0.116	0.003
12/09/2014	9:20	0.116	0.0031
15/09/2014	9:45	0.116	0.0032
05/10/2014	12:10	0.128	0.004
08/10/2014	14:10	0.137	0.0045
19/10/2014	13:15	0.128	0.0045
20/10/2014	10:40	0.128	0.004
27/10/2014	10:20	0.128	0.004
05/11/2014	15:30	0.128	0.004
10/11/2014	10:40	0.128	0.004
17/11/2014	14:40	0.165	0.0081
24/11/2014	15:05	0.174	0.0088
02/12/2014	10:10	0.177	0.0089
03/12/2014	9:10	0.177	0.0089

04/12/2014	8:20	0.177	0.0095
05/12/2014	9:00	0.180	0.0095
06/12/2014	9:45	0.180	0.01
07/12/2014	9:05	0.171	0.0085
08/12/2014	9:15	0.177	0.0091
09/12/2014	8:00	0.439	0.0904
10/12/2014	8:25	0.430	0.085
11/12/2014	9:15	0.439	0.0989
12/12/2014	9:05	0.439	0.099
13/12/2014	9:40	0.430	0.091
14/12/2014	9:00	0.427	0.091
16/12/2014	10:30	0.329	0.0453
19/12/2014	10:00	0.174	0.009
20/12/2014	9:50	0.171	0.008
21/12/2014	10:25	0.171	0.008
22/12/2014	15:05	0.134	0.0044

Appendix F – Seepage Monitoring Program Laboratory Results

Your P.O. #: 208979
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1004614

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/11
Report #: R1583803
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B444319
Received: 2014/05/31, 12:35

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/06/02	2014/06/02	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/06/02	BBY6SOP-00011	SM-4500-Cl-
Chromium III Dissolved (Calc'd)	1	N/A	2014/06/10		
Chromium, Hexavalent, Dissolved	1	N/A	2014/06/03	BBY6SOP-00015	SM-3500Cr B
Conductance - water	3	N/A	2014/06/02	BBY6SOP-00026	SM-2510B
Fluoride	3	N/A	2014/06/02	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	3	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	3	N/A	2014/06/06	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	3	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	3	N/A	2014/06/03	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	3	N/A	2014/05/31	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	3	N/A	2014/05/31	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	3	N/A	2014/05/31	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	3	N/A	2014/05/31	BBY6WI-00001	EPA 200.2
Filter and HNO3 Preserve for Metals	1	N/A	2014/06/04	BBY6WI-00001	EPA 200.2
pH Water (1)	3	N/A	2014/06/02	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	2	N/A	2014/06/02	BBY6SOP-00017	SM4500-SO42- E
Sulphate by Automated Colourimetry	1	N/A	2014/06/03	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	2	2014/06/04	2014/06/06	BBY6SOP-00033	SM 2540C
Total Dissolved Solids (Filt. Residue)	1	2014/06/05	2014/06/06	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

MINTO EXPLORATIONS LTD.
Maxxam Job #: B444319
Report Date: 2014/06/11
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==

Total cover pages: 2

Maxxam Job #: B444319
Report Date: 2014/06/11

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JS7167			JS7168	JS7169		JS7170		
Sampling Date		2014/05/29 16:00			2014/05/28 15:30	2014/05/28 14:45		2014/05/28 16:00		
	UNITS	**SS16**	**RDL**	**QC Batch**	**LDP**	**W3**	**QC Batch**	**W37**	**RDL**	**QC Batch**
ANIONS										
Nitrite (N)	mg/L	0.137	0.0050	7506635	<0.0050		7506635	<0.0050	0.0050	7506635
Calculated Parameters										
Dissolved Chromium III	mg/L					<0.0010	7511508		0.0010	
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE	FIELD	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	57.3	2.0	7506493	0.050		7506493	0.384	0.020	7506493
Misc. Inorganics										
Fluoride (F)	mg/L	0.740	0.010	7508345	0.390		7508345	0.280	0.010	7508345
Alkalinity (Total as CaCO3)	mg/L	167	0.50	7508246	171		7508246	144	0.50	7508246
Alkalinity (PP as CaCO3)	mg/L	0.80	0.50	7508246	<0.50		7508246	<0.50	0.50	7508246
Bicarbonate (HCO3)	mg/L	202	0.50	7508246	208		7508246	175	0.50	7508246
Carbonate (CO3)	mg/L	0.96	0.50	7508246	<0.50		7508246	<0.50	0.50	7508246
Hydroxide (OH)	mg/L	<0.50	0.50	7508246	<0.50		7508246	<0.50	0.50	7508246
Anions										
Dissolved Sulphate (SO4)	mg/L	427	5.0	7508475	29.8		7510459	53.4	0.50	7508475
Dissolved Chloride (Cl)	mg/L	3.1	0.50	7508421	5.8		7508421	28	0.50	7508421
Metals										
Dissolved Hex. Chromium (Cr 6+)	mg/L					<0.0010	7509937		0.0010	
Nutrients										
Total Ammonia (N)	mg/L	0.064	0.0050	7510502	0.016		7510502	0.053	0.0050	7510502
Nitrate plus Nitrite (N)	mg/L	57.4	2.0	7506633	0.050		7506633	0.384	0.020	7506633
Physical Properties										
Conductivity	uS/cm	1500	1.0	7508250	390		7508250	472	1.0	7508250
pH	pH	8.31		7508249	8.30		7508249	8.26		7508249
Physical Properties										
Total Dissolved Solids	mg/L	1170	10	7512930	240		7511331	312	10	7511331

N/A = Not Applicable
RDL = Reportable Detection Limit

ELEMENTS BY ATOMIC SPECTROSCOPY (WATER)

Maxxam ID		JS7169		
Sampling Date		2014/05/28 14:45		
	UNITS	**W3**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7511838

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS7167	JS7168	JS7170		
Sampling Date		2014/05/29 16:00	2014/05/28 15:30	2014/05/28 16:00		
	UNITS	**SS16**	**LDP**	**W37**	**RDL**	**QC Batch**
Misc. Inorganics						
Dissolved Hardness (CaCO3)	mg/L	682	174	201	0.50	7506250
Elements						
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	0.010	7514534

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS7167	JS7168	JS7170		
Sampling Date		2014/05/29 16:00	2014/05/28 15:30	2014/05/28 16:00		
	UNITS	**SS16**	**LDP**	**W37**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS						
Dissolved Aluminum (Al)	ug/L	4.7	10.5	10.1	3.0	7511696
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	0.50	7511696
Dissolved Arsenic (As)	ug/L	0.54	0.36	0.42	0.10	7511696
Dissolved Barium (Ba)	ug/L	59.6	61.8	74.7	1.0	7511696
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	0.10	7511696
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	1.0	7511696
Dissolved Boron (B)	ug/L	72	<50	<50	50	7511696
Dissolved Cadmium (Cd)	ug/L	0.042	0.053	0.030	0.010	7511696
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	1.0	7511696
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	0.50	7511696
Dissolved Copper (Cu)	ug/L	45.8	8.69	69.0	0.20	7511696
Dissolved Iron (Fe)	ug/L	9.4	19.1	28.2	5.0	7511696
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	0.20	7511696
Dissolved Lithium (Li)	ug/L	10.4	<5.0	<5.0	5.0	7511696
Dissolved Manganese (Mn)	ug/L	55.0	169	100	1.0	7511696
Dissolved Molybdenum (Mo)	ug/L	28.6	6.1	5.2	1.0	7511696
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	1.5	1.0	7511696
Dissolved Phosphorus (P)	ug/L	<10	30	15	10	7511696
Dissolved Selenium (Se)	ug/L	34.2	0.41	0.53	0.10	7511696
Dissolved Silicon (Si)	ug/L	3770	4690	3950	100	7511696
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	0.020	7511696
Dissolved Strontium (Sr)	ug/L	3570	511	569	1.0	7511696
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	0.050	7511696
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Uranium (U)	ug/L	8.45	1.89	0.85	0.10	7511696
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	0.50	7511696
Dissolved Calcium (Ca)	mg/L	157	45.6	50.9	0.050	7506251
Dissolved Magnesium (Mg)	mg/L	70.5	14.5	18.0	0.050	7506251
Dissolved Potassium (K)	mg/L	8.38	2.87	3.03	0.050	7506251
Dissolved Sodium (Na)	mg/L	38.5	12.5	14.0	0.050	7506251
Dissolved Sulphur (S)	mg/L	148	10.5	17.6	3.0	7506251

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7506633	Nitrate plus Nitrite (N)	2014/05/31	103	80 - 120	108	80 - 120	<0.020	mg/L	NC(1)	25
7506635	Nitrite (N)	2014/05/31	98	80 - 120	102	80 - 120	<0.0050	mg/L	NC	20
7508246	Alkalinity (Total as CaCO3)	2014/06/02	NC	80 - 120	100	80 - 120	<0.50	mg/L	0.07	20
7508246	Alkalinity (PP as CaCO3)	2014/06/02					<0.50	mg/L	NC	20
7508246	Bicarbonate (HCO3)	2014/06/02					<0.50	mg/L	0.9	20
7508246	Carbonate (CO3)	2014/06/02					<0.50	mg/L	NC	20
7508246	Hydroxide (OH)	2014/06/02					<0.50	mg/L	NC	20
7508250	Conductivity	2014/06/02			98	80 - 120	1.0, RDL=1.0	uS/cm	0.3	20
7508345	Fluoride (F)	2014/06/02	NC	80 - 120					0	20
7508421	Dissolved Chloride (Cl)	2014/06/02	NC	80 - 120	103	80 - 120	<0.50	mg/L	2.2	20
7508475	Dissolved Sulphate (SO4)	2014/06/02	NC	80 - 120	102	80 - 120	<0.50	mg/L	1.4	20
7509937	Dissolved Hex. Chromium (Cr 6+)	2014/06/03	105	80 - 120	104	80 - 120	<0.0010	mg/L		
7510459	Dissolved Sulphate (SO4)	2014/06/03	NC	80 - 120	92	80 - 120	<0.50	mg/L	0.5	20
7510502	Total Ammonia (N)	2014/06/03	NC	80 - 120	100	80 - 120	<0.0050	mg/L	1.4	20
7511331	Total Dissolved Solids	2014/06/06	100	80 - 120	104	80 - 120	12, RDL=10	mg/L	4.9	20
7511696	Dissolved Aluminum (Al)	2014/06/05	NC	80 - 120	102	80 - 120	<3.0	ug/L	0.5	20
7511696	Dissolved Antimony (Sb)	2014/06/05	100	80 - 120	97	80 - 120	<0.50	ug/L		
7511696	Dissolved Arsenic (As)	2014/06/05	100	80 - 120	101	80 - 120	<0.10	ug/L		
7511696	Dissolved Barium (Ba)	2014/06/05	97	80 - 120	101	80 - 120	<1.0	ug/L		
7511696	Dissolved Beryllium (Be)	2014/06/05	102	80 - 120	102	80 - 120	<0.10	ug/L		
7511696	Dissolved Bismuth (Bi)	2014/06/05	97	80 - 120	97	80 - 120	<1.0	ug/L		
7511696	Dissolved Cadmium (Cd)	2014/06/05	100	80 - 120	102	80 - 120	<0.010	ug/L		
7511696	Dissolved Chromium (Cr)	2014/06/05	104	80 - 120	103	80 - 120	<1.0	ug/L		
7511696	Dissolved Cobalt (Co)	2014/06/05	102	80 - 120	102	80 - 120	<0.50	ug/L		
7511696	Dissolved Copper (Cu)	2014/06/05	101	80 - 120	99	80 - 120	<0.20	ug/L		
7511696	Dissolved Iron (Fe)	2014/06/05	97	80 - 120	105	80 - 120	<5.0	ug/L		
7511696	Dissolved Lead (Pb)	2014/06/05	98	80 - 120	100	80 - 120	<0.20	ug/L		
7511696	Dissolved Lithium (Li)	2014/06/05	101	80 - 120	99	80 - 120	<5.0	ug/L		
7511696	Dissolved Manganese (Mn)	2014/06/05	100	80 - 120	104	80 - 120	<1.0	ug/L		
7511696	Dissolved Molybdenum (Mo)	2014/06/05	100	80 - 120	97	80 - 120	<1.0	ug/L		
7511696	Dissolved Nickel (Ni)	2014/06/05	100	80 - 120	102	80 - 120	<1.0	ug/L		
7511696	Dissolved Selenium (Se)	2014/06/05	107	80 - 120	107	80 - 120	<0.10	ug/L		
7511696	Dissolved Silver (Ag)	2014/06/05	102	80 - 120	101	80 - 120	<0.020	ug/L		
7511696	Dissolved Strontium (Sr)	2014/06/05	98	80 - 120	99	80 - 120	<1.0	ug/L		
7511696	Dissolved Thallium (Tl)	2014/06/05	99	80 - 120	103	80 - 120	<0.050	ug/L		
7511696	Dissolved Tin (Sn)	2014/06/05	94	80 - 120	100	80 - 120	<5.0	ug/L		
7511696	Dissolved Titanium (Ti)	2014/06/05	90	80 - 120	107	80 - 120	<5.0	ug/L		
7511696	Dissolved Uranium (U)	2014/06/05	96	80 - 120	100	80 - 120	<0.10	ug/L		
7511696	Dissolved Vanadium (V)	2014/06/05	103	80 - 120	100	80 - 120	<5.0	ug/L		

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7511696	Dissolved Zinc (Zn)	2014/06/05	103	80 - 120	104	80 - 120	<5.0	ug/L		
7511696	Dissolved Boron (B)	2014/06/05					<50	ug/L		
7511696	Dissolved Phosphorus (P)	2014/06/05					<10	ug/L		
7511696	Dissolved Silicon (Si)	2014/06/05					<100	ug/L		
7511696	Dissolved Zirconium (Zr)	2014/06/05					<0.50	ug/L		
7511838	Dissolved Chromium (Cr)	2014/06/05	100	80 - 120	94	80 - 120	<1.0	ug/L	NC	20
7512930	Total Dissolved Solids	2014/06/06	111	80 - 120	98	80 - 120	16, RDL=10	mg/L	4.3	20
7514534	Dissolved Mercury (Hg)	2014/06/06	102	80 - 120	102	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

Validation Signature Page

Maxxam Job #: B444319

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

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Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B444319 **COC #:** EB1004614 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail:

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208979
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

- ● Regular Turn Around Time (TAT) (5 days for most tests)
- **RUSH** (Please contact the lab) ○ 1 Day ○ 2 Day ○ 3 Day
- Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Dissolved Metals (DM) Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☑ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226	Cr 3+	Cr 6+																Number of Containers
1	SS16	JS7167	Water	5/29/14 16:00	X	X		X	X	X	X																					4
2	LDP	JS7168	Water	5/28/14 15:3	x	x		x	x	x	x																					4
3	W3	JS7169	Water	5/28/14 14:45												x	x															
4	W37	JS7170	Water	5/28/14 16:0	x	x		x	x	x	x																					
5																																
6																																
7																																
8																																
9																																
10																																
11																																
12	B444319																															

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Phil Emerson	30-May-14	16:00	SARANBIR TAKHAR	2014/05/31	12:35	☑	A: 2 B: 3 C: 4	Present?	N/A	☐
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

4 5 4
5 6 5

Your P.O. #: 208979
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1010314

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/06
Report #: R1580773
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B444590
Received: 2014/06/02, 10:20

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	4	2014/06/02	2014/06/03	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/06/03	BBY6SOP-00011	SM-4500-Cl-
Chloride by Automated Colourimetry	1	N/A	2014/06/04	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	4	N/A	2014/06/03	BBY6SOP-00026	SM-2510B
Fluoride	4	N/A	2014/06/02	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	4	N/A	2014/06/06	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	4	N/A	2014/06/03	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	4	N/A	2014/06/02	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	4	N/A	2014/06/02	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	4	N/A	2014/06/03	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	4	N/A	2014/06/02	BBY6WI-00001	EPA 200.2
pH Water (1)	4	N/A	2014/06/03	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	4	N/A	2014/06/03	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	4	2014/06/05	2014/06/06	BBY6SOP-00033	SM 2540C
Total Suspended Solids	4	N/A	2014/06/06	BBY6SOP-00034	SM - 2540 D

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

Maxxam Job #: B444590
Report Date: 2014/06/06

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

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Total cover pages: 2

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JS8912		JS8913			JS8914		JS8915		
Sampling Date		2014/05/30 16:00		2014/05/30 16:30			2014/05/30 17:00		2014/05/30		
	UNITS	**SS25**	**QC Batch**	**SS18**	**RDL**	**QC Batch**	**SS17**	**RDL**	**DUP**	**RDL**	**QC Batch**
ANIONS											
Nitrite (N)	mg/L	0.0414	7508737	0.0130	0.0050	7508737	0.0056	0.0050	0.0414	0.0050	7508737
Calculated Parameters											
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	4.45	7507303	4.37	0.20	7507303	2.15	0.040	5.46	0.20	7507303
Misc. Inorganics											
Fluoride (F)	mg/L	0.290	7508345	0.410	0.010	7508345	0.500	0.010	0.290	0.010	7508345
Alkalinity (Total as CaCO3)	mg/L	172	7508672	171	0.50	7508672	171	0.50	160	0.50	7508672
Alkalinity (PP as CaCO3)	mg/L	2.72	7508672	<0.50	0.50	7508672	<0.50	0.50	<0.50	0.50	7508672
Bicarbonate (HCO3)	mg/L	204	7508672	209	0.50	7508672	208	0.50	195	0.50	7508672
Carbonate (CO3)	mg/L	3.26	7508672	<0.50	0.50	7508672	<0.50	0.50	<0.50	0.50	7508672
Hydroxide (OH)	mg/L	<0.50	7508672	<0.50	0.50	7508672	<0.50	0.50	<0.50	0.50	7508672
Anions											
Dissolved Sulphate (SO4)	mg/L	19.4	7510459	59.9	0.50	7510459	43.7	0.50	28.9	0.50	7510459
Dissolved Chloride (Cl)	mg/L	1.9	7510445	1.8	0.50	7511968	1.2	0.50	2.2	0.50	7510445
Nutrients											
Total Ammonia (N)	mg/L	0.047	7510502	0.062	0.0050	7510502	0.028	0.0050	0.052	0.0050	7510502
Nitrate plus Nitrite (N)	mg/L	4.49	7508726	4.39	0.20	7508726	2.16	0.040	5.50	0.20	7508726
Physical Properties											
Conductivity	uS/cm	390	7508674	474	1.0	7508674	424	1.0	404	1.0	7508674
pH	pH	8.42	7508673	8.28		7508673	8.29		8.20		7508673
Physical Properties											
Total Suspended Solids	mg/L	4.8	7512838	11.5	4.0	7512838	24.3	4.0	18.0	4.0	7512838
Total Dissolved Solids	mg/L	286	7512930	318	10	7512930	285	10	280	10	7512930

N/A = Not Applicable
RDL = Reportable Detection Limit

Maxxam Job #: B444590
Report Date: 2014/06/06

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS8912		JS8913	JS8914	JS8915		
Sampling Date		2014/05/30 16:00		2014/05/30 16:30	2014/05/30 17:00	2014/05/30		
	UNITS	**SS25**	**RDL**	**SS18**	**SS17**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics								
Dissolved Hardness (CaCO3)	mg/L	195	0.50	217	190	193	0.50	7507520
Elements								
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	<0.010	<0.010	<0.010	0.010	7514534
Dissolved Metals by ICPMS								
Dissolved Aluminum (Al)	ug/L	19.4	6.0	8.3	8.8	16.1	3.0	7509842
Dissolved Antimony (Sb)	ug/L	<1.0	1.0	<0.50	<0.50	<0.50	0.50	7509842
Dissolved Arsenic (As)	ug/L	0.66	0.20	0.59	0.67	0.51	0.10	7509842
Dissolved Barium (Ba)	ug/L	38.2	2.0	63.8	55.9	38.8	1.0	7509842
Dissolved Beryllium (Be)	ug/L	<0.20	0.20	<0.10	<0.10	<0.10	0.10	7509842
Dissolved Bismuth (Bi)	ug/L	<2.0	2.0	<1.0	<1.0	<1.0	1.0	7509842
Dissolved Boron (B)	ug/L	<100	100	<50	<50	<50	50	7509842
Dissolved Cadmium (Cd)	ug/L	0.032	0.020	0.118	0.032	0.015	0.010	7509842
Dissolved Chromium (Cr)	ug/L	<2.0	2.0	<1.0	<1.0	<1.0	1.0	7509842
Dissolved Cobalt (Co)	ug/L	<1.0	1.0	<0.50	<0.50	<0.50	0.50	7509842
Dissolved Copper (Cu)	ug/L	55.2	0.40	176	74.8	53.7	0.20	7509842
Dissolved Iron (Fe)	ug/L	44	10	18.9	31.2	42.4	5.0	7509842
Dissolved Lead (Pb)	ug/L	<0.40	0.40	<0.20	<0.20	<0.20	0.20	7509842
Dissolved Lithium (Li)	ug/L	<10	10	<5.0	<5.0	<5.0	5.0	7509842
Dissolved Manganese (Mn)	ug/L	22.9	2.0	66.7	28.7	21.9	1.0	7509842
Dissolved Molybdenum (Mo)	ug/L	5.8	2.0	6.0	3.9	5.4	1.0	7509842
Dissolved Nickel (Ni)	ug/L	<2.0	2.0	<1.0	<1.0	<1.0	1.0	7509842
Dissolved Phosphorus (P)	ug/L	24	20	26	26	11	10	7509842
Dissolved Selenium (Se)	ug/L	1.53	0.20	4.23	2.51	1.87	0.10	7509842
Dissolved Silicon (Si)	ug/L	4680	200	4220	4090	4680	100	7509842
Dissolved Silver (Ag)	ug/L	<0.040	0.040	<0.020	<0.020	<0.020	0.020	7509842
Dissolved Strontium (Sr)	ug/L	459	2.0	2050	1650	452	1.0	7509842
Dissolved Thallium (Tl)	ug/L	<0.10	0.10	<0.050	<0.050	<0.050	0.050	7509842
Dissolved Tin (Sn)	ug/L	<10	10	<5.0	<5.0	<5.0	5.0	7509842
Dissolved Titanium (Ti)	ug/L	<10	10	<5.0	<5.0	<5.0	5.0	7509842
Dissolved Uranium (U)	ug/L	1.35	0.20	1.55	1.32	1.25	0.10	7509842
Dissolved Vanadium (V)	ug/L	<10	10	<5.0	<5.0	<5.0	5.0	7509842
Dissolved Zinc (Zn)	ug/L	<10	10	<5.0	<5.0	<5.0	5.0	7509842
Dissolved Zirconium (Zr)	ug/L	<1.0	1.0	<0.50	<0.50	<0.50	0.50	7509842
Dissolved Calcium (Ca)	mg/L	54.4	0.10	52.8	42.5	54.8	0.050	7507522

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS8912		JS8913	JS8914	JS8915		
Sampling Date		2014/05/30 16:00		2014/05/30 16:30	2014/05/30 17:00	2014/05/30		
	UNITS	**SS25**	**RDL**	**SS18**	**SS17**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	14.4	0.10	20.7	20.4	13.7	0.050	7507522
Dissolved Potassium (K)	mg/L	2.85	0.10	4.27	3.75	2.95	0.050	7507522
Dissolved Sodium (Na)	mg/L	9.37	0.10	13.3	13.4	8.78	0.050	7507522
Dissolved Sulphur (S)	mg/L	1810	6.0	22.3	16.2	6.6	3.0	7507522

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

CCME DISSOLVED METALS IN WATER (WATER) Comments

Sample JS8912-03 Elements by CRC ICPMS (dissolved): RDL raised due to sample matrix interference.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7508345	Fluoride (F)	2014/06/02	NC	80 - 120					NC	20
7508672	Alkalinity (Total as CaCO3)	2014/06/03	92	80 - 120	97	80 - 120	<0.50	mg/L	0.3	20
7508672	Alkalinity (PP as CaCO3)	2014/06/03					<0.50	mg/L	NC	20
7508672	Bicarbonate (HCO3)	2014/06/03					<0.50	mg/L	0.3	20
7508672	Carbonate (CO3)	2014/06/03					<0.50	mg/L	NC	20
7508672	Hydroxide (OH)	2014/06/03					<0.50	mg/L	NC	20
7508674	Conductivity	2014/06/03			99	80 - 120	1.0, RDL=1.0	uS/cm	1.5	20
7508726	Nitrate plus Nitrite (N)	2014/06/02	109	80 - 120	108	80 - 120	<0.020	mg/L	0.5	25
7508737	Nitrite (N)	2014/06/02	104	80 - 120	103	80 - 120	<0.0050	mg/L	0.4	20
7509842	Dissolved Aluminum (Al)	2014/06/05	111	80 - 120	112	80 - 120	<3.0	ug/L		
7509842	Dissolved Antimony (Sb)	2014/06/05	100	80 - 120	103	80 - 120	<0.50	ug/L		
7509842	Dissolved Arsenic (As)	2014/06/05	107	80 - 120	104	80 - 120	<0.10	ug/L		
7509842	Dissolved Barium (Ba)	2014/06/05	NC	80 - 120	101	80 - 120	<1.0	ug/L		
7509842	Dissolved Beryllium (Be)	2014/06/05	110	80 - 120	104	80 - 120	<0.10	ug/L		
7509842	Dissolved Bismuth (Bi)	2014/06/05	101	80 - 120	100	80 - 120	<1.0	ug/L		
7509842	Dissolved Cadmium (Cd)	2014/06/05	101	80 - 120	103	80 - 120	<0.010	ug/L		
7509842	Dissolved Chromium (Cr)	2014/06/05	102	80 - 120	99	80 - 120	<1.0	ug/L		
7509842	Dissolved Cobalt (Co)	2014/06/05	97	80 - 120	99	80 - 120	<0.50	ug/L		
7509842	Dissolved Copper (Cu)	2014/06/05	99	80 - 120	98	80 - 120	<0.20	ug/L		
7509842	Dissolved Iron (Fe)	2014/06/05	107	80 - 120	106	80 - 120	<5.0	ug/L		
7509842	Dissolved Lead (Pb)	2014/06/05	102	80 - 120	101	80 - 120	<0.20	ug/L		
7509842	Dissolved Lithium (Li)	2014/06/05	105	80 - 120	97	80 - 120	<5.0	ug/L		
7509842	Dissolved Manganese (Mn)	2014/06/05	101	80 - 120	105	80 - 120	<1.0	ug/L		
7509842	Dissolved Molybdenum (Mo)	2014/06/05	NC	80 - 120	98	80 - 120	<1.0	ug/L		
7509842	Dissolved Nickel (Ni)	2014/06/05	99	80 - 120	101	80 - 120	<1.0	ug/L		
7509842	Dissolved Selenium (Se)	2014/06/05	108	80 - 120	106	80 - 120	<0.10	ug/L		
7509842	Dissolved Silver (Ag)	2014/06/05	104	80 - 120	105	80 - 120	<0.020	ug/L		
7509842	Dissolved Strontium (Sr)	2014/06/05	NC	80 - 120	99	80 - 120	<1.0	ug/L		
7509842	Dissolved Thallium (Tl)	2014/06/05	104	80 - 120	101	80 - 120	<0.050	ug/L		
7509842	Dissolved Tin (Sn)	2014/06/05	95	80 - 120	101	80 - 120	<5.0	ug/L		
7509842	Dissolved Titanium (Ti)	2014/06/05	101	80 - 120	102	80 - 120	<5.0	ug/L		
7509842	Dissolved Uranium (U)	2014/06/05	103	80 - 120	97	80 - 120	<0.10	ug/L		
7509842	Dissolved Vanadium (V)	2014/06/05	101	80 - 120	100	80 - 120	<5.0	ug/L		
7509842	Dissolved Zinc (Zn)	2014/06/05	102	80 - 120	100	80 - 120	<5.0	ug/L		
7509842	Dissolved Boron (B)	2014/06/05					<50	ug/L		
7509842	Dissolved Phosphorus (P)	2014/06/05					<10	ug/L		
7509842	Dissolved Silicon (Si)	2014/06/05					<100	ug/L		
7509842	Dissolved Zirconium (Zr)	2014/06/05					<0.50	ug/L		
7510445	Dissolved Chloride (Cl)	2014/06/03	95	80 - 120	101	80 - 120	<0.50	mg/L	NC	20

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

Maxxam Job #: B444590
Report Date: 2014/06/06

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7510459	Dissolved Sulphate (SO4)	2014/06/03	NC	80 - 120	92	80 - 120	<0.50	mg/L	0.8	20
7510502	Total Ammonia (N)	2014/06/03	NC	80 - 120	100	80 - 120	<0.0050	mg/L	1.4	20
7511968	Dissolved Chloride (Cl)	2014/06/04	NC	80 - 120	102	80 - 120	<0.50	mg/L	0.5	20
7512838	Total Suspended Solids	2014/06/06	106	80 - 120	96	80 - 120	<4.0	mg/L	NC	20
7512930	Total Dissolved Solids	2014/06/06	111	80 - 120	98	80 - 120	16, RDL=10	mg/L	4.3	20
7514534	Dissolved Mercury (Hg)	2014/06/06	102	80 - 120	102	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B444590

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B444590 **COC #:** EB1010314 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Minto Explorations Ltd	Company Name:	Minto Explorations Ltd
Contact Name:	Elvina Wong	Contact Name:	Minto Environment
Address:	Suite 900 - 999 West Hastings St	Address:	Suite 900-999 West Hastings St
	Vancouver, B.C. PC: V6C 2W2		Vancouver, B.C. PC: V6C 2W2
Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120	Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120
E-mail		E-mail	minto_environment@mintomine.com

(Second pair of columns: **Report To:**)

PO #: 208979
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Phil Emerson

REGULATORY REQUIREMENTS:
☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:
● Regular Turn Around Time (TAT) (5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☑ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226																		Number of Containers
					Dissolved Metals (DM)		Total Metals																										
1	SS25	JS8912	Water	5/30/14 16:00	X	X		X	X	X	X																						4
2	SS18	JS8913	Water	5/30/14 16:30	X	X		X	X	X	X																						4
3	SS17	JS8914	Water	5/30/14 17:00	X	X		X	X	X	X																						4
4	DUP	JS8915	Water	5/30/14 0:00	X	X		X	X	X	X																						4
5																																	
6																																	
7																																	
8																																	
9																																	
10																																	
11																																	
12																																	

B444590

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd)	Time (24 hr)	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Phil Emerson	31-May-14	8:00		2014/06/02	10:20		A: 2 B: 2 C: 2	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208979
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1010914

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/09
Report #: R1582028
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B445213
Received: 2014/06/03, 14:05

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	4	2014/06/04	2014/06/04	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/06/04	BBY6SOP-00011	SM-4500-Cl-
Chloride by Automated Colourimetry	1	N/A	2014/06/05	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	4	N/A	2014/06/04	BBY6SOP-00026	SM-2510B
Fluoride	4	N/A	2014/06/04	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	4	N/A	2014/06/09	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	4	N/A	2014/06/04	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	4	N/A	2014/06/04	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	4	N/A	2014/06/04	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	4	N/A	2014/06/05	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	4	N/A	2014/06/03	BBY6WI-00001	EPA 200.2
pH Water (1)	4	N/A	2014/06/04	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	3	N/A	2014/06/04	BBY6SOP-00017	SM4500-SO42- E
Sulphate by Automated Colourimetry	1	N/A	2014/06/05	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	4	2014/06/06	2014/06/09	BBY6SOP-00033	SM 2540C
Total Suspended Solids	4	N/A	2014/06/09	BBY6SOP-00034	SM - 2540 D

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==

This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JT2491			JT2492			JT2493			JT2494		
Sampling Date		2014/05/31 13:30			2014/05/31 14:00			2014/06/01 14:00			2014/06/01 14:30		
	UNITS	**SS5**	**RDL**	**QC Batch**	**SS6**	**RDL**	**QC Batch**	**SS21**	**RDL**	**QC Batch**	**SS26**	**RDL**	**QC Batch**
ANIONS													
Nitrite (N)	mg/L	0.590(1)	0.025	7512155	0.0189(1)	0.0050	7512155	0.0699	0.0050	7512155	0.0185	0.0050	7512155
Calculated Parameters													
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	78.8	2.0	7509537	61.5	2.0	7509537	31.5	1.0	7509537	26.5	0.40	7509537
Misc. Inorganics													
Fluoride (F)	mg/L	0.460	0.010	7511361	0.380	0.010	7511361	0.550	0.010	7511361	0.300	0.010	7511361
Alkalinity (Total as CaCO3)	mg/L	379	0.50	7511261	181	0.50	7511261	271	0.50	7511261	338	0.50	7511261
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7511261	<0.50	0.50	7511261	<0.50	0.50	7511261	<0.50	0.50	7511261
Bicarbonate (HCO3)	mg/L	462	0.50	7511261	221	0.50	7511261	331	0.50	7511261	412	0.50	7511261
Carbonate (CO3)	mg/L	<0.50	0.50	7511261	<0.50	0.50	7511261	<0.50	0.50	7511261	<0.50	0.50	7511261
Hydroxide (OH)	mg/L	<0.50	0.50	7511261	<0.50	0.50	7511261	<0.50	0.50	7511261	<0.50	0.50	7511261
Anions													
Dissolved Sulphate (SO4)	mg/L	254	5.0	7511972	236	5.0	7511972	228	5.0	7511972	66.3	0.50	7513952
Dissolved Chloride (Cl)	mg/L	9.6	0.50	7513946	8.8	0.50	7511968	4.1	0.50	7511968	4.0	0.50	7511968
Nutrients													
Total Ammonia (N)	mg/L	0.063	0.0050	7512159	0.0096	0.0050	7512159	0.0097	0.0050	7512159	0.016	0.0050	7512159
Nitrate plus Nitrite (N)	mg/L	79.4(1)	2.0	7511788	61.6(1)	2.0	7511788	31.6	1.0	7511788	26.6	0.40	7511788
Physical Properties													
Conductivity	uS/cm	1670	1.0	7511268	1270	1.0	7511268	1130	1.0	7511268	913	1.0	7511268
pH	pH	8.15		7511267	8.15		7511267	7.76		7511267	8.02		7511267
Physical Properties													
Total Suspended Solids	mg/L	19.2	4.0	7514627	5.0	4.0	7514627	<4.0	4.0	7514627	<4.0	4.0	7514627
Total Dissolved Solids	mg/L	1270	10	7514708	990	10	7514708	814	10	7514743	592	10	7514743

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

Maxxam Job #: B445213
Report Date: 2014/06/09

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT2491	JT2492	JT2493	JT2494		
Sampling Date		2014/05/31 13:30	2014/05/31 14:00	2014/06/01 14:00	2014/06/01 14:30		
	UNITS	**SS5**	**SS6**	**SS21**	**SS26**	**RDL**	**QC Batch**
Misc. Inorganics							
Dissolved Hardness (CaCO3)	mg/L	802	591	555	460	0.50	7509108
Elements							
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	7517996
Dissolved Metals by ICPMS							
Dissolved Aluminum (Al)	ug/L	7.6	6.4	5.0	4.4	3.0	7511806
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511806
Dissolved Arsenic (As)	ug/L	0.78	0.64	0.53	0.41	0.10	7511806
Dissolved Barium (Ba)	ug/L	106	52.2	79.7	98.8	1.0	7511806
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	7511806
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511806
Dissolved Boron (B)	ug/L	64	<50	<50	<50	50	7511806
Dissolved Cadmium (Cd)	ug/L	0.219	0.089	0.084	0.037	0.010	7511806
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511806
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511806
Dissolved Copper (Cu)	ug/L	205	224	78.7	81.4	0.20	7511806
Dissolved Iron (Fe)	ug/L	19.9	14.1	42.9	45.2	5.0	7511806
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	7511806
Dissolved Lithium (Li)	ug/L	5.0	6.0	<5.0	<5.0	5.0	7511806
Dissolved Manganese (Mn)	ug/L	478	189	161	500	1.0	7511806
Dissolved Molybdenum (Mo)	ug/L	12.0	9.3	12.2	5.3	1.0	7511806
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511806
Dissolved Phosphorus (P)	ug/L	10	12	18	13	10	7511806
Dissolved Selenium (Se)	ug/L	23.7	32.5	11.7	4.71	0.10	7511806
Dissolved Silicon (Si)	ug/L	6620	7690	5550	7460	100	7511806
Dissolved Silver (Ag)	ug/L	0.042	<0.020	<0.020	0.024	0.020	7511806
Dissolved Strontium (Sr)	ug/L	5110	2210	3160	1090	1.0	7511806
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	7511806
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511806
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511806
Dissolved Uranium (U)	ug/L	8.07	14.6	3.88	4.97	0.10	7511806
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511806
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511806
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511806
Dissolved Calcium (Ca)	mg/L	225	172	154	134	0.050	7509109

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT2491	JT2492	JT2493	JT2494		
Sampling Date		2014/05/31 13:30	2014/05/31 14:00	2014/06/01 14:00	2014/06/01 14:30		
	UNITS	**SS5**	**SS6**	**SS21**	**SS26**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	58.3	39.2	41.4	30.3	0.050	7509109
Dissolved Potassium (K)	mg/L	6.07	7.41	5.54	4.99	0.050	7509109
Dissolved Sodium (Na)	mg/L	32.2	29.3	29.6	12.6	0.050	7509109
Dissolved Sulphur (S)	mg/L	93.1	85.8	84.2	22.4	3.0	7509109

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7511261	Alkalinity (Total as CaCO3)	2014/06/04	91	80 - 120	102	80 - 120	<0.50	mg/L	0.2	20
7511261	Alkalinity (PP as CaCO3)	2014/06/04					<0.50	mg/L	NC	20
7511261	Bicarbonate (HCO3)	2014/06/04					<0.50	mg/L	0.2	20
7511261	Carbonate (CO3)	2014/06/04					<0.50	mg/L	NC	20
7511261	Hydroxide (OH)	2014/06/04					<0.50	mg/L	NC	20
7511268	Conductivity	2014/06/04			102	80 - 120	1.1, RDL=1.0	uS/cm	2.5	20
7511361	Fluoride (F)	2014/06/04	NC	80 - 120	104	80 - 120	<0.010	mg/L	2.2	20
7511788	Nitrate plus Nitrite (N)	2014/06/04	102	80 - 120	98	80 - 120	<0.020	mg/L	0.7	25
7511806	Dissolved Aluminum (Al)	2014/06/05	99	80 - 120	103	80 - 120	<3.0	ug/L	NC	20
7511806	Dissolved Antimony (Sb)	2014/06/05	101	80 - 120	97	80 - 120	<0.50	ug/L	NC	20
7511806	Dissolved Arsenic (As)	2014/06/05	NC	80 - 120	101	80 - 120	<0.10	ug/L	0.1	20
7511806	Dissolved Barium (Ba)	2014/06/05	NC	80 - 120	97	80 - 120	<1.0	ug/L	1.4	20
7511806	Dissolved Beryllium (Be)	2014/06/05	98	80 - 120	97	80 - 120	<0.10	ug/L	NC	20
7511806	Dissolved Bismuth (Bi)	2014/06/05	99	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7511806	Dissolved Cadmium (Cd)	2014/06/05	99	80 - 120	97	80 - 120	<0.010	ug/L	NC	20
7511806	Dissolved Chromium (Cr)	2014/06/05	95	80 - 120	98	80 - 120	<1.0	ug/L	NC	20
7511806	Dissolved Cobalt (Co)	2014/06/05	96	80 - 120	99	80 - 120	<0.50	ug/L	3.2	20
7511806	Dissolved Copper (Cu)	2014/06/05	97	80 - 120	98	80 - 120	<0.20	ug/L	NC	20
7511806	Dissolved Iron (Fe)	2014/06/05	NC	80 - 120	105	80 - 120	<5.0	ug/L	2.9	20
7511806	Dissolved Lead (Pb)	2014/06/05	98	80 - 120	98	80 - 120	<0.20	ug/L	1.9	20
7511806	Dissolved Lithium (Li)	2014/06/05	96	80 - 120	92	80 - 120	<5.0	ug/L	NC	20
7511806	Dissolved Manganese (Mn)	2014/06/05	NC	80 - 120	99	80 - 120	<1.0	ug/L	4.9	20
7511806	Dissolved Molybdenum (Mo)	2014/06/05	NC	80 - 120	94	80 - 120	<1.0	ug/L	1.4	20
7511806	Dissolved Nickel (Ni)	2014/06/05	NC	80 - 120	100	80 - 120	<1.0	ug/L	0.7	20
7511806	Dissolved Selenium (Se)	2014/06/05	109	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
7511806	Dissolved Silver (Ag)	2014/06/05	100	80 - 120	99	80 - 120	<0.020	ug/L	NC	20
7511806	Dissolved Strontium (Sr)	2014/06/05	NC	80 - 120	99	80 - 120	<1.0	ug/L	5.0	20
7511806	Dissolved Thallium (Tl)	2014/06/05	100	80 - 120	100	80 - 120	<0.050	ug/L	NC	20
7511806	Dissolved Tin (Sn)	2014/06/05	99	80 - 120	94	80 - 120	<5.0	ug/L	NC	20
7511806	Dissolved Titanium (Ti)	2014/06/05	101	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7511806	Dissolved Uranium (U)	2014/06/05	102	80 - 120	98	80 - 120	<0.10	ug/L	NC	20
7511806	Dissolved Vanadium (V)	2014/06/05	96	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7511806	Dissolved Zinc (Zn)	2014/06/05	NC	80 - 120	101	80 - 120	<5.0	ug/L	1.2	20
7511806	Dissolved Boron (B)	2014/06/05					<50	ug/L	NC	20
7511806	Dissolved Phosphorus (P)	2014/06/05					<10	ug/L		
7511806	Dissolved Silicon (Si)	2014/06/05					<100	ug/L	2.2	20
7511806	Dissolved Zirconium (Zr)	2014/06/05					<0.50	ug/L	NC	20
7511968	Dissolved Chloride (Cl)	2014/06/04	NC	80 - 120	102	80 - 120	<0.50	mg/L	0.5	20
7511972	Dissolved Sulphate (SO4)	2014/06/04	NC	80 - 120	101	80 - 120	<0.50	mg/L	0.8	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7512155	Nitrite (N)	2014/06/04	96	80 - 120	94	80 - 120	<0.0050	mg/L	1.4	20
7512159	Total Ammonia (N)	2014/06/04	97	80 - 120	94	80 - 120	<0.0050	mg/L	NC	20
7513946	Dissolved Chloride (Cl)	2014/06/05	97	80 - 120	101	80 - 120	<0.50	mg/L	NC	20
7513952	Dissolved Sulphate (SO4)	2014/06/05	NC	80 - 120	96	80 - 120	<0.50	mg/L	0.7	20
7514627	Total Suspended Solids	2014/06/09	107	80 - 120	95	80 - 120	<4.0	mg/L	NC	20
7514708	Total Dissolved Solids	2014/06/09	NC	80 - 120	96	80 - 120	18, RDL=10	mg/L	5.4	20
7514743	Total Dissolved Solids	2014/06/09			112	80 - 120	<10	mg/L	1.5	20
7517996	Dissolved Mercury (Hg)	2014/06/09	92	80 - 120	108	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B445213

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B445213

COC #: EB1010914

Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208979
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Field Filtered? Y ☑ N ☐ Dissolved	Field Acidified? Y ☑ N ☐ Metals (DM)	Field Acidified? Y ☑ N ☐ Total Metals	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☑ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226																		Number of Containers
1	SS5	JT2491	Water	5/31/14 13:30	x	x		x	x	x	x																						4
2	SS6	JT2492	Water	5/31/14 14:00	x	x		x	x	x	x																						4
3	SS21	JT2493	Water	6/1/14 14:00	x	x		x	x	x	x																						4
4	SS26	JT2494	Water	6/1/14 14:30	x	x		x	x	x	x																						4
5																																	
6																																	
7																																	
8																																	
9																																	
10																																	
11																																	
12																																	

B445213

Print name and sign

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):
Chris Harry	2-Jun-14	7:30

Print name and sign

Received by	Date (yy/mm/dd):	Time (24 hr):
Laure Berthier	2014/06/03	14:05

Time Sensitive ☑

Laboratory Use Only

Temperature on Receipt (°C): A) ☐ B) ☐ C) 4
Just sampled & rec'd on ice: ☐

Custody Seal	Yes	No
Present?	☐	☒
Intact?	☐	☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Success Through Science®

Your P.O. #: 208979
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1011714

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/12
Report #: R1584382
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B446227
Received: 2014/06/05, 10:25

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/06/06	2014/06/07	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	1	N/A	2014/06/09	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	1	N/A	2014/06/07	BBY6SOP-00026	SM-2510B
Fluoride	1	N/A	2014/06/06	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	1	N/A	2014/06/08	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	1	N/A	2014/06/12	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/06/08	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	1	N/A	2014/06/06	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	1	N/A	2014/06/06	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	1	N/A	2014/06/06	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	1	N/A	2014/06/06	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	1	N/A	2014/06/06	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	1	N/A	2014/06/05	BBY6WI-00001	EPA 200.2
pH Water (1)	1	N/A	2014/06/07	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	1	N/A	2014/06/09	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	1	2014/06/09	2014/06/10	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

MINTO EXPLORATIONS LTD.

Maxxam Job #: B446227
Report Date: 2014/06/12

Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

-2-

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B446227
Report Date: 2014/06/12

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JT7104		
Sampling Date		2014/06/02 13:25		
	UNITS	**SS27**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	0.0625(1)	0.0050	7515352
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	26.8	0.40	7512617
Misc. Inorganics				
Fluoride (F)	mg/L	0.260	0.010	7515281
Alkalinity (Total as CaCO3)	mg/L	316	0.50	7514840
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7514840
Bicarbonate (HCO3)	mg/L	386	0.50	7514840
Carbonate (CO3)	mg/L	<0.50	0.50	7514840
Hydroxide (OH)	mg/L	<0.50	0.50	7514840
Anions				
Dissolved Sulphate (SO4)	mg/L	61.6	0.50	7518377
Dissolved Chloride (Cl)	mg/L	3.9	0.50	7518361
Nutrients				
Total Ammonia (N)	mg/L	0.051	0.0050	7515192
Nitrate plus Nitrite (N)	mg/L	26.8(1)	0.40	7515350
Physical Properties				
Conductivity	uS/cm	887	1.0	7514845
pH	pH	8.23		7514846
Physical Properties				
Total Dissolved Solids	mg/L	612	10	7517719

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT7104		
Sampling Date		2014/06/02 13:25		
	UNITS	**SS27**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	448	0.50	7513817
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7521272

RDL = Reportable Detection Limit

Maxxam Job #: B446227
Report Date: 2014/06/12

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT7104		
Sampling Date		2014/06/02 13:25		
	UNITS	**SS27**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	9.2	3.0	7514964
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7514964
Dissolved Arsenic (As)	ug/L	0.27	0.10	7514964
Dissolved Barium (Ba)	ug/L	86.0	1.0	7514964
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7514964
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7514964
Dissolved Boron (B)	ug/L	<50	50	7514964
Dissolved Cadmium (Cd)	ug/L	0.105	0.010	7514964
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7514964
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7514964
Dissolved Copper (Cu)	ug/L	71.0	0.20	7514964
Dissolved Iron (Fe)	ug/L	61.3	5.0	7514964
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7514964
Dissolved Lithium (Li)	ug/L	<5.0	5.0	7514964
Dissolved Manganese (Mn)	ug/L	458	1.0	7514964
Dissolved Molybdenum (Mo)	ug/L	4.5	1.0	7514964
Dissolved Nickel (Ni)	ug/L	<1.0	1.0	7514964
Dissolved Phosphorus (P)	ug/L	14	10	7514964
Dissolved Selenium (Se)	ug/L	4.73	0.10	7514964
Dissolved Silicon (Si)	ug/L	7310	100	7514964
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7514964
Dissolved Strontium (Sr)	ug/L	740	1.0	7514964
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7514964
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7514964
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7514964
Dissolved Uranium (U)	ug/L	5.30	0.10	7514964
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7514964
Dissolved Zinc (Zn)	ug/L	<5.0	5.0	7514964
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7514964
Dissolved Calcium (Ca)	mg/L	136	0.050	7512613
Dissolved Magnesium (Mg)	mg/L	26.4	0.050	7512613
Dissolved Potassium (K)	mg/L	4.57	0.050	7512613
Dissolved Sodium (Na)	mg/L	12.3	0.050	7512613
Dissolved Sulphur (S)	mg/L	20.1	3.0	7512613

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7514840	Alkalinity (Total as CaCO3)	2014/06/07	NC	80 - 120	95	80 - 120	<0.50	mg/L	0.6	20
7514840	Alkalinity (PP as CaCO3)	2014/06/07					<0.50	mg/L	NC	20
7514840	Bicarbonate (HCO3)	2014/06/07					<0.50	mg/L	1.1	20
7514840	Carbonate (CO3)	2014/06/07					<0.50	mg/L	NC	20
7514840	Hydroxide (OH)	2014/06/07					<0.50	mg/L	NC	20
7514845	Conductivity	2014/06/07			99	80 - 120	1.1, RDL=1.0	uS/cm	0.9	20
7514964	Dissolved Aluminum (Al)	2014/06/06	104	80 - 120	105	80 - 120	<3.0	ug/L	NC	20
7514964	Dissolved Antimony (Sb)	2014/06/06	100	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
7514964	Dissolved Arsenic (As)	2014/06/06	107	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
7514964	Dissolved Barium (Ba)	2014/06/06	101	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7514964	Dissolved Beryllium (Be)	2014/06/06	105	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
7514964	Dissolved Bismuth (Bi)	2014/06/06	102	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7514964	Dissolved Cadmium (Cd)	2014/06/06	102	80 - 120	103	80 - 120	<0.010	ug/L	NC	20
7514964	Dissolved Chromium (Cr)	2014/06/06	105	80 - 120	107	80 - 120	<1.0	ug/L	NC	20
7514964	Dissolved Cobalt (Co)	2014/06/06	102	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
7514964	Dissolved Copper (Cu)	2014/06/06	101	80 - 120	106	80 - 120	<0.20	ug/L	NC	20
7514964	Dissolved Iron (Fe)	2014/06/06	103	80 - 120	108	80 - 120	<5.0	ug/L	NC	20
7514964	Dissolved Lead (Pb)	2014/06/06	103	80 - 120	102	80 - 120	<0.20	ug/L	NC	20
7514964	Dissolved Lithium (Li)	2014/06/06	101	80 - 120	98	80 - 120	<5.0	ug/L	NC	20
7514964	Dissolved Manganese (Mn)	2014/06/06	105	80 - 120	108	80 - 120	<1.0	ug/L	NC	20
7514964	Dissolved Molybdenum (Mo)	2014/06/06	104	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7514964	Dissolved Nickel (Ni)	2014/06/06	102	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7514964	Dissolved Selenium (Se)	2014/06/06	103	80 - 120	105	80 - 120	<0.10	ug/L	NC	20
7514964	Dissolved Silver (Ag)	2014/06/06	101	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7514964	Dissolved Strontium (Sr)	2014/06/06	NC	80 - 120	105	80 - 120	<1.0	ug/L	3.0	20
7514964	Dissolved Thallium (Tl)	2014/06/06	98	80 - 120	105	80 - 120	<0.050	ug/L	NC	20
7514964	Dissolved Tin (Sn)	2014/06/06	101	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
7514964	Dissolved Titanium (Ti)	2014/06/06	99	80 - 120	110	80 - 120	<5.0	ug/L	NC	20
7514964	Dissolved Uranium (U)	2014/06/06	106	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
7514964	Dissolved Vanadium (V)	2014/06/06	106	80 - 120	107	80 - 120	<5.0	ug/L	NC	20
7514964	Dissolved Zinc (Zn)	2014/06/06	105	80 - 120	109	80 - 120	<5.0	ug/L	NC	20
7514964	Dissolved Boron (B)	2014/06/06					<50	ug/L	NC	20
7514964	Dissolved Phosphorus (P)	2014/06/06					<10	ug/L		
7514964	Dissolved Silicon (Si)	2014/06/06					<100	ug/L	5.8	20
7514964	Dissolved Zirconium (Zr)	2014/06/06					<0.50	ug/L	NC	20
7515192	Total Ammonia (N)	2014/06/06	99	80 - 120	96	80 - 120	<0.0050	mg/L	NC	20
7515281	Fluoride (F)	2014/06/06	100	80 - 120	100	80 - 120	<0.010	mg/L	6.5	20
7515350	Nitrate plus Nitrite (N)	2014/06/06	97	80 - 120	105	80 - 120	<0.020	mg/L	NC	25
7515352	Nitrite (N)	2014/06/06	93	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20

Maxxam Job #: B446227
Report Date: 2014/06/12

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: PE

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7517719	Total Dissolved Solids	2014/06/10	NC	80 - 120	102	80 - 120	<10	mg/L	3.6	20
7518361	Dissolved Chloride (Cl)	2014/06/09	NC	80 - 120	103	80 - 120	<0.50	mg/L	2.0	20
7518377	Dissolved Sulphate (SO4)	2014/06/09	92	80 - 120	100	80 - 120	0.51, RDL=0.50	mg/L	NC	20
7521272	Dissolved Mercury (Hg)	2014/06/12	89	80 - 120	100	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B446227

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B446227 **COC #:** EB1011714 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Minto Explorations Ltd
Contact Name:	Elvina Wong
Address:	Suite 900 - 999 West Hastings St
	Vancouver, B.C. PC: V6C 2W2
Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120
E-mail	

Report To:

Company Name:	Minto Explorations Ltd
Contact Name:	Minto Environment
Address:	Suite 900-999 West Hastings St
	Vancouver, B.C. PC: V6C 2W2
Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120
E-mail	minto_environment@mintomine.com

PO #:	208979
Quotation #:	
Project # :	
Proj. Name:	Minto Env. Monitoring
Location:	Yukon
Sampled by:	Phil Emerson / Chris Harry

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☑ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226																		Number of Containers
1	SS27	JT7104	Water	6/2/14 13:25	X	X		X	X	X	X																						3
2																																	
3																																	
4																																	
5																																	
6																																	
7																																	
8																																	
9																																	
10																																	
11																																	
12																																	

B446227

Print name and sign | Print name and sign | Laboratory Use Only

***Relinquished By:**	Date (yy/mm/dd):	Time (24hr):	Received by	Date (yy/mm/dd)	Time (24 hr)	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	3-Jun-14	8:30	M. Jaurel Berthier	2014/06/05	10:25		A: 3 B: 3 C: 3	Present?	☐	☒
						☑	Just sampled & rec'd on ice ☐	Intact?	☐	☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208979
Your Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your C.O.C. #: 08396831

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/29

Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B480496
Received: 2014/09/11, 10:20

Sample Matrix: Water
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	10	2014/09/12	2014/09/12	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	10	N/A	2014/09/12	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	10	N/A	2014/09/12	BBY6SOP-00026	SM 22 2510 B m
Fluoride	10	N/A	2014/09/12	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	6	N/A	2014/09/18	BBY7SOP-00002	EPA 6020a R1 m
Hardness (calculated as CaCO3)	4	N/A	2014/09/19	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	2	N/A	2014/09/17	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Mercury (Dissolved) by CVAF	8	N/A	2014/09/22	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	6	N/A	2014/09/18	BBY7SOP-00002	EPA 6020A R1 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/09/19	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	6	N/A	2014/09/17	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	4	N/A	2014/09/18	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	10	N/A	2014/09/12	BBY6SOP-00009	SM 22 4500-NH3- G m
Ammonia-N (Preserved)	1	N/A	2014/09/26	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	10	N/A	2014/09/12	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	10	N/A	2014/09/12	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	10	N/A	2014/09/15	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	6	N/A	2014/09/17	BBY7 WI-00004	BCMOE Reqs 08/14
Filter and HNO3 Preserve for Metals	4	N/A	2014/09/18	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	10	N/A	2014/09/12	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	7	N/A	2014/09/12	BBY6SOP-00017	SM 22 4500-SO42- E m
Sulphate by Automated Colourimetry	3	N/A	2014/09/15	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	10	2014/09/12	2014/09/13	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208979
Your Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your C.O.C. #: 08396831

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/29

Version: 2 - Revision

CERTIFICATE OF ANALYSIS – REVISED REPORT

MAXXAM JOB #: B480496
Received: 2014/09/11, 10:20

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B480496
Report Date: 2014/09/29

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: JD

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KO5259		KO5260			KO5261		
Sampling Date		2014/09/05 12:45		2014/09/05 13:30			2014/09/05 14:45		
COC Number		08396831		08396831			08396831		
	Units	**SS28**	**QC Batch**	**SS29**	**RDL**	**QC Batch**	**SS30**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	<0.0050 (1)	7636355	<0.0050 (1)	0.0050	7636349	0.0050 (1)	0.0050	7636349
Calculated Parameters									
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	48.6	7633674	28.4	1.0	7633674	17.9	0.20	7633674
Misc. Inorganics									
Fluoride (F)	mg/L	0.320	7636259	0.440	0.010	7636259	0.270	0.010	7636259
Alkalinity (Total as CaCO3)	mg/L	280	7635762	265	0.50	7635743	398	0.50	7635762
Alkalinity (PP as CaCO3)	mg/L	<0.50	7635762	<0.50	0.50	7635743	<0.50	0.50	7635762
Bicarbonate (HCO3)	mg/L	341	7635762	324	0.50	7635743	486	0.50	7635762
Carbonate (CO3)	mg/L	<0.50	7635762	<0.50	0.50	7635743	<0.50	0.50	7635762
Hydroxide (OH)	mg/L	<0.50	7635762	<0.50	0.50	7635743	<0.50	0.50	7635762
Anions									
Dissolved Sulphate (SO4)	mg/L	239	7636296	291	5.0	7636294	87.2	0.50	7639020
Dissolved Chloride (Cl)	mg/L	4.3	7636295	4.6	0.50	7636292	5.4	0.50	7636295
Nutrients									
Total Ammonia (N)	mg/L	0.019	7636246	0.024	0.0050	7636210	0.015	0.0050	7636246
Nitrate plus Nitrite (N)	mg/L	48.6 (1)	7636353	28.4 (1)	1.0	7636348	17.9 (1)	0.20	7636348
Physical Properties									
Conductivity	uS/cm	1360	7635769	1260	1.0	7635747	998	1.0	7635769
pH	pH	8.19	7635767	8.13	N/A	7635746	8.26	N/A	7635767
Physical Properties									
Total Dissolved Solids	mg/L	830	7635232	908	10	7635232	678	10	7635232

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B480496
Report Date: 2014/09/29

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: JD

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KO5262			KO5263		KO5264		
Sampling Date		2014/09/05 15:15			2014/09/05 16:20		2014/09/08 11:40		
COC Number		08396831			08396831		08396831		
	Units	**SS31**	**RDL**	**QC Batch**	**SS22**	**QC Batch**	**SS32**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	0.0095 (1)	0.0050	7636355	<0.0050 (1)	7636355	<0.0050 (2)	0.0050	7636355
Calculated Parameters									
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	24.8	0.40	7633674	<0.020	7633674	0.326	0.020	7633674
Misc. Inorganics									
Fluoride (F)	mg/L	0.190	0.010	7636259	0.140	7636259	0.270	0.010	7636259
Alkalinity (Total as CaCO3)	mg/L	372	0.50	7635762	183	7635762	93.4	0.50	7635762
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7635762	<0.50	7635762	<0.50	0.50	7635762
Bicarbonate (HCO3)	mg/L	454	0.50	7635762	223	7635762	114	0.50	7635762
Carbonate (CO3)	mg/L	<0.50	0.50	7635762	<0.50	7635762	<0.50	0.50	7635762
Hydroxide (OH)	mg/L	<0.50	0.50	7635762	<0.50	7635762	<0.50	0.50	7635762
Anions									
Dissolved Sulphate (SO4)	mg/L	73.9	0.50	7636296	15.0	7636296	5.69	0.50	7639020
Dissolved Chloride (Cl)	mg/L	4.6	0.50	7636295	1.1	7636295	0.59	0.50	7636295
Nutrients									
Total Ammonia (N)	mg/L	0.016	0.0050	7636246	0.014	7636210	0.012	0.0050	7636246
Nitrate plus Nitrite (N)	mg/L	24.8 (1)	0.40	7636353	<0.020 (1)	7636353	0.326 (2)	0.020	7636353
Physical Properties									
Conductivity	uS/cm	991	1.0	7635769	366	7635769	195	1.0	7635769
pH	pH	8.27	N/A	7635767	8.19	7635767	8.06	N/A	7635767
Physical Properties									
Total Dissolved Solids	mg/L	642	10	7635232	234	7635232	106	10	7635246

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.
(2) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KO5265			KO5266			KO5267		
Sampling Date		2014/09/08 13:20			2014/09/08 14:00			2014/09/08 14:45		
COC Number		08396831			08396831			08396831		
	Units	**SS33**	**RDL**	**QC Batch**	**SS8**	**RDL**	**QC Batch**	**SS6**	**RDL**	**QC Batch**
ANIONS										
Nitrite (N)	mg/L	0.525 (1)	0.010	7636355	0.852 (1)	0.025	7636349	0.0170 (1)	0.0050	7636349
Calculated Parameters										
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	77.9	2.0	7633674	93.8	2.0	7633674	86.8	2.0	7633674
Misc. Inorganics										
Fluoride (F)	mg/L	0.460	0.010	7636259	0.270	0.010	7636259	0.300	0.010	7636259
Alkalinity (Total as CaCO3)	mg/L	355	0.50	7635762	357	0.50	7635762	304	0.50	7635762
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7635762	<0.50	0.50	7635762	<0.50	0.50	7635762
Bicarbonate (HCO3)	mg/L	433	0.50	7635762	436	0.50	7635762	371	0.50	7635762
Carbonate (CO3)	mg/L	<0.50	0.50	7635762	<0.50	0.50	7635762	<0.50	0.50	7635762
Hydroxide (OH)	mg/L	<0.50	0.50	7635762	<0.50	0.50	7635762	<0.50	0.50	7635762
Anions										
Dissolved Sulphate (SO4)	mg/L	233	5.0	7636296	252	5.0	7636296	240	5.0	7636296
Dissolved Chloride (Cl)	mg/L	10	0.50	7636295	10	0.50	7636295	10	0.50	7636295
Nutrients										
Total Ammonia (N)	mg/L	0.24	0.0050	7636246	0.21	0.0050	7636246	0.014	0.0050	7636210
Nitrate plus Nitrite (N)	mg/L	78.4 (1)	2.0	7636353	94.7 (1)	2.0	7636348	86.8 (1)	2.0	7636348
Physical Properties										
Conductivity	uS/cm	1680	1.0	7635769	1860	1.0	7635769	1670	1.0	7635769
pH	pH	8.02	N/A	7635767	7.78	N/A	7635767	7.89	N/A	7635767
Physical Properties										
Total Dissolved Solids	mg/L	1240	10	7635246	1430	10	7635246	1340	10	7635246

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KO5268		KR9402		
Sampling Date		2014/09/05		2014/09/08		
COC Number		08396831		08396831		
	Units	**DUP**	**QC Batch**	**DUP**	**RDL**	**QC Batch**
ANIONS						
Nitrite (N)	mg/L	0.0095 (1)	7636349		0.0050	7636349
Calculated Parameters						
Filter and HNO3 Preservation	N/A	FIELD	ONSITE		N/A	ONSITE
Nitrate (N)	mg/L	24.8	7633674		0.40	7633674
Misc. Inorganics						
Fluoride (F)	mg/L	0.190	7636259		0.010	7636259
Alkalinity (Total as CaCO3)	mg/L	370	7635762		0.50	7635762
Alkalinity (PP as CaCO3)	mg/L	<0.50	7635762		0.50	7635762
Bicarbonate (HCO3)	mg/L	451	7635762		0.50	7635762
Carbonate (CO3)	mg/L	<0.50	7635762		0.50	7635762
Hydroxide (OH)	mg/L	<0.50	7635762		0.50	7635762
Anions						
Dissolved Sulphate (SO4)	mg/L	78.3	7639020		0.50	7639020
Dissolved Chloride (Cl)	mg/L	4.1	7636295		0.50	7636295
Nutrients						
Total Ammonia (N)	mg/L	0.014	7636210	0.26	0.0050	7655593
Nitrate plus Nitrite (N)	mg/L	24.8 (1)	7636348		0.40	
Physical Properties						
Conductivity	uS/cm	990	7635769		1.0	
pH	pH	8.22	7635767		N/A	
Physical Properties						
Total Dissolved Solids	mg/L	642	7635232		10	

RDL = Reportable Detection Limit
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B480496
Report Date: 2014/09/29

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: JD

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KO5259	KO5260	KO5261	KO5262		KO5263		
Sampling Date		2014/09/05 12:45	2014/09/05 13:30	2014/09/05 14:45	2014/09/05 15:15		2014/09/05 16:20		
COC Number		08396831	08396831	08396831	08396831		08396831		
	Units	**SS28**	**SS29**	**SS30**	**SS31**	**QC Batch**	**SS22**	**RDL**	**QC Batch**
Misc. Inorganics									
Dissolved Hardness (CaCO3)	mg/L	690	628	533	532	7633822	191	0.50	7633822
Elements									
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	7641871	<0.010	0.010	7641164
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	<3.0	<3.0	12.6	8.8	7641881	11.8	3.0	7641881
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	7641881	<0.50	0.50	7641881
Dissolved Arsenic (As)	ug/L	0.14	0.21	0.35	0.22	7641881	0.29	0.10	7641881
Dissolved Barium (Ba)	ug/L	90.0	99.1	93.4	91.3	7641881	130	1.0	7641881
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	7641881	<0.10	0.10	7641881
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	7641881	<1.0	1.0	7641881
Dissolved Boron (B)	ug/L	<50	<50	<50	<50	7641881	<50	50	7641881
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	<0.010	0.039	7641881	<0.010	0.010	7641881
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	7641881	<1.0	1.0	7641881
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	7641881	<0.50	0.50	7641881
Dissolved Copper (Cu)	ug/L	2.33	4.31	55.1	60.0	7641881	2.30	0.20	7641881
Dissolved Iron (Fe)	ug/L	13.3	6.3	34.5	96.6	7641881	16.9	5.0	7641881
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	7641881	<0.20	0.20	7641881
Dissolved Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	7641881	<5.0	5.0	7641881
Dissolved Manganese (Mn)	ug/L	<1.0	2.8	7.8	155	7641881	1.5	1.0	7641881
Dissolved Molybdenum (Mo)	ug/L	6.4	6.7	4.9	2.8	7641881	<1.0	1.0	7641881
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	7641881	<1.0	1.0	7641881
Dissolved Phosphorus (P)	ug/L	10	13	22	20	7641881	<10	10	7641881
Dissolved Selenium (Se)	ug/L	2.71	9.71	4.61	5.90	7641881	0.35	0.10	7641881
Dissolved Silicon (Si)	ug/L	5590	4910	7500	7400	7641881	5860	100	7641881
Dissolved Silver (Ag)	ug/L	0.035	0.035	0.046	0.022	7641881	<0.020	0.020	7641881
Dissolved Strontium (Sr)	ug/L	2810	3800	1450	838	7641881	337	1.0	7641881
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	7641881	<0.050	0.050	7641881
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	7641881	<5.0	5.0	7641881
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	7641881	<5.0	5.0	7641881
Dissolved Uranium (U)	ug/L	3.97	2.95	4.09	5.25	7641881	<0.10	0.10	7641881
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	7641881	<5.0	5.0	7641881
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	<5.0	7641881	<5.0	5.0	7641881
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	7641881	<0.50	0.50	7641881
Dissolved Calcium (Ca)	mg/L	191	175	151	159	7633907	53.7	0.050	7633907

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KO5259	KO5260	KO5261	KO5262		KO5263		
Sampling Date		2014/09/05 12:45	2014/09/05 13:30	2014/09/05 14:45	2014/09/05 15:15		2014/09/05 16:20		
COC Number		08396831	08396831	08396831	08396831		08396831		
	Units	**SS28**	**SS29**	**SS30**	**SS31**	**QC Batch**	**SS22**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	51.6	46.1	37.9	32.5	7633907	13.9	0.050	7633907
Dissolved Potassium (K)	mg/L	4.75	5.85	4.79	4.60	7633907	0.526	0.050	7633907
Dissolved Sodium (Na)	mg/L	30.2	32.2	15.2	13.1	7633907	6.37	0.050	7633907
Dissolved Sulphur (S)	mg/L	99.8	109	29.0	26.2	7633907	4.5	3.0	7633907
RDL = Reportable Detection Limit									

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KO5264			KO5265		KO5266	KO5267	KO5268		
Sampling Date		2014/09/08 11:40			2014/09/08 13:20		2014/09/08 14:00	2014/09/08 14:45	2014/09/05		
COC Number		08396831			08396831		08396831	08396831	08396831		
	Units	**SS32**	**RDL**	**QC Batch**	**SS33**	**RDL**	**SS8**	**SS6**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics											
Dissolved Hardness (CaCO3)	mg/L	91.8	0.50	7633822	958	0.50	996	961	539	0.50	7633822
Elements											
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7641139	<0.010	0.010	<0.010	<0.010	<0.010	0.010	7641871
Dissolved Metals by ICPMS											
Dissolved Aluminum (Al)	ug/L	<3.0	3.0	7641881	8.0	6.0	7.0	15.7	6.7	3.0	7642410
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7641881	<1.0	1.0	<0.50	<0.50	<0.50	0.50	7642410
Dissolved Arsenic (As)	ug/L	0.12	0.10	7641881	0.42	0.20	0.38	0.43	0.23	0.10	7642410
Dissolved Barium (Ba)	ug/L	15.2	1.0	7641881	149	2.0	59.8	76.9	94.7	1.0	7642410
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7641881	<0.20	0.20	<0.10	<0.10	<0.10	0.10	7642410
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7641881	<2.0	2.0	<1.0	<1.0	<1.0	1.0	7642410
Dissolved Boron (B)	ug/L	<50	50	7641881	<100	100	79	73	<50	50	7642410
Dissolved Cadmium (Cd)	ug/L	<0.010	0.010	7641881	0.508	0.020	0.041	0.087	0.040	0.010	7642410
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7641881	<2.0	2.0	<1.0	<1.0	<1.0	1.0	7642410
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7641881	<1.0	1.0	<0.50	<0.50	<0.50	0.50	7642410
Dissolved Copper (Cu)	ug/L	0.49	0.20	7641881	189	0.40	102	158	68.3	0.20	7642410
Dissolved Iron (Fe)	ug/L	<5.0	5.0	7641881	37	10	10.2	19.4	64.9	5.0	7642410
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7641881	<0.40	0.40	<0.20	<0.20	<0.20	0.20	7642410
Dissolved Lithium (Li)	ug/L	<5.0	5.0	7641881	<10	10	7.0	8.0	<5.0	5.0	7642410
Dissolved Manganese (Mn)	ug/L	<1.0	1.0	7641881	1040	2.0	197	105	168	1.0	7642410
Dissolved Molybdenum (Mo)	ug/L	2.9	1.0	7641881	15.7	2.0	5.1	7.3	2.8	1.0	7642410
Dissolved Nickel (Ni)	ug/L	<1.0	1.0	7641881	<2.0	2.0	<1.0	<1.0	<1.0	1.0	7642410
Dissolved Phosphorus (P)	ug/L	<10	10	7641881	21	20	<10	<10	24	10	7642410
Dissolved Selenium (Se)	ug/L	0.12	0.10	7641881	62.3	0.20	47.4	39.4	4.99	0.10	7642410
Dissolved Silicon (Si)	ug/L	5770	100	7641881	7950	200	7640	7760	7900	100	7642410
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7641881	<0.040	0.040	0.021	0.028	<0.020	0.020	7642410
Dissolved Strontium (Sr)	ug/L	154	1.0	7641881	5840	2.0	4030	4170	869	1.0	7642410
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7641881	<0.10	0.10	<0.050	<0.050	<0.050	0.050	7642410
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7641881	<10	10	<5.0	<5.0	<5.0	5.0	7642410
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7641881	<10	10	<5.0	<5.0	<5.0	5.0	7642410
Dissolved Uranium (U)	ug/L	0.36	0.10	7641881	7.55	0.20	9.52	12.8	5.51	0.10	7642410
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7641881	<10	10	<5.0	<5.0	<5.0	5.0	7642410
Dissolved Zinc (Zn)	ug/L	<5.0	5.0	7641881	<10	10	<5.0	<5.0	<5.0	5.0	7642410
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7641881	<1.0	1.0	<0.50	<0.50	<0.50	0.50	7642410
Dissolved Calcium (Ca)	mg/L	28.6	0.050	7633907	277	0.10	288	277	160	0.050	7633907
RDL = Reportable Detection Limit											

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KO5264			KO5265		KO5266	KO5267	KO5268		
Sampling Date		2014/09/08 11:40			2014/09/08 13:20		2014/09/08 14:00	2014/09/08 14:45	2014/09/05		
COC Number		08396831			08396831		08396831	08396831	08396831		
	Units	**SS32**	**RDL**	**QC Batch**	**SS33**	**RDL**	**SS8**	**SS6**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	4.98	0.050	7633907	64.4	0.10	67.4	65.3	34.2	0.050	7633907
Dissolved Potassium (K)	mg/L	1.16	0.050	7633907	7.29	0.10	7.70	8.02	5.55	0.050	7633907
Dissolved Sodium (Na)	mg/L	3.52	0.050	7633907	38.6	0.10	46.4	44.3	14.5	0.050	7633907
Dissolved Sulphur (S)	mg/L	<3.0	3.0	7633907	104	6.0	111	114	34.6	3.0	7633907

RDL = Reportable Detection Limit

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Sample KR9402-01 : Revised Report (Version: 2R): Additional analysis requested.

CCME DISSOLVED METALS IN WATER (WATER) Comments

Sample KO5265-02 Elements by CRC ICPMS (dissolved): Detection limits raised due to matrix interference.

Results relate only to the items tested.

Maxxam Job #: B480496
Report Date: 2014/09/29

QUALITY ASSURANCE REPORT

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208979
Sampler Initials: JD

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7635232	Total Dissolved Solids	2014/09/13	99	80 - 120	106	80 - 120	<10	mg/L	1.3 (1)	20
7635246	Total Dissolved Solids	2014/09/13	98	80 - 120	90	80 - 120	<10	mg/L	2.1	20
7635743	Alkalinity (PP as CaCO3)	2014/09/12					<0.50	mg/L	NC	20
7635743	Alkalinity (Total as CaCO3)	2014/09/12	NC	80 - 120	96	80 - 120	0.52 ,RDL=0.50	mg/L	0.83	20
7635743	Bicarbonate (HCO3)	2014/09/12					0.63 ,RDL=0.50	mg/L	0.22	20
7635743	Carbonate (CO3)	2014/09/12					<0.50	mg/L	NC	20
7635743	Hydroxide (OH)	2014/09/12					<0.50	mg/L	NC	20
7635746	pH	2014/09/12			101	97 - 103			0.48	N/A
7635747	Conductivity	2014/09/12			99	80 - 120	1.8 ,RDL=1.0	uS/cm	0.49	20
7635762	Alkalinity (PP as CaCO3)	2014/09/12					<0.50	mg/L	NC	20
7635762	Alkalinity (Total as CaCO3)	2014/09/12	NC	80 - 120	90	80 - 120	0.74 ,RDL=0.50	mg/L	0.33	20
7635762	Bicarbonate (HCO3)	2014/09/12					0.90 ,RDL=0.50	mg/L	0.36	20
7635762	Carbonate (CO3)	2014/09/12					<0.50	mg/L	NC	20
7635762	Hydroxide (OH)	2014/09/12					<0.50	mg/L	NC	20
7635767	pH	2014/09/12			101	97 - 103			0.74	N/A
7635769	Conductivity	2014/09/12			100	80 - 120	1.1 ,RDL=1.0	uS/cm	0.28	20
7636210	Total Ammonia (N)	2014/09/12	89	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7636246	Total Ammonia (N)	2014/09/12	98	80 - 120	100	80 - 120	<0.0050	mg/L	0.74	20
7636259	Fluoride (F)	2014/09/12	NC	80 - 120	96	80 - 120	0.014 ,RDL=0.010	mg/L	3.8	20
7636292	Dissolved Chloride (Cl)	2014/09/12	NC	80 - 120	100	80 - 120	<0.50	mg/L	NC	20
7636294	Dissolved Sulphate (SO4)	2014/09/12	NC	80 - 120	93	80 - 120	0.67 ,RDL=0.50	mg/L	19	20
7636295	Dissolved Chloride (Cl)	2014/09/12	98	80 - 120	100	80 - 120	<0.50	mg/L	NC	20
7636296	Dissolved Sulphate (SO4)	2014/09/12	NC	80 - 120	94	80 - 120	0.66 ,RDL=0.50	mg/L	4.7	20
7636348	Nitrate plus Nitrite (N)	2014/09/12	NC	80 - 120	108	80 - 120	<0.020	mg/L	1.4	25
7636349	Nitrite (N)	2014/09/12	100	80 - 120	102	80 - 120	<0.0050	mg/L	2.7	20
7636353	Nitrate plus Nitrite (N)	2014/09/12	101	80 - 120	109	80 - 120	<0.020	mg/L	NC	25
7636355	Nitrite (N)	2014/09/12	103	80 - 120	103	80 - 120	<0.0050	mg/L	NC	20
7639020	Dissolved Sulphate (SO4)	2014/09/15	102	80 - 120	100	80 - 120	<0.50	mg/L	0.41	20
7641139	Dissolved Mercury (Hg)	2014/09/17	93	80 - 120	104	80 - 120	<0.010	ug/L	NC	20
7641164	Dissolved Mercury (Hg)	2014/09/17	104	80 - 120	91	80 - 120	<0.010	ug/L	NC	20
7641871	Dissolved Mercury (Hg)	2014/09/22	100	80 - 120	110	80 - 120	<0.010	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7641881	Dissolved Aluminum (Al)	2014/09/17	100	80 - 120	105	80 - 120	<3.0	ug/L	NC	20
7641881	Dissolved Antimony (Sb)	2014/09/17	104	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7641881	Dissolved Arsenic (As)	2014/09/17	102	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
7641881	Dissolved Barium (Ba)	2014/09/17	NC	80 - 120	101	80 - 120	<1.0	ug/L	0.30	20
7641881	Dissolved Beryllium (Be)	2014/09/17	102	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
7641881	Dissolved Bismuth (Bi)	2014/09/17	98	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
7641881	Dissolved Boron (B)	2014/09/17					<50	ug/L	NC	20
7641881	Dissolved Cadmium (Cd)	2014/09/17	101	80 - 120	102	80 - 120	<0.010	ug/L	NC	20
7641881	Dissolved Chromium (Cr)	2014/09/17	99	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7641881	Dissolved Cobalt (Co)	2014/09/17	99	80 - 120	101	80 - 120	<0.50	ug/L	NC	20
7641881	Dissolved Copper (Cu)	2014/09/17	94	80 - 120	99	80 - 120	<0.20	ug/L	NC	20
7641881	Dissolved Iron (Fe)	2014/09/17	110	80 - 120	108	80 - 120	<5.0	ug/L	NC	20
7641881	Dissolved Lead (Pb)	2014/09/17	94	80 - 120	97	80 - 120	<0.20	ug/L	NC	20
7641881	Dissolved Lithium (Li)	2014/09/17	97	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7641881	Dissolved Manganese (Mn)	2014/09/17	96	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7641881	Dissolved Molybdenum (Mo)	2014/09/17	NC	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7641881	Dissolved Nickel (Ni)	2014/09/17	96	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7641881	Dissolved Phosphorus (P)	2014/09/17					<10	ug/L	NC	20
7641881	Dissolved Selenium (Se)	2014/09/17	112	80 - 120	106	80 - 120	<0.10	ug/L	NC	20
7641881	Dissolved Silicon (Si)	2014/09/17					<100	ug/L	2.3	20
7641881	Dissolved Silver (Ag)	2014/09/17	99	80 - 120	88	80 - 120	<0.020	ug/L	NC	20
7641881	Dissolved Strontium (Sr)	2014/09/17	NC	80 - 120	104	80 - 120	<1.0	ug/L	0.40	20
7641881	Dissolved Thallium (Tl)	2014/09/17	94	80 - 120	98	80 - 120	<0.050	ug/L	NC	20
7641881	Dissolved Tin (Sn)	2014/09/17	103	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7641881	Dissolved Titanium (Ti)	2014/09/17	99	80 - 120	94	80 - 120	<5.0	ug/L	NC	20
7641881	Dissolved Uranium (U)	2014/09/17	101	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7641881	Dissolved Vanadium (V)	2014/09/17	101	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7641881	Dissolved Zinc (Zn)	2014/09/17	100	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7641881	Dissolved Zirconium (Zr)	2014/09/17					<0.50	ug/L	NC	20
7642410	Dissolved Aluminum (Al)	2014/09/18	102	80 - 120	99	80 - 120	<3.0	ug/L	NC	20
7642410	Dissolved Antimony (Sb)	2014/09/18	102	80 - 120	99	80 - 120	<0.50	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7642410	Dissolved Arsenic (As)	2014/09/18	99	80 - 120	96	80 - 120	<0.10	ug/L	NC	20
7642410	Dissolved Barium (Ba)	2014/09/18	NC	80 - 120	98	80 - 120	<1.0	ug/L	0.82	20
7642410	Dissolved Beryllium (Be)	2014/09/18	95	80 - 120	89	80 - 120	<0.10	ug/L	NC	20
7642410	Dissolved Bismuth (Bi)	2014/09/18	99	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7642410	Dissolved Boron (B)	2014/09/18					<50	ug/L	NC	20
7642410	Dissolved Cadmium (Cd)	2014/09/18	96	80 - 120	97	80 - 120	<0.010	ug/L	NC	20
7642410	Dissolved Chromium (Cr)	2014/09/18	97	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7642410	Dissolved Cobalt (Co)	2014/09/18	94	80 - 120	98	80 - 120	<0.50	ug/L	NC	20
7642410	Dissolved Copper (Cu)	2014/09/18	90	80 - 120	100	80 - 120	<0.20	ug/L	3.2	20
7642410	Dissolved Iron (Fe)	2014/09/18	103	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7642410	Dissolved Lead (Pb)	2014/09/18	101	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7642410	Dissolved Lithium (Li)	2014/09/18	96	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7642410	Dissolved Manganese (Mn)	2014/09/18	NC	80 - 120	103	80 - 120	<1.0	ug/L	0.19	20
7642410	Dissolved Molybdenum (Mo)	2014/09/18	106	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
7642410	Dissolved Nickel (Ni)	2014/09/18	97	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
7642410	Dissolved Phosphorus (P)	2014/09/18					<10	ug/L	NC	20
7642410	Dissolved Selenium (Se)	2014/09/18	98	80 - 120	97	80 - 120	<0.10	ug/L	NC	20
7642410	Dissolved Silicon (Si)	2014/09/18					<100	ug/L	1.5	20
7642410	Dissolved Silver (Ag)	2014/09/18	95	80 - 120	91	80 - 120	<0.020	ug/L	NC	20
7642410	Dissolved Strontium (Sr)	2014/09/18	NC	80 - 120	99	80 - 120	<1.0	ug/L	0.65	20
7642410	Dissolved Thallium (Tl)	2014/09/18	99	80 - 120	98	80 - 120	<0.050	ug/L	NC	20
7642410	Dissolved Tin (Sn)	2014/09/18	100	80 - 120	94	80 - 120	<5.0	ug/L	NC	20
7642410	Dissolved Titanium (Ti)	2014/09/18	100	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7642410	Dissolved Uranium (U)	2014/09/18	100	80 - 120	98	80 - 120	<0.10	ug/L	NC	20
7642410	Dissolved Vanadium (V)	2014/09/18	100	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
7642410	Dissolved Zinc (Zn)	2014/09/18	91	80 - 120	98	80 - 120	<5.0	ug/L	NC	20
7642410	Dissolved Zirconium (Zr)	2014/09/18					<0.50	ug/L	NC	20
7655593	Total Ammonia (N)	2014/09/26	NC	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B480496 **COC #:** 08396831 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208979
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Jasmin Dobson, Martin Crill

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Field Filtered? Y ☑ N ☐ Dissolved	Field Acidified? Y ☑ N ☐ Metals (DM)	Field Acidified? Y ☐ N ☐ Total Metals	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226	Number of Containers
1	SS28	K05259	Water	14/09/05 12:45	X	X		X	X	X	X					3
2	SS29	K05260	Water	14/09/05 13:30	x	x		x	x	x	x					3
3	SS30	K05261	Water	14/09/05 14:45	x	x		x	x	x	x					3
4	SS31	K05262	Water	14/09/05 15:15	x	x		x	x	x	x					3
5	SS22	K05263	Water	14/09/05 16:20	x	x		x	x	x	x					3
6	SS32	K05264	Water	14/09/08 11:40	x	x		x	x	x	x					3
7	SS33	K05265	Water	14/09/08 13:20	x	x		x	x	x	x					3
8	SS8	K05266	Water	14/09/08 14:00	x	x		x	x	x	x					3
9	SS6	K05267	Water	14/09/08 14:45	x	x		x	x	x	x					3
10	DUP	K05268	Water	14/09/05	x	x		x	x	x	x					3
11																
12																

B480496

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Shaun Roberts	14/09/09	8:00	ARIBA SULTAN	2014/09/11	10:20		A) 6 B) 7 C) 7	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☑ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

Appendix G – Groundwater Quality Monitoring Program Laboratory Results

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 2014-11-08A

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/11/19
Report #: R1686270
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4A2444
Received: 2014/11/10, 09:40

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/11/10	2014/11/10	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	3	N/A	2014/11/10	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	3	N/A	2014/11/10	BBY6SOP-00026	SM 22 2510 B m
Fluoride	3	N/A	2014/11/12	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	3	N/A	2014/11/19	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	3	N/A	2014/11/17	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	3	N/A	2014/11/19	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	3	N/A	2014/11/18	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	3	N/A	2014/11/12	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	3	N/A	2014/11/10	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	3	N/A	2014/11/10	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	3	N/A	2014/11/10	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	3	N/A	2014/11/18	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	3	N/A	2014/11/10	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	3	N/A	2014/11/10	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	3	2014/11/12	2014/11/13	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 2014-11-08A

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/11/19
Report #: R1686270
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4A2444
Received: 2014/11/10, 09:40

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		LC5322	LC5323	LC5324		
Sampling Date		2014/11/07 13:20	2014/11/07 13:45	2014/11/07 00:00		
COC Number		2014-11-08A	2014-11-08A	2014-11-08A		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
ANIONS						
Nitrite (N)	mg/L	<0.050 (1)	1.07	1.29	0.050	7714363
Calculated Parameters						
Filter and HNO3 Preservation	N/A	FIELD	FIELD	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.669	0.428	0.467	0.050	7713980
Misc. Inorganics						
Fluoride (F)	mg/L	1.00	1.40	1.40	0.010	7716906
Alkalinity (Total as CaCO3)	mg/L	321	119	122	0.50	7713763
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	<0.50	0.50	7713763
Bicarbonate (HCO3)	mg/L	392	145	149	0.50	7713763
Carbonate (CO3)	mg/L	<0.50	<0.50	<0.50	0.50	7713763
Hydroxide (OH)	mg/L	<0.50	<0.50	<0.50	0.50	7713763
Anions						
Dissolved Sulphate (SO4)	mg/L	319	623	618	5.0	7714393
Dissolved Chloride (Cl)	mg/L	4.3	3.1	3.5	0.50	7714392
Nutrients						
Total Ammonia (N)	mg/L	0.96	0.23	0.23	0.0050	7716869
Nitrate plus Nitrite (N)	mg/L	0.669	1.50	1.75	0.020	7714361
Physical Properties						
Conductivity	uS/cm	1270	1410	1400	1.0	7713771
pH	pH	7.66	7.87	7.88	N/A	7713769
Physical Properties						
Total Dissolved Solids	mg/L	938	1110	1110	10	7715841

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) RDL raised due to sample matrix interference.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		LC5322	LC5323	LC5324		
Sampling Date		2014/11/07 13:20	2014/11/07 13:45	2014/11/07 00:00		
COC Number		2014-11-08A	2014-11-08A	2014-11-08A		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics						
Dissolved Hardness (CaCO3)	mg/L	516	609	599	0.50	7713305
Elements						
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	0.010	7722092
Dissolved Metals by ICPMS						
Dissolved Aluminum (Al)	ug/L	10.5	7.5	6.3	3.0	7723064
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	0.50	7723064
Dissolved Arsenic (As)	ug/L	1.03	1.13	1.14	0.10	7723064
Dissolved Barium (Ba)	ug/L	36.9	15.2	15.2	1.0	7723064
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	0.10	7723064
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	1.0	7723064
Dissolved Boron (B)	ug/L	1290	312	320	50	7723064
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	<0.010	0.010	7723064
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	1.0	7723064
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	0.50	7723064
Dissolved Copper (Cu)	ug/L	0.59	<0.20	<0.20	0.20	7723064
Dissolved Iron (Fe)	ug/L	382	199	206	5.0	7723064
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	0.20	7723064
Dissolved Lithium (Li)	ug/L	20.4	24.9	23.5	5.0	7723064
Dissolved Manganese (Mn)	ug/L	108	140	135	1.0	7723064
Dissolved Molybdenum (Mo)	ug/L	5.9	15.1	14.7	1.0	7723064
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	1.0	7723064
Dissolved Phosphorus (P)	ug/L	22	<10	<10	10	7723064
Dissolved Selenium (Se)	ug/L	1.73	0.18	0.18	0.10	7723064
Dissolved Silicon (Si)	ug/L	7280	5670	5970	100	7723064
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	0.020	7723064
Dissolved Strontium (Sr)	ug/L	7610	9740	9710	1.0	7723064
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	0.050	7723064
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	5.0	7723064
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	5.0	7723064
Dissolved Uranium (U)	ug/L	1.11	1.35	1.32	0.10	7723064
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	5.0	7723064
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	5.0	7723064
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	0.50	7723064
Dissolved Calcium (Ca)	mg/L	169	191	187	0.050	7713306

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		LC5322	LC5323	LC5324		
Sampling Date		2014/11/07 13:20	2014/11/07 13:45	2014/11/07 00:00		
COC Number		2014-11-08A	2014-11-08A	2014-11-08A		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	22.6	32.0	31.7	0.050	7713306
Dissolved Potassium (K)	mg/L	3.16	2.71	2.65	0.050	7713306
Dissolved Sodium (Na)	mg/L	84.6	70.5	70.2	0.050	7713306
Dissolved Sulphur (S)	mg/L	127	216	225	3.0	7713306
RDL = Reportable Detection Limit						

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

Results relate only to the items tested.

Maxxam Job #: B4A2444
Report Date: 2014/11/19

QUALITY ASSURANCE REPORT

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7713763	Alkalinity (PP as CaCO3)	2014/11/10					<0.50	mg/L	NC	20
7713763	Alkalinity (Total as CaCO3)	2014/11/10	NC	80 - 120	98	80 - 120	<0.50	mg/L	1.8	20
7713763	Bicarbonate (HCO3)	2014/11/10					<0.50	mg/L	1.8	20
7713763	Carbonate (CO3)	2014/11/10					<0.50	mg/L	NC	20
7713763	Hydroxide (OH)	2014/11/10					<0.50	mg/L	NC	20
7713769	pH	2014/11/10			101	97 - 103			0.13	N/A
7713771	Conductivity	2014/11/10			100	80 - 120	<1.0	uS/cm	0.45	20
7714361	Nitrate plus Nitrite (N)	2014/11/10	NC	80 - 120	109	80 - 120	<0.020	mg/L	0.90	25
7714363	Nitrite (N)	2014/11/10	88	80 - 120	103	80 - 120	<0.0050	mg/L	1.9	20
7714392	Dissolved Chloride (Cl)	2014/11/10	95	80 - 120	101	80 - 120	0.74, RDL=0.50	mg/L	0.53	20
7714393	Dissolved Sulphate (SO4)	2014/11/10	NC	80 - 120	95	80 - 120	<0.50	mg/L	1.4	20
7715841	Total Dissolved Solids	2014/11/13	99	80 - 120	104	80 - 120	<10	mg/L	2.2	20
7716869	Total Ammonia (N)	2014/11/12	87	80 - 120	95	80 - 120	<0.0050	mg/L	NC	20
7716906	Fluoride (F)	2014/11/12	105	80 - 120	102	80 - 120	<0.010	mg/L	9.5	20
7722092	Dissolved Mercury (Hg)	2014/11/17	107	80 - 120	106	80 - 120	<0.010	ug/L	NC	20
7723064	Dissolved Aluminum (Al)	2014/11/18	99	80 - 120	105	80 - 120	<3.0	ug/L	0.93	20
7723064	Dissolved Antimony (Sb)	2014/11/18	93	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7723064	Dissolved Arsenic (As)	2014/11/18	99	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7723064	Dissolved Barium (Ba)	2014/11/18	NC	80 - 120	98	80 - 120	<1.0	ug/L	1.3	20
7723064	Dissolved Beryllium (Be)	2014/11/18	96	80 - 120	96	80 - 120	<0.10	ug/L	NC	20
7723064	Dissolved Bismuth (Bi)	2014/11/18	95	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7723064	Dissolved Boron (B)	2014/11/18					<50	ug/L	NC	20
7723064	Dissolved Cadmium (Cd)	2014/11/18	98	80 - 120	100	80 - 120	<0.010	ug/L	NC	20
7723064	Dissolved Chromium (Cr)	2014/11/18	99	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7723064	Dissolved Cobalt (Co)	2014/11/18	100	80 - 120	103	80 - 120	<0.50	ug/L	NC	20
7723064	Dissolved Copper (Cu)	2014/11/18	101	80 - 120	102	80 - 120	<0.20	ug/L	5.7	20
7723064	Dissolved Iron (Fe)	2014/11/18	NC	80 - 120	108	80 - 120	<5.0	ug/L	3.9	20
7723064	Dissolved Lead (Pb)	2014/11/18	96	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7723064	Dissolved Lithium (Li)	2014/11/18	92	80 - 120	96	80 - 120	<5.0	ug/L	NC	20
7723064	Dissolved Manganese (Mn)	2014/11/18	NC	80 - 120	105	80 - 120	<1.0	ug/L	2.3	20
7723064	Dissolved Molybdenum (Mo)	2014/11/18	NC	80 - 120	100	80 - 120	<1.0	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7723064	Dissolved Nickel (Ni)	2014/11/18	101	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
7723064	Dissolved Phosphorus (P)	2014/11/18					<10	ug/L		
7723064	Dissolved Selenium (Se)	2014/11/18	96	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7723064	Dissolved Silicon (Si)	2014/11/18					<100	ug/L	1.6	20
7723064	Dissolved Silver (Ag)	2014/11/18	101	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7723064	Dissolved Strontium (Sr)	2014/11/18	NC	80 - 120	97	80 - 120	<1.0	ug/L	6.4	20
7723064	Dissolved Thallium (Tl)	2014/11/18	95	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
7723064	Dissolved Tin (Sn)	2014/11/18	99	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
7723064	Dissolved Titanium (Ti)	2014/11/18	106	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7723064	Dissolved Uranium (U)	2014/11/18	101	80 - 120	105	80 - 120	<0.10	ug/L	NC	20
7723064	Dissolved Vanadium (V)	2014/11/18	101	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7723064	Dissolved Zinc (Zn)	2014/11/18	100	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7723064	Dissolved Zirconium (Zr)	2014/11/18					<0.50	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B4A2444 **COC #:** 2014-11-08 A Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry, Helaina Moses

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

B4A2444

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N	Field Acidified? Y ☑ N	Total Metals Field Acidified? Y ☐ N	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-07-01	LC5322	Ground W	11/7/14 13:20	x	x		x	x	x	x	3
2	MW12-07-02	LC5323	Ground W	11/7/14 13:45	x	x		x	x	x	x	3
3	DUP	LC5324	Ground W	11/7/14 0:00	x	x		x	x	x	x	3
4												
5												
6												
7												
8												
9												
10												
11												
12												

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr)	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	8-Nov-14	9:00	Laurel Berthier	2014/11/10	09:40	☑	A) 4 B) 2 C) 3	Present?	☐	☒
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 2014-12-08B

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/12/18
Report #: R1720314
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B1497
Received: 2014/12/09, 10:15

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	2	2014/12/09	2014/12/10	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	2	N/A	2014/12/10	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	2	N/A	2014/12/10	BBY6SOP-00026	SM 22 2510 B m
Fluoride	2	N/A	2014/12/10	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	2	N/A	2014/12/18	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	2	N/A	2014/12/12	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	2	N/A	2014/12/18	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	2	N/A	2014/12/18	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	2	N/A	2014/12/09	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	2	N/A	2014/12/10	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	2	N/A	2014/12/10	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	2	N/A	2014/12/12	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	2	N/A	2014/12/18	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	2	N/A	2014/12/10	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	2	N/A	2014/12/10	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	2	2014/12/10	2014/12/11	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 2014-12-08B

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/12/18
Report #: R1720314
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B4B1497
Received: 2014/12/09, 10:15

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B4B1497
Report Date: 2014/12/18

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: H

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		LI2946		LI2947		
Sampling Date		2014/12/07 13:55		2014/12/07 14:20		
COC Number		2014-12-08B		2014-12-08B		
	Units	**MW12-07-01**	**RDL**	**MW12-07-02**	**RDL**	**QC Batch**
ANIONS						
Nitrite (N)	mg/L	1.86	0.050	1.47	0.025	7749935
Calculated Parameters						
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	1.05	0.20	0.66	0.10	7747986
Misc. Inorganics						
Fluoride (F)	mg/L	1.00	0.010	1.30	0.010	7749966
Alkalinity (Total as CaCO3)	mg/L	307	0.50	117	0.50	7748446
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50	0.50	7748446
Bicarbonate (HCO3)	mg/L	374	0.50	143	0.50	7748446
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50	0.50	7748446
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	7748446
Anions						
Dissolved Sulphate (SO4)	mg/L	377	5.0	624	5.0	7750037
Dissolved Chloride (Cl)	mg/L	3.3	0.50	1.7	0.50	7750034
Nutrients						
Total Ammonia (N)	mg/L	0.64	0.0050	0.29	0.0050	7748570
Nitrate plus Nitrite (N)	mg/L	2.92 (1)	0.20	2.13	0.10	7749931
Physical Properties						
Conductivity	uS/cm	1320	1.0	1410	1.0	7748444
pH	pH	7.84	N/A	7.99	N/A	7748441
Physical Properties						
Total Dissolved Solids	mg/L	994	10	1060	10	7749009

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) RDL raised due to sample matrix interference.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		LI2946	LI2947		
Sampling Date		2014/12/07 13:55	2014/12/07 14:20		
COC Number		2014-12-08B	2014-12-08B		
	Units	**MW12-07-01**	**MW12-07-02**	**RDL**	**QC Batch**
Misc. Inorganics					
Dissolved Hardness (CaCO3)	mg/L	566	649	0.50	7747776
Elements					
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	0.010	7752500
Dissolved Metals by ICPMS					
Dissolved Aluminum (Al)	ug/L	11.0	6.5	3.0	7753152
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	7753152
Dissolved Arsenic (As)	ug/L	1.91	1.66	0.10	7753152
Dissolved Barium (Ba)	ug/L	40.4	16.9	1.0	7753152
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	0.10	7753152
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	1.0	7753152
Dissolved Boron (B)	ug/L	1600	485	50	7753152
Dissolved Cadmium (Cd)	ug/L	<0.010	0.016	0.010	7753152
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	1.0	7753152
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	0.50	7753152
Dissolved Copper (Cu)	ug/L	0.42	0.27	0.20	7753152
Dissolved Iron (Fe)	ug/L	671	157	5.0	7753152
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	0.20	7753152
Dissolved Lithium (Li)	ug/L	21.3	26.4	5.0	7753152
Dissolved Manganese (Mn)	ug/L	172	141	1.0	7753152
Dissolved Molybdenum (Mo)	ug/L	3.1	15.8	1.0	7753152
Dissolved Nickel (Ni)	ug/L	1.1	<1.0	1.0	7753152
Dissolved Phosphorus (P)	ug/L	29	<10	10	7753152
Dissolved Selenium (Se)	ug/L	1.67	0.15	0.10	7753152
Dissolved Silicon (Si)	ug/L	7950	6370	100	7753152
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	0.020	7753152
Dissolved Strontium (Sr)	ug/L	8540	10900	1.0	7753152
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	0.050	7753152
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	5.0	7753152
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	7753152
Dissolved Uranium (U)	ug/L	0.48	1.50	0.10	7753152
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	5.0	7753152
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	7753152
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	0.50	7753152
Dissolved Calcium (Ca)	mg/L	188	207	0.050	7747777

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		LI2946	LI2947		
Sampling Date		2014/12/07 13:55	2014/12/07 14:20		
COC Number		2014-12-08B	2014-12-08B		
	Units	**MW12-07-01**	**MW12-07-02**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	23.3	31.8	0.050	7747777
Dissolved Potassium (K)	mg/L	3.18	2.76	0.050	7747777
Dissolved Sodium (Na)	mg/L	86.0	72.2	0.050	7747777
Dissolved Sulphur (S)	mg/L	151	237	3.0	7747777

RDL = Reportable Detection Limit

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Results relate only to the items tested.

Maxxam Job #: B4B1497
Report Date: 2014/12/18

QUALITY ASSURANCE REPORT

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: H

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7748441	pH	2014/12/10			102	97 - 103			0	N/A
7748444	Conductivity	2014/12/10			103	80 - 120	1.1, RDL=1.0	uS/cm	0.17	20
7748446	Alkalinity (PP as CaCO3)	2014/12/10					<0.50	mg/L		
7748446	Alkalinity (Total as CaCO3)	2014/12/10	NC	80 - 120	99	80 - 120	<0.50	mg/L		
7748446	Bicarbonate (HCO3)	2014/12/10					<0.50	mg/L		
7748446	Carbonate (CO3)	2014/12/10					<0.50	mg/L		
7748446	Hydroxide (OH)	2014/12/10					<0.50	mg/L		
7748570	Total Ammonia (N)	2014/12/09	NC	80 - 120	96	80 - 120	<0.0050	mg/L	NC	20
7749009	Total Dissolved Solids	2014/12/11	NC	80 - 120	102	80 - 120	10, RDL=10	mg/L	3.2	20
7749931	Nitrate plus Nitrite (N)	2014/12/10	101	80 - 120	105	80 - 120	<0.020	mg/L	1.2	25
7749935	Nitrite (N)	2014/12/10	98	80 - 120	97	80 - 120	<0.0050	mg/L	NC	20
7749966	Fluoride (F)	2014/12/10	96	80 - 120	96	80 - 120	0.012, RDL=0.010	mg/L	NC	20
7750034	Dissolved Chloride (Cl)	2014/12/10	NC	80 - 120	98	80 - 120	<0.50	mg/L		
7750037	Dissolved Sulphate (SO4)	2014/12/10	NC	80 - 120	94	80 - 120	<0.50	mg/L		
7752500	Dissolved Mercury (Hg)	2014/12/12	115	80 - 120	94	80 - 120	<0.010	ug/L	NC	20
7753152	Dissolved Aluminum (Al)	2014/12/18	102	80 - 120	106	80 - 120	<3.0	ug/L	NC	20
7753152	Dissolved Antimony (Sb)	2014/12/18	107	80 - 120	105	80 - 120	<0.50	ug/L	NC	20
7753152	Dissolved Arsenic (As)	2014/12/18	NC	80 - 120	105	80 - 120	<0.10	ug/L	1.5	20
7753152	Dissolved Barium (Ba)	2014/12/18	NC	80 - 120	102	80 - 120	<1.0	ug/L	4.9	20
7753152	Dissolved Beryllium (Be)	2014/12/18	102	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7753152	Dissolved Bismuth (Bi)	2014/12/18	96	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7753152	Dissolved Boron (B)	2014/12/18					<50	ug/L	0.62	20
7753152	Dissolved Cadmium (Cd)	2014/12/18	102	80 - 120	104	80 - 120	<0.010	ug/L	NC	20
7753152	Dissolved Chromium (Cr)	2014/12/18	101	80 - 120	106	80 - 120	<1.0	ug/L	NC	20
7753152	Dissolved Cobalt (Co)	2014/12/18	95	80 - 120	106	80 - 120	<0.50	ug/L	NC	20
7753152	Dissolved Copper (Cu)	2014/12/18	95	80 - 120	108	80 - 120	<0.20	ug/L	NC	20
7753152	Dissolved Iron (Fe)	2014/12/18	118	80 - 120	122 (1)	80 - 120	<5.0	ug/L	NC	20
7753152	Dissolved Lead (Pb)	2014/12/18	97	80 - 120	104	80 - 120	<0.20	ug/L	NC	20
7753152	Dissolved Lithium (Li)	2014/12/18	NC	80 - 120	101	80 - 120	<5.0	ug/L	2.9	20
7753152	Dissolved Manganese (Mn)	2014/12/18	NC	80 - 120	112	80 - 120	<1.0	ug/L	0.69	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7753152	Dissolved Molybdenum (Mo)	2014/12/18	NC	80 - 120	97	80 - 120	<1.0	ug/L	5.9	20
7753152	Dissolved Nickel (Ni)	2014/12/18	97	80 - 120	106	80 - 120	<1.0	ug/L	NC	20
7753152	Dissolved Phosphorus (P)	2014/12/18					<10	ug/L		
7753152	Dissolved Selenium (Se)	2014/12/18	115	80 - 120	122 (1)	80 - 120	<0.10	ug/L	NC	20
7753152	Dissolved Silicon (Si)	2014/12/18					<100	ug/L	11	20
7753152	Dissolved Silver (Ag)	2014/12/18	90	80 - 120	93	80 - 120	<0.020	ug/L	NC	20
7753152	Dissolved Strontium (Sr)	2014/12/18	NC	80 - 120	104	80 - 120	<1.0	ug/L	6.6	20
7753152	Dissolved Thallium (Tl)	2014/12/18	97	80 - 120	99	80 - 120	<0.050	ug/L	NC	20
7753152	Dissolved Tin (Sn)	2014/12/18	106	80 - 120	104	80 - 120	<5.0	ug/L	NC	20
7753152	Dissolved Titanium (Ti)	2014/12/18	101	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7753152	Dissolved Uranium (U)	2014/12/18	101	80 - 120	102	80 - 120	<0.10	ug/L	NC	20
7753152	Dissolved Vanadium (V)	2014/12/18	103	80 - 120	108	80 - 120	<5.0	ug/L	NC	20
7753152	Dissolved Zinc (Zn)	2014/12/18	99	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7753152	Dissolved Zirconium (Zr)	2014/12/18					<0.50	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Blank Spike outside acceptance criteria (10% of analytes failure allowed).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B4B1497

COC #: 2014-12-08 B

Click here to get the COC number

Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail:

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Helaina

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM): Field Filtered? Y ☑ N ☐	Dissolved Metals (DM): Field Addified? Y ☑ N ☐	Total Metals: Field Addified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-07-01	II2946	Ground W	12/7/14 13:55	x	x		x	x	x	x	3
2	MW12-07-02	II2947	Ground W	12/7/14 14:20	x	x		x	x	x	x	3
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

B4B1497

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Phil Emerson	8-Dec-14	8:30	Laurel Berthier	2014/12/09	10:15		A) 1 B) 1 C) 1	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB960314

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/03/24
Report #: R1539896
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B421376
Received: 2014/03/18, 09:05

Sample Matrix: Water
\# Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	2	2014/03/20	2014/03/20	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	2	N/A	2014/03/20	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	2	N/A	2014/03/20	BBY6SOP-00026	SM-2510B
Fluoride	2	N/A	2014/03/20	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	2	N/A	2014/03/20	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	2	N/A	2014/03/24	BBY7SOP-00015	EPA 245.7
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	2	N/A	2014/03/20	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	2	N/A	2014/03/20	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	2	N/A	2014/03/19	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	2	N/A	2014/03/19	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	2	N/A	2014/03/19	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	2	N/A	2014/03/19	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	2	N/A	2014/03/19	BBY6WI-00001	EPA 200.2
pH Water (1)	2	N/A	2014/03/20	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	2	N/A	2014/03/20	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	2	2014/03/20	2014/03/21	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

Maxxam Job #: B421376
Report Date: 2014/03/24

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

-2-

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B421376
Report Date: 2014/03/24

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JB4585		JB4586		
Sampling Date		2014/03/16 15:40		2014/03/16 17:20		
	UNITS	**MW12-07-01**	**RDL**	**MW12-07-02**	**RDL**	**QC Batch**
ANIONS						
Nitrite (N)	mg/L	1.81	0.050	0.495	0.0050	7421274
Calculated Parameters						
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	16.1	0.40	0.245	0.020	7420368
Misc. Inorganics						
Fluoride (F)	mg/L	0.880	0.010	1.40	0.010	7422826
Alkalinity (Total as CaCO3)	mg/L	308	0.50	110	0.50	7423121
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50	0.50	7423121
Bicarbonate (HCO3)	mg/L	376	0.50	134	0.50	7423121
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50	0.50	7423121
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	7423121
Anions						
Dissolved Sulphate (SO4)	mg/L	284	5.0	647	5.0	7423101
Dissolved Chloride (Cl)	mg/L	3.6	0.50	1.2	0.50	7423099
Nutrients						
Ammonia (N)	mg/L	0.39	0.0050	0.045	0.0050	7421259
Nitrate plus Nitrite (N)	mg/L	17.9	0.40	0.740	0.020	7421260
Physical Properties						
Conductivity	uS/cm	1200	1.0	1360	1.0	7423123
pH	pH	8.22		7.96		7423122
Physical Properties						
Total Dissolved Solids	mg/L	864	10	1060	10	7422252

N/A = Not Applicable
RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JB4585	JB4586		
Sampling Date		2014/03/16 15:40	2014/03/16 17:20		
	UNITS	**MW12-07-01**	**MW12-07-02**	**RDL**	**QC Batch**
Misc. Inorganics					
Dissolved Hardness (CaCO3)	mg/L	484	592	0.50	7420615
Elements					
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	0.010	7425793

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JB4585	JB4586		
Sampling Date		2014/03/16 15:40	2014/03/16 17:20		
	UNITS	**MW12-07-01**	**MW12-07-02**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS					
Dissolved Aluminum (Al)	ug/L	3.3	3.3	3.0	7421478
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	7421478
Dissolved Arsenic (As)	ug/L	1.56	1.59	0.10	7421478
Dissolved Barium (Ba)	ug/L	40.4	18.3	1.0	7421478
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	0.10	7421478
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	1.0	7421478
Dissolved Boron (B)	ug/L	1730	556	50	7421478
Dissolved Cadmium (Cd)	ug/L	0.018	<0.010	0.010	7421478
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	1.0	7421478
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	0.50	7421478
Dissolved Copper (Cu)	ug/L	4.09	0.44	0.20	7421478
Dissolved Iron (Fe)	ug/L	121	242	5.0	7421478
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	0.20	7421478
Dissolved Lithium (Li)	ug/L	17.8	27.3	5.0	7421478
Dissolved Manganese (Mn)	ug/L	93.8	142	1.0	7421478
Dissolved Molybdenum (Mo)	ug/L	14.4	16.6	1.0	7421478
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	1.0	7421478
Dissolved Phosphorus (P)	ug/L	30	<10	10	7421478
Dissolved Selenium (Se)	ug/L	2.74	<0.10	0.10	7421478
Dissolved Silicon (Si)	ug/L	6330	6230	100	7421478
Dissolved Silver (Ag)	ug/L	0.026	<0.020	0.020	7421478
Dissolved Strontium (Sr)	ug/L	7230	9720	1.0	7421478
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	0.050	7421478
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	5.0	7421478
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	7421478
Dissolved Uranium (U)	ug/L	4.27	1.30	0.10	7421478
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	5.0	7421478
Dissolved Zinc (Zn)	ug/L	48.0	<5.0	5.0	7421478
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	0.50	7421478
Dissolved Calcium (Ca)	mg/L	157	184	0.050	7420366
Dissolved Magnesium (Mg)	mg/L	22.3	32.4	0.050	7420366
Dissolved Potassium (K)	mg/L	3.41	2.62	0.050	7420366
Dissolved Sodium (Na)	mg/L	81.9	74.2	0.050	7420366
Dissolved Sulphur (S)	mg/L	92.4	218	3.0	7420366

RDL = Reportable Detection Limit

Maxxam Job #: B421376
Report Date: 2014/03/24

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7421259	Ammonia (N)	2014/03/19	NC	80 - 120	101	80 - 120	<0.0050	mg/L	0.2	20
7421260	Nitrate plus Nitrite (N)	2014/03/19	NC	80 - 120	106	80 - 120	<0.020	mg/L	NC	25
7421274	Nitrite (N)	2014/03/19	101	80 - 120	102	80 - 120	<0.0050	mg/L	NC	20
7421478	Dissolved Aluminum (Al)	2014/03/20	99	80 - 120	104	80 - 120	<3.0	ug/L	NC	20
7421478	Dissolved Antimony (Sb)	2014/03/20	101	80 - 120	103	80 - 120	<0.50	ug/L	NC	20
7421478	Dissolved Arsenic (As)	2014/03/20	NC	80 - 120	101	80 - 120	<0.10	ug/L	0.2	20
7421478	Dissolved Barium (Ba)	2014/03/20	NC	80 - 120	101	80 - 120	<1.0	ug/L	1.7	20
7421478	Dissolved Beryllium (Be)	2014/03/20	98	80 - 120	95	80 - 120	<0.10	ug/L	NC	20
7421478	Dissolved Bismuth (Bi)	2014/03/20	94	80 - 120	106	80 - 120	<1.0	ug/L	NC	20
7421478	Dissolved Cadmium (Cd)	2014/03/20	98	80 - 120	101	80 - 120	<0.010	ug/L	NC	20
7421478	Dissolved Chromium (Cr)	2014/03/20	101	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7421478	Dissolved Cobalt (Co)	2014/03/20	97	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7421478	Dissolved Copper (Cu)	2014/03/20	95	80 - 120	101	80 - 120	<0.20	ug/L	NC	20
7421478	Dissolved Iron (Fe)	2014/03/20	NC	80 - 120	105	80 - 120	<5.0	ug/L	2.4	20
7421478	Dissolved Lead (Pb)	2014/03/20	97	80 - 120	104	80 - 120	<0.20	ug/L	NC	20
7421478	Dissolved Lithium (Li)	2014/03/20	NC	80 - 120	87	80 - 120	<5.0	ug/L	1.9	20
7421478	Dissolved Manganese (Mn)	2014/03/20	NC	80 - 120	104	80 - 120	<1.0	ug/L	0.3	20
7421478	Dissolved Molybdenum (Mo)	2014/03/20	NC	80 - 120	98	80 - 120	<1.0	ug/L	4.1	20
7421478	Dissolved Nickel (Ni)	2014/03/20	97	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
7421478	Dissolved Selenium (Se)	2014/03/20	113	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
7421478	Dissolved Silver (Ag)	2014/03/20	99	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7421478	Dissolved Strontium (Sr)	2014/03/20	NC	80 - 120	101	80 - 120	<1.0	ug/L	0.4	20
7421478	Dissolved Thallium (Tl)	2014/03/20	103	80 - 120	108	80 - 120	<0.050	ug/L	NC	20
7421478	Dissolved Tin (Sn)	2014/03/20	97	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7421478	Dissolved Titanium (Ti)	2014/03/20	107	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7421478	Dissolved Uranium (U)	2014/03/20	104	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
7421478	Dissolved Vanadium (V)	2014/03/20	109	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7421478	Dissolved Zinc (Zn)	2014/03/20	94	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7421478	Dissolved Boron (B)	2014/03/20					<50	ug/L	NC	20
7421478	Dissolved Phosphorus (P)	2014/03/20					<10	ug/L		
7421478	Dissolved Silicon (Si)	2014/03/20					<100	ug/L	2.0	20
7421478	Dissolved Zirconium (Zr)	2014/03/20					<0.50	ug/L	NC	20
7422252	Total Dissolved Solids	2014/03/21	NC	80 - 120	112	80 - 120	14, RDL=10	mg/L	7.8	20
7422826	Fluoride (F)	2014/03/20	108	80 - 120	96	80 - 120	<0.010	mg/L	0	20
7423099	Dissolved Chloride (Cl)	2014/03/20	93	80 - 120	105	80 - 120	<0.50	mg/L	NC	20
7423101	Dissolved Sulphate (SO4)	2014/03/20	NC	80 - 120	101	80 - 120	<0.50	mg/L	0.2	20
7423121	Alkalinity (Total as CaCO3)	2014/03/20	NC	80 - 120	96	80 - 120	<0.50	mg/L	0.6	20
7423121	Alkalinity (PP as CaCO3)	2014/03/20					<0.50	mg/L	NC	20
7423121	Bicarbonate (HCO3)	2014/03/20					<0.50	mg/L	0.6	20

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

Maxxam Job #: B421376
Report Date: 2014/03/24

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7423121	Carbonate (CO3)	2014/03/20					<0.50	mg/L	NC	20
7423121	Hydroxide (OH)	2014/03/20					<0.50	mg/L	NC	20
7423123	Conductivity	2014/03/20			101	80 - 120	<1.0	uS/cm	0.8	20
7425793	Dissolved Mercury (Hg)	2014/03/24	95	80 - 120	100	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B421376

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B421376 **COC #:** EB960314 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: J Dobson, S Roberts

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT) (5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? ☑ Y ☐ N Field Acidified? ☑ Y ☐ N	Total Metals Field Acidified? ☐ Y ☐ N	☑ Nitrate ☑ Nitrite ☑ Ammonia	☑ Total Suspended Solids (TSS) ☐ TDS	☑ pH ☑ Conductivity ☑ Alkalinity	☑ Chloride ☑ Fluoride ☑ Sulphate	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226																		Number of Containers
1	MW12-07-01	JB4585	Ground W	14/03/16 15:40	X		X	X	X	X																						3
2	MW12-07-02	JB4586	Ground W	14/03/16 17:20	X		X	X	X	X																						3
3																																
4																																
5																																
6																																
7																																
8																																
9																																
10																																
11																																
12																																

B421376

Print name and sign

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Print name and sign Received by :	Date (yy/mm/dd) :	Time (24 hr)	Time Sensitive
J Dobson	14/03/17	09:00	Laurel Berthier	2014/03/18	09:05	☑

Laboratory Use Only

Temperature on Receipt (°C)			Custody Seal	Yes	No
A) 2	B) 2	C) 2	Present?	☐	☑
Just sampled & rec'd on ice ☐			Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB981614

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/04/28
Report #: R1558797
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B431441
Received: 2014/04/22, 10:20

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/04/23	2014/04/23	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	1	N/A	2014/04/23	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	1	N/A	2014/04/23	BBY6SOP-00026	SM-2510B
Fluoride	1	N/A	2014/04/22	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	1	N/A	2014/04/28	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	1	N/A	2014/04/25	BBY7SOP-00015	EPA 245.7
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/04/28	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	1	N/A	2014/04/25	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	1	N/A	2014/04/25	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	1	N/A	2014/04/23	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	1	N/A	2014/04/23	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	1	N/A	2014/04/24	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	1	N/A	2014/04/22	BBY6WI-00001	EPA 200.2
pH Water (1)	1	N/A	2014/04/23	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	1	N/A	2014/04/23	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	1	2014/04/25	2014/04/28	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JK5960		
Sampling Date		2014/04/19 15:15		
	UNITS	**MW12-07-01**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	3.80(1)	0.050	7462724
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	9.27	0.20	7460276
Misc. Inorganics				
Fluoride (F)	mg/L	1.00	0.010	7460465
Alkalinity (Total as CaCO3)	mg/L	319	0.50	7461673
Alkalinity (PP as CaCO3)	mg/L	4.54	0.50	7461673
Bicarbonate (HCO3)	mg/L	378	0.50	7461673
Carbonate (CO3)	mg/L	5.45	0.50	7461673
Hydroxide (OH)	mg/L	<0.50	0.50	7461673
Anions				
Dissolved Sulphate (SO4)	mg/L	269	5.0	7462853
Dissolved Chloride (Cl)	mg/L	3.7	0.50	7462842
Nutrients				
Ammonia (N)	mg/L	0.22	0.0050	7465055
Nitrate plus Nitrite (N)	mg/L	13.1(1)	0.20	7462716
Physical Properties				
Conductivity	uS/cm	1210	1.0	7461687
pH	pH	8.38		7461681
Physical Properties				
Total Dissolved Solids	mg/L	774	10	7464217

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JK5960		
Sampling Date		2014/04/19 15:15		
	UNITS	**MW12-07-01**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	524	0.50	7459837
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7464141

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JK5960		
Sampling Date		2014/04/19 15:15		
	UNITS	**MW12-07-01**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	4.6	3.0	7462692
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7462692
Dissolved Arsenic (As)	ug/L	0.86	0.10	7462692
Dissolved Barium (Ba)	ug/L	42.6	1.0	7462692
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7462692
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7462692
Dissolved Boron (B)	ug/L	435	50	7462692
Dissolved Cadmium (Cd)	ug/L	0.096	0.010	7462692
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7462692
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7462692
Dissolved Copper (Cu)	ug/L	2.98	0.20	7462692
Dissolved Iron (Fe)	ug/L	176	5.0	7462692
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7462692
Dissolved Lithium (Li)	ug/L	18.5	5.0	7462692
Dissolved Manganese (Mn)	ug/L	87.0	1.0	7462692
Dissolved Molybdenum (Mo)	ug/L	14.6	1.0	7462692
Dissolved Nickel (Ni)	ug/L	<1.0	1.0	7462692
Dissolved Phosphorus (P)	ug/L	18	10	7462692
Dissolved Selenium (Se)	ug/L	2.25	0.10	7462692
Dissolved Silicon (Si)	ug/L	6930	100	7462692
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7462692
Dissolved Strontium (Sr)	ug/L	7530	1.0	7462692
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7462692
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7462692
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7462692
Dissolved Uranium (U)	ug/L	3.74	0.10	7462692
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7462692
Dissolved Zinc (Zn)	ug/L	114	5.0	7462692
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7462692
Dissolved Calcium (Ca)	mg/L	175	0.050	7459840
Dissolved Magnesium (Mg)	mg/L	21.3	0.050	7459840
Dissolved Potassium (K)	mg/L	3.56	0.050	7459840
Dissolved Sodium (Na)	mg/L	71.9	0.050	7459840
Dissolved Sulphur (S)	mg/L	109	3.0	7459840

RDL = Reportable Detection Limit

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7460465	Fluoride (F)	2014/04/22	NC	80 - 120	106	80 - 120	<0.010	mg/L	NC	20
7461673	Alkalinity (Total as CaCO3)	2014/04/23	107	80 - 120	96	80 - 120	<0.50	mg/L	8.1	20
7461673	Alkalinity (PP as CaCO3)	2014/04/23					<0.50	mg/L	NC	20
7461673	Bicarbonate (HCO3)	2014/04/23					<0.50	mg/L	8.1	20
7461673	Carbonate (CO3)	2014/04/23					<0.50	mg/L	NC	20
7461673	Hydroxide (OH)	2014/04/23					<0.50	mg/L	NC	20
7461687	Conductivity	2014/04/23			100	80 - 120	1.3, RDL=1.0	uS/cm	0.3	20
7462692	Dissolved Aluminum (Al)	2014/04/25	98	80 - 120	105	80 - 120	<3.0	ug/L		
7462692	Dissolved Antimony (Sb)	2014/04/25	102	80 - 120	98	80 - 120	<0.50	ug/L		
7462692	Dissolved Arsenic (As)	2014/04/25	107	80 - 120	104	80 - 120	<0.10	ug/L		
7462692	Dissolved Barium (Ba)	2014/04/25	NC	80 - 120	104	80 - 120	<1.0	ug/L		
7462692	Dissolved Beryllium (Be)	2014/04/25	98	80 - 120	97	80 - 120	<0.10	ug/L		
7462692	Dissolved Bismuth (Bi)	2014/04/25	93	80 - 120	98	80 - 120	<1.0	ug/L	NC	20
7462692	Dissolved Cadmium (Cd)	2014/04/25	100	80 - 120	100	80 - 120	<0.010	ug/L		
7462692	Dissolved Chromium (Cr)	2014/04/25	96	80 - 120	100	80 - 120	<1.0	ug/L		
7462692	Dissolved Cobalt (Co)	2014/04/25	92	80 - 120	98	80 - 120	<0.50	ug/L		
7462692	Dissolved Copper (Cu)	2014/04/25	90	80 - 120	101	80 - 120	<0.20	ug/L		
7462692	Dissolved Iron (Fe)	2014/04/25	100	80 - 120	105	80 - 120	<5.0	ug/L		
7462692	Dissolved Lead (Pb)	2014/04/25	95	80 - 120	99	80 - 120	<0.20	ug/L		
7462692	Dissolved Lithium (Li)	2014/04/25	NC	80 - 120	98	80 - 120	<5.0	ug/L		
7462692	Dissolved Manganese (Mn)	2014/04/25	NC	80 - 120	104	80 - 120	<1.0	ug/L		
7462692	Dissolved Molybdenum (Mo)	2014/04/25	113	80 - 120	101	80 - 120	<1.0	ug/L		
7462692	Dissolved Nickel (Ni)	2014/04/25	92	80 - 120	101	80 - 120	<1.0	ug/L		
7462692	Dissolved Selenium (Se)	2014/04/25	110	80 - 120	105	80 - 120	<0.10	ug/L		
7462692	Dissolved Silver (Ag)	2014/04/25	98	80 - 120	97	80 - 120	<0.020	ug/L		
7462692	Dissolved Strontium (Sr)	2014/04/25	NC	80 - 120	103	80 - 120	<1.0	ug/L		
7462692	Dissolved Thallium (Tl)	2014/04/25	96	80 - 120	99	80 - 120	<0.050	ug/L		
7462692	Dissolved Tin (Sn)	2014/04/25	92	80 - 120	96	80 - 120	<5.0	ug/L		
7462692	Dissolved Titanium (Ti)	2014/04/25	108	80 - 120	108	80 - 120	<5.0	ug/L		
7462692	Dissolved Uranium (U)	2014/04/25	97	80 - 120	97	80 - 120	<0.10	ug/L		
7462692	Dissolved Vanadium (V)	2014/04/25	98	80 - 120	99	80 - 120	<5.0	ug/L		
7462692	Dissolved Zinc (Zn)	2014/04/25	NC	80 - 120	99	80 - 120	<5.0	ug/L		
7462692	Dissolved Boron (B)	2014/04/25					<50	ug/L		
7462692	Dissolved Phosphorus (P)	2014/04/25					<10	ug/L		
7462692	Dissolved Silicon (Si)	2014/04/25					<100	ug/L		
7462692	Dissolved Zirconium (Zr)	2014/04/25					<0.50	ug/L		
7462716	Nitrate plus Nitrite (N)	2014/04/23	NC	80 - 120	105	80 - 120	<0.020	mg/L	0.4	25
7462724	Nitrite (N)	2014/04/23	NC	80 - 120	99	80 - 120	<0.0050	mg/L	NC	20
7462842	Dissolved Chloride (Cl)	2014/04/23	NC	80 - 120	102	80 - 120	<0.50	mg/L	1.1	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7462853	Dissolved Sulphate (SO4)	2014/04/23	NC	80 - 120	100	80 - 120	<0.50	mg/L	1	20
7464141	Dissolved Mercury (Hg)	2014/04/25	103	80 - 120	108	80 - 120	<0.010	ug/L	NC	20
7464217	Total Dissolved Solids	2014/04/28	103	80 - 120	88	80 - 120	<10	mg/L	8.4	20
7465055	Ammonia (N)	2014/04/25	90	80 - 120	100	80 - 120	0.0058, RDL=0.0050	mg/L	NC	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B431441

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B431441

COC #: EB981614

Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail:

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry/ Shaun Roberts

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226																		Number of Containers
1	MW12-07-01	JK5960	Ground W	4/19/14 15:15	X	X		X	X	X	X																						3
2																																	
3																																	
4																																	
5																																	
6																																	
7																																	
8																																	
9																																	
10																																	
11																																	
12																																	

B431441

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd)	Time (24 hr)	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	21-Apr-14	9:00	Laurel Berthier	2014/04/22	10:20		A) 1 B) 1 C) 1	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB986214

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/05/07
Report #: R1564117
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B434517
Received: 2014/05/01, 10:05

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/05/02	2014/05/02	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	1	N/A	2014/05/03	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	1	N/A	2014/05/02	BBY6SOP-00026	SM-2510B
Fluoride	1	N/A	2014/05/05	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	1	N/A	2014/05/06	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	1	N/A	2014/05/06	BBY7SOP-00015	EPA 245.7
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/05/06	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	1	N/A	2014/05/05	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	1	N/A	2014/05/02	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	1	N/A	2014/05/02	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	1	N/A	2014/05/02	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	1	N/A	2014/05/05	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	1	N/A	2014/05/01	BBY6WI-00001	EPA 200.2
pH Water (1)	1	N/A	2014/05/02	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	1	N/A	2014/05/03	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	1	2014/05/05	2014/05/07	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

Maxxam Job #: B434517
Report Date: 2014/05/07

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JN1432		
Sampling Date		2014/04/28 17:00		
	UNITS	**MW12-07-01**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	4.37(1)	0.050	7473190
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	8.13	0.20	7470430
Misc. Inorganics				
Fluoride (F)	mg/L	0.950	0.010	7475132
Alkalinity (Total as CaCO3)	mg/L	314	0.50	7472916
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7472916
Bicarbonate (HCO3)	mg/L	383	0.50	7472916
Carbonate (CO3)	mg/L	<0.50	0.50	7472916
Hydroxide (OH)	mg/L	<0.50	0.50	7472916
Anions				
Dissolved Sulphate (SO4)	mg/L	307	5.0	7473813
Dissolved Chloride (Cl)	mg/L	2.8	0.50	7473811
Nutrients				
Ammonia (N)	mg/L	0.20	0.0050	7473141
Nitrate plus Nitrite (N)	mg/L	12.5(1)	0.20	7473107
Physical Properties				
Conductivity	uS/cm	1220	1.0	7472929
pH	pH	8.22		7472924
Physical Properties				
Total Dissolved Solids	mg/L	832	10	7474562

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JN1432		
Sampling Date		2014/04/28 17:00		
	UNITS	**MW12-07-01**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	543	0.50	7470843
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7476451

RDL = Reportable Detection Limit

Maxxam Job #: B434517
Report Date: 2014/05/07

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JN1432		
Sampling Date		2014/04/28 17:00		
	UNITS	**MW12-07-01**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	<3.0	3.0	7472668
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7472668
Dissolved Arsenic (As)	ug/L	0.65	0.10	7472668
Dissolved Barium (Ba)	ug/L	43.0	1.0	7472668
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7472668
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7472668
Dissolved Boron (B)	ug/L	571	50	7472668
Dissolved Cadmium (Cd)	ug/L	0.102	0.010	7472668
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7472668
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7472668
Dissolved Copper (Cu)	ug/L	3.51	0.20	7472668
Dissolved Iron (Fe)	ug/L	111	5.0	7472668
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7472668
Dissolved Lithium (Li)	ug/L	20.8	5.0	7472668
Dissolved Manganese (Mn)	ug/L	84.9	1.0	7472668
Dissolved Molybdenum (Mo)	ug/L	17.0	1.0	7472668
Dissolved Nickel (Ni)	ug/L	1.8	1.0	7472668
Dissolved Phosphorus (P)	ug/L	<10	10	7472668
Dissolved Selenium (Se)	ug/L	6.33	0.10	7472668
Dissolved Silicon (Si)	ug/L	6560	100	7472668
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7472668
Dissolved Strontium (Sr)	ug/L	8180	1.0	7472668
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7472668
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7472668
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7472668
Dissolved Uranium (U)	ug/L	3.88	0.10	7472668
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7472668
Dissolved Zinc (Zn)	ug/L	43.3	5.0	7472668
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7472668
Dissolved Calcium (Ca)	mg/L	180	0.050	7471107
Dissolved Magnesium (Mg)	mg/L	22.6	0.050	7471107
Dissolved Potassium (K)	mg/L	3.53	0.050	7471107
Dissolved Sodium (Na)	mg/L	75.0	0.050	7471107
Dissolved Sulphur (S)	mg/L	110	3.0	7471107

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7472668	Dissolved Aluminum (Al)	2014/05/05	108	80 - 120	107	80 - 120	<3.0	ug/L		
7472668	Dissolved Antimony (Sb)	2014/05/05	109	80 - 120	105	80 - 120	<0.50	ug/L		
7472668	Dissolved Arsenic (As)	2014/05/05	111	80 - 120	102	80 - 120	<0.10	ug/L		
7472668	Dissolved Barium (Ba)	2014/05/05	NC	80 - 120	104	80 - 120	<1.0	ug/L		
7472668	Dissolved Beryllium (Be)	2014/05/05	103	80 - 120	101	80 - 120	<0.10	ug/L		
7472668	Dissolved Bismuth (Bi)	2014/05/05	103	80 - 120	105	80 - 120	<1.0	ug/L		
7472668	Dissolved Cadmium (Cd)	2014/05/05	109	80 - 120	106	80 - 120	<0.010	ug/L		
7472668	Dissolved Chromium (Cr)	2014/05/05	109	80 - 120	106	80 - 120	<1.0	ug/L		
7472668	Dissolved Cobalt (Co)	2014/05/05	104	80 - 120	105	80 - 120	<0.50	ug/L		
7472668	Dissolved Copper (Cu)	2014/05/05	100	80 - 120	105	80 - 120	<0.20	ug/L		
7472668	Dissolved Iron (Fe)	2014/05/05	110	80 - 120	115	80 - 120	<5.0	ug/L		
7472668	Dissolved Lead (Pb)	2014/05/05	104	80 - 120	104	80 - 120	<0.20	ug/L	NC	20
7472668	Dissolved Lithium (Li)	2014/05/05	108	80 - 120	108	80 - 120	<5.0	ug/L		
7472668	Dissolved Manganese (Mn)	2014/05/05	104	80 - 120	103	80 - 120	<1.0	ug/L		
7472668	Dissolved Molybdenum (Mo)	2014/05/05	113	80 - 120	103	80 - 120	<1.0	ug/L		
7472668	Dissolved Nickel (Ni)	2014/05/05	101	80 - 120	107	80 - 120	<1.0	ug/L		
7472668	Dissolved Selenium (Se)	2014/05/05	113	80 - 120	107	80 - 120	<0.10	ug/L		
7472668	Dissolved Silver (Ag)	2014/05/05	94	80 - 120	94	80 - 120	<0.020	ug/L		
7472668	Dissolved Strontium (Sr)	2014/05/05	NC	80 - 120	102	80 - 120	<1.0	ug/L		
7472668	Dissolved Thallium (Tl)	2014/05/05	101	80 - 120	108	80 - 120	<0.050	ug/L		
7472668	Dissolved Tin (Sn)	2014/05/05	106	80 - 120	99	80 - 120	<5.0	ug/L		
7472668	Dissolved Titanium (Ti)	2014/05/05	104	80 - 120	110	80 - 120	<5.0	ug/L		
7472668	Dissolved Uranium (U)	2014/05/05	102	80 - 120	99	80 - 120	<0.10	ug/L		
7472668	Dissolved Vanadium (V)	2014/05/05	110	80 - 120	103	80 - 120	<5.0	ug/L		
7472668	Dissolved Zinc (Zn)	2014/05/05	104	80 - 120	106	80 - 120	<5.0	ug/L		
7472668	Dissolved Boron (B)	2014/05/05					<50	ug/L		
7472668	Dissolved Phosphorus (P)	2014/05/05					<10	ug/L		
7472668	Dissolved Silicon (Si)	2014/05/05					<100	ug/L		
7472668	Dissolved Zirconium (Zr)	2014/05/05					<0.50	ug/L		
7472916	Alkalinity (Total as CaCO3)	2014/05/02	NC	80 - 120	97	80 - 120	<0.50	mg/L	0.2	20
7472916	Alkalinity (PP as CaCO3)	2014/05/02					<0.50	mg/L	NC	20
7472916	Bicarbonate (HCO3)	2014/05/02					<0.50	mg/L	0.2	20
7472916	Carbonate (CO3)	2014/05/02					<0.50	mg/L	NC	20
7472916	Hydroxide (OH)	2014/05/02					<0.50	mg/L	NC	20
7472929	Conductivity	2014/05/02			100	80 - 120	1.6, RDL=1.0	uS/cm	0	20
7473107	Nitrate plus Nitrite (N)	2014/05/02	104	80 - 120	102	80 - 120	<0.020	mg/L	0.9	25
7473141	Ammonia (N)	2014/05/02	112	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7473190	Nitrite (N)	2014/05/02	103	80 - 120	98	80 - 120	<0.0050	mg/L	NC	20
7473811	Dissolved Chloride (Cl)	2014/05/03	97	80 - 120	104	80 - 120	<0.50	mg/L	1.2	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7473813	Dissolved Sulphate (SO4)	2014/05/03	NC	80 - 120	98	80 - 120	<0.50	mg/L	0.7	20
7474562	Total Dissolved Solids	2014/05/07	102	80 - 120	98	80 - 120	<10	mg/L	4.8	20
7475132	Fluoride (F)	2014/05/05			94	80 - 120	<0.010	mg/L	4.1	20
7476451	Dissolved Mercury (Hg)	2014/05/06	93	80 - 120	102	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.

NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B434517

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B434517 **COC #:** EB986214 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry/ Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

- ● Regular Turn Around Time (TAT) (5 days for most tests)
- **RUSH** (Please contact the lab)
- ○ 1 Day ○ 2 Day ○ 3 Day
- Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) (Field Filtered? Y ☑ N ☐; Field Acidified? Y ☑ N ☐)	Total Metals (Field Acidified? Y ☐ N ☐)	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226	Number of Containers
1	MW12-07-01	JN1432	Ground W	4/28/14 17:00	X		X	X	X	X					3
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															

B434517

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	30-Apr-14	7:15		2014/05/01	10:05	☑	A) 2 B) 3 C) 3	Present?	☐	☑
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB987614

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/05/09
Report #: R1565427
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B435285
Received: 2014/05/05, 09:20

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/05/05	2014/05/05	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	1	N/A	2014/05/05	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	1	N/A	2014/05/05	BBY6SOP-00026	SM-2510B
Fluoride	1	N/A	2014/05/06	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	1	N/A	2014/05/07	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	1	N/A	2014/05/09	BBY7SOP-00015	EPA 245.7
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/05/07	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	1	N/A	2014/05/06	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	1	N/A	2014/05/06	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	1	N/A	2014/05/06	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	1	N/A	2014/05/06	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	1	N/A	2014/05/07	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	1	N/A	2014/05/05	BBY6WI-00001	EPA 200.2
pH Water (1)	1	N/A	2014/05/05	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	1	N/A	2014/05/05	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	1	2014/05/07	2014/05/08	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

MINTO EXPLORATIONS LTD.
Maxxam Job #: B435285
Report Date: 2014/05/09
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B435285
Report Date: 2014/05/09

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JN6716		
Sampling Date		2014/04/30 14:00		
	UNITS	**MW12-07-02**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	1.05(1)	0.025	7476849
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.408	0.025	7474350
Misc. Inorganics				
Fluoride (F)	mg/L	1.40	0.010	7476805
Alkalinity (Total as CaCO3)	mg/L	111	0.50	7475371
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7475371
Bicarbonate (HCO3)	mg/L	135	0.50	7475371
Carbonate (CO3)	mg/L	<0.50	0.50	7475371
Hydroxide (OH)	mg/L	<0.50	0.50	7475371
Anions				
Dissolved Sulphate (SO4)	mg/L	617	5.0	7475208
Dissolved Chloride (Cl)	mg/L	1.5	0.50	7475180
Nutrients				
Ammonia (N)	mg/L	0.15	0.0050	7476636
Nitrate plus Nitrite (N)	mg/L	1.46(1)	0.020	7476843
Physical Properties				
Conductivity	uS/cm	1370	1.0	7475378
pH	pH	7.81		7475377
Physical Properties				
Total Dissolved Solids	mg/L	1070	10	7477353

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample arrived to laboratory past recommended hold time.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JN6716		
Sampling Date		2014/04/30 14:00		
	UNITS	**MW12-07-02**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	567	0.50	7474347
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7480225

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JN6716		
Sampling Date		2014/04/30 14:00		
	UNITS	**MW12-07-02**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	4.0	3.0	7476448
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7476448
Dissolved Arsenic (As)	ug/L	1.54	0.10	7476448
Dissolved Barium (Ba)	ug/L	17.8	1.0	7476448
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7476448
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7476448
Dissolved Boron (B)	ug/L	628	50	7476448
Dissolved Cadmium (Cd)	ug/L	0.015	0.010	7476448
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7476448
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7476448
Dissolved Copper (Cu)	ug/L	0.55	0.20	7476448
Dissolved Iron (Fe)	ug/L	213	5.0	7476448
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7476448
Dissolved Lithium (Li)	ug/L	24.3	5.0	7476448
Dissolved Manganese (Mn)	ug/L	136	1.0	7476448
Dissolved Molybdenum (Mo)	ug/L	17.9	1.0	7476448
Dissolved Nickel (Ni)	ug/L	<1.0	1.0	7476448
Dissolved Phosphorus (P)	ug/L	12	10	7476448
Dissolved Selenium (Se)	ug/L	0.23	0.10	7476448
Dissolved Silicon (Si)	ug/L	5580	100	7476448
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7476448
Dissolved Strontium (Sr)	ug/L	9820	1.0	7476448
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7476448
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7476448
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7476448
Dissolved Uranium (U)	ug/L	1.77	0.10	7476448
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7476448
Dissolved Zinc (Zn)	ug/L	<5.0	5.0	7476448
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7476448
Dissolved Calcium (Ca)	mg/L	177	0.050	7474348
Dissolved Magnesium (Mg)	mg/L	30.3	0.050	7474348
Dissolved Potassium (K)	mg/L	2.62	0.050	7474348
Dissolved Sodium (Na)	mg/L	73.7	0.050	7474348
Dissolved Sulphur (S)	mg/L	229	3.0	7474348

RDL = Reportable Detection Limit

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7475180	Dissolved Chloride (Cl)	2014/05/05	94	80 - 120	103	80 - 120	<0.50	mg/L	NC	20
7475208	Dissolved Sulphate (SO4)	2014/05/05	92	80 - 120	98	80 - 120	0.67, RDL=0.50	mg/L	4.3	20
7475371	Alkalinity (Total as CaCO3)	2014/05/05	NC	80 - 120	99	80 - 120	<0.50	mg/L	3.0	20
7475371	Alkalinity (PP as CaCO3)	2014/05/05					<0.50	mg/L	NC	20
7475371	Bicarbonate (HCO3)	2014/05/05					<0.50	mg/L	3.0	20
7475371	Carbonate (CO3)	2014/05/05					<0.50	mg/L	NC	20
7475371	Hydroxide (OH)	2014/05/05					<0.50	mg/L	NC	20
7475378	Conductivity	2014/05/05			99	80 - 120	<1.0	uS/cm	0.5	20
7476448	Dissolved Aluminum (Al)	2014/05/06	100	80 - 120	104	80 - 120	<3.0	ug/L	2.2	20
7476448	Dissolved Antimony (Sb)	2014/05/06	103	80 - 120	99	80 - 120	<0.50	ug/L		
7476448	Dissolved Arsenic (As)	2014/05/06	109	80 - 120	102	80 - 120	<0.10	ug/L		
7476448	Dissolved Barium (Ba)	2014/05/06	NC	80 - 120	100	80 - 120	<1.0	ug/L		
7476448	Dissolved Beryllium (Be)	2014/05/06	99	80 - 120	96	80 - 120	<0.10	ug/L		
7476448	Dissolved Bismuth (Bi)	2014/05/06	89	80 - 120	94	80 - 120	<1.0	ug/L		
7476448	Dissolved Cadmium (Cd)	2014/05/06	98	80 - 120	100	80 - 120	<0.010	ug/L		
7476448	Dissolved Chromium (Cr)	2014/05/06	96	80 - 120	100	80 - 120	<1.0	ug/L		
7476448	Dissolved Cobalt (Co)	2014/05/06	94	80 - 120	99	80 - 120	<0.50	ug/L		
7476448	Dissolved Copper (Cu)	2014/05/06	89	80 - 120	100	80 - 120	<0.20	ug/L		
7476448	Dissolved Iron (Fe)	2014/05/06	104	80 - 120	112	80 - 120	<5.0	ug/L		
7476448	Dissolved Lead (Pb)	2014/05/06	93	80 - 120	96	80 - 120	<0.20	ug/L		
7476448	Dissolved Lithium (Li)	2014/05/06	100	80 - 120	101	80 - 120	<5.0	ug/L		
7476448	Dissolved Manganese (Mn)	2014/05/06	93	80 - 120	98	80 - 120	<1.0	ug/L		
7476448	Dissolved Molybdenum (Mo)	2014/05/06	NC	80 - 120	96	80 - 120	<1.0	ug/L		
7476448	Dissolved Nickel (Ni)	2014/05/06	92	80 - 120	98	80 - 120	<1.0	ug/L		
7476448	Dissolved Selenium (Se)	2014/05/06	112	80 - 120	111	80 - 120	<0.10	ug/L		
7476448	Dissolved Silver (Ag)	2014/05/06	99	80 - 120	96	80 - 120	<0.020	ug/L		
7476448	Dissolved Strontium (Sr)	2014/05/06	NC	80 - 120	99	80 - 120	<1.0	ug/L		
7476448	Dissolved Thallium (Tl)	2014/05/06	92	80 - 120	100	80 - 120	<0.050	ug/L		
7476448	Dissolved Tin (Sn)	2014/05/06	93	80 - 120	95	80 - 120	<5.0	ug/L		
7476448	Dissolved Titanium (Ti)	2014/05/06	102	80 - 120	99	80 - 120	<5.0	ug/L		
7476448	Dissolved Uranium (U)	2014/05/06	97	80 - 120	96	80 - 120	<0.10	ug/L		
7476448	Dissolved Vanadium (V)	2014/05/06	91	80 - 120	98	80 - 120	<5.0	ug/L		
7476448	Dissolved Zinc (Zn)	2014/05/06	100	80 - 120	102	80 - 120	<5.0	ug/L		
7476448	Dissolved Boron (B)	2014/05/06					<50	ug/L		
7476448	Dissolved Phosphorus (P)	2014/05/06					<10	ug/L		
7476448	Dissolved Silicon (Si)	2014/05/06					<100	ug/L		
7476448	Dissolved Zirconium (Zr)	2014/05/06					<0.50	ug/L		
7476636	Ammonia (N)	2014/05/06	97	80 - 120	100	80 - 120	0.0051, RDL=0.0050	mg/L	0.3	20
7476805	Fluoride (F)	2014/05/06	98	80 - 120	98	80 - 120	0.010, RDL=0.010	mg/L	NC	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7476843	Nitrate plus Nitrite (N)	2014/05/06	97	80 - 120	101	80 - 120	<0.020	mg/L	NC	25
7476849	Nitrite (N)	2014/05/06	97	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7477353	Total Dissolved Solids	2014/05/08	105	80 - 120	102	80 - 120	<10	mg/L	3.4	20
7480225	Dissolved Mercury (Hg)	2014/05/09	101	80 - 120	112	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B435285

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B435285 **COC #:** EB987614 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Minto Explorations Ltd		
Contact Name:	Elvina Wong		
Address:	Suite 900 - 999 West Hastings St		
	Vancouver, B.C.	PC:	V6C 2W2
Phone / Fax#:	Ph: 604-684-8894	Fax:	604-688-2120
E-mail			

Report To:

Company Name:	Minto Explorations Ltd		
Contact Name:	Minto Environment		
Address:	Suite 900-999 West Hastings St		
	Vancouver, B.C.	PC:	V6C 2W2
Phone / Fax#:	Ph: 604-684-8894	Fax:	604-688-2120
E-mail	minto_environment@mintomine.com		

PO #:	208977
Quotation #:	
Project # :	
Proj. Name:	Minto Env. Monitoring
Location:	Yukon
Sampled by:	Phil Emerson/Chris Harry

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other ______
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT) (5 days for most tests)

RUSH (Please contact the lab)

○ 1 Day ○ 2 Day ○ 3 Day

Date Required: ______

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM): Field Filtered? Y ☑ N ☐	Dissolved Metals (DM): Field Addified? Y ☑ N ☐	Total Metals: Field Addified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226	Number of Containers
1	MW12-07-02	JN6716	Ground W	4/30/14 14:00	X	X		X	X	X	X					3
2																
3																
4																
5																
6																
7																
8																
9																
10																
11	B435285															
12																

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by	Date (yy/mm/dd)	Time (24 hr)	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	2-May-14	7:15	JOHN CURRIE	14/05/05	09:20		A) 4 B) 2 C) 2	Present?	☐	☐
						☑	Just sampled & rec'd on ice ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

1 1 3

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1003014

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/03
Report #: R1578493
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B443193
Received: 2014/05/28, 14:10

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/05/29	2014/05/30	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/05/29	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	3	N/A	2014/05/30	BBY6SOP-00026	SM-2510B
Fluoride	3	N/A	2014/05/29	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	3	N/A	2014/06/02	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	3	N/A	2014/06/03	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	3	N/A	2014/06/02	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	3	N/A	2014/06/01	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	3	N/A	2014/05/29	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	3	N/A	2014/05/29	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	3	N/A	2014/05/29	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	3	N/A	2014/05/30	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	3	N/A	2014/05/28	BBY6WI-00001	EPA 200.2
pH Water (1)	3	N/A	2014/05/30	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	3	N/A	2014/05/29	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	3	2014/05/31	2014/06/02	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

Maxxam Job #: B443193
Report Date: 2014/06/03

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JS1443		JS1444		JS1445		
Sampling Date		2014/05/24 14:30		2014/05/24 15:30		2014/05/24 00:00		
	UNITS	**MW12-07-01**	**RDL**	**MW12-07-02**	**RDL**	**DUP**	**RDL**	**QC Batch**
ANIONS								
Nitrite (N)	mg/L	4.83(1)	0.050	0.897(1)	0.025	4.96(1)	0.050	7504925
Calculated Parameters								
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	4.54	0.20	0.392	0.025	4.65	0.20	7501178
Misc. Inorganics								
Fluoride (F)	mg/L	1.00	0.010	1.40	0.010	1.00	0.010	7503462
Alkalinity (Total as CaCO3)	mg/L	334	0.50	110	0.50	336	0.50	7503581
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7503581
Bicarbonate (HCO3)	mg/L	408	0.50	135	0.50	410	0.50	7503581
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7503581
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7503581
Anions								
Dissolved Sulphate (SO4)	mg/L	291	5.0	628	5.0	292	5.0	7503938
Dissolved Chloride (Cl)	mg/L	3.5	0.50	2.0	0.50	3.4	0.50	7503916
Nutrients								
Ammonia (N)	mg/L	0.37	0.0050	0.20	0.0050	0.42	0.0050	7503775
Nitrate plus Nitrite (N)	mg/L	9.36(1)	0.20	1.29(1)	0.020	9.62(1)	0.20	7504914
Physical Properties								
Conductivity	uS/cm	1190	1.0	1390	1.0	1190	1.0	7503587
pH	pH	8.29		8.08		8.27		7503586
Physical Properties								
Total Dissolved Solids	mg/L	818	10	1060	10	830	10	7505731

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample arrived to laboratory past recommended hold time.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS1443	JS1444	JS1445		
Sampling Date		2014/05/24 14:30	2014/05/24 15:30	2014/05/24 00:00		
	UNITS	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics						
Dissolved Hardness (CaCO3)	mg/L	481	608	486	0.50	7502637
Elements						
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	0.010	7509950

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS1443	JS1444	JS1445		
Sampling Date		2014/05/24 14:30	2014/05/24 15:30	2014/05/24 00:00		
	UNITS	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS						
Dissolved Aluminum (Al)	ug/L	9.7	6.9	10.7	3.0	7504261
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	0.50	7504261
Dissolved Arsenic (As)	ug/L	1.00	1.09	0.84	0.10	7504261
Dissolved Barium (Ba)	ug/L	36.7	16.8	35.7	1.0	7504261
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	0.10	7504261
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	1.0	7504261
Dissolved Boron (B)	ug/L	787	297	690	50	7504261
Dissolved Cadmium (Cd)	ug/L	0.045	<0.010	0.049	0.010	7504261
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	1.0	7504261
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	0.50	7504261
Dissolved Copper (Cu)	ug/L	2.49	0.74	3.78	0.20	7504261
Dissolved Iron (Fe)	ug/L	261	236	142	5.0	7504261
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	0.20	7504261
Dissolved Lithium (Li)	ug/L	17.2	22.1	18.6	5.0	7504261
Dissolved Manganese (Mn)	ug/L	83.8	142	81.3	1.0	7504261
Dissolved Molybdenum (Mo)	ug/L	13.9	15.7	13.7	1.0	7504261
Dissolved Nickel (Ni)	ug/L	2.2	<1.0	<1.0	1.0	7504261
Dissolved Phosphorus (P)	ug/L	23	<10	19	10	7504261
Dissolved Selenium (Se)	ug/L	2.08	0.12	2.07	0.10	7504261
Dissolved Silicon (Si)	ug/L	6740	5970	6630	100	7504261
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	0.020	7504261
Dissolved Strontium (Sr)	ug/L	7300	9800	7310	1.0	7504261
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	0.050	7504261
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	5.0	7504261
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	5.0	7504261
Dissolved Uranium (U)	ug/L	3.25	1.09	3.44	0.10	7504261
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	5.0	7504261
Dissolved Zinc (Zn)	ug/L	56.9	<5.0	38.8	5.0	7504261
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	0.50	7504261
Dissolved Calcium (Ca)	mg/L	159	193	161	0.050	7501177
Dissolved Magnesium (Mg)	mg/L	20.2	30.7	20.4	0.050	7501177
Dissolved Potassium (K)	mg/L	3.35	2.75	3.18	0.050	7501177
Dissolved Sodium (Na)	mg/L	74.7	72.3	77.2	0.050	7501177
Dissolved Sulphur (S)	mg/L	97.8	217	91.6	3.0	7501177

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7503462	Fluoride (F)	2014/05/29	110	80 - 120	102	80 - 120	<0.010	mg/L	NC	20
7503581	Alkalinity (Total as CaCO3)	2014/05/30	107	80 - 120	95	80 - 120	<0.50	mg/L	5.1	20
7503581	Alkalinity (PP as CaCO3)	2014/05/30					<0.50	mg/L	NC	20
7503581	Bicarbonate (HCO3)	2014/05/30					<0.50	mg/L	5.1	20
7503581	Carbonate (CO3)	2014/05/30					<0.50	mg/L	NC	20
7503581	Hydroxide (OH)	2014/05/30					<0.50	mg/L	NC	20
7503587	Conductivity	2014/05/30			101	80 - 120	1.2, RDL=1.0	uS/cm	0.6	20
7503775	Ammonia (N)	2014/05/29	107	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7503916	Dissolved Chloride (Cl)	2014/05/29	101	80 - 120	103	80 - 120	<0.50	mg/L	0.7	20
7503938	Dissolved Sulphate (SO4)	2014/05/29	97	80 - 120	98	80 - 120	<0.50	mg/L	0.6	20
7504261	Dissolved Aluminum (Al)	2014/06/01	110	80 - 120	106	80 - 120	<3.0	ug/L		
7504261	Dissolved Antimony (Sb)	2014/06/01	104	80 - 120	99	80 - 120	<0.50	ug/L		
7504261	Dissolved Arsenic (As)	2014/06/01	105	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7504261	Dissolved Barium (Ba)	2014/06/01	101	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7504261	Dissolved Beryllium (Be)	2014/06/01	104	80 - 120	101	80 - 120	<0.10	ug/L		
7504261	Dissolved Bismuth (Bi)	2014/06/01	99	80 - 120	98	80 - 120	<1.0	ug/L		
7504261	Dissolved Cadmium (Cd)	2014/06/01	104	80 - 120	100	80 - 120	<0.010	ug/L		
7504261	Dissolved Chromium (Cr)	2014/06/01	103	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
7504261	Dissolved Cobalt (Co)	2014/06/01	103	80 - 120	99	80 - 120	<0.50	ug/L		
7504261	Dissolved Copper (Cu)	2014/06/01	100	80 - 120	97	80 - 120	<0.20	ug/L	NC	20
7504261	Dissolved Iron (Fe)	2014/06/01	105	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7504261	Dissolved Lead (Pb)	2014/06/01	101	80 - 120	99	80 - 120	<0.20	ug/L	NC	20
7504261	Dissolved Lithium (Li)	2014/06/01	102	80 - 120	97	80 - 120	<5.0	ug/L		
7504261	Dissolved Manganese (Mn)	2014/06/01	105	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7504261	Dissolved Molybdenum (Mo)	2014/06/01	100	80 - 120	103	80 - 120	<1.0	ug/L		
7504261	Dissolved Nickel (Ni)	2014/06/01	103	80 - 120	100	80 - 120	<1.0	ug/L		
7504261	Dissolved Selenium (Se)	2014/06/01	111	80 - 120	102	80 - 120	<0.10	ug/L		
7504261	Dissolved Silver (Ag)	2014/06/01	103	80 - 120	104	80 - 120	0.025, RDL=0.020	ug/L		
7504261	Dissolved Strontium (Sr)	2014/06/01	105	80 - 120	104	80 - 120	<1.0	ug/L		
7504261	Dissolved Thallium (Tl)	2014/06/01	81	80 - 120	101	80 - 120	<0.050	ug/L		
7504261	Dissolved Tin (Sn)	2014/06/01	96	80 - 120	95	80 - 120	<5.0	ug/L		
7504261	Dissolved Titanium (Ti)	2014/06/01	109	80 - 120	107	80 - 120	<5.0	ug/L		
7504261	Dissolved Uranium (U)	2014/06/01	98	80 - 120	96	80 - 120	<0.10	ug/L		
7504261	Dissolved Vanadium (V)	2014/06/01	104	80 - 120	96	80 - 120	<5.0	ug/L		
7504261	Dissolved Zinc (Zn)	2014/06/01	105	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7504261	Dissolved Boron (B)	2014/06/01					<50	ug/L		
7504261	Dissolved Phosphorus (P)	2014/06/01					<10	ug/L		
7504261	Dissolved Silicon (Si)	2014/06/01					<100	ug/L		
7504261	Dissolved Zirconium (Zr)	2014/06/01					<0.50	ug/L		

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7504914	Nitrate plus Nitrite (N)	2014/05/29	102	80 - 120	108	80 - 120	<0.020	mg/L	0.1	25
7504925	Nitrite (N)	2014/05/29	97	80 - 120	102	80 - 120	<0.0050	mg/L	0.5	20
7505731	Total Dissolved Solids	2014/06/02	NC	80 - 120	112	80 - 120	<10	mg/L	6.3	20
7509950	Dissolved Mercury (Hg)	2014/06/03	100	80 - 120	105	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was not sufficiently significant to permit a reliable recovery calculation.
NC (RPD): The RPD was not calculated. The level of analyte detected in the parent sample and its duplicate was not sufficiently significant to permit a reliable calculation.

Validation Signature Page

Maxxam Job #: B443193

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

==

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B443193 **COC #:** EB1003014 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry/ Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM): Field Filtered? Y ☑ N ☐	Dissolved Metals (DM): Field Acidified? Y ☑ N ☐	Total Metals: Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-07-01	JS1443	Ground W	5/24/14 14:30	X	X		X	X	X	X	3
2	MW12-07-02	JS1444	Ground W	5/24/14 15:30	X	X		X	X	X	X	3
3	DUP	JS1445	Ground W	5/24/14 0:00	X	X		X	X	X	X	3
4												
5												
6												
7												
8												
9												
10												
11												
12												

B443193

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd)	Time (24 hr)	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	~~26-May-14~~	9:45	Joanne Chen	2014/05/28	14:10		A) 4 B) 4 C) 5	Present?	☐	☐
	27-May-14					☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

5, 6, 5
4, 5, 4

NA JC

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1004814

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/06
Report #: R1580746
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B444318
Received: 2014/05/31, 12:35

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	4	2014/06/02	2014/06/02	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	4	N/A	2014/06/02	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	4	N/A	2014/06/02	BBY6SOP-00026	SM-2510B
Fluoride	4	N/A	2014/06/02	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	4	N/A	2014/06/06	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	4	N/A	2014/06/03	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	4	N/A	2014/05/31	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	4	N/A	2014/05/31	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	4	N/A	2014/05/31	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	4	N/A	2014/05/31	BBY6WI-00001	EPA 200.2
pH Water (1)	4	N/A	2014/06/02	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	3	N/A	2014/06/02	BBY6SOP-00017	SM4500-SO42- E
Sulphate by Automated Colourimetry	1	N/A	2014/06/03	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	4	2014/06/05	2014/06/06	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

Maxxam Job #: B444318
Report Date: 2014/06/06

-2-

This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B444318
Report Date: 2014/06/06

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JS7163	JS7164			JS7165			JS7166		
Sampling Date		2014/05/29 09:00	2014/05/29 10:30			2014/05/29 11:30			2014/05/30 00:00		
	UNITS	**MW12-05-01**	**MW12-05-03**	**RDL**	**QC Batch**	**MW12-05-05**	**RDL**	**QC Batch**	**DUP**	**RDL**	**QC Batch**
ANIONS											
Nitrite (N)	mg/L	0.161	0.132	0.0050	7506635	0.0905	0.0050	7506635	0.106	0.0050	7506635
Calculated Parameters											
Filter and HNO3 Preservation	N/A	FIELD	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.030	<0.020	0.020	7506493	0.291	0.020	7506493	0.026	0.020	7506493
Misc. Inorganics											
Fluoride (F)	mg/L	1.20	1.20	0.010	7508345	0.590	0.010	7508345	1.20	0.010	7508345
Alkalinity (Total as CaCO3)	mg/L	189	275	0.50	7508246	209	0.50	7508246	187	0.50	7508246
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	0.50	7508246	1.92	0.50	7508246	<0.50	0.50	7508246
Bicarbonate (HCO3)	mg/L	231	336	0.50	7508246	250	0.50	7508246	228	0.50	7508246
Carbonate (CO3)	mg/L	<0.50	<0.50	0.50	7508246	2.30	0.50	7508246	<0.50	0.50	7508246
Hydroxide (OH)	mg/L	<0.50	<0.50	0.50	7508246	<0.50	0.50	7508246	<0.50	0.50	7508246
Anions											
Dissolved Sulphate (SO4)	mg/L	643	717	5.0	7508475	36.4	0.50	7510459	647	5.0	7508475
Dissolved Chloride (Cl)	mg/L	12	9.3	0.50	7508421	6.5	0.50	7508421	12	0.50	7508421
Nutrients											
Total Ammonia (N)	mg/L	0.079	0.033	0.0050	7510502	0.019	0.0050	7510502	0.18	0.0050	7510502
Nitrate plus Nitrite (N)	mg/L	0.191	0.140	0.020	7506633	0.382	0.020	7506633	0.132	0.020	7506633
Physical Properties											
Conductivity	uS/cm	1530	1730	1.0	7508250	467	1.0	7508250	1540	1.0	7508250
pH	pH	8.28	8.22		7508249	8.35		7508249	8.26		7508249
Physical Properties											
Total Dissolved Solids	mg/L	1190	1400	10	7512930	278	10	7512930	1190	10	7512930

N/A = Not Applicable
RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS7163	JS7164	JS7165	JS7166		
Sampling Date		2014/05/29 09:00	2014/05/29 10:30	2014/05/29 11:30	2014/05/30 00:00		
	UNITS	**MW12-05-01**	**MW12-05-03**	**MW12-05-05**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics							
Dissolved Hardness (CaCO3)	mg/L	589	775	213	606	0.50	7506250
Elements							
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	7514534
Dissolved Metals by ICPMS							
Dissolved Aluminum (Al)	ug/L	9.4	<3.0	3.3	5.9	3.0	7511696
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511696
Dissolved Arsenic (As)	ug/L	0.83	0.30	0.15	0.93	0.10	7511696
Dissolved Barium (Ba)	ug/L	70.0	62.1	73.4	71.7	1.0	7511696
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	7511696
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511696
Dissolved Boron (B)	ug/L	177	167	165	152	50	7511696
Dissolved Cadmium (Cd)	ug/L	0.010	<0.010	<0.010	0.012	0.010	7511696
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511696
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511696
Dissolved Copper (Cu)	ug/L	0.34	<0.20	0.43	0.31	0.20	7511696
Dissolved Iron (Fe)	ug/L	17.9	3430	20.5	23.4	5.0	7511696
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	7511696
Dissolved Lithium (Li)	ug/L	7.0	5.8	<5.0	7.4	5.0	7511696
Dissolved Manganese (Mn)	ug/L	95.2	2370	209	96.1	1.0	7511696
Dissolved Molybdenum (Mo)	ug/L	<1.0	1.4	3.9	<1.0	1.0	7511696
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511696
Dissolved Phosphorus (P)	ug/L	19	<10	<10	18	10	7511696
Dissolved Selenium (Se)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	7511696
Dissolved Silicon (Si)	ug/L	6690	7760	6190	6790	100	7511696
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	7511696
Dissolved Strontium (Sr)	ug/L	5600	7760	764	5490	1.0	7511696
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	7511696
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Uranium (U)	ug/L	0.82	0.96	2.35	0.83	0.10	7511696
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511696
Dissolved Zinc (Zn)	ug/L	<5.0	5.4	12.0	<5.0	5.0	7511696
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511696
Dissolved Calcium (Ca)	mg/L	189	198	43.7	194	0.050	7506251

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS7163	JS7164	JS7165	JS7166		
Sampling Date		2014/05/29 09:00	2014/05/29 10:30	2014/05/29 11:30	2014/05/30 00:00		
	UNITS	**MW12-05-01**	**MW12-05-03**	**MW12-05-05**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	28.5	68.5	25.1	29.4	0.050	7506251
Dissolved Potassium (K)	mg/L	2.95	3.80	2.01	2.97	0.050	7506251
Dissolved Sodium (Na)	mg/L	111	108	17.7	108	0.050	7506251
Dissolved Sulphur (S)	mg/L	220	243	13.5	215	3.0	7506251

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7506633	Nitrate plus Nitrite (N)	2014/05/31	103	80 - 120	108	80 - 120	<0.020	mg/L	1	25
7506635	Nitrite (N)	2014/05/31	98	80 - 120	102	80 - 120	<0.0050	mg/L	0.09	20
7508246	Alkalinity (Total as CaCO3)	2014/06/02	NC	80 - 120	100	80 - 120	<0.50	mg/L	0.07	20
7508246	Alkalinity (PP as CaCO3)	2014/06/02					<0.50	mg/L	NC	20
7508246	Bicarbonate (HCO3)	2014/06/02					<0.50	mg/L	0.9	20
7508246	Carbonate (CO3)	2014/06/02					<0.50	mg/L	NC	20
7508246	Hydroxide (OH)	2014/06/02					<0.50	mg/L	NC	20
7508250	Conductivity	2014/06/02			98	80 - 120	1.0, RDL=1.0	uS/cm	0.3	20
7508345	Fluoride (F)	2014/06/02	NC	80 - 120					NC	20
7508421	Dissolved Chloride (Cl)	2014/06/02	NC	80 - 120	103	80 - 120	<0.50	mg/L	1.0	20
7508475	Dissolved Sulphate (SO4)	2014/06/02	NC	80 - 120	102	80 - 120	<0.50	mg/L	0.7	20
7510459	Dissolved Sulphate (SO4)	2014/06/03	NC	80 - 120	92	80 - 120	<0.50	mg/L	0.5	20
7510502	Total Ammonia (N)	2014/06/03	NC	80 - 120	100	80 - 120	<0.0050	mg/L	1.4	20
7511696	Dissolved Aluminum (Al)	2014/06/05	NC	80 - 120	102	80 - 120	<3.0	ug/L	0.5	20
7511696	Dissolved Antimony (Sb)	2014/06/05	100	80 - 120	97	80 - 120	<0.50	ug/L		
7511696	Dissolved Arsenic (As)	2014/06/05	100	80 - 120	101	80 - 120	<0.10	ug/L		
7511696	Dissolved Barium (Ba)	2014/06/05	97	80 - 120	101	80 - 120	<1.0	ug/L		
7511696	Dissolved Beryllium (Be)	2014/06/05	102	80 - 120	102	80 - 120	<0.10	ug/L		
7511696	Dissolved Bismuth (Bi)	2014/06/05	97	80 - 120	97	80 - 120	<1.0	ug/L		
7511696	Dissolved Cadmium (Cd)	2014/06/05	100	80 - 120	102	80 - 120	<0.010	ug/L		
7511696	Dissolved Chromium (Cr)	2014/06/05	104	80 - 120	103	80 - 120	<1.0	ug/L		
7511696	Dissolved Cobalt (Co)	2014/06/05	102	80 - 120	102	80 - 120	<0.50	ug/L		
7511696	Dissolved Copper (Cu)	2014/06/05	101	80 - 120	99	80 - 120	<0.20	ug/L		
7511696	Dissolved Iron (Fe)	2014/06/05	97	80 - 120	105	80 - 120	<5.0	ug/L		
7511696	Dissolved Lead (Pb)	2014/06/05	98	80 - 120	100	80 - 120	<0.20	ug/L		
7511696	Dissolved Lithium (Li)	2014/06/05	101	80 - 120	99	80 - 120	<5.0	ug/L		
7511696	Dissolved Manganese (Mn)	2014/06/05	100	80 - 120	104	80 - 120	<1.0	ug/L		
7511696	Dissolved Molybdenum (Mo)	2014/06/05	100	80 - 120	97	80 - 120	<1.0	ug/L		
7511696	Dissolved Nickel (Ni)	2014/06/05	100	80 - 120	102	80 - 120	<1.0	ug/L		
7511696	Dissolved Selenium (Se)	2014/06/05	107	80 - 120	107	80 - 120	<0.10	ug/L		
7511696	Dissolved Silver (Ag)	2014/06/05	102	80 - 120	101	80 - 120	<0.020	ug/L		
7511696	Dissolved Strontium (Sr)	2014/06/05	98	80 - 120	99	80 - 120	<1.0	ug/L		
7511696	Dissolved Thallium (Tl)	2014/06/05	99	80 - 120	103	80 - 120	<0.050	ug/L		
7511696	Dissolved Tin (Sn)	2014/06/05	94	80 - 120	100	80 - 120	<5.0	ug/L		
7511696	Dissolved Titanium (Ti)	2014/06/05	90	80 - 120	107	80 - 120	<5.0	ug/L		
7511696	Dissolved Uranium (U)	2014/06/05	96	80 - 120	100	80 - 120	<0.10	ug/L		
7511696	Dissolved Vanadium (V)	2014/06/05	103	80 - 120	100	80 - 120	<5.0	ug/L		
7511696	Dissolved Zinc (Zn)	2014/06/05	103	80 - 120	104	80 - 120	<5.0	ug/L		
7511696	Dissolved Boron (B)	2014/06/05					<50	ug/L		

Maxxam Job #: B444318
Report Date: 2014/06/06

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7511696	Dissolved Phosphorus (P)	2014/06/05					<10	ug/L		
7511696	Dissolved Silicon (Si)	2014/06/05					<100	ug/L		
7511696	Dissolved Zirconium (Zr)	2014/06/05					<0.50	ug/L		
7512930	Total Dissolved Solids	2014/06/06	111	80 - 120	98	80 - 120	16, RDL=10	mg/L	4.3	20
7514534	Dissolved Mercury (Hg)	2014/06/06	102	80 - 120	102	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B444318

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B444318 **COC #:** EB1004814 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM): Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals: Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-05-01	JS7163	Ground W	5/29/14 9:00	x	x		x	x	x	x	3
2	MW12-05-03	JS7164	Ground W	5/29/14 10:30	x	x		x	x	x	x	3
3	MW12-05-05	JS7165	Ground W	5/29/14 11:30	x	x		x	x	x	x	3
4	DUP	JS7166	Ground W	5/30/14 0:00	x	x		x	x	x	x	3
5												
6												
7												
8												
9												
10												
11												
12												

B444318

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	30-May-14	7:00	SARANBIR TAKHAR	2014/05/31	12:35	☑	A) 2 B) 3 C) 4	Present?	N/A	☐
							Just sampled & rec'd on ice ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

4 5 4
5 6 5

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1010414

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/06
Report #: R1580748
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B444595
Received: 2014/06/02, 10:20

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/06/02	2014/06/03	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/06/03	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	3	N/A	2014/06/03	BBY6SOP-00026	SM-2510B
Fluoride	3	N/A	2014/06/02	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	4	N/A	2014/06/06	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	4	N/A	2014/06/05	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	4	N/A	2014/06/03	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	3	N/A	2014/06/02	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	3	N/A	2014/06/02	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	3	N/A	2014/06/03	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	4	N/A	2014/06/02	BBY6WI-00001	EPA 200.2
pH Water (1)	3	N/A	2014/06/03	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	2	N/A	2014/06/03	BBY6SOP-00017	SM4500-SO42- E
Sulphate by Automated Colourimetry	1	N/A	2014/06/04	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	3	2014/06/05	2014/06/06	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==

MINTO EXPLORATIONS LTD.
Maxxam Job #: B444595
Report Date: 2014/06/06
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

This report has been generated and distributed using a secure automated process.

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JS8943		JS8944	JS8945			JS8946		
Sampling Date		2014/05/30 15:30		2014/05/30 16:30	2014/05/30 17:30			2014/05/30		
	UNITS	**MW12-06-02**	**RDL**	**MW12-06-04**	**MW12-06-06**	**RDL**	**QC Batch**	**DUP**	**RDL**	**QC Batch**
ANIONS										
Nitrite (N)	mg/L	0.525	0.010	1.12		0.050	7508737	0.834	0.025	7508737
Calculated Parameters										
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.165	0.020	0.324		0.050	7507303	0.248	0.025	7507303
Misc. Inorganics										
Fluoride (F)	mg/L	1.60	0.010	1.30		0.010	7508345	1.30	0.010	7508345
Alkalinity (Total as CaCO3)	mg/L	359	0.50	414		0.50	7508672	413	0.50	7508672
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50		0.50	7508672	<0.50	0.50	7508672
Bicarbonate (HCO3)	mg/L	437	0.50	505		0.50	7508672	504	0.50	7508672
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50		0.50	7508672	<0.50	0.50	7508672
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50		0.50	7508672	<0.50	0.50	7508672
Anions										
Dissolved Sulphate (SO4)	mg/L	185	0.50	159		0.50	7510459	177	0.50	7511972
Dissolved Chloride (Cl)	mg/L	1.6	0.50	0.79		0.50	7510445	1.2	0.50	7510445
Nutrients										
Total Ammonia (N)	mg/L	0.046	0.0050	0.022	0.033	0.0050	7510502	0.020	0.0050	7510502
Nitrate plus Nitrite (N)	mg/L	0.690	0.020	1.44		0.020	7508726	1.08	0.020	7508726
Physical Properties										
Conductivity	uS/cm	950	1.0	977		1.0	7508674	992	1.0	7508674
pH	pH	8.08		8.23			7508673	8.13		7508673
Physical Properties										
Total Dissolved Solids	mg/L	646	10	644		10	7512930	642	10	7512930

N/A = Not Applicable
RDL = Reportable Detection Limit

Maxxam Job #: B444595
Report Date: 2014/06/06

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS8943	JS8944	JS8945	JS8946		
Sampling Date		2014/05/30 15:30	2014/05/30 16:30	2014/05/30 17:30	2014/05/30		
	UNITS	**MW12-06-02**	**MW12-06-04**	**MW12-06-06**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics							
Dissolved Hardness (CaCO3)	mg/L	451	485	376	468	0.50	7507520
Elements							
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	7514534
Dissolved Metals by ICPMS							
Dissolved Aluminum (Al)	ug/L	4.2	3.1	7.1	<3.0	3.0	7511379
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511379
Dissolved Arsenic (As)	ug/L	5.86	2.32	0.18	2.27	0.10	7511379
Dissolved Barium (Ba)	ug/L	28.8	19.3	16.0	18.4	1.0	7511379
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	7511379
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511379
Dissolved Boron (B)	ug/L	541	514	397	646	50	7511379
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.124	<0.010	0.010	7511379
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511379
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511379
Dissolved Copper (Cu)	ug/L	0.27	0.25	0.72	<0.20	0.20	7511379
Dissolved Iron (Fe)	ug/L	974	531	42.3	454	5.0	7511379
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	7511379
Dissolved Lithium (Li)	ug/L	10.4	6.9	<5.0	6.8	5.0	7511379
Dissolved Manganese (Mn)	ug/L	35.2	52.6	41.6	50.8	1.0	7511379
Dissolved Molybdenum (Mo)	ug/L	7.2	8.7	6.2	8.7	1.0	7511379
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7511379
Dissolved Phosphorus (P)	ug/L	11	17	17	18	10	7511379
Dissolved Selenium (Se)	ug/L	<0.10	<0.10	0.20	0.10	0.10	7511379
Dissolved Silicon (Si)	ug/L	12400	10400	6920	8710	100	7511379
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	7511379
Dissolved Strontium (Sr)	ug/L	10700	2880	1520	2870	1.0	7511379
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	7511379
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511379
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511379
Dissolved Uranium (U)	ug/L	2.42	5.86	3.76	6.06	0.10	7511379
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7511379
Dissolved Zinc (Zn)	ug/L	6.4	5.2	67.2	7.6	5.0	7511379
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7511379
Dissolved Calcium (Ca)	mg/L	131	102	74.7	97.4	0.050	7507522

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JS8943	JS8944	JS8945	JS8946		
Sampling Date		2014/05/30 15:30	2014/05/30 16:30	2014/05/30 17:30	2014/05/30		
	UNITS	**MW12-06-02**	**MW12-06-04**	**MW12-06-06**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	29.9	56.2	46.0	54.7	0.050	7507522
Dissolved Potassium (K)	mg/L	3.58	3.90	3.40	3.66	0.050	7507522
Dissolved Sodium (Na)	mg/L	41.7	35.5	32.0	37.2	0.050	7507522
Dissolved Sulphur (S)	mg/L	75.0	62.7	50.2	56.8	3.0	7507522

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7508345	Fluoride (F)	2014/06/02	NC	80 - 120					0	20
7508672	Alkalinity (Total as CaCO3)	2014/06/03	92	80 - 120	97	80 - 120	<0.50	mg/L	0.3	20
7508672	Alkalinity (PP as CaCO3)	2014/06/03					<0.50	mg/L	NC	20
7508672	Bicarbonate (HCO3)	2014/06/03					<0.50	mg/L	0.3	20
7508672	Carbonate (CO3)	2014/06/03					<0.50	mg/L	NC	20
7508672	Hydroxide (OH)	2014/06/03					<0.50	mg/L	NC	20
7508674	Conductivity	2014/06/03			99	80 - 120	1.0, RDL=1.0	uS/cm	1.5	20
7508726	Nitrate plus Nitrite (N)	2014/06/02	109	80 - 120	108	80 - 120	<0.020	mg/L	0.5	25
7508737	Nitrite (N)	2014/06/02	104	80 - 120	103	80 - 120	<0.0050	mg/L	0.4	20
7510445	Dissolved Chloride (Cl)	2014/06/03	95	80 - 120	101	80 - 120	<0.50	mg/L	NC	20
7510459	Dissolved Sulphate (SO4)	2014/06/03	NC	80 - 120	92	80 - 120	<0.50	mg/L	0.3	20
7510502	Total Ammonia (N)	2014/06/03	NC	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7511379	Dissolved Aluminum (Al)	2014/06/05	106	80 - 120	105	80 - 120	<3.0	ug/L	NC	20
7511379	Dissolved Antimony (Sb)	2014/06/05	106	80 - 120	103	80 - 120	<0.50	ug/L	NC	20
7511379	Dissolved Arsenic (As)	2014/06/05	110	80 - 120	107	80 - 120	<0.10	ug/L	NC	20
7511379	Dissolved Barium (Ba)	2014/06/05	NC	80 - 120	103	80 - 120	<1.0	ug/L	2.3	20
7511379	Dissolved Beryllium (Be)	2014/06/05	104	80 - 120	98	80 - 120	<0.10	ug/L	NC	20
7511379	Dissolved Bismuth (Bi)	2014/06/05	97	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7511379	Dissolved Cadmium (Cd)	2014/06/05	103	80 - 120	101	80 - 120	<0.010	ug/L	3.3	20
7511379	Dissolved Chromium (Cr)	2014/06/05	105	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7511379	Dissolved Cobalt (Co)	2014/06/05	101	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7511379	Dissolved Copper (Cu)	2014/06/05	97	80 - 120	101	80 - 120	<0.20	ug/L	NC	20
7511379	Dissolved Iron (Fe)	2014/06/05	92	80 - 120	110	80 - 120	<5.0	ug/L	13.1	20
7511379	Dissolved Lead (Pb)	2014/06/05	101	80 - 120	101	80 - 120	<0.20	ug/L	NC	20
7511379	Dissolved Lithium (Li)	2014/06/05	99	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7511379	Dissolved Manganese (Mn)	2014/06/05	NC	80 - 120	104	80 - 120	<1.0	ug/L	0.9	20
7511379	Dissolved Molybdenum (Mo)	2014/06/05	NC	80 - 120	94	80 - 120	<1.0	ug/L	4.0	20
7511379	Dissolved Nickel (Ni)	2014/06/05	98	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7511379	Dissolved Selenium (Se)	2014/06/05	101	80 - 120	108	80 - 120	<0.10	ug/L	NC	20
7511379	Dissolved Silver (Ag)	2014/06/05	101	80 - 120	105	80 - 120	<0.020	ug/L	NC	20
7511379	Dissolved Strontium (Sr)	2014/06/05	NC	80 - 120	102	80 - 120	<1.0	ug/L	1.9	20
7511379	Dissolved Thallium (Tl)	2014/06/05	100	80 - 120	99	80 - 120	<0.050	ug/L	NC	20
7511379	Dissolved Tin (Sn)	2014/06/05	86	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7511379	Dissolved Titanium (Ti)	2014/06/05	95	80 - 120	104	80 - 120	<5.0	ug/L	NC	20
7511379	Dissolved Uranium (U)	2014/06/05	107	80 - 120	98	80 - 120	<0.10	ug/L	0.2	20
7511379	Dissolved Vanadium (V)	2014/06/05	106	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7511379	Dissolved Zinc (Zn)	2014/06/05	NC	80 - 120	105	80 - 120	<5.0	ug/L	0.2	20
7511379	Dissolved Boron (B)	2014/06/05					<50	ug/L	0.8	20
7511379	Dissolved Phosphorus (P)	2014/06/05					<10	ug/L	NC	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7511379	Dissolved Silicon (Si)	2014/06/05					<100	ug/L	1.1	20
7511379	Dissolved Zirconium (Zr)	2014/06/05					<0.50	ug/L	NC	20
7511972	Dissolved Sulphate (SO4)	2014/06/04	NC	80 - 120	101	80 - 120	<0.50	mg/L	0.8	20
7512930	Total Dissolved Solids	2014/06/06	111	80 - 120	98	80 - 120	16, RDL=10	mg/L	4.3	20
7514534	Dissolved Mercury (Hg)	2014/06/06	102	80 - 120	102	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B444595

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B444595 **COC #:** EB1010414 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail:

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT) (5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐
Priority of MW12-06-06; DM, Nutrients, TDS, pH Cond, Alk, and then Chloride and Sulphates

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM): Field Filtered? Y ☑ N ☐	Dissolved Metals (DM): Field Acidified? Y ☑ N ☐	Total Metals: Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
✓ 1	MW12-06-02	JS8943	Ground W	5/30/14 15:30	X	X		X	X	X	X	3
✓ 2	MW12-06-04	JS8944		5/30/14 16:30	X	X		X	X	X	X	3
✓ 3	MW12-06-06	JS8945		5/30/14 17:30	X	X		X	x	X	X	2
✓ 4	DUP	JS8946		5/30/14 0:00	X	X		X	X	X	X	3
5												
6												
7												
8												
9												
10												
11												
12												

B444595

Print name and sign			Print name and sign				Laboratory Use Only	
***Relinquished By:**	Date (yy/mm/dd):	Time (24hr):	Received by	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal Yes No
Phil Emerson	31-May-14	9:00		2014/06/02	10:20		A: 2 B: 2 C: 2	Present? ☐ ☑
						☑	Just sampled & rec'd on ice ☐	Intact? ☐ ☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1010814

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/09
Report #: R1582026
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B445218
Received: 2014/06/03, 14:05

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Hardness (calculated as CaCO3)	1	N/A	2014/06/06	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	1	N/A	2014/06/09	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/06/06	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	1	N/A	2014/06/06	BBY7SOP-00002	EPA 6020A
Filter and HNO3 Preserve for Metals	1	N/A	2014/06/03	BBY6WI-00001	EPA 200.2

* Results relate only to the items tested.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 1

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JT2514		
Sampling Date		2014/05/01 13:45		
	UNITS	**M12-DP3**	**RDL**	**QC Batch**
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE

N/A = Not Applicable
RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT2514		
Sampling Date		2014/05/01 13:45		
	UNITS	**M12-DP3**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	84.9	0.50	7509108
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010(1)	0.010	7517996

RDL = Reportable Detection Limit
(1) - Sample analyzed past recommended hold time.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT2514		
Sampling Date		2014/05/01 13:45		
	UNITS	**M12-DP3**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	14.0	3.0	7511815
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7511815
Dissolved Arsenic (As)	ug/L	0.41	0.10	7511815
Dissolved Barium (Ba)	ug/L	32.9	1.0	7511815
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7511815
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7511815
Dissolved Boron (B)	ug/L	<50	50	7511815
Dissolved Cadmium (Cd)	ug/L	0.161	0.010	7511815
Dissolved Chromium (Cr)	ug/L	2.5	1.0	7511815
Dissolved Cobalt (Co)	ug/L	4.16	0.50	7511815
Dissolved Copper (Cu)	ug/L	15.3	0.20	7511815
Dissolved Iron (Fe)	ug/L	1930	5.0	7511815
Dissolved Lead (Pb)	ug/L	2.00	0.20	7511815
Dissolved Lithium (Li)	ug/L	<5.0	5.0	7511815
Dissolved Manganese (Mn)	ug/L	360	1.0	7511815
Dissolved Molybdenum (Mo)	ug/L	1.9	1.0	7511815
Dissolved Nickel (Ni)	ug/L	21.4	1.0	7511815
Dissolved Phosphorus (P)	ug/L	27	10	7511815
Dissolved Selenium (Se)	ug/L	0.10	0.10	7511815
Dissolved Silicon (Si)	ug/L	800	100	7511815
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7511815
Dissolved Strontium (Sr)	ug/L	155	1.0	7511815
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7511815
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7511815
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7511815
Dissolved Uranium (U)	ug/L	0.12	0.10	7511815
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7511815
Dissolved Zinc (Zn)	ug/L	9.2	5.0	7511815
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7511815
Dissolved Calcium (Ca)	mg/L	24.3	0.050	7509109
Dissolved Magnesium (Mg)	mg/L	5.89	0.050	7509109
Dissolved Potassium (K)	mg/L	0.846	0.050	7509109
Dissolved Sodium (Na)	mg/L	2.67	0.050	7509109
Dissolved Sulphur (S)	mg/L	<3.0	3.0	7509109

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

Maxxam Job #: B445218
Report Date: 2014/06/09

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7511815	Dissolved Aluminum (Al)	2014/06/06	102	80 - 120	105	80 - 120	<3.0	ug/L	NC	20
7511815	Dissolved Antimony (Sb)	2014/06/06	103	80 - 120	101	80 - 120	<0.50	ug/L	NC	20
7511815	Dissolved Arsenic (As)	2014/06/06	100	80 - 120	102	80 - 120	<0.10	ug/L	2.1	20
7511815	Dissolved Barium (Ba)	2014/06/06	NC	80 - 120	104	80 - 120	<1.0	ug/L	0.4	20
7511815	Dissolved Beryllium (Be)	2014/06/06	104	80 - 120	103	80 - 120	<0.10	ug/L	NC	20
7511815	Dissolved Bismuth (Bi)	2014/06/06	95	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7511815	Dissolved Cadmium (Cd)	2014/06/06	101	80 - 120	101	80 - 120	<0.010	ug/L	NC	20
7511815	Dissolved Chromium (Cr)	2014/06/06	107	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7511815	Dissolved Cobalt (Co)	2014/06/06	102	80 - 120	105	80 - 120	<0.50	ug/L	NC	20
7511815	Dissolved Copper (Cu)	2014/06/06	99	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7511815	Dissolved Iron (Fe)	2014/06/06	NC	80 - 120	108	80 - 120	<5.0	ug/L	1	20
7511815	Dissolved Lead (Pb)	2014/06/06	97	80 - 120	101	80 - 120	<0.20	ug/L	NC	20
7511815	Dissolved Lithium (Li)	2014/06/06	107	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7511815	Dissolved Manganese (Mn)	2014/06/06	NC	80 - 120	104	80 - 120	<1.0	ug/L	3.6	20
7511815	Dissolved Molybdenum (Mo)	2014/06/06	NC	80 - 120	101	80 - 120	<1.0	ug/L	NC	20
7511815	Dissolved Nickel (Ni)	2014/06/06	96	80 - 120	106	80 - 120	<1.0	ug/L	NC	20
7511815	Dissolved Selenium (Se)	2014/06/06	103	80 - 120	111	80 - 120	<0.10	ug/L	NC	20
7511815	Dissolved Silver (Ag)	2014/06/06	104	80 - 120	101	80 - 120	<0.020	ug/L	NC	20
7511815	Dissolved Strontium (Sr)	2014/06/06	NC	80 - 120	101	80 - 120	<1.0	ug/L	0.7	20
7511815	Dissolved Thallium (Tl)	2014/06/06	99	80 - 120	102	80 - 120	<0.050	ug/L	NC	20
7511815	Dissolved Tin (Sn)	2014/06/06	102	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7511815	Dissolved Titanium (Ti)	2014/06/06	110	80 - 120	108	80 - 120	<5.0	ug/L	NC	20
7511815	Dissolved Uranium (U)	2014/06/06	103	80 - 120	104	80 - 120	<0.10	ug/L	NC	20
7511815	Dissolved Vanadium (V)	2014/06/06	105	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7511815	Dissolved Zinc (Zn)	2014/06/06	98	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7511815	Dissolved Boron (B)	2014/06/06					<50	ug/L	NC	20
7511815	Dissolved Phosphorus (P)	2014/06/06					<10	ug/L		
7511815	Dissolved Silicon (Si)	2014/06/06					<100	ug/L	0.4	20
7511815	Dissolved Zirconium (Zr)	2014/06/06					<0.50	ug/L	NC	20
7517996	Dissolved Mercury (Hg)	2014/06/09	92	80 - 120	108	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B445218

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

David Huang, BBY Scientific Specialist

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B445218 **COC #:** EB1010814 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry/ Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT) (5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☐ N ☐	☑ Nitrate ☑ Nitrite ☑ Ammonia	Total Suspended Solids (TSS) ☐ TDS ☑	☑ pH ☑ Conductivity ☑ Alkalinity	☑ Chloride ☑ Fluoride ☑ Sulphate	Number of Containers
1	MW12-DP3	JT2514	Ground W	5/1/14 13:45	X	X						1
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

B445218

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	2-Jun-14	7:30		2014/06/03	14 05	☑	A: 1 B: 1 C: 4	Present?	☐	☒
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Your C.O.C. #: EB1011614

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/06/11
Report #: R1583205
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B446224
Received: 2014/06/05, 10:25

Sample Matrix: Water
Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	2	2014/06/06	2014/06/06	BBY6SOP-00026	SM2320B
Alkalinity - Water	2	2014/06/06	2014/06/07	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	4	N/A	2014/06/09	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	2	N/A	2014/06/06	BBY6SOP-00026	SM-2510B
Conductance - water	2	N/A	2014/06/07	BBY6SOP-00026	SM-2510B
Fluoride	4	N/A	2014/06/06	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	4	N/A	2014/06/10	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	4	N/A	2014/06/11	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/06/10	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	4	N/A	2014/06/10	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	4	N/A	2014/06/06	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	4	N/A	2014/06/06	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	4	N/A	2014/06/06	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	4	N/A	2014/06/06	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	4	N/A	2014/06/05	BBY6WI-00001	EPA 200.2
pH Water (1)	2	N/A	2014/06/06	BBY6SOP-00026	SM-4500H+B
pH Water (1)	2	N/A	2014/06/07	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	4	N/A	2014/06/09	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	4	2014/06/09	2014/06/10	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

MINTO EXPLORATIONS LTD.

Maxxam Job #: B446224
Report Date: 2014/06/11

Client Project #: MINTO ENV. MONITORING

Your P.O. #: 208977
Sampler Initials: PE

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JT7093		JT7094		JT7095		JT7096		
Sampling Date		2014/06/02 10:00		2014/06/02 10:30		2014/06/02 11:00		2014/06/02 00:00		
	UNITS	**MW09-03-02**	**QC Batch**	**MW09-03-01**	**QC Batch**	**MW09-03-03**	**QC Batch**	**DUP**	**RDL**	**QC Batch**
ANIONS										
Nitrite (N)	mg/L	0.149 (1)	7515352	0.0742 (1)	7515352	0.0183 (1)	7515352	0.0832 (1)	0.0050	7515352
Calculated Parameters										
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	ONSITE	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.047	7512617	<0.020	7512617	0.530	7512617	0.031	0.020	7512617
Misc. Inorganics										
Fluoride (F)	mg/L	0.870	7515281	0.750	7515281	0.470	7515281	0.750	0.010	7515281
Alkalinity (Total as CaCO3)	mg/L	135	7514788	508	7514840	87.5	7514788	500	0.50	7514853
Alkalinity (PP as CaCO3)	mg/L	<0.50	7514788	<0.50	7514840	<0.50	7514788	<0.50	0.50	7514853
Bicarbonate (HCO3)	mg/L	164	7514788	620	7514840	107	7514788	610	0.50	7514853
Carbonate (CO3)	mg/L	<0.50	7514788	<0.50	7514840	<0.50	7514788	<0.50	0.50	7514853
Hydroxide (OH)	mg/L	<0.50	7514788	<0.50	7514840	<0.50	7514788	<0.50	0.50	7514853
Anions										
Dissolved Sulphate (SO4)	mg/L	21.6	7518377	0.53	7518377	12.8	7518377	0.64	0.50	7518377
Dissolved Chloride (Cl)	mg/L	<0.50	7518361	4.3	7518361	0.68	7518361	4.2	0.50	7518361
Nutrients										
Total Ammonia (N)	mg/L	0.031	7515192	0.17	7515192	0.012	7515192	0.20	0.0050	7515192
Nitrate plus Nitrite (N)	mg/L	0.196 (1)	7515350	0.086 (1)	7515350	0.549 (1)	7515350	0.114 (1)	0.020	7515350
Physical Properties										
Conductivity	uS/cm	301	7514791	912	7514845	203	7514791	898	1.0	7514858
pH	pH	8.16	7514792	8.10	7514846	8.07	7514792	8.15		7514859
Physical Properties										
Total Dissolved Solids	mg/L	172	7517719	610	7517719	138	7517719	604	10	7517719

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT7093	JT7094	JT7095	JT7096		
Sampling Date		2014/06/02 10:00	2014/06/02 10:30	2014/06/02 11:00	2014/06/02 00:00		
	UNITS	**MW09-03-02**	**MW09-03-01**	**MW09-03-03**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics							
Dissolved Hardness (CaCO3)	mg/L	142	484	94.5	449	0.50	7513817
Elements							
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	0.010	7520686
Dissolved Metals by ICPMS							
Dissolved Aluminum (Al)	ug/L	6.7	<3.0	<3.0	<3.0	3.0	7515109
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7515109
Dissolved Arsenic (As)	ug/L	<0.10	0.79	<0.10	0.67	0.10	7515109
Dissolved Barium (Ba)	ug/L	53.0	678	33.6	687	1.0	7515109
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	0.10	7515109
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7515109
Dissolved Boron (B)	ug/L	108	371	<50	311	50	7515109
Dissolved Cadmium (Cd)	ug/L	0.060	0.046	0.015	0.026	0.010	7515109
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	1.0	7515109
Dissolved Cobalt (Co)	ug/L	<0.50	1.12	<0.50	1.09	0.50	7515109
Dissolved Copper (Cu)	ug/L	0.71	3.64	1.72	3.03	0.20	7515109
Dissolved Iron (Fe)	ug/L	53.1	23500	5.9	22000	5.0	7515109
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	0.20	7515109
Dissolved Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7515109
Dissolved Manganese (Mn)	ug/L	139	19200	6.4	18200	1.0	7515109
Dissolved Molybdenum (Mo)	ug/L	4.1	16.9	5.3	16.3	1.0	7515109
Dissolved Nickel (Ni)	ug/L	1.9	<1.0	<1.0	<1.0	1.0	7515109
Dissolved Phosphorus (P)	ug/L	<10	<10	<10	<10	10	7515109
Dissolved Selenium (Se)	ug/L	<0.10	<0.10	0.28	0.19	0.10	7515109
Dissolved Silicon (Si)	ug/L	4670	10400	4540	10000	100	7515109
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	0.020	7515109
Dissolved Strontium (Sr)	ug/L	730	1540	191	1450	1.0	7515109
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	0.050	7515109
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7515109
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7515109
Dissolved Uranium (U)	ug/L	1.40	0.19	1.00	0.18	0.10	7515109
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	5.0	7515109
Dissolved Zinc (Zn)	ug/L	7.3	13.5	<5.0	8.6	5.0	7515109
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	0.50	7515109
Dissolved Calcium (Ca)	mg/L	40.5	152	30.7	142	0.050	7512613

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JT7093	JT7094	JT7095	JT7096		
Sampling Date		2014/06/02 10:00	2014/06/02 10:30	2014/06/02 11:00	2014/06/02 00:00		
	UNITS	**MW09-03-02**	**MW09-03-01**	**MW09-03-03**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	9.91	25.3	4.30	22.9	0.050	7512613
Dissolved Potassium (K)	mg/L	2.50	3.67	1.67	3.43	0.050	7512613
Dissolved Sodium (Na)	mg/L	5.56	15.9	3.51	15.0	0.050	7512613
Dissolved Sulphur (S)	mg/L	8.9	3.4	4.0	<3.0	3.0	7512613

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7514788	Alkalinity (Total as CaCO3)	2014/06/06	90	80 - 120	95	80 - 120	<0.50	mg/L	0.2	20
7514788	Alkalinity (PP as CaCO3)	2014/06/06					<0.50	mg/L	NC	20
7514788	Bicarbonate (HCO3)	2014/06/06					<0.50	mg/L	0.3	20
7514788	Carbonate (CO3)	2014/06/06					<0.50	mg/L	NC	20
7514788	Hydroxide (OH)	2014/06/06					<0.50	mg/L	NC	20
7514791	Conductivity	2014/06/06			98	80 - 120	<1.0	uS/cm	0	20
7514840	Alkalinity (Total as CaCO3)	2014/06/07	NC	80 - 120	95	80 - 120	<0.50	mg/L	0.6	20
7514840	Alkalinity (PP as CaCO3)	2014/06/07					<0.50	mg/L	NC	20
7514840	Bicarbonate (HCO3)	2014/06/07					<0.50	mg/L	1.1	20
7514840	Carbonate (CO3)	2014/06/07					<0.50	mg/L	NC	20
7514840	Hydroxide (OH)	2014/06/07					<0.50	mg/L	NC	20
7514845	Conductivity	2014/06/07			99	80 - 120	1.1, RDL=1.0	uS/cm	0.9	20
7514853	Alkalinity (Total as CaCO3)	2014/06/07	NC	80 - 120	97	80 - 120	<0.50	mg/L	8.0	20
7514853	Alkalinity (PP as CaCO3)	2014/06/07					<0.50	mg/L	10.9	20
7514853	Bicarbonate (HCO3)	2014/06/07					<0.50	mg/L	8.3	20
7514853	Carbonate (CO3)	2014/06/07					<0.50	mg/L	10.9	20
7514853	Hydroxide (OH)	2014/06/07					<0.50	mg/L	NC	20
7514858	Conductivity	2014/06/07			100	80 - 120	1.1, RDL=1.0	uS/cm	0.5	20
7515109	Dissolved Aluminum (Al)	2014/06/09	106	80 - 120	101	80 - 120	<3.0	ug/L	NC	20
7515109	Dissolved Antimony (Sb)	2014/06/09	107	80 - 120	101	80 - 120	<0.50	ug/L	NC	20
7515109	Dissolved Arsenic (As)	2014/06/09	NC	80 - 120	102	80 - 120	<0.10	ug/L	1.4	20
7515109	Dissolved Barium (Ba)	2014/06/09	NC	80 - 120	99	80 - 120	<1.0	ug/L	0.5	20
7515109	Dissolved Beryllium (Be)	2014/06/09	105	80 - 120	99	80 - 120	<0.10	ug/L	NC	20
7515109	Dissolved Bismuth (Bi)	2014/06/09	98	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7515109	Dissolved Cadmium (Cd)	2014/06/09	105	80 - 120	100	80 - 120	<0.010	ug/L	NC	20
7515109	Dissolved Chromium (Cr)	2014/06/09	103	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
7515109	Dissolved Cobalt (Co)	2014/06/09	101	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7515109	Dissolved Copper (Cu)	2014/06/09	NC	80 - 120	101	80 - 120	<0.20	ug/L	2.5	20
7515109	Dissolved Iron (Fe)	2014/06/09	NC	80 - 120	101	80 - 120	<5.0	ug/L	3.5	20
7515109	Dissolved Lead (Pb)	2014/06/09	101	80 - 120	100	80 - 120	<0.20	ug/L	NC	20
7515109	Dissolved Lithium (Li)	2014/06/09	NC	80 - 120	97	80 - 120	<5.0	ug/L	2.0	20
7515109	Dissolved Manganese (Mn)	2014/06/09	NC	80 - 120	103	80 - 120	<1.0	ug/L	1.0	20
7515109	Dissolved Molybdenum (Mo)	2014/06/09	NC	80 - 120	100	80 - 120	<1.0	ug/L	0.2	20
7515109	Dissolved Nickel (Ni)	2014/06/09	97	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7515109	Dissolved Selenium (Se)	2014/06/09	107	80 - 120	99	80 - 120	<0.10	ug/L	NC	20
7515109	Dissolved Silver (Ag)	2014/06/09	105	80 - 120	100	80 - 120	<0.020	ug/L	NC	20
7515109	Dissolved Strontium (Sr)	2014/06/09	NC	80 - 120	99	80 - 120	<1.0	ug/L	0.05	20
7515109	Dissolved Thallium (Tl)	2014/06/09	105	80 - 120	101	80 - 120	<0.050	ug/L	NC	20
7515109	Dissolved Tin (Sn)	2014/06/09	100	80 - 120	99	80 - 120	<5.0	ug/L	NC	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7515109	Dissolved Titanium (Ti)	2014/06/09	105	80 - 120	95	80 - 120	<5.0	ug/L	NC	20
7515109	Dissolved Uranium (U)	2014/06/09	92	80 - 120	93	80 - 120	<0.10	ug/L	NC	20
7515109	Dissolved Vanadium (V)	2014/06/09	108	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7515109	Dissolved Zinc (Zn)	2014/06/09	NC	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7515109	Dissolved Boron (B)	2014/06/09					<50	ug/L	0.4	20
7515109	Dissolved Phosphorus (P)	2014/06/09					<10	ug/L		
7515109	Dissolved Silicon (Si)	2014/06/09					<100	ug/L	0.008	20
7515109	Dissolved Zirconium (Zr)	2014/06/09					<0.50	ug/L	NC	20
7515192	Total Ammonia (N)	2014/06/06	99	80 - 120	96	80 - 120	<0.0050	mg/L	0.2	20
7515281	Fluoride (F)	2014/06/06	100	80 - 120	100	80 - 120	<0.010	mg/L	6.5	20
7515350	Nitrate plus Nitrite (N)	2014/06/06	97	80 - 120	105	80 - 120	<0.020	mg/L	NC	25
7515352	Nitrite (N)	2014/06/06	93	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7517719	Total Dissolved Solids	2014/06/10	NC	80 - 120	102	80 - 120	<10	mg/L	3.6	20
7518361	Dissolved Chloride (Cl)	2014/06/09	NC	80 - 120	103	80 - 120	<0.50	mg/L	2.0	20
7518377	Dissolved Sulphate (SO4)	2014/06/09	92	80 - 120	100	80 - 120	0.51, RDL=0.50	mg/L	NC	20
7520686	Dissolved Mercury (Hg)	2014/06/11	96	80 - 120	86	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable
RDL = Reportable Detection Limit
RPD = Relative Percent Difference
Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.
Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.
Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.
Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.
NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).
NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B446224

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B446224 **COC #:** EB1011614 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Minto Explorations Ltd	Company Name:	Minto Explorations Ltd	PO #:	208977
Contact Name:	Elvina Wong	Contact Name:	Minto Environment	Quotation #:	
Address:	Suite 900 - 999 West Hastings St	Address:	Suite 900-999 West Hastings St	Project # :	
	Vancouver, B.C. PC: V6C 2W2		Vancouver, B.C. PC: V6C 2W2	Proj. Name:	Minto Env. Monitoring
Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120	Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120	Location:	Yukon
E-mail		E-mail	minto_environment@mintomine.com	Sampled by:	Phil Emerson / Chris Harry

(The middle column is under the heading **Report To:**)

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

Lab Use Only

	Sample Identification	Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐ Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW09-03-02	JT7093	Ground W	6/2/14 10:00	X		X	X	X	X	3
2	MW09-03-01	JT7094	Ground W	6/2/14 10:30	X		X	X	X	X	3
3	MW09-03-03	JT7095	Ground W	6/2/14 11:00	X		X	X	X	X	3
4	DUP	JT7096	Ground W	6/2/14 0:00	X		X	X	X	X	3
5											
6											
7											
8											
9											
10											
11											
12											

(In each of rows 1–4, the Dissolved Metals (DM) column is marked X under both Field Filtered? and Field Acidified?)

B446224

Print name and sign

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by	Date (yy/mm/dd)	Time (24 hr)	Time Sensitive
Chris Harry	3-Jun-14	8:30		2014/06/05	10:25	☑

Laboratory Use Only

Temperature on Receipt (°C): A: 3 B: 3 C: 3
Just sampled & rec'd on ice ☐

Custody Seal	Yes	No
Present?	☐	☑
Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1024014

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/07/02
Report #: R1596010
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B453276
Received: 2014/06/25, 12:50

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/06/26	2014/06/26	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/06/26	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	3	N/A	2014/06/26	BBY6SOP-00026	SM-2510B
Fluoride	3	N/A	2014/06/26	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	3	N/A	2014/07/02	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	3	N/A	2014/07/02	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	3	N/A	2014/07/02	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	3	N/A	2014/07/02	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	3	N/A	2014/06/26	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	3	N/A	2014/06/26	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	3	N/A	2014/06/26	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	3	N/A	2014/06/27	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	3	N/A	2014/06/25	BBY6WI-00001	EPA 200.2
pH Water (1)	3	N/A	2014/06/26	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	3	N/A	2014/06/26	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	3	2014/06/27	2014/06/30	BBY6SOP-00033	SM 2540C

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==
This report has been generated and distributed using a secure automated process.

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

Maxxam Job #: B453276
Report Date: 2014/07/02

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JY0762		JY0763		JY0764		
Sampling Date		2014/06/22 10:15		2014/06/22 11:15		2014/06/22		
	UNITS	**MW12-07-01**	**RDL**	**MW12-07-02**	**RDL**	**DUP**	**RDL**	**QC Batch**
ANIONS								
Nitrite (N)	mg/L	4.75(1)	0.050	0.504(1)	0.010	4.43(1)	0.050	7543135
Calculated Parameters								
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	1.37	0.10	0.225	0.020	1.15	0.10	7539877
Misc. Inorganics								
Fluoride (F)	mg/L	1.10	0.010	1.40	0.010	1.10	0.010	7543145
Alkalinity (Total as CaCO3)	mg/L	350	0.50	111	0.50	353	0.50	7542939
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7542939
Bicarbonate (HCO3)	mg/L	427	0.50	135	0.50	431	0.50	7542939
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7542939
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	<0.50	0.50	7542939
Anions								
Dissolved Sulphate (SO4)	mg/L	273	5.0	658	5.0	266	5.0	7543096
Dissolved Chloride (Cl)	mg/L	3.3	0.50	1.5	0.50	3.2	0.50	7543037
Nutrients								
Total Ammonia (N)	mg/L	0.57	0.0050	0.22	0.0050	0.55	0.0050	7542342
Nitrate plus Nitrite (N)	mg/L	6.11(1)	0.10	0.728(1)	0.020	5.58(1)	0.10	7543125
Physical Properties								
Conductivity	uS/cm	1200	1.0	1390	1.0	1190	1.0	7542944
pH	pH	8.08		7.94		8.05		7542943
Physical Properties								
Total Dissolved Solids	mg/L	814	10	1060	10	790	10	7543887

N/A = Not Applicable
RDL = Reportable Detection Limit
(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JY0762	JY0763	JY0764		
Sampling Date		2014/06/22 10:15	2014/06/22 11:15	2014/06/22		
	UNITS	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics						
Dissolved Hardness (CaCO3)	mg/L	473	579	470	0.50	7541296
Elements						
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	0.010	7548012

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JY0762	JY0763	JY0764		
Sampling Date		2014/06/22 10:15	2014/06/22 11:15	2014/06/22		
	UNITS	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS						
Dissolved Aluminum (Al)	ug/L	10.4	12.7	8.2	3.0	7548996
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	0.50	7548996
Dissolved Arsenic (As)	ug/L	0.80	1.22	0.83	0.10	7548996
Dissolved Barium (Ba)	ug/L	37.6	17.4	36.9	1.0	7548996
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	0.10	7548996
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	1.0	7548996
Dissolved Boron (B)	ug/L	853	335	979	50	7548996
Dissolved Cadmium (Cd)	ug/L	0.048	0.015	0.019	0.010	7548996
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	1.0	7548996
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	0.50	7548996
Dissolved Copper (Cu)	ug/L	1.57	2.30	1.74	0.20	7548996
Dissolved Iron (Fe)	ug/L	275	247	291	5.0	7548996
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	0.20	7548996
Dissolved Lithium (Li)	ug/L	22.2	26.5	22.0	5.0	7548996
Dissolved Manganese (Mn)	ug/L	83.6	132	80.3	1.0	7548996
Dissolved Molybdenum (Mo)	ug/L	12.9	16.8	12.9	1.0	7548996
Dissolved Nickel (Ni)	ug/L	1.0	<1.0	2.0	1.0	7548996
Dissolved Phosphorus (P)	ug/L	11	<10	15	10	7548996
Dissolved Selenium (Se)	ug/L	1.95	<0.10	1.93	0.10	7548996
Dissolved Silicon (Si)	ug/L	6440	5310	6210	100	7548996
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	0.020	7548996
Dissolved Strontium (Sr)	ug/L	7240	10300	7170	1.0	7548996
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	0.050	7548996
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	5.0	7548996
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	5.0	7548996
Dissolved Uranium (U)	ug/L	2.75	1.04	2.75	0.10	7548996
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	5.0	7548996
Dissolved Zinc (Zn)	ug/L	37.2	5.4	28.6	5.0	7548996
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	0.50	7548996
Dissolved Calcium (Ca)	mg/L	156	180	154	0.050	7540367
Dissolved Magnesium (Mg)	mg/L	20.5	31.7	20.5	0.050	7540367
Dissolved Potassium (K)	mg/L	3.21	2.73	3.13	0.050	7540367
Dissolved Sodium (Na)	mg/L	71.7	71.0	75.1	0.050	7540367
Dissolved Sulphur (S)	mg/L	103	228	99.1	3.0	7540367

RDL = Reportable Detection Limit

Maxxam Job #: B453276
Report Date: 2014/07/02

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7542342	Total Ammonia (N)	2014/06/26	NC	80 - 120	96	80 - 120	<0.0050	mg/L	2.6	20
7542939	Alkalinity (Total as CaCO3)	2014/06/26	NC	80 - 120	99	80 - 120	<0.50	mg/L	3.9	20
7542939	Alkalinity (PP as CaCO3)	2014/06/26					<0.50	mg/L	NC	20
7542939	Bicarbonate (HCO3)	2014/06/26					<0.50	mg/L	3.9	20
7542939	Carbonate (CO3)	2014/06/26					<0.50	mg/L	NC	20
7542939	Hydroxide (OH)	2014/06/26					<0.50	mg/L	NC	20
7542944	Conductivity	2014/06/26			99	80 - 120	<1.0	uS/cm	0.4	20
7543037	Dissolved Chloride (Cl)	2014/06/26	NC	80 - 120	103	80 - 120	<0.50	mg/L	NC	20
7543096	Dissolved Sulphate (SO4)	2014/06/26	NC	80 - 120	99	80 - 120	<0.50	mg/L	NC	20
7543125	Nitrate plus Nitrite (N)	2014/06/26	103	80 - 120	106	80 - 120	<0.020	mg/L	1.1	25
7543135	Nitrite (N)	2014/06/26	100	80 - 120	103	80 - 120	<0.0050	mg/L	NC	20
7543145	Fluoride (F)	2014/06/26	NC	80 - 120	98	80 - 120	<0.010	mg/L	0	20
7543887	Total Dissolved Solids	2014/06/30	NC	80 - 120	90	80 - 120	<10	mg/L	3.0	20
7548012	Dissolved Mercury (Hg)	2014/07/02	99	80 - 120	103	80 - 120	<0.010	ug/L	NC	20
7548996	Dissolved Aluminum (Al)	2014/07/02	103	80 - 120	99	80 - 120	<3.0	ug/L		
7548996	Dissolved Antimony (Sb)	2014/07/02	103	80 - 120	98	80 - 120	<0.50	ug/L		
7548996	Dissolved Arsenic (As)	2014/07/02	100	80 - 120	99	80 - 120	<0.10	ug/L		
7548996	Dissolved Barium (Ba)	2014/07/02	101	80 - 120	100	80 - 120	<1.0	ug/L		
7548996	Dissolved Beryllium (Be)	2014/07/02	98	80 - 120	96	80 - 120	<0.10	ug/L		
7548996	Dissolved Bismuth (Bi)	2014/07/02	94	80 - 120	93	80 - 120	<1.0	ug/L		
7548996	Dissolved Cadmium (Cd)	2014/07/02	99	80 - 120	96	80 - 120	<0.010	ug/L		
7548996	Dissolved Chromium (Cr)	2014/07/02	92	80 - 120	94	80 - 120	<1.0	ug/L		
7548996	Dissolved Cobalt (Co)	2014/07/02	93	80 - 120	95	80 - 120	<0.50	ug/L		
7548996	Dissolved Copper (Cu)	2014/07/02	95	80 - 120	95	80 - 120	<0.20	ug/L		
7548996	Dissolved Iron (Fe)	2014/07/02	103	80 - 120	104	80 - 120	<5.0	ug/L		
7548996	Dissolved Lead (Pb)	2014/07/02	93	80 - 120	94	80 - 120	<0.20	ug/L	NC	20
7548996	Dissolved Lithium (Li)	2014/07/02	103	80 - 120	99	80 - 120	<5.0	ug/L		
7548996	Dissolved Manganese (Mn)	2014/07/02	94	80 - 120	96	80 - 120	<1.0	ug/L		
7548996	Dissolved Molybdenum (Mo)	2014/07/02	93	80 - 120	94	80 - 120	<1.0	ug/L		
7548996	Dissolved Nickel (Ni)	2014/07/02	94	80 - 120	97	80 - 120	<1.0	ug/L		
7548996	Dissolved Selenium (Se)	2014/07/02	107	80 - 120	102	80 - 120	<0.10	ug/L		
7548996	Dissolved Silver (Ag)	2014/07/02	100	80 - 120	95	80 - 120	<0.020	ug/L		
7548996	Dissolved Strontium (Sr)	2014/07/02	100	80 - 120	98	80 - 120	<1.0	ug/L		
7548996	Dissolved Thallium (Tl)	2014/07/02	94	80 - 120	94	80 - 120	<0.050	ug/L		
7548996	Dissolved Tin (Sn)	2014/07/02	100	80 - 120	97	80 - 120	<5.0	ug/L		
7548996	Dissolved Titanium (Ti)	2014/07/02	91	80 - 120	99	80 - 120	<5.0	ug/L		
7548996	Dissolved Uranium (U)	2014/07/02	91	80 - 120	91	80 - 120	<0.10	ug/L		
7548996	Dissolved Vanadium (V)	2014/07/02	93	80 - 120	92	80 - 120	<5.0	ug/L		
7548996	Dissolved Zinc (Zn)	2014/07/02	99	80 - 120	97	80 - 120	<5.0	ug/L		

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7548996	Dissolved Boron (B)	2014/07/02					<50	ug/L		
7548996	Dissolved Phosphorus (P)	2014/07/02					<10	ug/L		
7548996	Dissolved Silicon (Si)	2014/07/02					<100	ug/L		
7548996	Dissolved Zirconium (Zr)	2014/07/02					<0.50	ug/L		

N/A = Not Applicable

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Validation Signature Page

Maxxam Job #: B453276

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

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Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B453276 **COC #:** EB1024014 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) – Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals – Field Acidified? Y ☐ N ☐	☑ Nitrate ☑ Nitrite ☑ Ammonia	Total Suspended Solids (TSS) ☐ TDS ☑	☑ pH ☑ Conductivity ☑ Alkalinity	☑ Chloride ☑ Fluoride ☑ Sulphate	Number of Containers
1	MW12-07-01	JY0762	Ground W	6/22/14 10:15	x	x		x	x	x	x	3
2	MW12-07-02	JY0763	Ground W	6/22/14 11:15	x	x		x	x	x	x	3
3	DUP	JY0764	Ground W	6/22/14 0:00	x	x		x	x	x	x	3
4												
5												
6												
7												
8												
9												
10												
11												
12												

B453276

Print name and sign | Print name and sign | Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	24-Jun-14	8:15	KEBECCA HONZW	2014/06/25	12:50		A) 6 B) 5 C) 6	Present?	☐	☐ N/A
						☑	Just sampled & rec'd on ice ☑	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your C.O.C. #: EB1027514

Attention: MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/07/11
Report #: R1601519
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B455903
Received: 2014/07/03, 09:05

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/07/04	2014/07/04	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	1	N/A	2014/07/04	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	1	N/A	2014/07/04	BBY6SOP-00026	SM-2510B
Fluoride	1	N/A	2014/07/04	BBY6SOP-00012	SM - 4500 F C
Hardness Total (calculated as CaCO3)	1	N/A	2014/07/09	BBY7SOP-00002	EPA 6020A
Hardness (calculated as CaCO3)	1	N/A	2014/07/07	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	1	N/A	2014/07/07	BBY7SOP-00015	BC MOE Lab Manual
Mercury (Total) by CVAF	1	2014/07/07	2014/07/08	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/07/07	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	1	N/A	2014/07/07	BBY7SOP-00002	EPA 6020A
Na, K, Ca, Mg, S by CRC ICPMS (total)	1	2014/07/03	2014/07/09	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (total)	1	2014/07/04	2014/07/08	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	1	N/A	2014/07/07	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	1	N/A	2014/07/04	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	1	N/A	2014/07/04	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	1	N/A	2014/07/04	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	1	N/A	2014/07/03	BBY6WI-00001	EPA 200.2
pH Water (1)	1	N/A	2014/07/04	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	1	N/A	2014/07/04	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	1	2014/07/04	2014/07/05	BBY6SOP-00033	SM 2540C
Total Suspended Solids-Low Level	1	2014/07/04	2014/07/08	BBY6SOP-00034	SM-2540 D

* Results relate only to the items tested.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.

Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604) 638-5020

==

This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total cover pages: 2

Maxxam Job #: B455903
Report Date: 2014/07/11

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		JZ8387		
Sampling Date		2014/07/01 13:30		
	UNITS	**MW11-04A**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	0.0071	0.0050	7552694
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	1.00	0.020	7550871
Misc. Inorganics				
Fluoride (F)	mg/L	0.080	0.010	7552411
Alkalinity (Total as CaCO3)	mg/L	85.3	0.50	7552410
Alkalinity (PP as CaCO3)	mg/L	64.8	0.50	7552410
Bicarbonate (HCO3)	mg/L	<0.50	0.50	7552410
Carbonate (CO3)	mg/L	24.6	0.50	7552410
Hydroxide (OH)	mg/L	15.1	0.50	7552410
Anions				
Dissolved Sulphate (SO4)	mg/L	7.40	0.50	7552632
Dissolved Chloride (Cl)	mg/L	<0.50	0.50	7552626
Nutrients				
Total Ammonia (N)	mg/L	0.058	0.0050	7554843
Nitrate plus Nitrite (N)	mg/L	1.01	0.020	7552690
Physical Properties				
Conductivity	uS/cm	333	1.0	7552412
pH	pH	11.0		7552414
Physical Properties				
Total Suspended Solids	mg/L	47.2	1.0	7551718
Total Dissolved Solids	mg/L	178	10	7551703

N/A = Not Applicable
RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JZ8387		
Sampling Date		2014/07/01 13:30		
	UNITS	**MW11-04A**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	136	0.50	7549914
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7554209

RDL = Reportable Detection Limit

Maxxam Job #: B455903
Report Date: 2014/07/11

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		JZ8387		
Sampling Date		2014/07/01 13:30		
	UNITS	**MW11-04A**	**RDL**	**QC Batch**
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	142	3.0	7554448
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7554448
Dissolved Arsenic (As)	ug/L	0.60	0.10	7554448
Dissolved Barium (Ba)	ug/L	270	1.0	7554448
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7554448
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7554448
Dissolved Boron (B)	ug/L	<50	50	7554448
Dissolved Cadmium (Cd)	ug/L	0.010	0.010	7554448
Dissolved Chromium (Cr)	ug/L	1.7	1.0	7554448
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7554448
Dissolved Copper (Cu)	ug/L	11.9	0.20	7554448
Dissolved Iron (Fe)	ug/L	<5.0	5.0	7554448
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7554448
Dissolved Lithium (Li)	ug/L	16.5	5.0	7554448
Dissolved Manganese (Mn)	ug/L	<1.0	1.0	7554448
Dissolved Molybdenum (Mo)	ug/L	1.9	1.0	7554448
Dissolved Nickel (Ni)	ug/L	<1.0	1.0	7554448
Dissolved Phosphorus (P)	ug/L	<10	10	7554448
Dissolved Selenium (Se)	ug/L	1.86	0.10	7554448
Dissolved Silicon (Si)	ug/L	3960	100	7554448
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7554448
Dissolved Strontium (Sr)	ug/L	319	1.0	7554448
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7554448
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7554448
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7554448
Dissolved Uranium (U)	ug/L	<0.10	0.10	7554448
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7554448
Dissolved Zinc (Zn)	ug/L	<5.0	5.0	7554448
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7554448
Dissolved Calcium (Ca)	mg/L	54.3	0.050	7550044
Dissolved Magnesium (Mg)	mg/L	<0.050	0.050	7550044
Dissolved Potassium (K)	mg/L	3.71	0.050	7550044
Dissolved Sodium (Na)	mg/L	3.42	0.050	7550044
Dissolved Sulphur (S)	mg/L	<3.0	3.0	7550044

RDL = Reportable Detection Limit

Maxxam Job #: B455903
Report Date: 2014/07/11

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

CCME TOTAL METALS IN WATER (WATER)

Maxxam ID		JZ8387		
Sampling Date		2014/07/01 13:30		
	UNITS	**MW11-04A**	**RDL**	**QC Batch**
Calculated Parameters				
Total Hardness (CaCO3)	mg/L	169	0.50	7549913
Elements				
Total Mercury (Hg)	ug/L	<0.010	0.010	7554850

RDL = Reportable Detection Limit

Maxxam Job #: B455903
Report Date: 2014/07/11

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

CCME TOTAL METALS IN WATER (WATER)

Maxxam ID		JZ8387		
Sampling Date		2014/07/01 13:30		
	UNITS	**MW11-04A**	**RDL**	**QC Batch**
Total Metals by ICPMS				
Total Aluminum (Al)	ug/L	508	3.0	7552324
Total Antimony (Sb)	ug/L	<0.50	0.50	7552324
Total Arsenic (As)	ug/L	0.96	0.10	7552324
Total Barium (Ba)	ug/L	310	1.0	7552324
Total Beryllium (Be)	ug/L	<0.10	0.10	7552324
Total Bismuth (Bi)	ug/L	<1.0	1.0	7552324
Total Boron (B)	ug/L	<50	50	7552324
Total Cadmium (Cd)	ug/L	0.044	0.010	7552324
Total Chromium (Cr)	ug/L	2.7	1.0	7552324
Total Cobalt (Co)	ug/L	<0.50	0.50	7552324
Total Copper (Cu)	ug/L	75.5	0.50	7552324
Total Iron (Fe)	ug/L	493	10	7552324
Total Lead (Pb)	ug/L	0.33	0.20	7552324
Total Lithium (Li)	ug/L	18.8	5.0	7552324
Total Manganese (Mn)	ug/L	16.3	1.0	7552324
Total Molybdenum (Mo)	ug/L	2.2	1.0	7552324
Total Nickel (Ni)	ug/L	<1.0	1.0	7552324
Total Phosphorus (P)	ug/L	47	10	7552324
Total Selenium (Se)	ug/L	1.85	0.10	7552324
Total Silicon (Si)	ug/L	4860	100	7552324
Total Silver (Ag)	ug/L	0.172	0.020	7552324
Total Strontium (Sr)	ug/L	383	1.0	7552324
Total Thallium (Tl)	ug/L	<0.050	0.050	7552324
Total Tin (Sn)	ug/L	<5.0	5.0	7552324
Total Titanium (Ti)	ug/L	22.9	5.0	7552324
Total Uranium (U)	ug/L	<0.10	0.10	7552324
Total Vanadium (V)	ug/L	<5.0	5.0	7552324
Total Zinc (Zn)	ug/L	10.6	5.0	7552324
Total Zirconium (Zr)	ug/L	<0.50	0.50	7552324
Total Calcium (Ca)	mg/L	67.5	0.050	7550045
Total Magnesium (Mg)	mg/L	0.149	0.050	7550045
Total Potassium (K)	mg/L	4.25	0.050	7550045
Total Sodium (Na)	mg/L	3.91	0.050	7550045
Total Sulphur (S)	mg/L	3.2	3.0	7550045

RDL = Reportable Detection Limit

General Comments

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	UNITS	Value (%)	QC Limits
7551703	Total Dissolved Solids	2014/07/05	103	80 - 120	102	80 - 120	<10	mg/L	1.6(1)	20
7551718	Total Suspended Solids	2014/07/08			100	80 - 120	<1.0	mg/L		
7552324	Total Aluminum (Al)	2014/07/08	106	80 - 120	110	80 - 120	<3.0	ug/L	NC	20
7552324	Total Antimony (Sb)	2014/07/08	109	80 - 120	114	80 - 120	<0.50	ug/L	NC	20
7552324	Total Arsenic (As)	2014/07/08	108	80 - 120	106	80 - 120	<0.10	ug/L	3.7	20
7552324	Total Barium (Ba)	2014/07/08	NC	80 - 120	107	80 - 120	<1.0	ug/L	3.2	20
7552324	Total Beryllium (Be)	2014/07/08	111	80 - 120	111	80 - 120	<0.10	ug/L	NC	20
7552324	Total Bismuth (Bi)	2014/07/08	109	80 - 120	110	80 - 120	<1.0	ug/L	NC	20
7552324	Total Cadmium (Cd)	2014/07/08	102	80 - 120	108	80 - 120	<0.010	ug/L	NC	20
7552324	Total Chromium (Cr)	2014/07/08	107	80 - 120	108	80 - 120	<1.0	ug/L	NC	20
7552324	Total Cobalt (Co)	2014/07/08	108	80 - 120	107	80 - 120	<0.50	ug/L	NC	20
7552324	Total Copper (Cu)	2014/07/08	107	80 - 120	109	80 - 120	<0.50	ug/L	NC	20
7552324	Total Iron (Fe)	2014/07/08	NC	80 - 120	112	80 - 120	<10	ug/L	1.2	20
7552324	Total Lead (Pb)	2014/07/08	106	80 - 120	108	80 - 120	<0.20	ug/L	NC	20
7552324	Total Lithium (Li)	2014/07/08	104	80 - 120	111	80 - 120	<5.0	ug/L	NC	20
7552324	Total Manganese (Mn)	2014/07/08	NC	80 - 120	108	80 - 120	<1.0	ug/L	0.1	20
7552324	Total Molybdenum (Mo)	2014/07/08	108	80 - 120	112	80 - 120	<1.0	ug/L	NC	20
7552324	Total Nickel (Ni)	2014/07/08	106	80 - 120	112	80 - 120	<1.0	ug/L	NC	20
7552324	Total Selenium (Se)	2014/07/08	104	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7552324	Total Silver (Ag)	2014/07/08	100	80 - 120	105	80 - 120	<0.020	ug/L	NC	20
7552324	Total Strontium (Sr)	2014/07/08	NC	80 - 120	106	80 - 120	<1.0	ug/L	0.1	20
7552324	Total Thallium (Tl)	2014/07/08	106	80 - 120	106	80 - 120	<0.050	ug/L	NC	20
7552324	Total Tin (Sn)	2014/07/08	105	80 - 120	111	80 - 120	<5.0	ug/L	NC	20
7552324	Total Titanium (Ti)	2014/07/08	102	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7552324	Total Uranium (U)	2014/07/08	107	80 - 120	106	80 - 120	<0.10	ug/L	NC	20
7552324	Total Vanadium (V)	2014/07/08	103	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7552324	Total Zinc (Zn)	2014/07/08	NC	80 - 120	128(2, 3)	80 - 120	<5.0	ug/L	NC	20
7552324	Total Boron (B)	2014/07/08					<50	ug/L	NC	20
7552324	Total Phosphorus (P)	2014/07/08					<10	ug/L		
7552324	Total Silicon (Si)	2014/07/08					<100	ug/L	1	20
7552324	Total Zirconium (Zr)	2014/07/08					<0.50	ug/L	NC	20
7552410	Alkalinity (Total as CaCO3)	2014/07/04	NC	80 - 120	93	80 - 120	<0.50	mg/L	0.8	20
7552410	Alkalinity (PP as CaCO3)	2014/07/04					<0.50	mg/L	3.5	20
7552410	Bicarbonate (HCO3)	2014/07/04					<0.50	mg/L	1.1	20
7552410	Carbonate (CO3)	2014/07/04					<0.50	mg/L	3.5	20
7552410	Hydroxide (OH)	2014/07/04					<0.50	mg/L	NC	20
7552411	Fluoride (F)	2014/07/04	96	80 - 120	100	80 - 120	0.010, RDL=0.010	mg/L	0	20
7552412	Conductivity	2014/07/04			98	80 - 120	<1.0	uS/cm	0.5	20
7552626	Dissolved Chloride (Cl)	2014/07/04	107	80 - 120	104	80 - 120	<0.50	mg/L	NC	20

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7552632	Dissolved Sulphate (SO4)	2014/07/04	108	80 - 120	99	80 - 120	<0.50	mg/L	5.1	20
7552690	Nitrate plus Nitrite (N)	2014/07/04	NC	80 - 120	108	80 - 120	<0.020	mg/L	0.8	25
7552694	Nitrite (N)	2014/07/04	101	80 - 120	103	80 - 120	<0.0050	mg/L	2.4	20
7554209	Dissolved Mercury (Hg)	2014/07/07	83	80 - 120	87	80 - 120	<0.010	ug/L	NC	20
7554448	Dissolved Aluminum (Al)	2014/07/07	101	80 - 120	101	80 - 120	<3.0	ug/L	NC	20
7554448	Dissolved Antimony (Sb)	2014/07/07	98	80 - 120	99	80 - 120	<0.50	ug/L		
7554448	Dissolved Arsenic (As)	2014/07/07	101	80 - 120	100	80 - 120	<0.10	ug/L		
7554448	Dissolved Barium (Ba)	2014/07/07	NC	80 - 120	101	80 - 120	<1.0	ug/L		
7554448	Dissolved Beryllium (Be)	2014/07/07	99	80 - 120	97	80 - 120	<0.10	ug/L		
7554448	Dissolved Bismuth (Bi)	2014/07/07	99	80 - 120	98	80 - 120	<1.0	ug/L		
7554448	Dissolved Cadmium (Cd)	2014/07/07	97	80 - 120	99	80 - 120	<0.010	ug/L		
7554448	Dissolved Chromium (Cr)	2014/07/07	94	80 - 120	99	80 - 120	<1.0	ug/L		
7554448	Dissolved Cobalt (Co)	2014/07/07	92	80 - 120	95	80 - 120	<0.50	ug/L		
7554448	Dissolved Copper (Cu)	2014/07/07	93	80 - 120	93	80 - 120	<0.20	ug/L		
7554448	Dissolved Iron (Fe)	2014/07/07	93	80 - 120	106	80 - 120	<5.0	ug/L		
7554448	Dissolved Lead (Pb)	2014/07/07	101	80 - 120	100	80 - 120	<0.20	ug/L		
7554448	Dissolved Lithium (Li)	2014/07/07	99	80 - 120	96	80 - 120	<5.0	ug/L		
7554448	Dissolved Manganese (Mn)	2014/07/07	95	80 - 120	103	80 - 120	<1.0	ug/L		
7554448	Dissolved Molybdenum (Mo)	2014/07/07	98	80 - 120	95	80 - 120	<1.0	ug/L		
7554448	Dissolved Nickel (Ni)	2014/07/07	90	80 - 120	94	80 - 120	<1.0	ug/L		
7554448	Dissolved Selenium (Se)	2014/07/07	97	80 - 120	98	80 - 120	<0.10	ug/L		
7554448	Dissolved Silver (Ag)	2014/07/07	103	80 - 120	92	80 - 120	<0.020	ug/L		
7554448	Dissolved Strontium (Sr)	2014/07/07	NC	80 - 120	99	80 - 120	<1.0	ug/L		
7554448	Dissolved Thallium (Tl)	2014/07/07	101	80 - 120	99	80 - 120	<0.050	ug/L		
7554448	Dissolved Tin (Sn)	2014/07/07	98	80 - 120	98	80 - 120	<5.0	ug/L		
7554448	Dissolved Titanium (Ti)	2014/07/07	102	80 - 120	102	80 - 120	<5.0	ug/L		
7554448	Dissolved Uranium (U)	2014/07/07	98	80 - 120	97	80 - 120	<0.10	ug/L		
7554448	Dissolved Vanadium (V)	2014/07/07	100	80 - 120	98	80 - 120	<5.0	ug/L		
7554448	Dissolved Zinc (Zn)	2014/07/07	NC	80 - 120	94	80 - 120	<5.0	ug/L		
7554448	Dissolved Boron (B)	2014/07/07					<50	ug/L		
7554448	Dissolved Phosphorus (P)	2014/07/07					<10	ug/L		
7554448	Dissolved Silicon (Si)	2014/07/07					<100	ug/L		
7554448	Dissolved Zirconium (Zr)	2014/07/07					<0.50	ug/L		

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**UNITS**	**Value (%)**	**QC Limits**
7554843	Total Ammonia (N)	2014/07/07	85	80 - 120	102	80 - 120	0.0050, RDL=0.0050	mg/L	0.9	20
7554850	Total Mercury (Hg)	2014/07/08	94	80 - 120	100	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

RDL = Reportable Detection Limit

RPD = Relative Percent Difference

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) - Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

(2) - Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

(3) - Blank Spike outside acceptance criteria (10% of analytes failure allowed).

Validation Signature Page

Maxxam Job #: B455903

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

==

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B455903 **COC #:** EB1027514 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Phil Emerson

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT) (5 days for most tests)
RUSH (Please contact the lab) ○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☑ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☑ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW11-04A	JZ8387	Ground W	7/1/14 13:30	x	x	x	x	x	x	x	5
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

B455903

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	2-Jul-14	7:00	WELBERT PASCUAL	2014/07/03	09:05		A) 3 B) 3 C) 4	Present?	☐	☐ N/A
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

3,4,3

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1035214

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/07/28
Report #: R1610633
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B462185
Received: 2014/07/22, 09:45

Sample Matrix: Water
Samples Received: 3

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	3	2014/07/22	2014/07/22	BBY6SOP-00026	SM2320B
Chloride by Automated Colourimetry	3	N/A	2014/07/23	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	3	N/A	2014/07/22	BBY6SOP-00026	SM-2510B
Fluoride	3	N/A	2014/07/23	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	3	N/A	2014/07/24	BBY7SOP-00002	EPA 6020A
Mercury (Dissolved) by CVAF	3	N/A	2014/07/25	BBY7SOP-00015	BC MOE Lab Manual
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	3	N/A	2014/07/24	BBY7SOP-00002	EPA 6020A
Elements by CRC ICPMS (dissolved)	3	N/A	2014/07/23	BBY7SOP-00002	EPA 6020A
Ammonia-N (Preserved)	3	N/A	2014/07/22	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	3	N/A	2014/07/22	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	3	N/A	2014/07/22	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	3	N/A	2014/07/23	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	3	N/A	2014/07/23	BBY6WI-00001	EPA 200.2
pH Water (1)	3	N/A	2014/07/22	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	3	N/A	2014/07/23	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	3	2014/07/23	2014/07/24	BBY6SOP-00033	SM 2540C

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 1

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KD7010		KD7011	KD7012		
Sampling Date		2014/07/18 14:00		2014/07/18 15:00	2014/07/18		
COC Number		EB1035214		EB1035214	EB1035214		
	Units	**MW12-07-01**	**RDL**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
ANIONS							
Nitrite (N)	mg/L	1.78 (1)	0.050	0.771 (1)	0.811 (1)	0.025	7574234
Calculated Parameters							
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.318	0.050	0.322	0.337	0.025	7572978
Misc. Inorganics							
Fluoride (F)	mg/L	1.00	0.010	1.40	1.40	0.010	7575701
Alkalinity (Total as CaCO3)	mg/L	336	0.50	109	109	0.50	7574148
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50	<0.50	0.50	7574148
Bicarbonate (HCO3)	mg/L	410	0.50	133	133	0.50	7574148
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50	<0.50	0.50	7574148
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	<0.50	0.50	7574148
Anions							
Dissolved Sulphate (SO4)	mg/L	290	5.0	651	640	5.0	7575722
Dissolved Chloride (Cl)	mg/L	2.8	0.50	1.4	1.4	0.50	7575718
Nutrients							
Total Ammonia (N)	mg/L	0.59	0.0050	0.19	0.20	0.0050	7574159
Nitrate plus Nitrite (N)	mg/L	2.10 (1)	0.040	1.09 (1)	1.15 (1)	0.020	7574223
Physical Properties							
Conductivity	uS/cm	1190	1.0	1390	1400	1.0	7574153
pH	pH	8.12	N/A	7.94	7.92	N/A	7574151
Physical Properties							
Total Dissolved Solids	mg/L	816	10	1050	1080	10	7574823

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B462185
Report Date: 2014/07/28

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KD7010	KD7011	KD7012		
Sampling Date		2014/07/18 14:00	2014/07/18 15:00	2014/07/18		
COC Number		EB1035214	EB1035214	EB1035214		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Misc. Inorganics						
Dissolved Hardness (CaCO3)	mg/L	498	613	609	0.50	7573268
Elements						
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	0.010	7578084
Dissolved Metals by ICPMS						
Dissolved Aluminum (Al)	ug/L	5.6	4.1	6.4	3.0	7574883
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	0.50	7574883
Dissolved Arsenic (As)	ug/L	0.92	1.15	1.12	0.10	7574883
Dissolved Barium (Ba)	ug/L	36.8	16.2	16.2	1.0	7574883
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	0.10	7574883
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	1.0	7574883
Dissolved Boron (B)	ug/L	569	301	311	50	7574883
Dissolved Cadmium (Cd)	ug/L	0.029	<0.010	<0.010	0.010	7574883
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	1.0	7574883
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	0.50	7574883
Dissolved Copper (Cu)	ug/L	2.27	0.42	0.60	0.20	7574883
Dissolved Iron (Fe)	ug/L	265	246	265	5.0	7574883
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	0.45	0.20	7574883
Dissolved Lithium (Li)	ug/L	20.8	24.3	23.9	5.0	7574883
Dissolved Manganese (Mn)	ug/L	83.4	131	129	1.0	7574883
Dissolved Molybdenum (Mo)	ug/L	13.1	16.6	16.7	1.0	7574883
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	1.0	7574883
Dissolved Phosphorus (P)	ug/L	11	<10	<10	10	7574883
Dissolved Selenium (Se)	ug/L	1.78	<0.10	<0.10	0.10	7574883
Dissolved Silicon (Si)	ug/L	6310	5780	5630	100	7574883
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	0.020	7574883
Dissolved Strontium (Sr)	ug/L	7180	9640	9840	1.0	7574883
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	0.050	7574883
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	5.0	7574883
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	5.0	7574883
Dissolved Uranium (U)	ug/L	2.81	0.94	0.93	0.10	7574883
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	5.0	7574883
Dissolved Zinc (Zn)	ug/L	41.1	<5.0	<5.0	5.0	7574883
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	0.50	7574883
Dissolved Calcium (Ca)	mg/L	163	192	192	0.050	7573330

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KD7010	KD7011	KD7012		
Sampling Date		2014/07/18 14:00	2014/07/18 15:00	2014/07/18		
COC Number		EB1035214	EB1035214	EB1035214		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	22.3	32.3	31.3	0.050	7573330
Dissolved Potassium (K)	mg/L	3.10	2.58	2.54	0.050	7573330
Dissolved Sodium (Na)	mg/L	80.2	75.5	72.9	0.050	7573330
Dissolved Sulphur (S)	mg/L	100	212	208	3.0	7573330
RDL = Reportable Detection Limit						

GENERAL COMMENTS

Results relate only to the items tested.

Maxxam Job #: B462185
Report Date: 2014/07/28

QUALITY ASSURANCE REPORT

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: CH

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7574148	Alkalinity (PP as CaCO3)	2014/07/22					<0.50	mg/L	NC	20
7574148	Alkalinity (Total as CaCO3)	2014/07/22	NC	80 - 120	90	80 - 120	<0.50	mg/L	0.2	20
7574148	Bicarbonate (HCO3)	2014/07/22					<0.50	mg/L	0.2	20
7574148	Carbonate (CO3)	2014/07/22					<0.50	mg/L	NC	20
7574148	Hydroxide (OH)	2014/07/22					<0.50	mg/L	NC	20
7574153	Conductivity	2014/07/22			97	80 - 120	1.1 ,RDL=1.0	uS/cm	0	20
7574159	Total Ammonia (N)	2014/07/22	NC	80 - 120	97	80 - 120	<0.0050	mg/L		
7574223	Nitrate plus Nitrite (N)	2014/07/22	104	80 - 120	99	80 - 120	<0.020	mg/L	0.2	25
7574234	Nitrite (N)	2014/07/22	101	80 - 120	99	80 - 120	<0.0050	mg/L	0.1	20
7574823	Total Dissolved Solids	2014/07/24	NC	80 - 120	80	80 - 120	<10	mg/L		
7574883	Dissolved Aluminum (Al)	2014/07/23	NC	80 - 120	109	80 - 120	<3.0	ug/L		
7574883	Dissolved Antimony (Sb)	2014/07/23	98	80 - 120	100	80 - 120	<0.50	ug/L		
7574883	Dissolved Arsenic (As)	2014/07/23	99	80 - 120	100	80 - 120	<0.10	ug/L		
7574883	Dissolved Barium (Ba)	2014/07/23	NC	80 - 120	102	80 - 120	<1.0	ug/L		
7574883	Dissolved Beryllium (Be)	2014/07/23	93	80 - 120	98	80 - 120	<0.10	ug/L		
7574883	Dissolved Bismuth (Bi)	2014/07/23	90	80 - 120	100	80 - 120	<1.0	ug/L		
7574883	Dissolved Boron (B)	2014/07/23					<50	ug/L		
7574883	Dissolved Cadmium (Cd)	2014/07/23	96	80 - 120	101	80 - 120	<0.010	ug/L		
7574883	Dissolved Chromium (Cr)	2014/07/23	97	80 - 120	104	80 - 120	<1.0	ug/L		
7574883	Dissolved Cobalt (Co)	2014/07/23	98	80 - 120	103	80 - 120	<0.50	ug/L		
7574883	Dissolved Copper (Cu)	2014/07/23	93	80 - 120	107	80 - 120	<0.20	ug/L		
7574883	Dissolved Iron (Fe)	2014/07/23	NC	80 - 120	107	80 - 120	<5.0	ug/L		
7574883	Dissolved Lead (Pb)	2014/07/23	92	80 - 120	98	80 - 120	<0.20	ug/L		
7574883	Dissolved Lithium (Li)	2014/07/23	NC	80 - 120	98	80 - 120	<5.0	ug/L		
7574883	Dissolved Manganese (Mn)	2014/07/23	NC	80 - 120	101	80 - 120	<1.0	ug/L		
7574883	Dissolved Molybdenum (Mo)	2014/07/23	NC	80 - 120	93	80 - 120	<1.0	ug/L		
7574883	Dissolved Nickel (Ni)	2014/07/23	97	80 - 120	106	80 - 120	<1.0	ug/L		
7574883	Dissolved Phosphorus (P)	2014/07/23					<10	ug/L		
7574883	Dissolved Selenium (Se)	2014/07/23	86	80 - 120	99	80 - 120	<0.10	ug/L		
7574883	Dissolved Silicon (Si)	2014/07/23					<100	ug/L		
7574883	Dissolved Silver (Ag)	2014/07/23	92	80 - 120	95	80 - 120	<0.020	ug/L		

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7574883	Dissolved Strontium (Sr)	2014/07/23	NC	80 - 120	97	80 - 120	<1.0	ug/L		
7574883	Dissolved Thallium (Tl)	2014/07/23	91	80 - 120	96	80 - 120	<0.050	ug/L		
7574883	Dissolved Tin (Sn)	2014/07/23	98	80 - 120	100	80 - 120	<5.0	ug/L		
7574883	Dissolved Titanium (Ti)	2014/07/23	101	80 - 120	106	80 - 120	<5.0	ug/L		
7574883	Dissolved Uranium (U)	2014/07/23	98	80 - 120	98	80 - 120	<0.10	ug/L		
7574883	Dissolved Vanadium (V)	2014/07/23	NC	80 - 120	106	80 - 120	<5.0	ug/L		
7574883	Dissolved Zinc (Zn)	2014/07/23	91	80 - 120	102	80 - 120	<5.0	ug/L		
7574883	Dissolved Zirconium (Zr)	2014/07/23					<0.50	ug/L		
7575701	Fluoride (F)	2014/07/23	99	80 - 120	100	80 - 120	<0.010	mg/L		
7575718	Dissolved Chloride (Cl)	2014/07/23	94	80 - 120	103	80 - 120	<0.50	mg/L		
7575722	Dissolved Sulphate (SO4)	2014/07/23	NC	80 - 120	99	80 - 120	0.68 ,RDL=0.50	mg/L		
7578084	Dissolved Mercury (Hg)	2014/07/25	89	80 - 120	97	80 - 120	<0.010	ug/L		

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B462185 **COC #:** EB1035214 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris Harry

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-07-01	KD7010	Ground W	7/18/14 14:00	x	x		x	x	x	x	3
2	MW12-07-02	KD7011	Ground W	7/18/14 15:00	x	x		x	x	x	x	3
3	DUP	KD7012	Ground W	7/18/14 0:00	x	x		x	x	x	x	3
4												
5												
6												
7												
8												
9												
10												
11												
12												

B462185

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris harry	21-Jul-14	7:00		2014/07/22	09:45		A) 9 B) 10 C) 10	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

Your P.O. #: 113796
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1038214, 08395401

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/08/05
Report #: R1615602
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B464214
Received: 2014/07/28, 09:35

Sample Matrix: Water
Samples Received: 14

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	13	2014/07/29	2014/07/29	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	12	N/A	2014/07/28	BBY6SOP-00011	SM-4500-Cl-
Chloride by Automated Colourimetry	1	N/A	2014/07/29	BBY6SOP-00011	SM-4500-Cl-
Conductance - water	13	N/A	2014/07/29	BBY6SOP-00026	SM 22 2510 B m
Fluoride	13	N/A	2014/07/29	BBY6SOP-00012	SM - 4500 F C
Hardness (calculated as CaCO3)	14	N/A	2014/08/01	BBY7SOP-00002	EPA 6020A R1 m
Mercury (Dissolved) by CVAF	14	N/A	2014/08/01	BBY7SOP-00015	BCMOE BCLM Jul2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	14	N/A	2014/08/01	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	14	N/A	2014/08/01	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	13	N/A	2014/07/29	BBY6SOP-00009	SM-4500NH3G
Nitrate + Nitrite (N)	13	N/A	2014/07/28	BBY6SOP-00010	SM 4500NO3-I
Nitrite (N) by CFA	13	N/A	2014/07/28	BBY6SOP-00010	EPA 353.2
Nitrogen - Nitrate (as N)	13	N/A	2014/07/28	BBY6SOP-00010	SM 4500NO3-I
Filter and HNO3 Preserve for Metals	14	N/A	2014/08/01	BBY6WI-00001	EPA 200.2
pH Water (1)	13	N/A	2014/07/29	BBY6SOP-00026	SM-4500H+B
Sulphate by Automated Colourimetry	11	N/A	2014/07/28	BBY6SOP-00017	SM4500-SO42- E
Sulphate by Automated Colourimetry	2	N/A	2014/07/29	BBY6SOP-00017	SM4500-SO42- E
Total Dissolved Solids (Filt. Residue)	12	2014/07/29	2014/07/30	BBY6SOP-00033	SM 2540C
Total Dissolved Solids (Filt. Residue)	1	2014/07/30	2014/07/31	BBY6SOP-00033	SM 2540C

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 113796
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1038214, 08395401

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/08/05
Report #: R1615602
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B464214
Received: 2014/07/28, 09:35

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B464214
Report Date: 2014/08/05

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 113796
Sampler Initials: CH

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KE9958	KE9959	KE9960	KE9961		KE9962	
Sampling Date		2014/07/24 09:30	2014/07/24 11:00	2014/07/24 11:20	2014/07/24 00:00		2014/07/24 14:15	
COC Number		EB1038214	EB1038214	EB1038214	EB1038214		EB1038214	
	Units	**MW09-03-01**	**MW09-03-02**	**MW09-03-03**	**DUP**	**RDL**	**MW09-01-03**	**QC Batch**
ANIONS								
Nitrite (N)	mg/L	0.0967 (1)	0.0530 (1)	0.0079 (1)	0.143 (1)	0.0050		7581047
Calculated Parameters								
Filter and HNO3 Preservation	N/A	FIELD	FIELD	FIELD	FIELD	N/A	FIELD	ONSITE
Nitrate (N)	mg/L	0.064	<0.020	0.484	0.067	0.020		7580409
Misc. Inorganics								
Fluoride (F)	mg/L	0.880	0.750	0.470	0.870	0.010		7582214
Alkalinity (Total as CaCO3)	mg/L	127	487	77.2	129	0.50		7582332
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	<0.50	<0.50	0.50		7582332
Bicarbonate (HCO3)	mg/L	155	594	94.2	158	0.50		7582332
Carbonate (CO3)	mg/L	<0.50	<0.50	<0.50	<0.50	0.50		7582332
Hydroxide (OH)	mg/L	<0.50	<0.50	<0.50	<0.50	0.50		7582332
Anions								
Dissolved Sulphate (SO4)	mg/L	23.6	<0.50	10.9	23.5	0.50		7580887
Dissolved Chloride (Cl)	mg/L	0.62	4.1	0.54	0.67	0.50		7580863
Nutrients								
Total Ammonia (N)	mg/L	0.027	0.20	0.015	0.031	0.0050		7583274
Nitrate plus Nitrite (N)	mg/L	0.161 (1)	0.061 (1)	0.492 (1)	0.210 (1)	0.020		7581045
Physical Properties								
Conductivity	uS/cm	299	916	180	301	1.0		7582335
pH	pH	8.11	7.93	7.99	8.13	N/A		7582334
Physical Properties								
Total Dissolved Solids	mg/L	154	572	94	162	10		7581063

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KE9963		KE9964			KE9965		
Sampling Date		2014/07/25 09:00		2014/07/25 10:00			2014/07/25 10:45		
COC Number		EB1038214		EB1038214			EB1038214		
	Units	**MW12-05-01**	**QC Batch**	**MW12-05-03**	**RDL**	**QC Batch**	**MW12-05-05**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	0.0608	7581047	0.0354	0.0050	7581047	0.0305	0.0050	7581047
Calculated Parameters									
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	<0.020	7580409	<0.020	0.020	7580409	0.224	0.020	7580409
Misc. Inorganics									
Fluoride (F)	mg/L	1.20	7582214	1.20	0.010	7582214	0.580	0.010	7582214
Alkalinity (Total as CaCO3)	mg/L	180	7582332	267	0.50	7582332	203	0.50	7582332
Alkalinity (PP as CaCO3)	mg/L	<0.50	7582332	<0.50	0.50	7582332	<0.50	0.50	7582332
Bicarbonate (HCO3)	mg/L	219	7582332	325	0.50	7582332	248	0.50	7582332
Carbonate (CO3)	mg/L	<0.50	7582332	<0.50	0.50	7582332	<0.50	0.50	7582332
Hydroxide (OH)	mg/L	<0.50	7582332	<0.50	0.50	7582332	<0.50	0.50	7582332
Anions									
Dissolved Sulphate (SO4)	mg/L	702	7580887	754	5.0	7580887	35.1	0.50	7582508
Dissolved Chloride (Cl)	mg/L	14	7582453	9.7	0.50	7580863	7.4	0.50	7580863
Nutrients									
Total Ammonia (N)	mg/L	0.088	7583274	0.037	0.0050	7583274	0.036	0.0050	7583274
Nitrate plus Nitrite (N)	mg/L	0.079	7581045	0.040	0.020	7581045	0.255	0.020	7581045
Physical Properties									
Conductivity	uS/cm	1580	7582335	1750	1.0	7582335	474	1.0	7582335
pH	pH	8.03	7582334	8.06	N/A	7582334	8.08	N/A	7582334
Physical Properties									
Total Dissolved Solids	mg/L	1230	7581063	1370	10	7581063	252	10	7581063

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Job #: B464214
Report Date: 2014/08/05

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 113796
Sampler Initials: CH

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KE9966		KE9967			KE9968		KE9969		
Sampling Date		2014/07/25 11:15		2014/07/25 00:00			2014/07/25 14:00		2014/07/25 14:45		
COC Number		EB1038214		EB1038214			EB1038214		EB1038214		
	Units	**MW12-05-07**	**RDL**	**DUP1**	**RDL**	**QC Batch**	**MW12-06-02**	**QC Batch**	**MW12-06-04**	**RDL**	**QC Batch**
ANIONS											
Nitrite (N)	mg/L	0.0137	0.0050	0.0362	0.0050	7581047	0.164	7581047	0.276	0.0050	7581047
Calculated Parameters											
Filter and HNO3 Preservation	N/A	FIELD	N/A	FIELD	N/A	ONSITE	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	<0.020	0.020	<0.020	0.020	7580409	0.054	7580409	0.089	0.020	7580409
Misc. Inorganics											
Fluoride (F)	mg/L	0.610	0.010	1.10	0.010	7582214	1.50	7582214	1.30	0.010	7582214
Alkalinity (Total as CaCO3)	mg/L	235	0.50	178	0.50	7582332	352	7582332	396	0.50	7582332
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	<0.50	0.50	7582332	<0.50	7582332	<0.50	0.50	7582332
Bicarbonate (HCO3)	mg/L	287	0.50	217	0.50	7582332	430	7582332	484	0.50	7582332
Carbonate (CO3)	mg/L	<0.50	0.50	<0.50	0.50	7582332	<0.50	7582332	<0.50	0.50	7582332
Hydroxide (OH)	mg/L	<0.50	0.50	<0.50	0.50	7582332	<0.50	7582332	<0.50	0.50	7582332
Anions											
Dissolved Sulphate (SO4)	mg/L	11.4	0.50	703	5.0	7580887	199	7582508	170	0.50	7580887
Dissolved Chloride (Cl)	mg/L	9.1	0.50	15	0.50	7580863	1.8	7580863	1.3	0.50	7580863
Nutrients											
Total Ammonia (N)	mg/L	0.080	0.0050	0.075	0.0050	7583274	0.072	7583274	0.016	0.0050	7583274
Nitrate plus Nitrite (N)	mg/L	0.022	0.020	0.049	0.020	7581045	0.218	7581045	0.365	0.020	7581045
Physical Properties											
Conductivity	uS/cm	483	1.0	1580	1.0	7582335	977	7582335	996	1.0	7582335
pH	pH	8.22	N/A	8.03	N/A	7582334	7.97	7582334	8.11	N/A	7582334
Physical Properties											
Total Dissolved Solids	mg/L	262	10	1220	10	7581063	640	7581063	616	10	7581063

RDL = Reportable Detection Limit
N/A = Not Applicable

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KE9970		KE9971		
Sampling Date		2014/07/25 15:15		2014/07/25 00:00		
COC Number		08395401		08395401		
	Units	**MW12-06-06**	**QC Batch**	**DUP2**	**RDL**	**QC Batch**
ANIONS						
Nitrite (N)	mg/L	0.0521	7581047	0.204	0.0050	7581047
Calculated Parameters						
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.953	7580409	0.059	0.020	7580409
Misc. Inorganics						
Fluoride (F)	mg/L	0.680	7582214	1.30	0.010	7582214
Alkalinity (Total as CaCO3)	mg/L	294	7582332	396	0.50	7582332
Alkalinity (PP as CaCO3)	mg/L	<0.50	7582332	<0.50	0.50	7582332
Bicarbonate (HCO3)	mg/L	358	7582332	483	0.50	7582332
Carbonate (CO3)	mg/L	<0.50	7582332	<0.50	0.50	7582332
Hydroxide (OH)	mg/L	<0.50	7582332	<0.50	0.50	7582332
Anions						
Dissolved Sulphate (SO4)	mg/L	153	7580887	173	0.50	7580887
Dissolved Chloride (Cl)	mg/L	5.3	7580863	1.1	0.50	7580863
Nutrients						
Total Ammonia (N)	mg/L	0.010	7583274	0.012	0.0050	7583274
Nitrate plus Nitrite (N)	mg/L	1.01	7581045	0.263	0.020	7581045
Physical Properties						
Conductivity	uS/cm	816	7582335	997	1.0	7582335
pH	pH	8.10	7582334	8.07	N/A	7582334
Physical Properties						
Total Dissolved Solids	mg/L	472	7581063	602	10	7583150

RDL = Reportable Detection Limit
N/A = Not Applicable

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KE9958	KE9959	KE9960	KE9961	KE9962	KE9963		
Sampling Date		2014/07/24 09:30	2014/07/24 11:00	2014/07/24 11:20	2014/07/24 00:00	2014/07/24 14:15	2014/07/25 09:00		
COC Number		EB1038214	EB1038214	EB1038214	EB1038214	EB1038214	EB1038214		
	Units	**MW09-03-01**	**MW09-03-02**	**MW09-03-03**	**DUP**	**MW09-01-03**	**MW12-05-01**	**RDL**	**QC Batch**
Misc. Inorganics									
Dissolved Hardness (CaCO3)	mg/L	140	433	81.1	136	1760	639	0.50	7580303
Elements									
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	7586314
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	3.4	<3.0	<3.0	3.1	4.1	5.4	3.0	7586205
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	6.07	<0.50	0.50	7586205
Dissolved Arsenic (As)	ug/L	<0.10	0.70	<0.10	<0.10	3.67	0.75	0.10	7586205
Dissolved Barium (Ba)	ug/L	41.6	592	24.9	41.1	33.0	67.5	1.0	7586205
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	7586205
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	7586205
Dissolved Boron (B)	ug/L	120	318	<50	94	658	103	50	7586205
Dissolved Cadmium (Cd)	ug/L	0.020	<0.010	<0.010	0.017	0.603	0.019	0.010	7586205
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	7586205
Dissolved Cobalt (Co)	ug/L	<0.50	0.77	<0.50	<0.50	1.89	<0.50	0.50	7586205
Dissolved Copper (Cu)	ug/L	0.33	3.18	2.47	0.36	199	0.28	0.20	7586205
Dissolved Iron (Fe)	ug/L	<5.0	20300	83.8	20.8	19.6	26.6	5.0	7586205
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	7586205
Dissolved Lithium (Li)	ug/L	<5.0	<5.0	<5.0	<5.0	16.8	7.0	5.0	7586205
Dissolved Manganese (Mn)	ug/L	62.1	17600	96.5	60.9	96.2	99.9	1.0	7586205
Dissolved Molybdenum (Mo)	ug/L	3.7	15.8	4.5	3.8	1090	2.1	1.0	7586205
Dissolved Nickel (Ni)	ug/L	1.1	<1.0	<1.0	1.2	50.7	<1.0	1.0	7586205
Dissolved Phosphorus (P)	ug/L	<10	<10	<10	<10	189	12	10	7586205
Dissolved Selenium (Se)	ug/L	<0.10	0.13	0.24	<0.10	13.9	0.27	0.10	7586205
Dissolved Silicon (Si)	ug/L	4530	9500	4470	4500	24000	7050	100	7586205
Dissolved Silver (Ag)	ug/L	<0.020	0.031	<0.020	<0.020	0.030	<0.020	0.020	7586205
Dissolved Strontium (Sr)	ug/L	696	1460	173	661	8600	5800	1.0	7586205
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	7586205
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7586205
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7586205
Dissolved Uranium (U)	ug/L	1.49	0.19	0.78	1.41	1.60	0.84	0.10	7586205
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7586205
Dissolved Zinc (Zn)	ug/L	6.2	15.4	<5.0	7.5	80.0	<5.0	5.0	7586205
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	7586205
Dissolved Calcium (Ca)	mg/L	40.3	136	26.7	39.6	444	206	0.050	7580305

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KE9958	KE9959	KE9960	KE9961	KE9962	KE9963		
Sampling Date		2014/07/24 09:30	2014/07/24 11:00	2014/07/24 11:20	2014/07/24 00:00	2014/07/24 14:15	2014/07/25 09:00		
COC Number		EB1038214	EB1038214	EB1038214	EB1038214	EB1038214	EB1038214		
	Units	**MW09-03-01**	**MW09-03-02**	**MW09-03-03**	**DUP**	**MW09-01-03**	**MW12-05-01**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	9.48	22.7	3.50	9.03	158	30.1	0.050	7580305
Dissolved Potassium (K)	mg/L	2.57	3.45	1.54	2.46	43.0	3.07	0.050	7580305
Dissolved Sodium (Na)	mg/L	5.19	14.5	3.33	5.17	363	114	0.050	7580305
Dissolved Sulphur (S)	mg/L	9.5	3.4	5.0	8.7	404	238	3.0	7580305

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KE9964	KE9965	KE9966	KE9967	KE9968		KE9969		
Sampling Date		2014/07/25 10:00	2014/07/25 10:45	2014/07/25 11:15	2014/07/25 00:00	2014/07/25 14:00		2014/07/25 14:45		
COC Number		EB1038214	EB1038214	EB1038214	EB1038214	EB1038214		EB1038214		
	Units	**MW12-05-03**	**MW12-05-05**	**MW12-05-07**	**DUP1**	**MW12-06-02**	**QC Batch**	**MW12-06-04**	**RDL**	**QC Batch**
Misc. Inorganics										
Dissolved Hardness (CaCO3)	mg/L	747	211	216	606	412	7580303	470	0.50	7580303
Elements										
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	7586314	<0.010	0.010	7586375
Dissolved Metals by ICPMS										
Dissolved Aluminum (Al)	ug/L	<3.0	<3.0	3.3	6.6	<3.0	7586205	3.2	3.0	7586205
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	7586205	<0.50	0.50	7586205
Dissolved Arsenic (As)	ug/L	0.33	0.16	0.24	0.90	4.61	7586205	2.12	0.10	7586205
Dissolved Barium (Ba)	ug/L	57.9	74.4	900	66.9	50.9	7586205	18.9	1.0	7586205
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	7586205	<0.10	0.10	7586205
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	7586205	<1.0	1.0	7586205
Dissolved Boron (B)	ug/L	108	58	<50	86	239	7586205	172	50	7586205
Dissolved Cadmium (Cd)	ug/L	<0.010	0.015	<0.010	0.049	0.042	7586205	0.016	0.010	7586205
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	7586205	<1.0	1.0	7586205
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	7586205	<0.50	0.50	7586205
Dissolved Copper (Cu)	ug/L	<0.20	0.65	<0.20	<0.20	0.40	7586205	0.49	0.20	7586205
Dissolved Iron (Fe)	ug/L	3620	45.7	113	26.8	1220	7586205	694	5.0	7586205
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	7586205	<0.20	0.20	7586205
Dissolved Lithium (Li)	ug/L	6.0	<5.0	<5.0	7.0	8.8	7586205	6.6	5.0	7586205
Dissolved Manganese (Mn)	ug/L	2090	216	549	95.7	37.4	7586205	50.0	1.0	7586205
Dissolved Molybdenum (Mo)	ug/L	2.7	4.2	1.6	<1.0	5.1	7586205	8.2	1.0	7586205
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	7586205	<1.0	1.0	7586205
Dissolved Phosphorus (P)	ug/L	15	<10	63	23	11	7586205	<10	10	7586205
Dissolved Selenium (Se)	ug/L	<0.10	<0.10	0.22	0.23	<0.10	7586205	<0.10	0.10	7586205
Dissolved Silicon (Si)	ug/L	7570	5800	6140	6310	10000	7586205	8570	100	7586205
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	<0.020	7586205	<0.020	0.020	7586205
Dissolved Strontium (Sr)	ug/L	7960	731	608	6070	10200	7586205	2980	1.0	7586205
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	7586205	<0.050	0.050	7586205
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	7586205	<5.0	5.0	7586205
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	7586205	<5.0	5.0	7586205
Dissolved Uranium (U)	ug/L	1.03	2.22	1.06	0.83	2.20	7586205	5.53	0.10	7586205
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	7586205	<5.0	5.0	7586205
Dissolved Zinc (Zn)	ug/L	<5.0	7.6	<5.0	<5.0	5.6	7586205	<5.0	5.0	7586205
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	7586205	<0.50	0.50	7586205
Dissolved Calcium (Ca)	mg/L	192	41.8	47.2	197	114	7580305	98.0	0.050	7580305

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KE9964	KE9965	KE9966	KE9967	KE9968		KE9969		
Sampling Date		2014/07/25 10:00	2014/07/25 10:45	2014/07/25 11:15	2014/07/25 00:00	2014/07/25 14:00		2014/07/25 14:45		
COC Number		EB1038214	EB1038214	EB1038214	EB1038214	EB1038214		EB1038214		
	Units	**MW12-05-03**	**MW12-05-05**	**MW12-05-07**	**DUP1**	**MW12-06-02**	**QC Batch**	**MW12-06-04**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	64.7	26.0	23.9	27.6	30.9	7580305	54.7	0.050	7580305
Dissolved Potassium (K)	mg/L	3.74	1.99	1.82	2.93	3.19	7580305	3.45	0.050	7580305
Dissolved Sodium (Na)	mg/L	101	17.5	17.2	104	38.8	7580305	34.9	0.050	7580305
Dissolved Sulphur (S)	mg/L	265	14.0	9.0	234	59.9	7580305	53.5	3.0	7580305

RDL = Reportable Detection Limit

Maxxam Job #: B464214
Report Date: 2014/08/05

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 113796
Sampler Initials: CH

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KE9970	KE9971		
Sampling Date		2014/07/25 15:15	2014/07/25 00:00		
COC Number		08395401	08395401		
	Units	**MW12-06-06**	**DUP2**	**RDL**	**QC Batch**
Misc. Inorganics					
Dissolved Hardness (CaCO3)	mg/L	375	470	0.50	7580303
Elements					
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	0.010	7586375
Dissolved Metals by ICPMS					
Dissolved Aluminum (Al)	ug/L	<3.0	<3.0	3.0	7586205
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	7586205
Dissolved Arsenic (As)	ug/L	<0.10	2.11	0.10	7586205
Dissolved Barium (Ba)	ug/L	14.5	19.6	1.0	7586205
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	0.10	7586205
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	1.0	7586205
Dissolved Boron (B)	ug/L	70	183	50	7586205
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	7586205
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	1.0	7586205
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	0.50	7586205
Dissolved Copper (Cu)	ug/L	0.31	<0.20	0.20	7586205
Dissolved Iron (Fe)	ug/L	8.1	690	5.0	7586205
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	0.20	7586205
Dissolved Lithium (Li)	ug/L	<5.0	6.4	5.0	7586205
Dissolved Manganese (Mn)	ug/L	38.4	51.3	1.0	7586205
Dissolved Molybdenum (Mo)	ug/L	5.7	8.2	1.0	7586205
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	1.0	7586205
Dissolved Phosphorus (P)	ug/L	<10	<10	10	7586205
Dissolved Selenium (Se)	ug/L	0.19	<0.10	0.10	7586205
Dissolved Silicon (Si)	ug/L	6640	7960	100	7586205
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	0.020	7586205
Dissolved Strontium (Sr)	ug/L	1540	2890	1.0	7586205
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	0.050	7586205
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	5.0	7586205
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	7586205
Dissolved Uranium (U)	ug/L	3.60	5.39	0.10	7586205
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	5.0	7586205
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	7586205
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	0.50	7586205
Dissolved Calcium (Ca)	mg/L	73.0	97.0	0.050	7580305
RDL = Reportable Detection Limit					

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KE9970	KE9971		
Sampling Date		2014/07/25 15:15	2014/07/25 00:00		
COC Number		08395401	08395401		
	Units	**MW12-06-06**	**DUP2**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	46.8	55.2	0.050	7580305
Dissolved Potassium (K)	mg/L	3.18	3.68	0.050	7580305
Dissolved Sodium (Na)	mg/L	29.6	35.1	0.050	7580305
Dissolved Sulphur (S)	mg/L	47.7	57.2	3.0	7580305

RDL = Reportable Detection Limit

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample containers and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in these samples prior to analysis.

Results relate only to the items tested.

Maxxam Job #: B464214
Report Date: 2014/08/05

QUALITY ASSURANCE REPORT

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 113796
Sampler Initials: CH

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7580863	Dissolved Chloride (Cl)	2014/07/28	NC	80 - 120	104	80 - 120	<0.50	mg/L	NC	20
7580887	Dissolved Sulphate (SO4)	2014/07/28	NC	80 - 120	95	80 - 120	<0.50	mg/L	23.3 (1)	20
7581045	Nitrate plus Nitrite (N)	2014/07/28	111	80 - 120	107	80 - 120	<0.020	mg/L	1.6	25
7581047	Nitrite (N)	2014/07/28	104	80 - 120	102	80 - 120	<0.0050	mg/L	1.5	20
7581063	Total Dissolved Solids	2014/07/30	102	80 - 120	90	80 - 120	<10	mg/L	3.1	20
7582214	Fluoride (F)	2014/07/29	NC	80 - 120	104	80 - 120	<0.010	mg/L	0	20
7582332	Alkalinity (PP as CaCO3)	2014/07/29					<0.50	mg/L		
7582332	Alkalinity (Total as CaCO3)	2014/07/29	NC	80 - 120	99	80 - 120	<0.50	mg/L		
7582332	Bicarbonate (HCO3)	2014/07/29					<0.50	mg/L		
7582332	Carbonate (CO3)	2014/07/29					<0.50	mg/L		
7582332	Hydroxide (OH)	2014/07/29					<0.50	mg/L		
7582334	pH	2014/07/29			101	97 - 103				
7582335	Conductivity	2014/07/29			100	80 - 120	1.0 ,RDL=1.0	uS/cm		
7582453	Dissolved Chloride (Cl)	2014/07/29	98	80 - 120	103	80 - 120	<0.50	mg/L		
7582508	Dissolved Sulphate (SO4)	2014/07/29	NC	80 - 120	97	80 - 120	<0.50	mg/L		
7583150	Total Dissolved Solids	2014/07/31	NC	80 - 120	98	80 - 120	<10	mg/L		
7583274	Total Ammonia (N)	2014/07/29	NC	80 - 120	106	80 - 120	0.0062 ,RDL=0.0050	mg/L	0.4	20
7586205	Dissolved Aluminum (Al)	2014/08/01	100	80 - 120	103	80 - 120	<3.0	ug/L	NC	20
7586205	Dissolved Antimony (Sb)	2014/08/01	102	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
7586205	Dissolved Arsenic (As)	2014/08/01	104	80 - 120	103	80 - 120	<0.10	ug/L	2.6	20
7586205	Dissolved Barium (Ba)	2014/08/01	NC	80 - 120	100	80 - 120	<1.0	ug/L	3.5	20
7586205	Dissolved Beryllium (Be)	2014/08/01	98	80 - 120	98	80 - 120	<0.10	ug/L	NC	20
7586205	Dissolved Bismuth (Bi)	2014/08/01	82	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
7586205	Dissolved Boron (B)	2014/08/01					<50	ug/L	NC	20
7586205	Dissolved Cadmium (Cd)	2014/08/01	96	80 - 120	103	80 - 120	<0.010	ug/L	NC	20
7586205	Dissolved Chromium (Cr)	2014/08/01	94	80 - 120	101	80 - 120	<1.0	ug/L	NC	20
7586205	Dissolved Cobalt (Co)	2014/08/01	94	80 - 120	103	80 - 120	<0.50	ug/L	NC	20
7586205	Dissolved Copper (Cu)	2014/08/01	90	80 - 120	105	80 - 120	<0.20	ug/L	NC	20
7586205	Dissolved Iron (Fe)	2014/08/01	93	80 - 120	105	80 - 120	<5.0	ug/L	2.3	20
7586205	Dissolved Lead (Pb)	2014/08/01	92	80 - 120	98	80 - 120	<0.20	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7586205	Dissolved Lithium (Li)	2014/08/01	NC	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7586205	Dissolved Manganese (Mn)	2014/08/01	NC	80 - 120	105	80 - 120	<1.0	ug/L	6.4	20
7586205	Dissolved Molybdenum (Mo)	2014/08/01	NC	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7586205	Dissolved Nickel (Ni)	2014/08/01	92	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7586205	Dissolved Phosphorus (P)	2014/08/01					<10	ug/L	NC	20
7586205	Dissolved Selenium (Se)	2014/08/01	97	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7586205	Dissolved Silicon (Si)	2014/08/01					<100	ug/L	2.5	20
7586205	Dissolved Silver (Ag)	2014/08/01	82	80 - 120	94	80 - 120	<0.020	ug/L	NC	20
7586205	Dissolved Strontium (Sr)	2014/08/01	NC	80 - 120	104	80 - 120	<1.0	ug/L	1.1	20
7586205	Dissolved Thallium (Tl)	2014/08/01	93	80 - 120	98	80 - 120	<0.050	ug/L	NC	20
7586205	Dissolved Tin (Sn)	2014/08/01	103	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7586205	Dissolved Titanium (Ti)	2014/08/01	106	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7586205	Dissolved Uranium (U)	2014/08/01	97	80 - 120	96	80 - 120	<0.10	ug/L	0	20
7586205	Dissolved Vanadium (V)	2014/08/01	100	80 - 120	105	80 - 120	<5.0	ug/L	NC	20
7586205	Dissolved Zinc (Zn)	2014/08/01	91	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7586205	Dissolved Zirconium (Zr)	2014/08/01					<0.50	ug/L	NC	20
7586314	Dissolved Mercury (Hg)	2014/08/01	104	80 - 120	103	80 - 120	<0.010	ug/L		
7586375	Dissolved Mercury (Hg)	2014/08/01	81	80 - 120	98	80 - 120	<0.010	ug/L		

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

(1) Recovery or RPD for this parameter is outside control limits. The overall quality control for this analysis meets acceptability criteria.

Maxxam Job #: B464214
Report Date: 2014/08/05

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 113796
Sampler Initials: CH

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B464214 **COC #:** EB1038214 Page: 1 of 2

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Minto Explorations Ltd
Contact Name:	Elvina Wong
Address:	Suite 900 - 999 West Hastings St
	Vancouver, B.C. PC: V6C 2W2
Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120
E-mail	

Report To:

Company Name:	Minto Explorations Ltd
Contact Name:	Minto Environment
Address:	Suite 900-999 West Hastings St
	Vancouver, B.C. PC: V6C 2W2
Phone / Fax#:	Ph: 604-684-8894 Fax: 604-688-2120
E-mail	minto_environment@mintomine.com

PO #:	208977
Quotation #:	
Project # :	
Proj. Name:	Minto Env. Monitoring
Location:	Yukon
Sampled by:	Chris H/ Phil E/ Rick M

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y☑ N☐	Field Acidified? Y☑ N☐	Total Metals Field Acidified? Y☐ N☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW09-03-01	KE9958	Ground W	7/24/14 9:30	X	X		X	X	X	X	3
2	MW09-03-02	KE9959	Ground W	7/24/14 11:00	x	x		x	x	x	x	3
3	MW09-03-03	KE9960	Ground W	7/24/14 11:20	x	x		x	x	x	x	3
4	DUP	KE9961	Ground W	7/24/14 0:00	x	x		x	x	x	x	3
5	MW09-01-03	KE9962	Ground W	7/24/14 14:15	x	x						1
6	MW12-05-01	KE9963	Ground W	7/25/14 9:00	x	x		x	x	x	x	3
7	MW12-05-03	KE9964	Ground W	7/25/14 10:00	x	x		x	x	x	x	3
8	MW12-05-05	KE9965	Ground W	7/25/14 10:45	x	x		x	x	x	x	3
9	MW12-05-07	KE9966	Ground W	7/25/14 11:15	x	x		x	x	x	x	3
10	DUP1	KE9967	Ground W	7/25/14 0:00	x	x		x	x	x	x	3
11	MW12-06-02	KE9968	Ground W	7/25/14 14:00	x	x		x	x	x	x	3
12	MW12-06-04	KE9969	Ground W	7/25/14 14:45	x	x		x	x	x	x	3

B464214

Print name and sign			Print name and sign				Laboratory Use Only			
***Relinquished By:**	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	**Custody Seal**	Yes	No
Chris Harry	25-Jul-14	18:00		2014/07/28	09:35	☑	A) 3 B) 3 C) 4	Present?	☐	☑
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

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Maxxam

Burnaby: 4600 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386 Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B464214 **COC #** 08395401

Page: 2 of 2

Invoice To: Require Report? Yes ☐ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-9094 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancovuer, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8094 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 113796
Quotation #:
Project #:
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Chris H/ Phil E/ Rick M

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Total Metals Field Acidified? Y ☑ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☑ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Phosphate	DOC (Diss'd Organic Carbon)	TOC (Total Organic Carbon)	Ra 226	Number of Containers
1	MW12-06-06	KE9970	Ground W	7/25/14 15:15	x	x		x	x	x	x					3
2	DUP2	KE9971	Ground W	7/25/14 0:00	x	x		x	x	x	x					3
3																
4																
5																
6																
7																
8																
9																
10																
11																
12																

B464214

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	25-Jul-14	18:00		2014/07/28	09:35		A) 3 B) 3 C) 4	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

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5,3,4

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1046814

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/02
Report #: R1634695
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B471593
Received: 2014/08/18, 09:40

Sample Matrix: Water
\# Samples Received: 4

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	4	2014/08/18	2014/08/19	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	4	N/A	2014/08/18	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	4	N/A	2014/08/19	BBY6SOP-00026	SM 22 2510 B m
Fluoride	4	N/A	2014/08/18	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	4	N/A	2014/08/25	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	4	N/A	2014/08/22	BBY7SOP-00015	BCMOE BCLM Jul2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	4	N/A	2014/08/25	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	4	N/A	2014/08/23	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	4	N/A	2014/08/19	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	4	N/A	2014/08/18	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	4	N/A	2014/08/18	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	4	N/A	2014/08/19	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	4	N/A	2014/08/23	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	4	N/A	2014/08/19	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	3	N/A	2014/08/18	BBY6SOP-00017	SM 22 4500-SO42- E m
Sulphate by Automated Colourimetry	1	N/A	2014/08/19	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	4	2014/08/20	2014/08/21	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: EB1046814

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/02
Report #: R1634695
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B471593
Received: 2014/08/18, 09:40

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KJ2126	KJ2127	KJ2128			KJ2129		
Sampling Date		2014/08/15 10:30	2014/08/15 11:05	2014/08/15 00:00			2014/08/15 13:45		
COC Number		EB1046814	EB1046814	EB1046814			EB1046814		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**RDL**	**QC Batch**	**MW11-04A**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	1.21	0.849	1.39	0.025	7604923	0.0130	0.0050	7604923
Calculated Parameters									
Filter and HNO3 Preservation	N/A	FIELD	FIELD	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.477	0.360	0.448	0.025	7604101	1.19	0.020	7604101
Misc. Inorganics									
Fluoride (F)	mg/L	1.00	1.40	1.40	0.010	7604981	0.088	0.010	7604981
Alkalinity (Total as CaCO3)	mg/L	329	114	115	0.50	7605007	50.9	0.50	7605007
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	<0.50	0.50	7605007	27.8	0.50	7605007
Bicarbonate (HCO3)	mg/L	402	139	140	0.50	7605007	<0.50	0.50	7605007
Carbonate (CO3)	mg/L	<0.50	<0.50	<0.50	0.50	7605007	27.8	0.50	7605007
Hydroxide (OH)	mg/L	<0.50	<0.50	<0.50	0.50	7605007	1.57	0.50	7605007
Anions									
Dissolved Sulphate (SO4)	mg/L	340	644	644	5.0	7605823	6.84	0.50	7607323
Dissolved Chloride (Cl)	mg/L	3.0	1.9	2.0	0.50	7605810	3.1	0.50	7605810
Nutrients									
Total Ammonia (N)	mg/L	0.46	0.20	0.31	0.0050	7606811	0.12	0.0050	7606811
Nitrate plus Nitrite (N)	mg/L	1.69	1.21	1.84	0.020	7604922	1.20	0.020	7604922
Physical Properties									
Conductivity	uS/cm	1230	1410	1380	1.0	7605010	157	1.0	7605010
pH	pH	8.22	7.99	8.04	N/A	7605009	10.3	N/A	7605009
Physical Properties									
Total Dissolved Solids	mg/L	876	1090	1080	10	7607432	148	10	7607432

RDL = Reportable Detection Limit
N/A = Not Applicable

Maxxam Job #: B471593
Report Date: 2014/09/02

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: PE

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KJ2126	KJ2127	KJ2128		KJ2129		
Sampling Date		2014/08/15 10:30	2014/08/15 11:05	2014/08/15 00:00		2014/08/15 13:45		
COC Number		EB1046814	EB1046814	EB1046814		EB1046814		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**QC Batch**	**MW11-04A**	**RDL**	**QC Batch**
Misc. Inorganics								
Dissolved Hardness (CaCO3)	mg/L	519	624	606	7604098	136	0.50	7604098
Elements								
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	7611049	<0.010	0.010	7611049
Dissolved Metals by ICPMS								
Dissolved Aluminum (Al)	ug/L	12.1	3.4	4.6	7611002	720	3.0	7611002
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	7611002	0.74	0.50	7611002
Dissolved Arsenic (As)	ug/L	1.19	1.04	1.13	7611002	3.59	0.10	7611002
Dissolved Barium (Ba)	ug/L	33.5	15.4	14.7	7611002	195	1.0	7611002
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	7611002	<0.10	0.10	7611002
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	7611002	<1.0	1.0	7611002
Dissolved Boron (B)	ug/L	1130	349	845	7611002	<50	50	7611002
Dissolved Cadmium (Cd)	ug/L	0.049	<0.010	<0.010	7611002	0.013	0.010	7611002
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	7611002	2.0	1.0	7611002
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	7611002	<0.50	0.50	7611002
Dissolved Copper (Cu)	ug/L	4.26	2.55	1.00	7611002	137	0.20	7611002
Dissolved Iron (Fe)	ug/L	270	234	213	7611002	5.9	5.0	7611002
Dissolved Lead (Pb)	ug/L	<0.20	0.23	<0.20	7611002	<0.20	0.20	7611002
Dissolved Lithium (Li)	ug/L	18.4	22.4	24.0	7611002	13.6	5.0	7611002
Dissolved Manganese (Mn)	ug/L	84.6	137	140	7611002	<1.0	1.0	7611002
Dissolved Molybdenum (Mo)	ug/L	14.0	17.0	17.9	7611002	2.5	1.0	7611002
Dissolved Nickel (Ni)	ug/L	1.1	<1.0	<1.0	7611002	<1.0	1.0	7611002
Dissolved Phosphorus (P)	ug/L	30	18	14	7611002	11	10	7611002
Dissolved Selenium (Se)	ug/L	5.73	0.13	0.29	7611002	2.33	0.10	7611002
Dissolved Silicon (Si)	ug/L	7170	6150	6320	7611002	5890	100	7611002
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	7611002	<0.020	0.020	7611002
Dissolved Strontium (Sr)	ug/L	7680	10100	10400	7611002	409	1.0	7611002
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	7611002	<0.050	0.050	7611002
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	7611002	<5.0	5.0	7611002
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	7611002	<5.0	5.0	7611002
Dissolved Uranium (U)	ug/L	2.30	0.67	0.85	7611002	<0.10	0.10	7611002
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	7611002	17.1	5.0	7611002
Dissolved Zinc (Zn)	ug/L	234	<5.0	<5.0	7611002	<5.0	5.0	7611002
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	7611002	<0.50	0.50	7611002
Dissolved Calcium (Ca)	mg/L	174	200	192	7604100	54.3	0.050	7614375
RDL = Reportable Detection Limit								

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KJ2126	KJ2127	KJ2128		KJ2129		
Sampling Date		2014/08/15 10:30	2014/08/15 11:05	2014/08/15 00:00		2014/08/15 13:45		
COC Number		EB1046814	EB1046814	EB1046814		EB1046814		
	Units	**MW12-07-01**	**MW12-07-02**	**DUP**	**QC Batch**	**MW11-04A**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	20.9	30.5	30.9	7604100	<0.050	0.050	7604100
Dissolved Potassium (K)	mg/L	2.98	2.47	2.60	7604100	3.91	0.050	7604100
Dissolved Sodium (Na)	mg/L	77.0	68.9	72.4	7604100	5.57	0.050	7614375
Dissolved Sulphur (S)	mg/L	122	215	233	7604100	<3.0	3.0	7604100

RDL = Reportable Detection Limit

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Sample KJ2129, Na, K, Ca, Mg, S by CRC ICPMS (diss.): Test repeated.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7604922	Nitrate plus Nitrite (N)	2014/08/18	108	80 - 120	109	80 - 120	<0.020	mg/L	0.093	25
7604923	Nitrite (N)	2014/08/18	98	80 - 120	101	80 - 120	<0.0050	mg/L	0.75	20
7604981	Fluoride (F)	2014/08/18	99	80 - 120	96	80 - 120	<0.010	mg/L	NC	20
7605007	Alkalinity (PP as CaCO3)	2014/08/19					<0.50	mg/L	NC	20
7605007	Alkalinity (Total as CaCO3)	2014/08/19	NC	80 - 120	97	80 - 120	0.52 ,RDL=0.50	mg/L	0.12	20
7605007	Bicarbonate (HCO3)	2014/08/19					<0.50	mg/L	0.12	20
7605007	Carbonate (CO3)	2014/08/19					<0.50	mg/L	NC	20
7605007	Hydroxide (OH)	2014/08/19					<0.50	mg/L	NC	20
7605009	pH	2014/08/19			101	97 - 103			0.36	N/A
7605010	Conductivity	2014/08/19			98	80 - 120	1.1 ,RDL=1.0	uS/cm	0.91	20
7605810	Dissolved Chloride (Cl)	2014/08/18	95	80 - 120	103	80 - 120	<0.50	mg/L	NC	20
7605823	Dissolved Sulphate (SO4)	2014/08/18	NC	80 - 120	98	80 - 120	<0.50	mg/L	0.25	20
7606811	Total Ammonia (N)	2014/08/19	102	80 - 120	106	80 - 120	<0.0050	mg/L	0.73	20
7607323	Dissolved Sulphate (SO4)	2014/08/19	94	80 - 120	98	80 - 120	<0.50	mg/L	3.7	20
7607432	Total Dissolved Solids	2014/08/21	103	80 - 120	82	80 - 120	<10	mg/L		
7611002	Dissolved Aluminum (Al)	2014/08/23	NC	80 - 120	106	80 - 120	<3.0	ug/L	1.7	20
7611002	Dissolved Antimony (Sb)	2014/08/23	107	80 - 120	108	80 - 120	<0.50	ug/L	NC	20
7611002	Dissolved Arsenic (As)	2014/08/23	102	80 - 120	97	80 - 120	<0.10	ug/L	NC	20
7611002	Dissolved Barium (Ba)	2014/08/23	NC	80 - 120	97	80 - 120	<1.0	ug/L	0.62	20
7611002	Dissolved Beryllium (Be)	2014/08/23	98	80 - 120	94	80 - 120	<0.10	ug/L	NC	20
7611002	Dissolved Bismuth (Bi)	2014/08/23	104	80 - 120	105	80 - 120	<1.0	ug/L	NC	20
7611002	Dissolved Boron (B)	2014/08/23					<50	ug/L	NC	20
7611002	Dissolved Cadmium (Cd)	2014/08/23	105	80 - 120	104	80 - 120	<0.010	ug/L	NC	20
7611002	Dissolved Chromium (Cr)	2014/08/23	101	80 - 120	104	80 - 120	<1.0	ug/L	NC	20
7611002	Dissolved Cobalt (Co)	2014/08/23	99	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
7611002	Dissolved Copper (Cu)	2014/08/23	96	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7611002	Dissolved Iron (Fe)	2014/08/23	101	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7611002	Dissolved Lead (Pb)	2014/08/23	94	80 - 120	94	80 - 120	<0.20	ug/L	NC	20
7611002	Dissolved Lithium (Li)	2014/08/23	92	80 - 120	91	80 - 120	<5.0	ug/L	NC	20
7611002	Dissolved Manganese (Mn)	2014/08/23	NC	80 - 120	104	80 - 120	<1.0	ug/L	3.2	20
7611002	Dissolved Molybdenum (Mo)	2014/08/23	NC	80 - 120	98	80 - 120	<1.0	ug/L	6.7	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7611002	Dissolved Nickel (Ni)	2014/08/23	98	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7611002	Dissolved Phosphorus (P)	2014/08/23					<10	ug/L	NC	20
7611002	Dissolved Selenium (Se)	2014/08/23	100	80 - 120	99	80 - 120	<0.10	ug/L	3.4	20
7611002	Dissolved Silicon (Si)	2014/08/23					<100	ug/L	1.6	20
7611002	Dissolved Silver (Ag)	2014/08/23	103	80 - 120	97	80 - 120	<0.020	ug/L	NC	20
7611002	Dissolved Strontium (Sr)	2014/08/23	NC	80 - 120	94	80 - 120	<1.0	ug/L	1.7	20
7611002	Dissolved Thallium (Tl)	2014/08/23	101	80 - 120	99	80 - 120	<0.050	ug/L	NC	20
7611002	Dissolved Tin (Sn)	2014/08/23	107	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7611002	Dissolved Titanium (Ti)	2014/08/23	102	80 - 120	109	80 - 120	<5.0	ug/L	NC	20
7611002	Dissolved Uranium (U)	2014/08/23	105	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7611002	Dissolved Vanadium (V)	2014/08/23	105	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7611002	Dissolved Zinc (Zn)	2014/08/23	102	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7611002	Dissolved Zirconium (Zr)	2014/08/23					<0.50	ug/L	NC	20
7611049	Dissolved Mercury (Hg)	2014/08/22	98	80 - 120	109	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B471593 **COC #:** EB1046814 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Phil Emerson / Martin Crill

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:

Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Field Filtered? Y ☑ N ☐ / Dissolved	Field Acidified? Y ☑ N ☐ / Metals (DM)	Field Acidified? Y ☐ N ☐ / Total Metals	Nitrate ☑ Nitrite ☑ Ammonia	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-07-01	KJ2126	Ground W	8/15/14 10:30	x	x		x	x	x	x	3
2	MW12-07-02	KJ2127	Ground W	5/15/14 11:05	x	x		x	x	x	x	3
3	DUP	KJ2128	Ground W	8/15/14 0:00	x	x		x	x	x	x	3
4	MW11-04A	KJ2129	Ground W	8/15/14 13:45	x	x		x	x	x	x	3
5												
6												
7												
8												
9												
10												
11												
12												

B471593

Print name and sign: *Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Print name and sign: Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Laboratory Use Only: Temperature on Receipt (°C)	Custody Seal	Yes	No
Chris Harry	16-Aug-14	7:30	REBECCA BANZON	2014/08/18	09:40		A) 8 B) 8 C) 7	Present?	☐	☑
						☑	Just sampled & rec'd on ice: ☑	Intact?	☐	☐ N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 08396521

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/12
Report #: R1641885
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B478452
Received: 2014/09/04, 16:05

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/09/06	2014/09/06	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	1	N/A	2014/09/08	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	1	N/A	2014/09/06	BBY6SOP-00026	SM 22 2510 B m
Fluoride	1	N/A	2014/09/08	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	1	N/A	2014/09/12	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	1	N/A	2014/09/11	BBY7SOP-00015	BCMOE BCLM Jul2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/09/12	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	1	N/A	2014/09/12	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	1	N/A	2014/09/09	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	1	N/A	2014/09/06	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	1	N/A	2014/09/06	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	1	N/A	2014/09/08	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	1	N/A	2014/09/12	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	1	N/A	2014/09/06	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	1	N/A	2014/09/08	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	1	2014/09/08	2014/09/09	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 08396521

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/12
Report #: R1641885
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B478452
Received: 2014/09/04, 16:05

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Total Cover Pages : 2

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KN3264		
Sampling Date		2014/09/01 08:40		
COC Number		08396521		
	Units	**MW13-DP5**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	<0.0050 (1)	0.0050	7628339
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	7.88	0.20	7626522
Misc. Inorganics				
Fluoride (F)	mg/L	0.390	0.010	7630028
Alkalinity (Total as CaCO3)	mg/L	291	0.50	7628220
Alkalinity (PP as CaCO3)	mg/L	3.83	0.50	7628220
Bicarbonate (HCO3)	mg/L	345	0.50	7628220
Carbonate (CO3)	mg/L	4.60	0.50	7628220
Hydroxide (OH)	mg/L	<0.50	0.50	7628220
Anions				
Dissolved Sulphate (SO4)	mg/L	119	0.50	7630057
Dissolved Chloride (Cl)	mg/L	19	0.50	7630056
Nutrients				
Total Ammonia (N)	mg/L	0.023	0.0050	7631645
Nitrate plus Nitrite (N)	mg/L	7.88 (1)	0.20	7628338
Physical Properties				
Conductivity	uS/cm	850	1.0	7628221
pH	pH	8.36	N/A	7628222
Physical Properties				
Total Dissolved Solids	mg/L	548	10	7628884

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KN3264		
Sampling Date		2014/09/01 08:40		
COC Number		08396521		
	Units	**MW13-DP5**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	393	0.50	7626544
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7634166
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	<3.0	3.0	7633939
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7633939
Dissolved Arsenic (As)	ug/L	0.29	0.10	7633939
Dissolved Barium (Ba)	ug/L	181	1.0	7633939
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7633939
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7633939
Dissolved Boron (B)	ug/L	<50	50	7633939
Dissolved Cadmium (Cd)	ug/L	0.018	0.010	7633939
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7633939
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7633939
Dissolved Copper (Cu)	ug/L	5.38	0.20	7633939
Dissolved Iron (Fe)	ug/L	5.3	5.0	7633939
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7633939
Dissolved Lithium (Li)	ug/L	<5.0	5.0	7633939
Dissolved Manganese (Mn)	ug/L	<1.0	1.0	7633939
Dissolved Molybdenum (Mo)	ug/L	8.1	1.0	7633939
Dissolved Nickel (Ni)	ug/L	1.9	1.0	7633939
Dissolved Phosphorus (P)	ug/L	<10	10	7633939
Dissolved Selenium (Se)	ug/L	3.42	0.10	7633939
Dissolved Silicon (Si)	ug/L	6080	100	7633939
Dissolved Silver (Ag)	ug/L	0.028	0.020	7633939
Dissolved Strontium (Sr)	ug/L	1050	1.0	7633939
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7633939
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7633939
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7633939
Dissolved Uranium (U)	ug/L	3.55	0.10	7633939
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7633939
Dissolved Zinc (Zn)	ug/L	<5.0	5.0	7633939
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7633939
Dissolved Calcium (Ca)	mg/L	94.0	0.050	7626545
RDL = Reportable Detection Limit				

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KN3264		
Sampling Date		2014/09/01 08:40		
COC Number		08396521		
	Units	**MW13-DP5**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	38.3	0.050	7626545
Dissolved Potassium (K)	mg/L	5.67	0.050	7626545
Dissolved Sodium (Na)	mg/L	23.0	0.050	7626545
Dissolved Sulphur (S)	mg/L	36.5	3.0	7626545
RDL = Reportable Detection Limit				

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received were not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7628220	Alkalinity (PP as CaCO3)	2014/09/06					<0.50	mg/L	NC	20
7628220	Alkalinity (Total as CaCO3)	2014/09/06	NC	80 - 120	97	80 - 120	0.50 ,RDL=0.50	mg/L	1.0	20
7628220	Bicarbonate (HCO3)	2014/09/06					0.61 ,RDL=0.50	mg/L	0.98	20
7628220	Carbonate (CO3)	2014/09/06					<0.50	mg/L	NC	20
7628220	Hydroxide (OH)	2014/09/06					<0.50	mg/L	NC	20
7628221	Conductivity	2014/09/06			98	80 - 120	1.1 ,RDL=1.0	uS/cm	0	20
7628222	pH	2014/09/06			102	97 - 103			2.2	N/A
7628338	Nitrate plus Nitrite (N)	2014/09/06	102	80 - 120	106	80 - 120	<0.020	mg/L	NC	25
7628339	Nitrite (N)	2014/09/06	96	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7628884	Total Dissolved Solids	2014/09/09	NC	80 - 120	86	80 - 120	<10	mg/L	0	20
7630028	Fluoride (F)	2014/09/08	95	80 - 120	96	80 - 120	0.018 ,RDL=0.010	mg/L	0	20
7630056	Dissolved Chloride (Cl)	2014/09/08	NC	80 - 120	93	80 - 120	<0.50	mg/L	0.13	20
7630057	Dissolved Sulphate (SO4)	2014/09/08	100	80 - 120	89	80 - 120	0.78 ,RDL=0.50	mg/L	2.2	20
7631645	Total Ammonia (N)	2014/09/09	99	80 - 120	104	80 - 120	<0.0050	mg/L	NC	20
7633939	Dissolved Aluminum (Al)	2014/09/12	98	80 - 120	101	80 - 120	<3.0	ug/L	NC	20
7633939	Dissolved Antimony (Sb)	2014/09/12	99	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7633939	Dissolved Arsenic (As)	2014/09/12	97	80 - 120	102	80 - 120	<0.10	ug/L	3.1	20
7633939	Dissolved Barium (Ba)	2014/09/12	NC	80 - 120	101	80 - 120	<1.0	ug/L	3.5	20
7633939	Dissolved Beryllium (Be)	2014/09/12	99	80 - 120	107	80 - 120	<0.10	ug/L	NC	20
7633939	Dissolved Bismuth (Bi)	2014/09/12	92	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7633939	Dissolved Boron (B)	2014/09/12					<50	ug/L	0.31	20
7633939	Dissolved Cadmium (Cd)	2014/09/12	94	80 - 120	102	80 - 120	<0.010	ug/L	NC	20
7633939	Dissolved Chromium (Cr)	2014/09/12	95	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7633939	Dissolved Cobalt (Co)	2014/09/12	92	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
7633939	Dissolved Copper (Cu)	2014/09/12	89	80 - 120	105	80 - 120	<0.20	ug/L	NC	20
7633939	Dissolved Iron (Fe)	2014/09/12	NC	80 - 120	104	80 - 120	<5.0	ug/L	1.2	20
7633939	Dissolved Lead (Pb)	2014/09/12	90	80 - 120	100	80 - 120	<0.20	ug/L	NC	20
7633939	Dissolved Lithium (Li)	2014/09/12	NC	80 - 120	105	80 - 120	<5.0	ug/L	2.5	20
7633939	Dissolved Manganese (Mn)	2014/09/12	NC	80 - 120	102	80 - 120	<1.0	ug/L	0.92	20
7633939	Dissolved Molybdenum (Mo)	2014/09/12	NC	80 - 120	99	80 - 120	<1.0	ug/L	0.33	20
7633939	Dissolved Nickel (Ni)	2014/09/12	90	80 - 120	107	80 - 120	<1.0	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7633939	Dissolved Phosphorus (P)	2014/09/12					<10	ug/L		
7633939	Dissolved Selenium (Se)	2014/09/12	81	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7633939	Dissolved Silicon (Si)	2014/09/12					<100	ug/L	2.6	20
7633939	Dissolved Silver (Ag)	2014/09/12	83	80 - 120	99	80 - 120	<0.020	ug/L	NC	20
7633939	Dissolved Strontium (Sr)	2014/09/12	NC	80 - 120	106	80 - 120	<1.0	ug/L	0.38	20
7633939	Dissolved Thallium (Tl)	2014/09/12	91	80 - 120	97	80 - 120	<0.050	ug/L	NC	20
7633939	Dissolved Tin (Sn)	2014/09/12	90	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7633939	Dissolved Titanium (Ti)	2014/09/12	106	80 - 120	91	80 - 120	<5.0	ug/L	NC	20
7633939	Dissolved Uranium (U)	2014/09/12	96	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7633939	Dissolved Vanadium (V)	2014/09/12	94	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7633939	Dissolved Zinc (Zn)	2014/09/12	NC	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7633939	Dissolved Zirconium (Zr)	2014/09/12					<0.50	ug/L	NC	20
7634166	Dissolved Mercury (Hg)	2014/09/11	89	80 - 120	95	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B478452

COC #: 08396521

Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name:	Minto Explorations Ltd			
Contact Name:	Elvina Wong			
Address:	Suite 900 - 999 West Hastings St			
	Vancouver, B.C.	PC: V6C 2W2		
Phone / Fax#:	Ph: 604-684-8894	Fax: 604-688-2120		
E-mail				

Report To:

Company Name:	Minto Explorations Ltd	
Contact Name:	Minto Environment	
Address:	Suite 900-999 West Hastings St	
	Vancouver, B.C.	PC: V6C 2W2
Phone / Fax#:	Ph: 604-684-8894	Fax: 604-688-2120
E-mail	minto_environment@mintomine.com	

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Shaun Roberts, Rick Martin

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other ______
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required: ______

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM) Field Filtered? Y☑ N☐	Field Acidified? Y☑ N☐	Total Metals Field Acidified? Y☐ N☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑																						Number of Containers
1	MW13-DP5	KN3264	Ground W	14/09/01 8:40	x	x		x	x	x	x																						3
2																																	
3																																	
4																																	
5																																	
6																																	
7																																	
8																																	
9																																	
10																																	
11																																	
12																																	

B478452

Print name and sign *Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Print name and sign Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Laboratory Use Only Temperature on Receipt (°C)	Custody Seal	Yes	No
Shaun Roberts	14/09/03	9:00	JOHN CURRIE	2014/09/04	16:05		A) 8 B) 6 C) 8	Present?	☐	☐
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐ N/A	☐

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS. 8 6 8

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 08396918

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/23
Report #: R1648132
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B482708
Received: 2014/09/17, 13:55

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	2	2014/09/18	2014/09/19	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	2	N/A	2014/09/18	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	2	N/A	2014/09/19	BBY6SOP-00026	SM 22 2510 B m
Fluoride	2	N/A	2014/09/19	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	2	N/A	2014/09/23	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	2	N/A	2014/09/23	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	2	N/A	2014/09/23	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	2	N/A	2014/09/22	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	2	N/A	2014/09/18	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	2	N/A	2014/09/18	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	2	N/A	2014/09/18	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	2	N/A	2014/09/19	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	1	N/A	2014/09/18	BBY7 WI-00004	BCMOE Reqs 08/14
Filter and HNO3 Preserve for Metals	1	N/A	2014/09/22	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	2	N/A	2014/09/19	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	2	N/A	2014/09/18	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	2	2014/09/18	2014/09/19	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 08396918

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/09/23
Report #: R1648132
Version: 1

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B482708
Received: 2014/09/17, 13:55

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B482708
Report Date: 2014/09/23

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: HM

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KP9016		KP9017		
Sampling Date		2014/09/14 13:55		2014/09/14 14:25		
COC Number		08396918		08396918		
	Units	**MW12-07-01**	**QC Batch**	**MW12-07-02**	**RDL**	**QC Batch**
ANIONS						
Nitrite (N)	mg/L	1.07 (1)	7644074	0.945 (1)	0.025	7644074
Calculated Parameters						
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	LAB	N/A	7642945
Nitrate (N)	mg/L	0.455	7641370	0.391	0.025	7641370
Misc. Inorganics						
Fluoride (F)	mg/L	1.10	7646243	1.30	0.010	7646243
Alkalinity (Total as CaCO3)	mg/L	295	7643592	123	0.50	7643592
Alkalinity (PP as CaCO3)	mg/L	<0.50	7643592	<0.50	0.50	7643592
Bicarbonate (HCO3)	mg/L	360	7643592	150	0.50	7643592
Carbonate (CO3)	mg/L	<0.50	7643592	<0.50	0.50	7643592
Hydroxide (OH)	mg/L	<0.50	7643592	<0.50	0.50	7643592
Anions						
Dissolved Sulphate (SO4)	mg/L	342	7643436	628	5.0	7643436
Dissolved Chloride (Cl)	mg/L	2.8	7643433	2.2	0.50	7643433
Nutrients						
Total Ammonia (N)	mg/L	0.41	7644561	0.34	0.0050	7644561
Nitrate plus Nitrite (N)	mg/L	1.52 (1)	7644071	1.34 (1)	0.020	7644071
Physical Properties						
Conductivity	uS/cm	1260	7643599	1400	1.0	7643599
pH	pH	8.11	7643598	7.91	N/A	7643598
Physical Properties						
Total Dissolved Solids	mg/L	938	7643016	1160	10	7643016

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

Maxxam Job #: B482708
Report Date: 2014/09/23

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: HM

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KP9016		KP9017		
Sampling Date		2014/09/14 13:55		2014/09/14 14:25		
COC Number		08396918		08396918		
	Units	**MW12-07-01**	**QC Batch**	**MW12-07-02**	**RDL**	**QC Batch**
Misc. Inorganics						
Dissolved Hardness (CaCO3)	mg/L	532	7642533	629	0.50	7642533
Elements						
Dissolved Mercury (Hg)	ug/L	<0.010	7649971	<0.010	0.010	7649971
Dissolved Metals by ICPMS						
Dissolved Aluminum (Al)	ug/L	4.5	7645852	5.1	3.0	7648300
Dissolved Antimony (Sb)	ug/L	<0.50	7645852	<0.50	0.50	7648300
Dissolved Arsenic (As)	ug/L	1.52	7645852	1.88	0.10	7648300
Dissolved Barium (Ba)	ug/L	38.1	7645852	16.4	1.0	7648300
Dissolved Beryllium (Be)	ug/L	<0.10	7645852	<0.10	0.10	7648300
Dissolved Bismuth (Bi)	ug/L	<1.0	7645852	<1.0	1.0	7648300
Dissolved Boron (B)	ug/L	709	7645852	655	50	7648300
Dissolved Cadmium (Cd)	ug/L	<0.010	7645852	<0.010	0.010	7648300
Dissolved Chromium (Cr)	ug/L	<1.0	7645852	<1.0	1.0	7648300
Dissolved Cobalt (Co)	ug/L	<0.50	7645852	<0.50	0.50	7648300
Dissolved Copper (Cu)	ug/L	0.95	7645852	<0.20	0.20	7648300
Dissolved Iron (Fe)	ug/L	537	7645852	9.1	5.0	7648300
Dissolved Lead (Pb)	ug/L	<0.20	7645852	<0.20	0.20	7648300
Dissolved Lithium (Li)	ug/L	19.8	7645852	24.6	5.0	7648300
Dissolved Manganese (Mn)	ug/L	90.8	7645852	190	1.0	7648300
Dissolved Molybdenum (Mo)	ug/L	16.0	7645852	15.0	1.0	7648300
Dissolved Nickel (Ni)	ug/L	<1.0	7645852	<1.0	1.0	7648300
Dissolved Phosphorus (P)	ug/L	16	7645852	<10	10	7648300
Dissolved Selenium (Se)	ug/L	1.06	7645852	0.25	0.10	7648300
Dissolved Silicon (Si)	ug/L	6700	7645852	6540	100	7648300
Dissolved Silver (Ag)	ug/L	<0.020	7645852	<0.020	0.020	7648300
Dissolved Strontium (Sr)	ug/L	7780	7645852	10100	1.0	7648300
Dissolved Thallium (Tl)	ug/L	<0.050	7645852	<0.050	0.050	7648300
Dissolved Tin (Sn)	ug/L	<5.0	7645852	<5.0	5.0	7648300
Dissolved Titanium (Ti)	ug/L	<5.0	7645852	<5.0	5.0	7648300
Dissolved Uranium (U)	ug/L	2.11	7645852	0.56	0.10	7648300
Dissolved Vanadium (V)	ug/L	<5.0	7645852	<5.0	5.0	7648300
Dissolved Zinc (Zn)	ug/L	10.6	7645852	<5.0	5.0	7648300
Dissolved Zirconium (Zr)	ug/L	<0.50	7645852	<0.50	0.50	7648300
Dissolved Calcium (Ca)	mg/L	175	7641203	198	0.050	7641203

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KP9016		KP9017		
Sampling Date		2014/09/14 13:55		2014/09/14 14:25		
COC Number		08396918		08396918		
	Units	**MW12-07-01**	**QC Batch**	**MW12-07-02**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	23.3	7641203	32.4	0.050	7641203
Dissolved Potassium (K)	mg/L	3.51	7641203	2.87	0.050	7641203
Dissolved Sodium (Na)	mg/L	77.5	7641203	73.8	0.050	7641203
Dissolved Sulphur (S)	mg/L	135	7641203	231	3.0	7641203
RDL = Reportable Detection Limit						

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Results relate only to the items tested.

Maxxam Job #: B482708
Report Date: 2014/09/23

QUALITY ASSURANCE REPORT

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: HM

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7643016	Total Dissolved Solids	2014/09/19	98	80 - 120	96	80 - 120	<10	mg/L	3.3	20
7643433	Dissolved Chloride (Cl)	2014/09/18	91	80 - 120	99	80 - 120	0.61 ,RDL=0.50	mg/L	0.27	20
7643436	Dissolved Sulphate (SO4)	2014/09/18	NC	80 - 120	90	80 - 120	<0.50	mg/L	0.93	20
7643592	Alkalinity (PP as CaCO3)	2014/09/18					<0.50	mg/L	NC	20
7643592	Alkalinity (Total as CaCO3)	2014/09/18	NC	80 - 120	97	80 - 120	<0.50	mg/L	0.071	20
7643592	Bicarbonate (HCO3)	2014/09/18					<0.50	mg/L	0.097	20
7643592	Carbonate (CO3)	2014/09/18					<0.50	mg/L	NC	20
7643592	Hydroxide (OH)	2014/09/18					<0.50	mg/L	NC	20
7643598	pH	2014/09/18			101	97 - 103			0.12	N/A
7643599	Conductivity	2014/09/18			99	80 - 120	1.0 ,RDL=1.0	uS/cm	0.39	20
7644071	Nitrate plus Nitrite (N)	2014/09/18	100	80 - 120	106	80 - 120	<0.020	mg/L	3.2	25
7644074	Nitrite (N)	2014/09/18	98	80 - 120	107	80 - 120	<0.0050	mg/L	NC	20
7644561	Total Ammonia (N)	2014/09/18	NC	80 - 120	109	80 - 120	<0.0050	mg/L	0.14	20
7645852	Dissolved Aluminum (Al)	2014/09/22	107	80 - 120	109	80 - 120	<3.0	ug/L	NC	20
7645852	Dissolved Antimony (Sb)	2014/09/22	NC	80 - 120	111	80 - 120	<0.50	ug/L	NC	20
7645852	Dissolved Arsenic (As)	2014/09/22	100	80 - 120	106	80 - 120	<0.10	ug/L	11	20
7645852	Dissolved Barium (Ba)	2014/09/22	NC	80 - 120	107	80 - 120	<1.0	ug/L	0.99	20
7645852	Dissolved Beryllium (Be)	2014/09/22	95	80 - 120	97	80 - 120	<0.10	ug/L	NC	20
7645852	Dissolved Bismuth (Bi)	2014/09/22	95	80 - 120	98	80 - 120	<1.0	ug/L	NC	20
7645852	Dissolved Boron (B)	2014/09/22					<50	ug/L	NC	20
7645852	Dissolved Cadmium (Cd)	2014/09/22	102	80 - 120	106	80 - 120	<0.010	ug/L	0.94	20
7645852	Dissolved Chromium (Cr)	2014/09/22	99	80 - 120	107	80 - 120	<1.0	ug/L	NC	20
7645852	Dissolved Cobalt (Co)	2014/09/22	NC	80 - 120	104	80 - 120	<0.50	ug/L	0.11	20
7645852	Dissolved Copper (Cu)	2014/09/22	NC	80 - 120	99	80 - 120	<0.20	ug/L	1.4	20
7645852	Dissolved Iron (Fe)	2014/09/22	NC	80 - 120	113	80 - 120	<5.0	ug/L	0.31	20
7645852	Dissolved Lead (Pb)	2014/09/22	99	80 - 120	105	80 - 120	<0.20	ug/L	NC	20
7645852	Dissolved Lithium (Li)	2014/09/22	93	80 - 120	96	80 - 120	<5.0	ug/L	NC	20
7645852	Dissolved Manganese (Mn)	2014/09/22	NC	80 - 120	107	80 - 120	<1.0	ug/L	0.84	20
7645852	Dissolved Molybdenum (Mo)	2014/09/22	NC	80 - 120	109	80 - 120	<1.0	ug/L	NC	20
7645852	Dissolved Nickel (Ni)	2014/09/22	NC	80 - 120	107	80 - 120	<1.0	ug/L	1.0	20
7645852	Dissolved Phosphorus (P)	2014/09/22					<10	ug/L		

Maxxam Job #: B482708
Report Date: 2014/09/23

QUALITY ASSURANCE REPORT(CONT'D)

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: HM

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7645852	Dissolved Selenium (Se)	2014/09/22	102	80 - 120	107	80 - 120	<0.10	ug/L	5.9	20
7645852	Dissolved Silicon (Si)	2014/09/22					<100	ug/L	0.52	20
7645852	Dissolved Silver (Ag)	2014/09/22	104	80 - 120	100	80 - 120	<0.020	ug/L	NC	20
7645852	Dissolved Strontium (Sr)	2014/09/22	NC	80 - 120	111	80 - 120	<1.0	ug/L	3.8	20
7645852	Dissolved Thallium (Tl)	2014/09/22	98	80 - 120	105	80 - 120	<0.050	ug/L	NC	20
7645852	Dissolved Tin (Sn)	2014/09/22	99	80 - 120	104	80 - 120	<5.0	ug/L	NC	20
7645852	Dissolved Titanium (Ti)	2014/09/22	85	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
7645852	Dissolved Uranium (U)	2014/09/22	95	80 - 120	94	80 - 120	<0.10	ug/L	0.65	20
7645852	Dissolved Vanadium (V)	2014/09/22	100	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7645852	Dissolved Zinc (Zn)	2014/09/22	NC	80 - 120	106	80 - 120	<5.0	ug/L	NC	20
7645852	Dissolved Zirconium (Zr)	2014/09/22					<0.50	ug/L	NC	20
7646243	Fluoride (F)	2014/09/19	106	80 - 120	98	80 - 120	<0.010	mg/L	NC	20
7648300	Dissolved Aluminum (Al)	2014/09/22	100	80 - 120	105	80 - 120	<3.0	ug/L	NC	20
7648300	Dissolved Antimony (Sb)	2014/09/22	108	80 - 120	101	80 - 120	<0.50	ug/L	NC	20
7648300	Dissolved Arsenic (As)	2014/09/22	NC	80 - 120	98	80 - 120	<0.10	ug/L	2.2	20
7648300	Dissolved Barium (Ba)	2014/09/22	NC	80 - 120	100	80 - 120	<1.0	ug/L	2.1	20
7648300	Dissolved Beryllium (Be)	2014/09/22	91	80 - 120	98	80 - 120	<0.10	ug/L	NC	20
7648300	Dissolved Bismuth (Bi)	2014/09/22	91	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
7648300	Dissolved Boron (B)	2014/09/22					<50	ug/L	NC	20
7648300	Dissolved Cadmium (Cd)	2014/09/22	103	80 - 120	102	80 - 120	<0.010	ug/L	NC	20
7648300	Dissolved Chromium (Cr)	2014/09/22	100	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
7648300	Dissolved Cobalt (Co)	2014/09/22	99	80 - 120	99	80 - 120	<0.50	ug/L	NC	20
7648300	Dissolved Copper (Cu)	2014/09/22	90	80 - 120	95	80 - 120	<0.20	ug/L	NC	20
7648300	Dissolved Iron (Fe)	2014/09/22	NC	80 - 120	102	80 - 120	<5.0	ug/L	1.1	20
7648300	Dissolved Lead (Pb)	2014/09/22	97	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7648300	Dissolved Lithium (Li)	2014/09/22	88	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7648300	Dissolved Manganese (Mn)	2014/09/22	NC	80 - 120	102	80 - 120	<1.0	ug/L	0.34	20
7648300	Dissolved Molybdenum (Mo)	2014/09/22	NC	80 - 120	102	80 - 120	<1.0	ug/L	2.6	20
7648300	Dissolved Nickel (Ni)	2014/09/22	90	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
7648300	Dissolved Phosphorus (P)	2014/09/22					<10	ug/L		
7648300	Dissolved Selenium (Se)	2014/09/22	101	80 - 120	104	80 - 120	<0.10	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7648300	Dissolved Silicon (Si)	2014/09/22					<100	ug/L	2.1	20
7648300	Dissolved Silver (Ag)	2014/09/22	96	80 - 120	89	80 - 120	<0.020	ug/L	NC	20
7648300	Dissolved Strontium (Sr)	2014/09/22	NC	80 - 120	104	80 - 120	<1.0	ug/L	2.1	20
7648300	Dissolved Thallium (Tl)	2014/09/22	96	80 - 120	104	80 - 120	<0.050	ug/L	NC	20
7648300	Dissolved Tin (Sn)	2014/09/22	104	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
7648300	Dissolved Titanium (Ti)	2014/09/22	96	80 - 120	90	80 - 120	<5.0	ug/L	NC	20
7648300	Dissolved Uranium (U)	2014/09/22	90	80 - 120	93	80 - 120	<0.10	ug/L	2.2	20
7648300	Dissolved Vanadium (V)	2014/09/22	100	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7648300	Dissolved Zinc (Zn)	2014/09/22	95	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7648300	Dissolved Zirconium (Zr)	2014/09/22					<0.50	ug/L	NC	20
7649971	Dissolved Mercury (Hg)	2014/09/23	NC	80 - 120	83	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B482708 **COC #** 08396918 ıber Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail:

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Helaina M, Phil E

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM)		Total Metals	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
					Field Filtered? Y ☑ N ☐	Field Acidified? Y ☑ N ☐	Field Acidified? Y ☐ N ☐					
1	MW12-07-01	KP9016	Ground W	14/09/2014 13:55:0	x	x		x	x	x	x	3
2	MW12-07-02	KP9017	Ground W	14/09/2014 14:25:0	X	X		X	X	X	X	3
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

B482708

Print name and sign / Print name and sign / Laboratory Use Only

***Relinquished By:**	Date (yy/mm/dd):	Time (24hr):	Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes / No
Helaina Moses	14-Sep-16	7:15	Laurel Berthier	2014/09/17	13:55		A) 3 B) 4 C) 3	Present?	☐ / ☒
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐ / ☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

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Your P.O. #: 208977
Your Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your C.O.C. #: 08398238

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/10/10
Report #: R1660430
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B488520
Received: 2014/10/02, 09:50

Sample Matrix: Water
Samples Received: 1

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	1	2014/10/03	2014/10/03	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	1	N/A	2014/10/03	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	1	N/A	2014/10/03	BBY6SOP-00026	SM 22 2510 B m
Fluoride	1	N/A	2014/10/03	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	1	N/A	2014/10/08	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	1	N/A	2014/10/10	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/10/08	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	1	N/A	2014/10/08	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	1	N/A	2014/10/03	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	1	N/A	2014/10/03	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	1	N/A	2014/10/03	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	1	N/A	2014/10/03	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	1	N/A	2014/10/03	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	1	N/A	2014/10/03	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	1	N/A	2014/10/06	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	1	2014/10/03	2014/10/07	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your C.O.C. #: 08398238

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/10/10
Report #: R1660430
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B488520
Received: 2014/10/02, 09:50

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B488520
Report Date: 2014/10/10

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: SR

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KT4749		
Sampling Date		2014/09/27 10:20		
COC Number		08398238		
	Units	**MW12-DP4**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	0.0588 (1)	0.0050	7665760
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	4.47	0.20	7662925
Misc. Inorganics				
Fluoride (F)	mg/L	0.340	0.010	7665809
Alkalinity (Total as CaCO3)	mg/L	301	0.50	7665683
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7665683
Bicarbonate (HCO3)	mg/L	367	0.50	7665683
Carbonate (CO3)	mg/L	<0.50	0.50	7665683
Hydroxide (OH)	mg/L	<0.50	0.50	7665683
Anions				
Dissolved Sulphate (SO4)	mg/L	121	0.50	7668827
Dissolved Chloride (Cl)	mg/L	18	0.50	7665445
Nutrients				
Total Ammonia (N)	mg/L	0.052	0.0050	7665755
Nitrate plus Nitrite (N)	mg/L	4.52 (1)	0.20	7665758
Physical Properties				
Conductivity	uS/cm	838	1.0	7665688
pH	pH	7.90	N/A	7665687
Physical Properties				
Total Dissolved Solids	mg/L	634	10	7664619

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B488520
Report Date: 2014/10/10

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: SR

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KT4749		
Sampling Date		2014/09/27 10:20		
COC Number		08398238		
	Units	**MW12-DP4**	**RDL**	**QC Batch**
Misc. Inorganics				
Dissolved Hardness (CaCO3)	mg/L	406	0.50	7663782
Elements				
Dissolved Mercury (Hg)	ug/L	<0.010	0.010	7673826
Dissolved Metals by ICPMS				
Dissolved Aluminum (Al)	ug/L	4.2	3.0	7667940
Dissolved Antimony (Sb)	ug/L	<0.50	0.50	7667940
Dissolved Arsenic (As)	ug/L	0.31	0.10	7667940
Dissolved Barium (Ba)	ug/L	222	1.0	7667940
Dissolved Beryllium (Be)	ug/L	<0.10	0.10	7667940
Dissolved Bismuth (Bi)	ug/L	<1.0	1.0	7667940
Dissolved Boron (B)	ug/L	<50	50	7667940
Dissolved Cadmium (Cd)	ug/L	0.052	0.010	7667940
Dissolved Chromium (Cr)	ug/L	<1.0	1.0	7667940
Dissolved Cobalt (Co)	ug/L	<0.50	0.50	7667940
Dissolved Copper (Cu)	ug/L	4.97	0.20	7667940
Dissolved Iron (Fe)	ug/L	9.5	5.0	7667940
Dissolved Lead (Pb)	ug/L	<0.20	0.20	7667940
Dissolved Lithium (Li)	ug/L	<5.0	5.0	7667940
Dissolved Manganese (Mn)	ug/L	1340	1.0	7667940
Dissolved Molybdenum (Mo)	ug/L	8.3	1.0	7667940
Dissolved Nickel (Ni)	ug/L	3.4	1.0	7667940
Dissolved Phosphorus (P)	ug/L	15	10	7667940
Dissolved Selenium (Se)	ug/L	2.24	0.10	7667940
Dissolved Silicon (Si)	ug/L	6000	100	7667940
Dissolved Silver (Ag)	ug/L	<0.020	0.020	7667940
Dissolved Strontium (Sr)	ug/L	979	1.0	7667940
Dissolved Thallium (Tl)	ug/L	<0.050	0.050	7667940
Dissolved Tin (Sn)	ug/L	<5.0	5.0	7667940
Dissolved Titanium (Ti)	ug/L	<5.0	5.0	7667940
Dissolved Uranium (U)	ug/L	3.99	0.10	7667940
Dissolved Vanadium (V)	ug/L	<5.0	5.0	7667940
Dissolved Zinc (Zn)	ug/L	<5.0	5.0	7667940
Dissolved Zirconium (Zr)	ug/L	<0.50	0.50	7667940
Dissolved Calcium (Ca)	mg/L	100	0.050	7663972
RDL = Reportable Detection Limit				

Maxxam Job #: B488520
Report Date: 2014/10/10

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: SR

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KT4749		
Sampling Date		2014/09/27 10:20		
COC Number		08398238		
	Units	**MW12-DP4**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	37.9	0.050	7663972
Dissolved Potassium (K)	mg/L	4.38	0.050	7663972
Dissolved Sodium (Na)	mg/L	19.8	0.050	7663972
Dissolved Sulphur (S)	mg/L	37.9	3.0	7663972
RDL = Reportable Detection Limit				

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7664619	Total Dissolved Solids	2014/10/07	NC	80 - 120	96	80 - 120	<10	mg/L	3.1	20
7665445	Dissolved Chloride (Cl)	2014/10/03	97	80 - 120	99	80 - 120	<0.50	mg/L	NC	20
7665683	Alkalinity (PP as CaCO3)	2014/10/03					<0.50	mg/L	NC	20
7665683	Alkalinity (Total as CaCO3)	2014/10/03	NC	80 - 120	97	80 - 120	<0.50	mg/L	0.54	20
7665683	Bicarbonate (HCO3)	2014/10/03					<0.50	mg/L	0.54	20
7665683	Carbonate (CO3)	2014/10/03					<0.50	mg/L	NC	20
7665683	Hydroxide (OH)	2014/10/03					<0.50	mg/L	NC	20
7665687	pH	2014/10/03			101	97 - 103				
7665688	Conductivity	2014/10/03			100	80 - 120	<1.0	uS/cm	0.88	20
7665755	Total Ammonia (N)	2014/10/03	86	80 - 120	101	80 - 120	<0.0050	mg/L	NC	20
7665758	Nitrate plus Nitrite (N)	2014/10/03	107	80 - 120	105	80 - 120	<0.020	mg/L	NC	25
7665760	Nitrite (N)	2014/10/03	99	80 - 120	102	80 - 120	<0.0050	mg/L	NC	20
7665809	Fluoride (F)	2014/10/03	102	80 - 120	100	80 - 120	<0.010	mg/L	0	20
7667940	Dissolved Aluminum (Al)	2014/10/08	108	80 - 120	102	80 - 120	<3.0	ug/L	NC	20
7667940	Dissolved Antimony (Sb)	2014/10/08	99	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7667940	Dissolved Arsenic (As)	2014/10/08	105	80 - 120	105	80 - 120	<0.10	ug/L	NC	20
7667940	Dissolved Barium (Ba)	2014/10/08	98	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
7667940	Dissolved Beryllium (Be)	2014/10/08	103	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7667940	Dissolved Bismuth (Bi)	2014/10/08	99	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7667940	Dissolved Boron (B)	2014/10/08					<50	ug/L	NC	20
7667940	Dissolved Cadmium (Cd)	2014/10/08	99	80 - 120	101	80 - 120	<0.010	ug/L	NC	20
7667940	Dissolved Chromium (Cr)	2014/10/08	104	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7667940	Dissolved Cobalt (Co)	2014/10/08	103	80 - 120	104	80 - 120	<0.50	ug/L	NC	20
7667940	Dissolved Copper (Cu)	2014/10/08	102	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7667940	Dissolved Iron (Fe)	2014/10/08	107	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7667940	Dissolved Lead (Pb)	2014/10/08	100	80 - 120	102	80 - 120	<0.20	ug/L	NC	20
7667940	Dissolved Lithium (Li)	2014/10/08	98	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7667940	Dissolved Manganese (Mn)	2014/10/08	102	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7667940	Dissolved Molybdenum (Mo)	2014/10/08	100	80 - 120	101	80 - 120	<1.0	ug/L	NC	20
7667940	Dissolved Nickel (Ni)	2014/10/08	106	80 - 120	107	80 - 120	<1.0	ug/L	NC	20
7667940	Dissolved Phosphorus (P)	2014/10/08					<10	ug/L	NC	20

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7667940	Dissolved Selenium (Se)	2014/10/08	100	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7667940	Dissolved Silicon (Si)	2014/10/08					<100	ug/L	2.1	20
7667940	Dissolved Silver (Ag)	2014/10/08	101	80 - 120	93	80 - 120	<0.020	ug/L	NC	20
7667940	Dissolved Strontium (Sr)	2014/10/08	NC	80 - 120	100	80 - 120	<1.0	ug/L	1.4	20
7667940	Dissolved Thallium (Tl)	2014/10/08	87	80 - 120	96	80 - 120	<0.050	ug/L	NC	20
7667940	Dissolved Tin (Sn)	2014/10/08	96	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7667940	Dissolved Titanium (Ti)	2014/10/08	111	80 - 120	98	80 - 120	<5.0	ug/L	NC	20
7667940	Dissolved Uranium (U)	2014/10/08	99	80 - 120	99	80 - 120	<0.10	ug/L	NC	20
7667940	Dissolved Vanadium (V)	2014/10/08	106	80 - 120	101	80 - 120	<5.0	ug/L	NC	20
7667940	Dissolved Zinc (Zn)	2014/10/08	103	80 - 120	104	80 - 120	<5.0	ug/L	NC	20
7667940	Dissolved Zirconium (Zr)	2014/10/08					<0.50	ug/L	NC	20
7668827	Dissolved Sulphate (SO4)	2014/10/06	98	80 - 120	98	80 - 120	<0.50	mg/L	NC	20
7673826	Dissolved Mercury (Hg)	2014/10/10	110	80 - 120	99	80 - 120	<0.010	ug/L	NC	20

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

Maxxam Job #: B488520
Report Date: 2014/10/10

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: SR

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Maxxam Job #: B488520 **COC #:** 08398238 Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Shaun Roberts, Rick Martin

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

Field Filtered? Y ☑ N ☐ — Field Acidified? Y ☑ N ☐ — Field Acidified? Y ☐ N ☐

B488520

	Sample Identification	Lab Identification (Lab Use Only)	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM)	Total Metals	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-DP4	KT4749	Ground W	14/09/27 10:20	x	x	x	x	x	x	3
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Print name and sign — Print name and sign — Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Shaun Roberts	14/09/30	8:30	Laurel Berthier	2014/10/02	09:50	☑	A) 2 B) 3 C) 2	Present?	☐	☑
							Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 2014-10-03 C

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/10/14
Report #: R1661612
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B489726
Received: 2014/10/06, 01:05

Sample Matrix: Water
Samples Received: 2

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	2	2014/10/06	2014/10/07	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	2	N/A	2014/10/06	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	2	N/A	2014/10/07	BBY6SOP-00026	SM 22 2510 B m
Fluoride	2	N/A	2014/10/07	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	2	N/A	2014/10/09	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	2	N/A	2014/10/12	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	2	N/A	2014/10/09	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	2	N/A	2014/10/08	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	2	N/A	2014/10/07	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	2	N/A	2014/10/07	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	2	N/A	2014/10/07	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	2	N/A	2014/10/07	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	2	N/A	2014/10/08	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	2	N/A	2014/10/07	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	2	N/A	2014/10/06	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	2	2014/10/09	2014/10/10	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your C.O.C. #: 2014-10-03 C

Attention:MINTO DISTRIBUTION LIST

MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/10/14
Report #: R1661612
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B489726
Received: 2014/10/06, 01:05

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B489726
Report Date: 2014/10/14

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KU3685			KU3686		
Sampling Date		2014/10/02 15:05			2014/10/02 16:10		
COC Number		2014-10-03 C			2014-10-03 C		
	Units	**MW12-07-01**	**RDL**	**QC Batch**	**MW12-07-02**	**RDL**	**QC Batch**
ANIONS							
Nitrite (N)	mg/L	2.30 (1)	0.025	7670097	0.768 (1)	0.025	7670097
Calculated Parameters							
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.98	0.10	7667447	0.346	0.025	7667447
Misc. Inorganics							
Fluoride (F)	mg/L	1.10	0.010	7672166	1.40	0.010	7672166
Alkalinity (Total as CaCO3)	mg/L	278	0.50	7668569	125	0.50	7670503
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7668569	<0.50	0.50	7670503
Bicarbonate (HCO3)	mg/L	339	0.50	7668569	153	0.50	7670503
Carbonate (CO3)	mg/L	<0.50	0.50	7668569	<0.50	0.50	7670503
Hydroxide (OH)	mg/L	<0.50	0.50	7668569	<0.50	0.50	7670503
Anions							
Dissolved Sulphate (SO4)	mg/L	410	5.0	7668825	622	5.0	7668825
Dissolved Chloride (Cl)	mg/L	3.3	0.50	7668824	3.0	0.50	7668824
Nutrients							
Total Ammonia (N)	mg/L	0.27	0.0050	7670203	0.61	0.0050	7670203
Nitrate plus Nitrite (N)	mg/L	3.28 (1)	0.10	7670092	1.11 (1)	0.020	7670092
Physical Properties							
Conductivity	uS/cm	1270	1.0	7668573	1400	1.0	7668573
pH	pH	8.10	N/A	7668572	7.91	N/A	7668572
Physical Properties							
Total Dissolved Solids	mg/L	942	10	7672665	1110	10	7672665

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B489726
Report Date: 2014/10/14

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KU3685	KU3686		
Sampling Date		2014/10/02 15:05	2014/10/02 16:10		
COC Number		2014-10-03 C	2014-10-03 C		
	Units	**MW12-07-01**	**MW12-07-02**	**RDL**	**QC Batch**
Misc. Inorganics					
Dissolved Hardness (CaCO3)	mg/L	527	630	0.50	7667444
Elements					
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	0.010	7674867
Dissolved Metals by ICPMS					
Dissolved Aluminum (Al)	ug/L	4.0	5.2	3.0	7671183
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	0.50	7671183
Dissolved Arsenic (As)	ug/L	1.40	0.38	0.10	7671183
Dissolved Barium (Ba)	ug/L	35.6	16.8	1.0	7671183
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	0.10	7671183
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	1.0	7671183
Dissolved Boron (B)	ug/L	2470	350	50	7671183
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.010	7671183
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	1.0	7671183
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	0.50	7671183
Dissolved Copper (Cu)	ug/L	0.78	0.31	0.20	7671183
Dissolved Iron (Fe)	ug/L	705	266	5.0	7671183
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	0.20	7671183
Dissolved Lithium (Li)	ug/L	20.8	27.2	5.0	7671183
Dissolved Manganese (Mn)	ug/L	91.7	242	1.0	7671183
Dissolved Molybdenum (Mo)	ug/L	16.2	7.0	1.0	7671183
Dissolved Nickel (Ni)	ug/L	1.6	<1.0	1.0	7671183
Dissolved Phosphorus (P)	ug/L	48	<10	10	7671183
Dissolved Selenium (Se)	ug/L	2.36	0.24	0.10	7671183
Dissolved Silicon (Si)	ug/L	6830	6120	100	7671183
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	0.020	7671183
Dissolved Strontium (Sr)	ug/L	7730	9640	1.0	7671183
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	0.050	7671183
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	5.0	7671183
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	5.0	7671183
Dissolved Uranium (U)	ug/L	2.02	0.25	0.10	7671183
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	5.0	7671183
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	5.0	7671183
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	0.50	7671183
Dissolved Calcium (Ca)	mg/L	173	200	0.050	7667446

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KU3685	KU3686		
Sampling Date		2014/10/02 15:05	2014/10/02 16:10		
COC Number		2014-10-03 C	2014-10-03 C		
	Units	**MW12-07-01**	**MW12-07-02**	**RDL**	**QC Batch**
Dissolved Magnesium (Mg)	mg/L	23.2	31.4	0.050	7667446
Dissolved Potassium (K)	mg/L	3.04	2.67	0.050	7667446
Dissolved Sodium (Na)	mg/L	89.0	69.6	0.050	7667446
Dissolved Sulphur (S)	mg/L	147	220	3.0	7667446

RDL = Reportable Detection Limit

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7668569	Alkalinity (PP as CaCO3)	2014/10/07					<0.50	mg/L	NC	20
7668569	Alkalinity (Total as CaCO3)	2014/10/07	NC	80 - 120	96	80 - 120	<0.50	mg/L	0.22	20
7668569	Bicarbonate (HCO3)	2014/10/07					<0.50	mg/L	0.22	20
7668569	Carbonate (CO3)	2014/10/07					<0.50	mg/L	NC	20
7668569	Hydroxide (OH)	2014/10/07					<0.50	mg/L	NC	20
7668572	pH	2014/10/07			101	97 - 103			0.25	N/A
7668573	Conductivity	2014/10/07			100	80 - 120	1.2 ,RDL=1.0	uS/cm	0.17	20
7668824	Dissolved Chloride (Cl)	2014/10/06	95	80 - 120	100	80 - 120	0.73 ,RDL=0.50	mg/L	5.7	20
7668825	Dissolved Sulphate (SO4)	2014/10/06	NC	80 - 120	100	80 - 120	<0.50	mg/L	0.61	20
7670092	Nitrate plus Nitrite (N)	2014/10/07	105	80 - 120	106	80 - 120	<0.020	mg/L	NC	25
7670097	Nitrite (N)	2014/10/07	100	80 - 120	100	80 - 120	<0.0050	mg/L	NC	20
7670203	Total Ammonia (N)	2014/10/07	99	80 - 120	100	80 - 120	0.0054 ,RDL=0.0050	mg/L	7.7	20
7670503	Alkalinity (PP as CaCO3)	2014/10/07					<0.50	mg/L	NC	20
7670503	Alkalinity (Total as CaCO3)	2014/10/07	NC	80 - 120	96	80 - 120	<0.50	mg/L	0.099	20
7670503	Bicarbonate (HCO3)	2014/10/07					<0.50	mg/L	0.084	20
7670503	Carbonate (CO3)	2014/10/07					<0.50	mg/L	NC	20
7670503	Hydroxide (OH)	2014/10/07					<0.50	mg/L	NC	20
7671183	Dissolved Aluminum (Al)	2014/10/08	101	80 - 120	104	80 - 120	<3.0	ug/L	NC	20
7671183	Dissolved Antimony (Sb)	2014/10/08	101	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7671183	Dissolved Arsenic (As)	2014/10/08	105	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7671183	Dissolved Barium (Ba)	2014/10/08	100	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Beryllium (Be)	2014/10/08	102	80 - 120	101	80 - 120	<0.10	ug/L	NC	20
7671183	Dissolved Bismuth (Bi)	2014/10/08	100	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Boron (B)	2014/10/08					<50	ug/L	NC	20
7671183	Dissolved Cadmium (Cd)	2014/10/08	100	80 - 120	99	80 - 120	<0.010	ug/L	NC	20
7671183	Dissolved Chromium (Cr)	2014/10/08	106	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Cobalt (Co)	2014/10/08	104	80 - 120	102	80 - 120	<0.50	ug/L	NC	20
7671183	Dissolved Copper (Cu)	2014/10/08	102	80 - 120	100	80 - 120	<0.20	ug/L	NC	20
7671183	Dissolved Iron (Fe)	2014/10/08	108	80 - 120	109	80 - 120	<5.0	ug/L	NC	20
7671183	Dissolved Lead (Pb)	2014/10/08	99	80 - 120	98	80 - 120	<0.20	ug/L	NC	20

Maxxam Job #: B489726
Report Date: 2014/10/14

QUALITY ASSURANCE REPORT(CONT'D)

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV. MONITORING
Site Location: YUKON
Your P.O. #: 208977
Sampler Initials: JD

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7671183	Dissolved Lithium (Li)	2014/10/08	98	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7671183	Dissolved Manganese (Mn)	2014/10/08	103	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Molybdenum (Mo)	2014/10/08	101	80 - 120	97	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Nickel (Ni)	2014/10/08	104	80 - 120	103	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Phosphorus (P)	2014/10/08					<10	ug/L		
7671183	Dissolved Selenium (Se)	2014/10/08	103	80 - 120	99	80 - 120	<0.10	ug/L	NC	20
7671183	Dissolved Silicon (Si)	2014/10/08					<100	ug/L	NC	20
7671183	Dissolved Silver (Ag)	2014/10/08	102	80 - 120	90	80 - 120	<0.020	ug/L	NC	20
7671183	Dissolved Strontium (Sr)	2014/10/08	101	80 - 120	99	80 - 120	<1.0	ug/L	NC	20
7671183	Dissolved Thallium (Tl)	2014/10/08	85	80 - 120	100	80 - 120	<0.050	ug/L	NC	20
7671183	Dissolved Tin (Sn)	2014/10/08	99	80 - 120	100	80 - 120	<5.0	ug/L	NC	20
7671183	Dissolved Titanium (Ti)	2014/10/08	92	80 - 120	99	80 - 120	<5.0	ug/L	NC	20
7671183	Dissolved Uranium (U)	2014/10/08	100	80 - 120	99	80 - 120	<0.10	ug/L	NC	20
7671183	Dissolved Vanadium (V)	2014/10/08	103	80 - 120	103	80 - 120	<5.0	ug/L	NC	20
7671183	Dissolved Zinc (Zn)	2014/10/08	105	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7671183	Dissolved Zirconium (Zr)	2014/10/08					<0.50	ug/L	NC	20
7672166	Fluoride (F)	2014/10/07	NC	80 - 120	100	80 - 120	<0.010	mg/L	0	20
7672665	Total Dissolved Solids	2014/10/10	NC	80 - 120	90	80 - 120	12 ,RDL=10	mg/L	2.9	20
7674867	Dissolved Mercury (Hg)	2014/10/12	85	80 - 120	94	80 - 120	<0.010	ug/L	NC	20

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Andy Lu, Data Validation Coordinator

Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B489726 **COC #:** 2014-10-03 C Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Jasmin D, Martin C, Shaun R, Helaina M

REGULATORY REQUIREMENTS:

☐ CSR
☑ CCME
☐ BC Water Quality
☐ Other
☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT)
(5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only Lab Identification	Sample Type	Date/Time(24hr) Sampled	Field Filtered? Y ☑ N ☐ Dissolved	Field Acidified? Y ☑ N ☐ Metals (DM)	Field Acidified? Y ☐ N ☐ Total Metals	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-07-01	KU3685	Ground W	10/2/14 15:05	x	x		x	x	x	x	3
2	MW12-07-02	KU3686	Ground W	10/2/14 16:10	x	x		x	x	x	x	3
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

B489726

Print name and sign / Print name and sign / Laboratory Use Only

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Received by :	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive	Temperature on Receipt (°C)	Custody Seal	Yes	No
Helaina Moses	3-Oct-14	10:35		2014/10/06	10:05		A) 4 B) 5 C) 3	Present?	☐	☒
						☑	Just sampled & rec'd on ice: ☐	Intact?	☐	☐ NA

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

BBY FCD-00077R2_C

Maxxam Analytics Success Through Science ©

3, 4, 4

Your P.O. #: 208977
Your Project #: MINTO ENV.MONITORING
Your C.O.C. #: 2014-10-07 A

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/10/20
Report #: R1667290
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B491300
Received: 2014/10/09, 08:40

Sample Matrix: Water
Samples Received: 11

Analyses	Quantity	Date Extracted	Date Analyzed	Laboratory Method	Analytical Method
Alkalinity - Water	10	2014/10/10	2014/10/11	BBY6SOP-00026	SM 22 2320 B m
Alkalinity - Water	1	2014/10/17	2014/10/17	BBY6SOP-00026	SM 22 2320 B m
Chloride by Automated Colourimetry	10	N/A	2014/10/10	BBY6SOP-00011	SM 22 4500-Cl- G m
Chloride by Automated Colourimetry	1	N/A	2014/10/17	BBY6SOP-00011	SM 22 4500-Cl- G m
Conductance - water	10	N/A	2014/10/11	BBY6SOP-00026	SM 22 2510 B m
Conductance - water	1	N/A	2014/10/17	BBY6SOP-00026	SM 22 2510 B m
Fluoride	11	N/A	2014/10/10	BBY6SOP-00048	SM 22 4500-F C m
Hardness (calculated as CaCO3)	10	N/A	2014/10/14	BBY7SOP-00002	EPA 6020a R1 m
Hardness (calculated as CaCO3)	1	N/A	2014/10/20	BBY7SOP-00002	EPA 6020a R1 m
Mercury (Dissolved) by CVAF	11	N/A	2014/10/16	BBY7SOP-00015	BCMOE BCLM Oct2013 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	10	N/A	2014/10/14	BBY7SOP-00002	EPA 6020A R1 m
Na, K, Ca, Mg, S by CRC ICPMS (diss.)	1	N/A	2014/10/20	BBY7SOP-00002	EPA 6020A R1 m
Elements by CRC ICPMS (dissolved)	11	N/A	2014/10/10	BBY7SOP-00002	EPA 6020A R1 m
Ammonia-N (Preserved)	11	N/A	2014/10/10	BBY6SOP-00009	SM 22 4500-NH3- G m
Nitrate + Nitrite (N)	11	N/A	2014/10/10	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrite (N) by CFA	11	N/A	2014/10/10	BBY6SOP-00010	SM 22 4500-NO3- I m
Nitrogen - Nitrate (as N)	11	N/A	2014/10/10	BBY6SOP-00010	SM 22 4500-NO3 I m
Filter and HNO3 Preserve for Metals	11	N/A	2014/10/10	BBY7 WI-00004	BCMOE Reqs 08/14
pH Water (1)	10	N/A	2014/10/11	BBY6SOP-00026	SM 22 4500-H+ B m
pH Water (1)	1	N/A	2014/10/17	BBY6SOP-00026	SM 22 4500-H+ B m
Sulphate by Automated Colourimetry	8	N/A	2014/10/10	BBY6SOP-00017	SM 22 4500-SO42- E m
Sulphate by Automated Colourimetry	2	N/A	2014/10/14	BBY6SOP-00017	SM 22 4500-SO42- E m
Sulphate by Automated Colourimetry	1	N/A	2014/10/17	BBY6SOP-00017	SM 22 4500-SO42- E m
Total Dissolved Solids (Filt. Residue)	11	2014/10/10	2014/10/11	BBY6SOP-00033	SM 22 2540 C m

* RPDs calculated using raw data. The rounding of final results may result in the apparent difference.

(1) The BC-MOE and APHA Standard Method require pH to be analysed within 15 minutes of sampling and therefore field analysis is required for compliance. All Laboratory pH analyses in this report are reported past the BC-MOE/APHA Standard Method holding time.

Your P.O. #: 208977
Your Project #: MINTO ENV.MONITORING
Your C.O.C. #: 2014-10-07 A

Attention:MINTO DISTRIBUTION LIST
MINTO EXPLORATIONS LTD.
Yukon/Whitehorse
2 - 25 Pilgrim Way
Whitehorse, YT
CANADA Y1A 6E6

Report Date: 2014/10/20
Report #: R1667290
Version: 1 - Final

CERTIFICATE OF ANALYSIS

MAXXAM JOB #: B491300
Received: 2014/10/09, 08:40

Encryption Key

Please direct all questions regarding this Certificate of Analysis to your Project Manager.
Ken Pomeroy, Project Manager
Email: KPomeroy@maxxam.ca
Phone# (604)638-5020
==
This report has been generated and distributed using a secure automated process.
Maxxam has procedures in place to guard against improper use of the electronic signature and have the required "signatories", as per section 5.10.2 of ISO/IEC 17025:2005(E), signing the reports. For Service Group specific validation please refer to the Validation Signature Page.

Maxxam Job #: B491300
Report Date: 2014/10/20

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Your P.O. #: 208977
Sampler Initials: HM

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KV2823		KV2824			KV2825		
Sampling Date		2014/10/04 11:00		2014/10/04 11:50			2014/10/05 10:30		
COC Number		2014-10-07 A		2014-10-07 A			2014-10-07 A		
	Units	**MW12-05-01**	**QC Batch**	**MW12-05-03**	**RDL**	**QC Batch**	**MW12-05-05**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	0.139 (1)	7675409	0.0404 (1)	0.0050	7675409	0.0433 (1)	0.0050	7675409
Calculated Parameters									
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	N/A	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.023	7672494	<0.020	0.020	7672494	0.200	0.020	7672494
Misc. Inorganics									
Fluoride (F)	mg/L	1.10	7674865	1.20	0.010	7674865	0.550	0.010	7674865
Alkalinity (Total as CaCO3)	mg/L	187	7674676	288	0.50	7674676	217	0.50	7674676
Alkalinity (PP as CaCO3)	mg/L	<0.50	7674676	<0.50	0.50	7674676	<0.50	0.50	7674676
Bicarbonate (HCO3)	mg/L	229	7674676	352	0.50	7674676	265	0.50	7674676
Carbonate (CO3)	mg/L	<0.50	7674676	<0.50	0.50	7674676	<0.50	0.50	7674676
Hydroxide (OH)	mg/L	<0.50	7674676	<0.50	0.50	7674676	<0.50	0.50	7674676
Anions									
Dissolved Sulphate (SO4)	mg/L	728	7675301	736	5.0	7675295	33.3	0.50	7675301
Dissolved Chloride (Cl)	mg/L	12	7675299	9.2	0.50	7675292	6.1	0.50	7675299
Nutrients									
Total Ammonia (N)	mg/L	0.11	7675623	0.040	0.0050	7675627	0.018	0.0050	7675624
Nitrate plus Nitrite (N)	mg/L	0.162 (1)	7675403	0.045 (1)	0.020	7675403	0.243 (1)	0.020	7675403
Physical Properties									
Conductivity	uS/cm	1620	7674679	1750	1.0	7674679	475	1.0	7674679
pH	pH	8.15	7674678	8.19	N/A	7674678	8.23	N/A	7674678
Physical Properties									
Total Dissolved Solids	mg/L	1280	7674486	1400	10	7674486	258	10	7674486

RDL = Reportable Detection Limit
N/A = Not Applicable
(1) Sample arrived to laboratory past recommended hold time.

Maxxam Job #: B491300
Report Date: 2014/10/20

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Your P.O. #: 208977
Sampler Initials: HM

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KV2826			KV2827		KV2828		
Sampling Date		2014/10/05 11:15			2014/10/06 13:45		2014/10/06 10:10		
COC Number		2014-10-07 A			2014-10-07 A		2014-10-07 A		
	Units	**MW12-05-07**	**RDL**	**QC Batch**	**MW11-04A**	**QC Batch**	**MW09-03-01**	**RDL**	**QC Batch**
ANIONS									
Nitrite (N)	mg/L	2.91 (1)	0.050	7675409	0.0216 (2)	7675409	0.120 (2)	0.0050	7675409
Calculated Parameters									
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	<0.20	0.20	7672494	1.22	7672494	0.024	0.020	7672494
Misc. Inorganics									
Fluoride (F)	mg/L	0.620	0.010	7674863	0.087	7674863	0.820	0.010	7674865
Alkalinity (Total as CaCO3)	mg/L	268	0.50	7674676	71.4	7681482	135	0.50	7674676
Alkalinity (PP as CaCO3)	mg/L	5.72	0.50	7674676	47.0	7681482	<0.50	0.50	7674676
Bicarbonate (HCO3)	mg/L	313	0.50	7674676	<0.50	7681482	164	0.50	7674676
Carbonate (CO3)	mg/L	6.86	0.50	7674676	29.3	7681482	<0.50	0.50	7674676
Hydroxide (OH)	mg/L	<0.50	0.50	7674676	7.66	7681482	<0.50	0.50	7674676
Anions									
Dissolved Sulphate (SO4)	mg/L	38.6	0.50	7682953	7.70	7678191	22.7	0.50	7678191
Dissolved Chloride (Cl)	mg/L	8.0	0.50	7682951	1.9	7675292	0.60	0.50	7675299
Nutrients									
Total Ammonia (N)	mg/L	0.24	0.0050	7675627	0.11	7675624	0.035	0.0050	7675624
Nitrate plus Nitrite (N)	mg/L	3.10 (1)	0.20	7675403	1.24 (2)	7675403	0.144 (2)	0.020	7675403
Physical Properties									
Conductivity	uS/cm	569	1.0	7674679	214	7683172	299	1.0	7674679
pH	pH	8.45	N/A	7674678	10.8	7683171	8.19	N/A	7674678
Physical Properties									
Total Dissolved Solids	mg/L	362	10	7674486	151	7674486	162	10	7674486

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) RDL raised due to sample matrix interference. Sample arrived to laboratory past recommended hold time.

(2) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

Maxxam Job #: B491300
Report Date: 2014/10/20

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Your P.O. #: 208977
Sampler Initials: HM

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KV2829		KV2830		KV2831		KV2832		
Sampling Date		2014/10/06 10:45		2014/10/06 11:10		2014/10/06 15:45		2014/10/06 16:20		
COC Number		2014-10-07 A		2014-10-07 A		2014-10-07 A		2014-10-07 A		
	Units	**MW09-03-02**	**QC Batch**	**MW09-03-03**	**QC Batch**	**MW12-06-02**	**QC Batch**	**MW12-06-04**	**RDL**	**QC Batch**
ANIONS										
Nitrite (N)	mg/L	0.0429 (1)	7675409	0.0051 (1)	7675409	0.0882 (1)	7675409	0.0998 (1)	0.0050	7675409
Calculated Parameters										
Filter and HNO3 Preservation	N/A	FIELD	ONSITE	FIELD	ONSITE	FIELD	ONSITE	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	<0.020	7672494	0.507	7672494	0.026	7672494	0.029	0.020	7672494
Misc. Inorganics										
Fluoride (F)	mg/L	0.690	7674865	0.440	7674863	1.50	7674865	1.20	0.010	7674865
Alkalinity (Total as CaCO3)	mg/L	500	7674676	87.3	7674676	363	7674676	418	0.50	7674676
Alkalinity (PP as CaCO3)	mg/L	<0.50	7674676	<0.50	7674676	<0.50	7674676	<0.50	0.50	7674676
Bicarbonate (HCO3)	mg/L	610	7674676	107	7674676	443	7674676	510	0.50	7674676
Carbonate (CO3)	mg/L	<0.50	7674676	<0.50	7674676	<0.50	7674676	<0.50	0.50	7674676
Hydroxide (OH)	mg/L	<0.50	7674676	<0.50	7674676	<0.50	7674676	<0.50	0.50	7674676
Anions										
Dissolved Sulphate (SO4)	mg/L	<0.50	7675295	10.3	7675295	187	7675301	164	0.50	7675301
Dissolved Chloride (Cl)	mg/L	4.2	7675292	0.57	7675292	1.6	7675299	1.3	0.50	7675299
Nutrients										
Total Ammonia (N)	mg/L	0.15	7675624	0.0090	7675624	0.050	7675624	0.023	0.0050	7675623
Nitrate plus Nitrite (N)	mg/L	0.045 (1)	7675403	0.512 (1)	7675403	0.114 (1)	7675403	0.129 (1)	0.020	7675403
Physical Properties										
Conductivity	uS/cm	893	7674679	193	7674679	977	7674679	992	1.0	7674679
pH	pH	8.02	7674678	8.10	7674678	8.05	7674678	8.14	N/A	7674678
Physical Properties										
Total Dissolved Solids	mg/L	577	7674486	106	7674486	630	7674486	618	10	7674486

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

Maxxam Job #: B491300
Report Date: 2014/10/20

MINTO EXPLORATIONS LTD.
Client Project #: MINTO ENV.MONITORING
Your P.O. #: 208977
Sampler Initials: HM

RESULTS OF CHEMICAL ANALYSES OF WATER

Maxxam ID		KV2833		
Sampling Date		2014/10/06 16:50		
COC Number		2014-10-07 A		
	Units	**MW12-06-06**	**RDL**	**QC Batch**
ANIONS				
Nitrite (N)	mg/L	0.102 (1)	0.0050	7675409
Calculated Parameters				
Filter and HNO3 Preservation	N/A	FIELD	N/A	ONSITE
Nitrate (N)	mg/L	0.993	0.020	7672494
Misc. Inorganics				
Fluoride (F)	mg/L	0.650	0.010	7674863
Alkalinity (Total as CaCO3)	mg/L	313	0.50	7674676
Alkalinity (PP as CaCO3)	mg/L	<0.50	0.50	7674676
Bicarbonate (HCO3)	mg/L	382	0.50	7674676
Carbonate (CO3)	mg/L	<0.50	0.50	7674676
Hydroxide (OH)	mg/L	<0.50	0.50	7674676
Anions				
Dissolved Sulphate (SO4)	mg/L	146	0.50	7675295
Dissolved Chloride (Cl)	mg/L	5.1	0.50	7675292
Nutrients				
Total Ammonia (N)	mg/L	0.0093	0.0050	7675624
Nitrate plus Nitrite (N)	mg/L	1.09 (1)	0.020	7675403
Physical Properties				
Conductivity	uS/cm	807	1.0	7674679
pH	pH	8.23	N/A	7674678
Physical Properties				
Total Dissolved Solids	mg/L	519	10	7674486

RDL = Reportable Detection Limit

N/A = Not Applicable

(1) Sample analysed past hold time: sample was received on the hold time expiry date which did not allow sufficient time for preparation and analysis.

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KV2823	KV2824	KV2825	KV2826		KV2827		
Sampling Date		2014/10/04 11:00	2014/10/04 11:50	2014/10/05 10:30	2014/10/05 11:15		2014/10/06 13:45		
COC Number		2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A		2014-10-07 A		
	Units	**MW12-05-01**	**MW12-05-03**	**MW12-05-05**	**MW12-05-07**	**QC Batch**	**MW11-04A**	**RDL**	**QC Batch**
Misc. Inorganics									
Dissolved Hardness (CaCO3)	mg/L	674	799	216	232	7672752	131	0.50	7681942
Elements									
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	7680047	<0.010	0.010	7680047
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	6.8	4.2	3.4	5.8	7675014	734	3.0	7675014
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	7675014	2.16	0.50	7675014
Dissolved Arsenic (As)	ug/L	0.87	0.39	0.14	0.40	7675014	3.38	0.10	7675014
Dissolved Barium (Ba)	ug/L	65.1	56.0	78.0	953	7675014	174	1.0	7675014
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	7675014	<0.10	0.10	7675014
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	7675014	<1.0	1.0	7675014
Dissolved Boron (B)	ug/L	739	92	<50	759	7675014	<50	50	7675014
Dissolved Cadmium (Cd)	ug/L	<0.010	<0.010	0.011	0.019	7675014	0.045	0.010	7675014
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	7675014	3.5	1.0	7675014
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	7675014	<0.50	0.50	7675014
Dissolved Copper (Cu)	ug/L	0.21	<0.20	0.88	0.31	7675014	82.4	0.20	7675014
Dissolved Iron (Fe)	ug/L	18.3	4140	40.4	60.2	7675014	5.3	5.0	7675014
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	7675014	<0.20	0.20	7675014
Dissolved Lithium (Li)	ug/L	6.7	5.3	<5.0	<5.0	7675014	12.2	5.0	7675014
Dissolved Manganese (Mn)	ug/L	100	2070	265	570	7675014	<1.0	1.0	7675014
Dissolved Molybdenum (Mo)	ug/L	<1.0	4.9	5.0	3.0	7675014	2.3	1.0	7675014
Dissolved Nickel (Ni)	ug/L	<1.0	<1.0	<1.0	<1.0	7675014	<1.0	1.0	7675014
Dissolved Phosphorus (P)	ug/L	32	<10	<10	119	7675014	11	10	7675014
Dissolved Selenium (Se)	ug/L	0.21	0.11	<0.10	0.34	7675014	2.18	0.10	7675014
Dissolved Silicon (Si)	ug/L	7450	8100	6530	6720	7675014	5710	100	7675014
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	7675014	<0.020	0.020	7675014
Dissolved Strontium (Sr)	ug/L	5820	8070	730	722	7675014	374	1.0	7675014
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	7675014	<0.050	0.050	7675014
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	7675014	<5.0	5.0	7675014
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	7675014	<5.0	5.0	7675014
Dissolved Uranium (U)	ug/L	0.95	1.20	2.31	1.37	7675014	<0.10	0.10	7675014
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	7675014	14.7	5.0	7675014
Dissolved Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	<5.0	7675014	<5.0	5.0	7675014
Dissolved Zirconium (Zr)	ug/L	<0.50	<0.50	<0.50	<0.50	7675014	<0.50	0.50	7675014
Dissolved Calcium (Ca)	mg/L	221	209	45.9	52.4	7672846	52.5	0.050	7682009
Dissolved Magnesium (Mg)	mg/L	29.9	67.5	24.6	24.6	7672846	<0.050	0.050	7682009

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KV2823	KV2824	KV2825	KV2826		KV2827		
Sampling Date		2014/10/04 11:00	2014/10/04 11:50	2014/10/05 10:30	2014/10/05 11:15		2014/10/06 13:45		
COC Number		2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A		2014-10-07 A		
	Units	**MW12-05-01**	**MW12-05-03**	**MW12-05-05**	**MW12-05-07**	**QC Batch**	**MW11-04A**	**RDL**	**QC Batch**
Dissolved Potassium (K)	mg/L	3.17	3.79	2.07	2.59	7672846	4.43	0.050	7682009
Dissolved Sodium (Na)	mg/L	117	100	16.2	22.4	7672846	5.14	0.050	7682009
Dissolved Sulphur (S)	mg/L	237	249	11.4	5.6	7672846	<3.0	3.0	7682009

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KV2828	KV2829	KV2830	KV2831	KV2832	KV2833		
Sampling Date		2014/10/06 10:10	2014/10/06 10:45	2014/10/06 11:10	2014/10/06 15:45	2014/10/06 16:20	2014/10/06 16:50		
COC Number		2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A		
	Units	**MW09-03-01**	**MW09-03-02**	**MW09-03-03**	**MW12-06-02**	**MW12-06-04**	**MW12-06-06**	**RDL**	**QC Batch**
Misc. Inorganics									
Dissolved Hardness (CaCO3)	mg/L	141	459	101	451	495	387	0.50	7672752
Elements									
Dissolved Mercury (Hg)	ug/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.010	7680047
Dissolved Metals by ICPMS									
Dissolved Aluminum (Al)	ug/L	<3.0	<3.0	6.2	3.8	<3.0	<3.0	3.0	7675014
Dissolved Antimony (Sb)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	7675014
Dissolved Arsenic (As)	ug/L	<0.10	0.51	<0.10	4.98	2.30	<0.10	0.10	7675014
Dissolved Barium (Ba)	ug/L	51.7	544	41.5	35.1	16.8	14.1	1.0	7675014
Dissolved Beryllium (Be)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	7675014
Dissolved Bismuth (Bi)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	7675014
Dissolved Boron (B)	ug/L	64	321	60	308	99	90	50	7675014
Dissolved Cadmium (Cd)	ug/L	0.150	0.032	0.022	<0.010	<0.010	<0.010	0.010	7675014
Dissolved Chromium (Cr)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	7675014
Dissolved Cobalt (Co)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50	7675014
Dissolved Copper (Cu)	ug/L	0.21	2.07	1.54	0.30	<0.20	0.22	0.20	7675014
Dissolved Iron (Fe)	ug/L	<5.0	19200	483	1210	699	13.0	5.0	7675014
Dissolved Lead (Pb)	ug/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.20	7675014
Dissolved Lithium (Li)	ug/L	<5.0	<5.0	<5.0	9.1	6.2	<5.0	5.0	7675014
Dissolved Manganese (Mn)	ug/L	72.1	16300	592	40.2	49.6	33.3	1.0	7675014
Dissolved Molybdenum (Mo)	ug/L	4.0	14.3	5.0	5.5	8.3	6.2	1.0	7675014
Dissolved Nickel (Ni)	ug/L	1.8	<1.0	<1.0	<1.0	<1.0	<1.0	1.0	7675014
Dissolved Phosphorus (P)	ug/L	<10	<10	<10	12	<10	<10	10	7675014
Dissolved Selenium (Se)	ug/L	<0.10	0.79	0.40	<0.10	<0.10	0.19	0.10	7675014
Dissolved Silicon (Si)	ug/L	4820	10200	4820	10600	8940	7040	100	7675014
Dissolved Silver (Ag)	ug/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020	7675014
Dissolved Strontium (Sr)	ug/L	706	1390	212	10400	2870	1610	1.0	7675014
Dissolved Thallium (Tl)	ug/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050	7675014
Dissolved Tin (Sn)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7675014
Dissolved Titanium (Ti)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7675014
Dissolved Uranium (U)	ug/L	1.59	0.22	0.93	2.37	5.81	3.94	0.10	7675014
Dissolved Vanadium (V)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5.0	7675014
Dissolved Zinc (Zn)	ug/L	<5.0	10.4	10.5	7.2	22.7	8.8	5.0	7675014
Dissolved Zirconium (Zr)	ug/L	<0.50	0.55	<0.50	<0.50	<0.50	<0.50	0.50	7675014
Dissolved Calcium (Ca)	mg/L	41.5	147	33.5	128	105	78.0	0.050	7672846
Dissolved Magnesium (Mg)	mg/L	9.04	22.3	4.25	31.9	56.7	46.8	0.050	7672846

RDL = Reportable Detection Limit

CCME DISSOLVED METALS IN WATER (WATER)

Maxxam ID		KV2828	KV2829	KV2830	KV2831	KV2832	KV2833		
Sampling Date		2014/10/06 10:10	2014/10/06 10:45	2014/10/06 11:10	2014/10/06 15:45	2014/10/06 16:20	2014/10/06 16:50		
COC Number		2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A	2014-10-07 A		
	Units	**MW09-03-01**	**MW09-03-02**	**MW09-03-03**	**MW12-06-02**	**MW12-06-04**	**MW12-06-06**	**RDL**	**QC Batch**
Dissolved Potassium (K)	mg/L	2.54	3.75	1.63	3.36	3.53	3.21	0.050	7672846
Dissolved Sodium (Na)	mg/L	4.78	14.0	3.69	39.8	34.2	29.0	0.050	7672846
Dissolved Sulphur (S)	mg/L	6.6	<3.0	3.2	65.5	56.9	48.4	3.0	7672846

RDL = Reportable Detection Limit

GENERAL COMMENTS

Effective October 1, 2013, the BC MOE SAMPLE PRESERVATION & HOLDING TIME REQUIREMENTS states that Mercury in water requires a glass or PTFE container with Hydrochloric Acid (HCl) preservation. Sample container and preservation received was not in compliance. Maxxam added HCl to stabilize Mercury in this sample prior to analysis.

Results relate only to the items tested.

QUALITY ASSURANCE REPORT

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	**Parameter**	**Date**	**% Recovery**	**QC Limits**	**% Recovery**	**QC Limits**	**Value**	**Units**	**Value (%)**	**QC Limits**
7674486	Total Dissolved Solids	2014/10/11	98	80 - 120	90	80 - 120	<10	mg/L	3.3	20
7674676	Alkalinity (PP as CaCO3)	2014/10/11					<0.50	mg/L	NC	20
7674676	Alkalinity (Total as CaCO3)	2014/10/11	NC	80 - 120	101	80 - 120	<0.50	mg/L	0.032	20
7674676	Bicarbonate (HCO3)	2014/10/11					<0.50	mg/L	0.026	20
7674676	Carbonate (CO3)	2014/10/11					<0.50	mg/L	NC	20
7674676	Hydroxide (OH)	2014/10/11					<0.50	mg/L	NC	20
7674678	pH	2014/10/11			101	97 - 103			0.37	N/A
7674679	Conductivity	2014/10/11			100	80 - 120	<1.0	uS/cm	1.4	20
7674863	Fluoride (F)	2014/10/10	NC	80 - 120	90	80 - 120	<0.010	mg/L	0	20
7674865	Fluoride (F)	2014/10/10	102	80 - 120	96	80 - 120	<0.010	mg/L	0	20
7675014	Dissolved Aluminum (Al)	2014/10/10	102	80 - 120	100	80 - 120	<3.0	ug/L	NC	20
7675014	Dissolved Antimony (Sb)	2014/10/10	103	80 - 120	97	80 - 120	<0.50	ug/L	NC	20
7675014	Dissolved Arsenic (As)	2014/10/10	106	80 - 120	105	80 - 120	<0.10	ug/L	7.1	20
7675014	Dissolved Barium (Ba)	2014/10/10	NC	80 - 120	94	80 - 120	<1.0	ug/L	2.9	20
7675014	Dissolved Beryllium (Be)	2014/10/10	100	80 - 120	98	80 - 120	<0.10	ug/L	NC	20
7675014	Dissolved Bismuth (Bi)	2014/10/10	95	80 - 120	100	80 - 120	<1.0	ug/L	NC	20
7675014	Dissolved Boron (B)	2014/10/10					<50	ug/L	NC	20
7675014	Dissolved Cadmium (Cd)	2014/10/10	96	80 - 120	95	80 - 120	<0.010	ug/L	NC	20
7675014	Dissolved Chromium (Cr)	2014/10/10	99	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7675014	Dissolved Cobalt (Co)	2014/10/10	95	80 - 120	100	80 - 120	<0.50	ug/L	NC	20
7675014	Dissolved Copper (Cu)	2014/10/10	90	80 - 120	103	80 - 120	<0.20	ug/L	NC	20
7675014	Dissolved Iron (Fe)	2014/10/10	NC	80 - 120	103	80 - 120	<5.0	ug/L	2.6	20
7675014	Dissolved Lead (Pb)	2014/10/10	97	80 - 120	99	80 - 120	<0.20	ug/L	NC	20
7675014	Dissolved Lithium (Li)	2014/10/10	NC	80 - 120	91	80 - 120	<5.0	ug/L	NC	20
7675014	Dissolved Manganese (Mn)	2014/10/10	NC	80 - 120	99	80 - 120	<1.0	ug/L	0.75	20
7675014	Dissolved Molybdenum (Mo)	2014/10/10	NC	80 - 120	88	80 - 120	<1.0	ug/L	3.4	20
7675014	Dissolved Nickel (Ni)	2014/10/10	94	80 - 120	102	80 - 120	<1.0	ug/L	NC	20
7675014	Dissolved Phosphorus (P)	2014/10/10					<10	ug/L	NC	20
7675014	Dissolved Selenium (Se)	2014/10/10	96	80 - 120	100	80 - 120	<0.10	ug/L	NC	20
7675014	Dissolved Silicon (Si)	2014/10/10					<100	ug/L	2.2	20
7675014	Dissolved Silver (Ag)	2014/10/10	97	80 - 120	87	80 - 120	<0.020	ug/L	NC	20

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits
7675014	Dissolved Strontium (Sr)	2014/10/10	NC	80 - 120	95	80 - 120	<1.0	ug/L	2.2	20
7675014	Dissolved Thallium (Tl)	2014/10/10	95	80 - 120	94	80 - 120	<0.050	ug/L	NC	20
7675014	Dissolved Tin (Sn)	2014/10/10	99	80 - 120	90	80 - 120	<5.0	ug/L	NC	20
7675014	Dissolved Titanium (Ti)	2014/10/10	104	80 - 120	104	80 - 120	<5.0	ug/L	NC	20
7675014	Dissolved Uranium (U)	2014/10/10	NC	80 - 120	95	80 - 120	<0.10	ug/L	1.6	20
7675014	Dissolved Vanadium (V)	2014/10/10	102	80 - 120	97	80 - 120	<5.0	ug/L	NC	20
7675014	Dissolved Zinc (Zn)	2014/10/10	NC	80 - 120	102	80 - 120	<5.0	ug/L	NC	20
7675014	Dissolved Zirconium (Zr)	2014/10/10					<0.50	ug/L	NC	20
7675292	Dissolved Chloride (Cl)	2014/10/10	95	80 - 120	100	80 - 120	<0.50	mg/L	NC	20
7675295	Dissolved Sulphate (SO4)	2014/10/10			95	80 - 120	<0.50	mg/L		
7675299	Dissolved Chloride (Cl)	2014/10/10	94	80 - 120	99	80 - 120	<0.50	mg/L		
7675301	Dissolved Sulphate (SO4)	2014/10/10	NC	80 - 120	95	80 - 120	<0.50	mg/L		
7675403	Nitrate plus Nitrite (N)	2014/10/10	NC	80 - 120	103	80 - 120	<0.020	mg/L	5.1	25
7675409	Nitrite (N)	2014/10/10	NC	80 - 120	102	80 - 120	<0.0050	mg/L	0.59	20
7675623	Total Ammonia (N)	2014/10/10	NC	80 - 120	101	80 - 120	<0.0050	mg/L	3.4	20
7675624	Total Ammonia (N)	2014/10/10	99	80 - 120	108	80 - 120	<0.0050	mg/L	NC	20
7675627	Total Ammonia (N)	2014/10/10	NC	80 - 120	100	80 - 120	<0.0050	mg/L	3.6	20
7678191	Dissolved Sulphate (SO4)	2014/10/14	102	80 - 120	97	80 - 120	<0.50	mg/L	0.37	20
7680047	Dissolved Mercury (Hg)	2014/10/16	97	80 - 120	106	80 - 120	<0.010	ug/L	NC	20
7681482	Alkalinity (PP as CaCO3)	2014/10/17					<0.50	mg/L	NC	20
7681482	Alkalinity (Total as CaCO3)	2014/10/17	NC	80 - 120	101	80 - 120	0.57 ,RDL=0.50	mg/L	5.1	20
7681482	Bicarbonate (HCO3)	2014/10/17					0.70 ,RDL=0.50	mg/L	5.1	20
7681482	Carbonate (CO3)	2014/10/17					<0.50	mg/L	NC	20
7681482	Hydroxide (OH)	2014/10/17					<0.50	mg/L	NC	20
7682951	Dissolved Chloride (Cl)	2014/10/17			102	80 - 120	<0.50	mg/L		
7682953	Dissolved Sulphate (SO4)	2014/10/17			98	80 - 120	<0.50	mg/L		
7683171	pH	2014/10/17			102	97 - 103				
7683172	Conductivity	2014/10/17			102	80 - 120	<1.0	uS/cm		

N/A = Not Applicable

Duplicate: Paired analysis of a separate portion of the same sample. Used to evaluate the variance in the measurement.

QUALITY ASSURANCE REPORT(CONT'D)

			Matrix Spike		Spiked Blank		Method Blank		RPD	
QC Batch	Parameter	Date	% Recovery	QC Limits	% Recovery	QC Limits	Value	Units	Value (%)	QC Limits

Matrix Spike: A sample to which a known amount of the analyte of interest has been added. Used to evaluate sample matrix interference.

Spiked Blank: A blank matrix sample to which a known amount of the analyte, usually from a second source, has been added. Used to evaluate method accuracy.

Method Blank: A blank matrix containing all reagents used in the analytical procedure. Used to identify laboratory contamination.

NC (Matrix Spike): The recovery in the matrix spike was not calculated. The relative difference between the concentration in the parent sample and the spiked amount was too small to permit a reliable recovery calculation (matrix spike concentration was less than 2x that of the native sample concentration).

NC (Duplicate RPD): The duplicate RPD was not calculated. The concentration in the sample and/or duplicate was too low to permit a reliable RPD calculation (one or both samples < 5x RDL).

VALIDATION SIGNATURE PAGE

The analytical data and all QC contained in this report were reviewed and validated by the following individual(s).

Rob Reinert, Data Validation Coordinator

Maxxam

Burnaby: 4606 Canada Way, Burnaby, BC V5G 1K5 Ph: (604) 734-7276 Fax: (604) 731-2386, Toll Free: (800) 665-8566

CHAIN OF CUSTODY RECORD

Click here to get the COC number

Maxxam Job #: B491300 **COC #:** 2014-10-07 A Page: 1 of 1

Invoice To: Require Report? Yes ☑ No ☐

Company Name: Minto Explorations Ltd
Contact Name: Elvina Wong
Address: Suite 900 - 999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail:

Report To:

Company Name: Minto Explorations Ltd
Contact Name: Minto Environment
Address: Suite 900-999 West Hastings St
Vancouver, B.C. PC: V6C 2W2
Phone / Fax#: Ph: 604-684-8894 Fax: 604-688-2120
E-mail: minto_environment@mintomine.com

PO #: 208977
Quotation #:
Project # :
Proj. Name: Minto Env. Monitoring
Location: Yukon
Sampled by: Helaina M, Shaun R

REGULATORY REQUIREMENTS:

- ☐ CSR
- ☑ CCME
- ☐ BC Water Quality
- ☐ Other
- ☐ DRINKING WATER

SERVICE REQUESTED:

● Regular Turn Around Time (TAT) (5 days for most tests)
RUSH (Please contact the lab)
○ 1 Day ○ 2 Day ○ 3 Day
Date Required:

SPECIAL INSTRUCTIONS:
Return Cooler ☐ **Ship Sample Bottles (please specify)** ☐

ANALYSIS REQUESTED

	Sample Identification	Lab Use Only: Lab Identification	Sample Type	Date/Time(24hr) Sampled	Dissolved Metals (DM): Field Filtered? Y ☑ N ☐	Dissolved Metals (DM): Field Acidified? Y ☑ N ☐	Total Metals: Field Acidified? Y ☐ N ☐	Nitrate ☑ Nitrite ☑ Ammonia ☑	Total Suspended Solids (TSS) ☐ TDS ☑	pH ☑ Conductivity ☑ Alkalinity ☑	Chloride ☑ Fluoride ☑ Sulphate ☑	Number of Containers
1	MW12-05-01	KV2823	Ground W	10/4/14 11:00	x	x		x	x	x	x	3
2	MW12-05-03	KV2824	Ground W	10/4/14 11:50	x	x		x	x	x	x	3
3	MW12-05-05	KV2825	Ground W	10/5/14 10:30	x	x		x	x	x	x	3
4	MW12-05-07	KV2826	Ground W	10/5/14 11:15	x	x		x	x	x	x	3
5	MW11-04A	KV2827	Ground W	10/6/14 13:45	x	x		x	x	x	x	3
6	MW09-03-01	KV2828	Ground W	10/6/14 10:10	x	x		x	x	x	x	3
7	MW09-03-02	KV2829	Ground W	10/6/14 10:45	x	x		x	x	x	x	3
8	MW09-03-03	KV2830	Ground W	10/6/14 11:10	x	x		x	x	x	x	3
9	MW12-06-02	KV2831	Ground W	10/6/14 15:45	x	x		x	x	x	x	3
10	MW12-06-04	KV2832	Ground W	10/6/14 16:20	x	x		x	x	x	x	3
11	MW12-06-06	KV2833	Ground W	10/6/14 16:50	x	x		x	x	x	x	3
12												

B491300

Print name and sign

*Relinquished By:	Date (yy/mm/dd):	Time (24hr):	Print name and sign: Received by:	Date (yy/mm/dd):	Time (24 hr):	Time Sensitive
Helaina Moses	7-Sep-14	7:30	JUVAHNUE Roy	2014/10/09	08:40	☑

Laboratory Use Only

Temperature on Receipt (°C)		Custody Seal	Yes	No
A) 3 B) 2 C) 2		Present?	☐	☐
Just sampled & rec'd on ice: ☐		Intact?	☐	☐

N/A

*IT IS THE RESPONSIBILITY OF THE RELINQUISHER TO ENSURE THE ACCURACY OF THE CHAIN OF CUSTODY RECORDS. AN INCOMPLETE CHAIN OF CUSTODY MAY RESULT IN ANALYTICAL TAT DELAYS.

5, 4, 5
3, 2, 3

BBY FCD-00077R2_C

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Appendix H – Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2014

Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2014

Report Prepared For:
Capstone Mining Corp. Minto Mine
13-151 Industrial Road
Whitehorse, YT
Y1A 2V3

Prepared By:
Minnow Environmental Inc.
101-1025 Hillside Ave.
Victoria, BC
V8T 2A2

March 2015

Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2014

Report Prepared for:

Capstone Mining Corp. Minto Mine

Report Prepared by:

Minnow Environmental Inc.

Lisa Bowron

Lisa Bowron, M.Sc.
Project Manager

Pierre Stecko, M.Sc., EP, RPBio
Project Principal

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1.0 INTRODUCTION

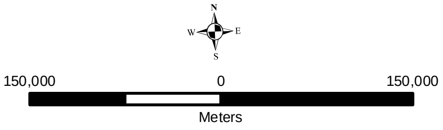
1.1 Site Description

The Minto Mine is a high-grade copper mine located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A approximately 240 km northwest of Whitehorse, Yukon Territory (62°37'N latitude and 137°15'W longitude; Figure 1.1). It is owned and operated by Minto Explorations Ltd. (MintoEx), a wholly owned subsidiary of Capstone Mining Corporation (Capstone). Development of the mine was initiated in 1997, commercial operations started in October 2007 and the anticipated operating life is to the year 2022. The facility is permitted to conduct open pit and underground mining with milling at a rate of 4,200 tonnes of copper/gold/silver ore per day, and produced 37.2 million pounds of copper in 2014. Copper reserves are approximately 440 million pounds. Mine-impacted seepage from the Tailings Storage Facility and under the Mill Valley Fill Expansion (MVFE) is collected at the Minto Creek Detention Structure at the toe of the MVFE and pumped to the main pit (Figure 1.2). Non-impacted water and treated mine-impacted water are collected in a Water Storage Pond (WSP; Figure 1.2). Effluent from the WSP is periodically discharged to Minto Creek under conditions specified in Water Use Licence (WUL) QZ96-006 (Amendment 7, April 2011 and Amendment 8, September 2012). Minto Creek, in turn, discharges to the Yukon River approximately 12 km south-east of the mine site (Figure 1.2).

1.2 Background

Under the WUL, the Minto Mine implements a routine water quality surveillance program in Minto Creek and reference tributaries at sampling frequencies that vary from weekly to monthly during the ice-free period (typically from April to October or November). In accordance with the WUL, the Minto Mine submits water quality data as original laboratory reports and monthly summary reports within 30-days of month-end. Water quality monitoring data have indicated that total suspended solids concentrations can increase dramatically during high flow events and that concentrations of a number of metals (including aluminum, chromium, copper and iron) are generally concurrently higher than national water quality guidelines for the protection of aquatic life even under background and reference conditions (e.g., HKP 1994; Minnow 2009a, 2010a, 2010b).

In 2014, Minto Mine conducted an Investigation of Cause (IOC) as required under the Metal Mining Effluent Regulations (MMER; Minnow 2015). This study documented some mine influence on Minto Creek water quality. Conductivity, hardness, nitrate, arsenic and copper were greater in Minto Creek than at reference areas but analytes were generally below



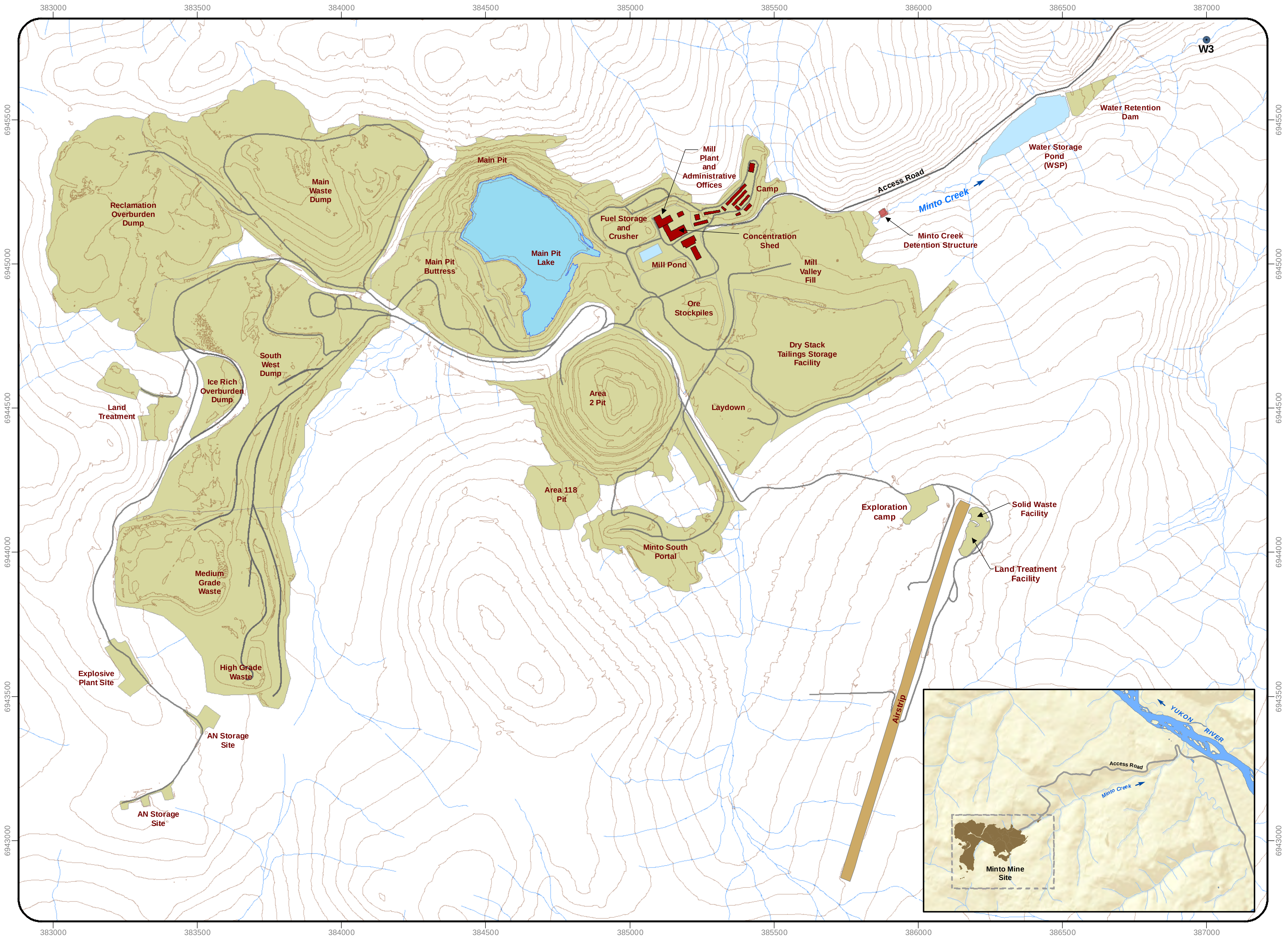
MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
Data Source: Department of Natural Resources Canada
All rights reserved.
Created By: M.LaPalme
Creation Date: January 2015
Project No. 2537

Map of Canada

Figure 1.1: Location of the Minto Mine

Created by:

minnow
environmental inc.



Features

- ● Final Effluent Discharge Point
- → Direction of Flow
- — Mine Road
- — Contour
- — Watercourse
- ▭ Waterbody
- ▭ Mine Feature Footprint
- ▭ Main Pit Lake
- ▭ Minto Creek Detention Structure
- ■ Building

N
W E
S

320 0 320

Meters

MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
Data Source: National Topographic Data Base (NTDB)
compiled by Department of Natural Resources Canada
at a scale of 1:50,000. All rights reserved.

Mine infrastructure data provided by Access Mining Consultants Inc.
Mine site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

Created By: M.LaPalme
Creation Date: January 2015
Project No. 2537

Figure 1.2: Minto Mine Site Layout and Receiving Environment

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minnow
environmental inc.

Canadian Water Quality Guidelines (CWQG) for the protection of aquatic life. The only exception was for copper, whose mean concentration was greater than CWQG but lower than water quality guidelines. Of these analytes, concentrations of nitrate were most strongly associated with the release of water from the Water Storage Pond, but remained below the CWQG.

The Minto Mine also implements annual biological monitoring under the WUL, which includes monitoring of sediment, periphyton, benthic invertebrates, fish and fish habitat. The biological monitoring program has been modified over time, but data from 1994 (baseline) and 2006-2013 have been reported previously. The sediment and benthic program conducted in September 2013 demonstrated that a few analytes measured in sediments of Minto Creek had concentrations that were greater than Interim Sediment Quality Guidelines (ISGQs) for the protection of aquatic life (Minnow 2014). However, only copper in upper Minto Creek and lower Minto Creek was elevated to concentrations greater than ISQGs, baseline and reference. In 2013, the periphyton community of lower Minto Creek differed from that of the reference creek (lower Wolverine Creek), and this was consistent with observations in the field (the available area to collect periphyton samples was much smaller at lower Minto Creek than in Wolverine Creek, and light penetration was lower). Differences in erosional benthic invertebrate community composition between lower Minto Creek and the reference area (lower Wolverine Creek) were apparent based on lower density and higher Bray-Curtis distance but greater diversity, greater dominance of EPT taxa (Ephemeroptera [mayfly], Plecoptera [stonefly], Trichoptera [caddisfly] taxa) and lower dominance of chironomids (non-biting midges), the latter three of which typically indicate a healthy community. This suggests limited mine-related impact to the erosional benthic invertebrate community of lower Minto Creek.

1.3 Objectives

The objectives of this study and report are to characterize and interpret current sediment quality, the periphyton community and the benthic invertebrate community of Minto Creek relative to reference conditions and conditions documented in previous years. Additional data on the quality of biological tissues (periphyton and benthic invertebrates) and supporting environmental data are also reported.

1.4 Report Overview

This report is presented in nine sections, the first of which is this introduction. Section 2.0 presents the methods used in sample collection, sample analysis and data analysis. Section 3.0 provides a description of the sampling areas and a summary of supporting physical and chemical data collected in the field. Sediment, periphyton community, benthic invertebrate community and tissue chemistry results are presented in Sections 4.0 – 7.0, respectively. Conclusions and recommendations of the study are provided in Section 8.0. All the references cited throughout this report are listed in Section 9.0.

2.0 METHODS

Minnow Environmental Inc. implemented the Minto Creek sediment, periphyton and benthic invertebrate community assessment from September 9th to 15th, 2014 with the assistance of Minto Mine staff. The study design was consistent with the design submitted to the Yukon Water Board in June 2011 in accordance with the Minto Mine Water Use Licence (QZ06-006-Amendment 7). Sediment sampling was undertaken in upper Minto Creek, lower Minto Creek and corresponding reference areas (Table 2.1; Figure 2.1). Periphyton and benthic invertebrate community sampling were undertaken in erosional habitat of lower Minto Creek and a corresponding reference area (Table 2.1; Figure 2.1). Tissue sampling (periphyton and benthic invertebrate) was also undertaken in lower Minto Creek and corresponding reference areas (Table 2.1; Figure 2.1). Supporting measures (e.g., field meter measures, water quality samples, etc.) were collected at all sampling stations.

2.1 Supporting Measures

2.1.1 Field Collection

A number of environmental variables were measured to support the sediment quality, periphyton and benthic invertebrate community data collected for the Minto Creek assessment. The location of each station was recorded using a Geographic Positioning System (GPS) with coordinates recorded in Universal Transverse Mercator (UTM) units (using the North American Datum of 1983).

Supporting measures collected concurrent with sediment sampling (i.e., at depositional areas) included core penetration depth (lower creek areas only), sample texture, and the presence or absence of organic detritus. *In situ* measurements of temperature, dissolved oxygen, conductivity, and pH were also taken at each station using either a YSI 650 MDS (Multiparameter Display System) field meter equipped with a YSI 6600 Sonde (Yellow Springs Instruments, Yellow Springs, OH) or a Hanna 4M multiparameter meter (Woonsocket, RI).

At each periphyton and benthic invertebrate community station, *in situ* water quality measurements were taken using a field meter (described above), water depth was measured using a meter stick and water velocity was measured using a Marsh-McBirney Flo-Mate 2000 portable flow meter (Marsh-McBirney Ltd., Frederick, MD). Creek wetted and bankfull widths were measured at each sampling station using a tape measure. Additional data collected to characterize each periphyton and benthic invertebrate sampling station included: elevation, gradient, water appearance, creek morphology, bank condition, substrate texture,

Table 2.1: Minto Mine Water Use Licence sediment, periphyton and benthic invertebrate monitoring program overview - September 2014.

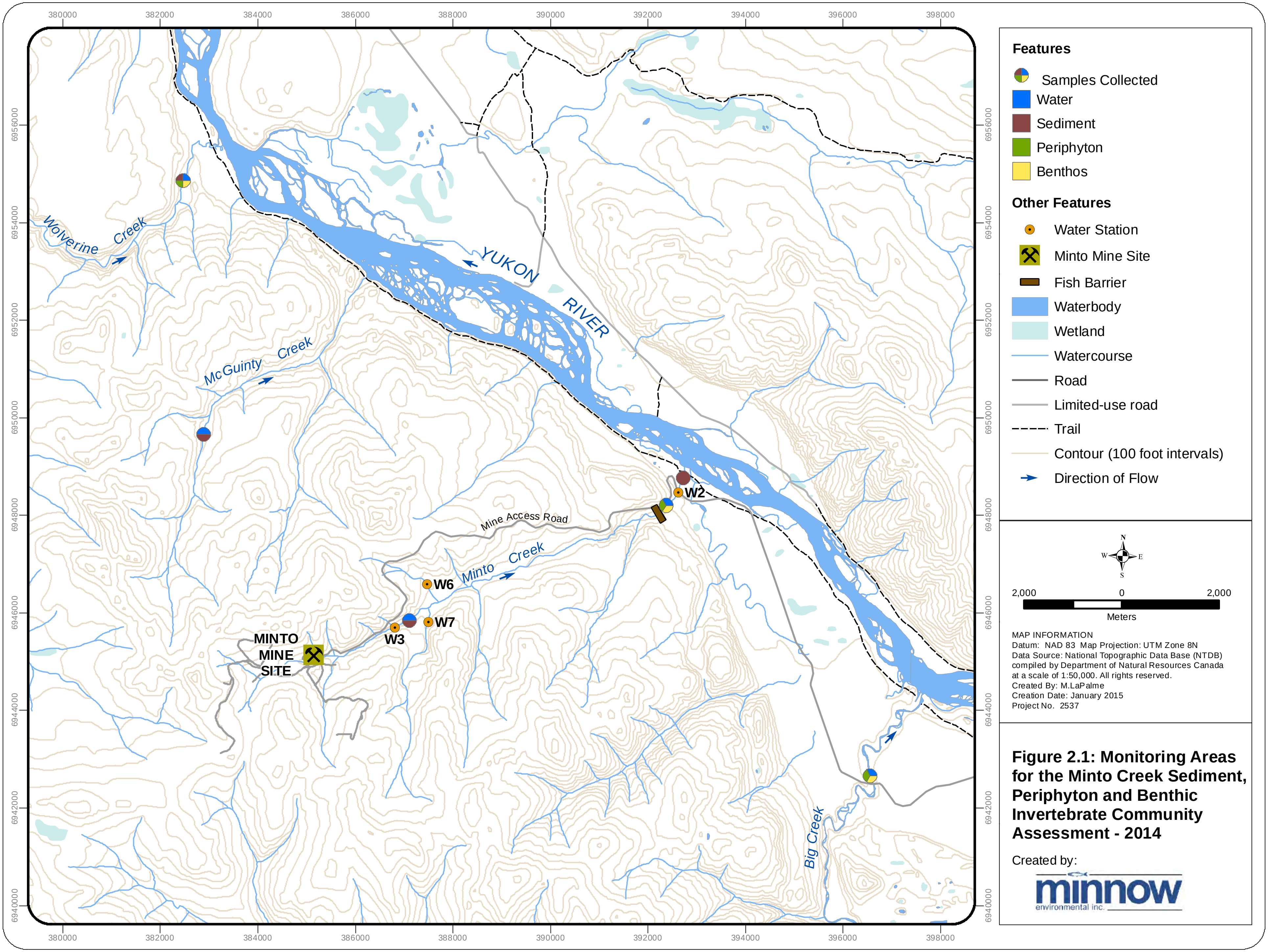
			Minto Mine Water Use Licence (QZ96-006, Amendment 8)						Selenium	
Area Type	**Area**	**Station**	**Water**	**Sediment by Spoon[1]**	**Sediment by Hand Corer/Petite Ponar[2]**	**Periphyton Chlorophyll 'a'**	**Periphyton Community**	**Benthic Community by Hess Sampler[3]**	**Periphyton[4]**	**Benthic Invertebrate Tissue[4]**
Lower Creek Areas	Lower Wolverine Creek (Reference)	LWC-1	✓		✓	✓	✓	✓	Target 5 periphyton tissue samples	Target 5 benthic invertebrate tissue samples
		LWC-2			✓	✓	✓	✓		
		LWC-3			✓	✓	✓	✓		
		LWC-4			✓	✓	✓	✓		
		LWC-5			✓	✓	✓	✓		
	Lower Big Creek (Reference)	LBC-1	✓						Target 5 periphyton tissue samples	Target 5 benthic invertebrate tissue samples
		LBC-2								
		LBC-3								
		LBC-4								
		LBC-5								
	Lower Minto Creek (Exposed)	LMC-1	✓		✓	✓	✓	✓	Target 5 periphyton tissue samples	Target 5 benthic invertebrate tissue samples
		LMC-2			✓	✓	✓	✓		
		LMC-3			✓	✓	✓	✓		
		LMC-4			✓	✓	✓	✓		
		LMC-5			✓	✓	✓	✓		
Upper Creek Areas	Upper McGuinty Creek (Reference)	URC-1	✓	✓						
		URC-2		✓						
		URC-3		✓						
		URC-4		✓						
		URC-5		✓						
	Upper Minto Creek (Exposed)	UMC-1	✓	✓						
		UMC-2		✓						
		UMC-3		✓						
		UMC-4		✓						
		UMC-5		✓						

[1] Top 2 centimeters collected; minimum 3-grab composite

[2] Top 2 centimeters collected; 3-grab composite

[3] 500 um mesh; 3-grab composite

[4] Productivity permitting; in some cases, replication (of 5) may not be achieved with reasonable effort



MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
Data Source: National Topographic Data Base (NTDB)
compiled by Department of Natural Resources Canada
at a scale of 1:50,000. All rights reserved.
Created By: M.LaPalme
Creation Date: January 2015
Project No. 2537

Figure 2.1: Monitoring Areas for the Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2014

Created by:

minnow environmental inc.

instream cover, instream features, overhead canopy, aquatic vegetation, riparian vegetation, surrounding land use and anthropogenic disturbance. In addition, at each benthic invertebrate station, the intermediate axis length of 100 rocks that were washed during the benthic invertebrate sampling were measured and recorded, and the percent embeddedness of ten randomly selected rocks was also evaluated and recorded. This type of substrate characterization is similar to the Canadian Aquatic Biomonitoring Network (CABIN) protocol (CABIN 2012) for characterizing benthic invertebrate habitat and provided additional information to assess and standardize habitat conditions among sampling stations. Summary statistics of intermediate axis lengths were calculated for each station including the median and geometric mean as per CABIN protocol.

Water samples for chemical analysis were collected at each periphyton and benthic sampling area. Samples were collected into a master bottle and poured into pre-labeled sample bottles. Preservatives were added to the sample bottles, as required. Since amber bottles were not available for all samples, dissolved organic carbon (DOC), total organic carbon (TOC) and total inorganic carbon (TIC) were collected in clear glass bottles that were wrapped in aluminum foil. Water samples for DOC and for dissolved ICP-MS (Inductively Coupled Plasma-Mass Spectrometry) analytes were filtered in the field using 0.45 µm polypropylene filters. Immediately after collection, water samples were placed in a cooler, and later placed in a refrigerator at approximately 4°C until they were submitted to the ALS Group Environmental Laboratory in Whitehorse, YT, for analysis of alkalinity by auto titration, anions by ion chromatography, total and dissolved organic carbon by combustion, total inorganic carbon by CO_2 purge, total cyanide by CFA, conductivity measured using a conductivity electrode, hardness calculated from the sum of calcium and magnesium concentrations, total and dissolved mercury by CVAFS (low), total and dissolved metals by CCMS and ICPOES, total and dissolved phosphorus by colour, total dissolved and suspended solids by gravimetrics, pH and turbidty by meter and ammonia by fluorescence. The productivity of lower Minto Creek and lower Wolverine Creek was evaluated through measurements of chlorophyll *a* in periphyton. Chlorophyll *a* is the primary photosynthetic pigment of all oxygen-evolving photosynthetic organisms (Wetzel 2001) and therefore provides an indicator of the standing stock of photosynthetic organisms representing the lowest trophic level. Minto Creek is a lotic system, so measuring chlorophyll *a* in periphyton is considered to be more representative of productivity than measuring it in water. A stainless steel razor blade was used to scrape periphyton from rocks and transfer it to labeled sampling jars. The surface area sampled at each station was carefully recorded. All samples were maintained in coolers with ice packs during transportation and then at 4°C in a refrigerator on site until submission to the ALS Group Environmental Laboratory (ALS; Whitehorse, Yukon).

2.1.2 Data Analysis

Water chemistry data quality was assessed prior to data analysis and interpretation, and was judged to be acceptable (Appendix A). Water quality of Minto Creek was evaluated relative to WUL standards, concentrations measured at reference areas, applicable water quality guidelines, and previous water quality (e.g., water quality results included in previous annual reports).

Supporting field measures (temperature, dissolved oxygen, pH and specific conductivity) and chlorophyll *a* results were tested for differences between lower Minto Creek and reference (lower Wolverine Creek) using a t-test. Prior to the t-test, data were tested for normality and homogeneity of variance (equal variance). Data that were not found to be normal were log transformed. If, after transformation, data could not be normalized or if data did not have equal variance, a non-parametric Mann-Whitney U-test was applied. All tests had alpha set at 0.05. Statistical comparisons were conducted using SPSS software (SPSS 2003). Chlorophyll *a* was evaluated to British Columbia water quality guidelines. Creek productivity was also characterized by comparing chlorophyll *a* concentration to the Dodds et al. (1998) productivity classification system for temperate streams.

2.2 Sediment Quality

2.2.1 Sample Collection and Laboratory Analysis

Sediment samples were collected for analysis of particle size and for chemical analysis at depositional areas within Minto Creek and reference creeks (Table 2.1; Figure 2.1). At lower Minto Creek and lower Wolverine Creek, sediment samples for particle size analysis were collected using a 15.24 cm x 15.24 cm (6" x 6") stainless steel petite ponar grab (0.023 m^2 sampling area). A composite sample was created by collecting the surficial two centimeters of sediment from each of three acceptable grabs (i.e., full to each edge of the sampler) using a stainless steel spoon. Sediment samples for physical characterization were then placed into pre-labeled Ziploc™ bags. Sediment samples for chemical analyses were collected using a 4.7 cm (2") (inside diameter) Lexan™ core tube, which was carefully inserted into sediment deposits, capped using a fitted plastic cap and retrieved by hand. From each acceptable core (i.e., each core containing an intact, representative sediment-water interface), the surficial two centimeters of sediment was manually extruded upwards into a graded core collar, cut with a stainless steel core knife, and placed into a pre-labeled Ziploc™ bag. Samples from three cores treated in this manner were composited to form a by ponar or by coring, as described above, was not effective in the upper creek areas and sediments were collected using a stainless steel spoon. Specifically, at locations of sediment deposition, surficial sediment was carefully collected by slowly spooning the sediment into a Ziploc™ bag, with care taken to avoid the loss of fine material. In order to be as consistent as possible with the sediment collected in the lower Creek areas, samples included only the top 2 centimeters of deposited sediment. Immediately after collection, sediment samples were placed in a cooler, and later placed in a refrigerator at approximately 4°C until they were submitted to the ALS Group Environmental Laboratory in Burnaby, BC or Whitehorse, YT, for analysis of particle size by dry and wet sieving and pipette sedimentation method, total organic carbon and loss on ignition by combustion, inorganic carbon is derived from a calculation, metals by CRC ICPMS, mercury by CVAFS, total Kjeldahl nitrogen is by colrimetric analysis and pH is measured by a pH probe.

2.2.2 Data Analysis

Sediment data quality was assessed prior to data analysis and interpretation, and was judged to be acceptable (Appendix A). Sediment quality data were evaluated relative to sediment quality guidelines (SQGs) for the protection of aquatic life (e.g., CCME 1999) and reference concentrations to identify metals with the potential to adversely affect aquatic life and/or whose concentrations were elevated due to mine activity. Sediment quality data were also evaluated by comparison to results obtained in previous years of sampling (1994 and 2006-2013). However, interpretation was conducted with careful consideration of a significant methodological change made in 2010 and carried through to 2014 (sediments collected as described above) relative to previous years. Due in part to these methodological changes relationships between analytes of concern and percent TOC were investigated (Appendix Figures C.1 and C.2). Analytes of concern were also normalized to percent TOC and lithium concentrations to help bridge the gap between these methodological changes (Appendix Figures C.3–C.6). If values were less than method detection limit, statistics were calculated using detection limit (i.e., if value was < 0.1 mg/kg, statistics were calculated using the value 0.1 mg/kg). Sediments collected in all years previous to 2010 were collected within the active channel of the creek using an aluminum or Teflon scoop. Samples were submitted whole for analysis of particle size distribution, which generally included significant quantities of gravel and sand. Only material passing through a 230 mesh sieve (< 63 µm; silt and clay) was digested and analyzed for metals. While this approach does result in the analysis of geochemically-relevant fine sediment (e.g., Horowitz 1991), it represents an impediment to the interpretation of the biological significance of sediment chemistry as organisms are exposed approach does result in the analysis of geochemically-relevant fine sediment (e.g., Horowitz 1991), it represents an impediment to the interpretation of the biological significance of sediment chemistry as organisms are exposed to whole sediment, and sediment quality guidelines (SQGs) for the protection of aquatic life (e.g., CCME 1999) apply to whole sediment.

2.3 Periphyton Community

2.3.1 Sample Collection and Laboratory Analysis

Periphyton is the assemblage of algae, bacteria, fungi, and meiofauna attached to submerged substrate in freshwaters. However, periphyton communities are generally characterized on the basis of the attached algae community. Attached algal communities are representative of the lowest trophic level and are indicators of productivity. Periphyton was collected from randomly selected rocks at each station with the use of a stainless steel razor blade. Five rocks were selected for periphyton community analysis and plastic templates were used to measure the area sampled (total area for all rocks was 125 cm^2). Samples were preserved with Lugol’s iodine solution and shipped to Plankton R Us Inc. (Winnipeg, MB) for analysis to species level.

2.3.2 Data Analysis

Periphyton communities were evaluated using summary metrics including number of organisms per sample, number of taxa, Simpson’s Diversity, Simpson’s Evenness and Bray-Curtis Index (Environment Canada 2012). Periphyton were also evaluated in terms of density (cells/cm^2) and biomass, (µg/cm^2). Additional non-statistical comparisons were made using percent community composition of dominant taxa (calculated as the abundance of each respective taxon group relative to the total number of organisms in the sample).

The diversity metric “number of taxa” (also known as taxon richness) included all separate taxa identified to the species level. Simpson’s Diversity (“D”) and Simpson’s Evenness (“E”) indices were computed according to formulae presented by Smith and Wilson (1996) and recommended by Environment Canada (2012). These indices takes into account both the relative abundance of taxa, and the number of taxa, with values ranging from 0 (low diversity or evenness) to 1 (high diversity or evenness). The Bray-Curtis (B-C) index was also calculated according to Environment Canada (2012). This metric takes into account the abundance of each taxon at each station compared to the median abundance computed from the reference stations (lower Wolverine Creek), to compute an index of the relative “dissimilarity” of each station from the hypothetical reference median station. Larger B-C index values indicate greater dissimilarity from reference.

Periphyton community endpoints were summarized by separately reporting mean, median, minimum, maximum, and standard deviation for each study area. Differences among effluent-exposed and reference areas were tested using a t-test, with significance set at alpha < 0.10. Prior to the t-test, data were tested for the assumptions of normality and homogeneity of variance. If data were not found to be normal or variances were not equal, a non-parametric Mann-Whitney U-test was conducted. Regardless of normality and homogeneity of variance, ANOVAs were run to obtain a mean square error which was used to calculate the minimum detectable effect. All statistics were conducted using SPSS (SPSS 2003).

Periphyton data collected in 2014 were compared to data collected in baseline studies (HKP 1994) and in 2011-2013. Due to differences in reporting of periphyton community in the 1994 report (e.g., taxa identified only as present, common or dominant), a non-statistical comparison was performed using proportional abundances at the taxonomic level of Phylum.

2.4 Benthic Invertebrate Community

2.4.1 Sample Collection and Laboratory Analysis

Benthic invertebrate community samples were collected in erosional habitat of lower Minto Creek and lower Wolverine Creek as required under the WUL. Benthic invertebrate community samples were collected from riffle/run habitat with cobble and gravel substrate using a Hess sampler (0.1 m^2) outfitted with 500 µm mesh. Five replicate samples were collected at each monitoring location and consisted of a three-grab composite (0.3 m^2 of bottom area in total). For each grab, the substrate within the sampler was disturbed and scrubbed (by hand and nail brush) with care taken to ensure that all dislodged organic material was swept into the sampler collection net. The substrate was disturbed to a depth of approximately 5 – 10 cm over a period of approximately ten minutes. This procedure was repeated for the second and third grab, following which all of the material contained in the collection net was carefully transferred to a pre-labeled 2 litre wide-mouth plastic jar using a stainless steel spoon and a wash bottle while working over a plastic tub to avoid any potential loss of organisms. Any organisms that adhered to the sieve bag were removed by hand and added to the sample. All samples were labeled internally (using wooden sticks) and externally with the station number, area identifier, Minnow project number, date and field personnel in order to ensure correct identification at the laboratory. Samples were preserved within six hours of collection using buffered formalin solution to a nominal concentration of 10% in ambient water.

All benthic invertebrate samples were shipped to Cordillera Consulting in Summerland, BC. Each sample was elutriated to remove sand, gravel and clay, and the remaining organic material was preserved in 70% ethanol. The elutriate was examined for any mollusc or trichopteran cases then each sample was examined to estimate the total number of invertebrates. If the estimated number was greater than 600 individuals and the sample was fine and non-clumping, a subsample was taken using a Folsom Plankton Splitter (Motodo 1959; Van Guelpen et al. 1982). Empty snail or bivalve shells, empty caddisfly cases, invertebrate fragments such as legs, gills, antennae etc. were not removed or counted. When organism fragments were encountered, only the heads were counted towards the total. Larval and pupa exuviae were not counted while terrestrial stages and terrestrial drop-ins were indicated as such and do not contribute to the total count. Benthic invertebrates were identified to the "lowest practicable taxonomic level" (which in most cases was genus) and counted. Following identification and counting, representative specimens of each taxon were preserved in a museum quality vial with a polyseal lid to create a voucher collection. The interior labels were used to identify the taxa, the client, date collected, site code and the project. Laboratory quality assurance/quality control (QA/QC) included an assessment of sub-sampling error and sorting efficiency on at least 10% of the samples.

2.4.2 Data Analysis

Benthic invertebrate community data quality was assessed prior to data analysis and interpretation, and was judged to be acceptable (Appendix A). Benthic invertebrate communities were evaluated using summary metrics including invertebrate density (number of organisms per m^2 calculated based on a sample area of 0.3 m^2), number of taxa, Simpson's Diversity, Simpson's Evenness and Bray-Curtis Index. These endpoints were calculated after the exclusion of either non-benthic organisms or taxa smaller than 500 µm in size, including, Collembola, Ostracods, Nemata and Turbellaria. For each benthic invertebrate sample, total organism density (individuals/m^2) was calculated. The diversity metric "number of taxa" (also known as taxon richness) included all separate taxa identified to the species/variant level. Simpson's Diversity ("D") and Simpson's Evenness ("E") indices were computed according to formulae presented by Smith and Wilson (1996) and recommended by Environment Canada (2012). These indices take into account both the relative abundance of taxa, and the number of taxa, with values ranging from 0 (low diversity or evenness) to 1 (high diversity or evenness). Bray-Curtis (B-C) index was also calculated according to Environment Canada (2012). This metric takes into account the abundance of each taxon at each station compared to the median abundance computed from the reference stations (lower Wolverine Creek), to compute an index of the relative "dissimilarity" of each station from the hypothetical reference median station. Larger B-C index values indicate greater dissimilarity from reference.

The relative proportions of the most abundant taxa were calculated relative to the total number of organisms in the sample. Dominant taxon groups were defined as those groups representing greater than 10% of total organism abundance in one or more areas or any groups considered to be important indicators of environmental stress. In this study, relative proportions of oligochaetes (worms), chironomids, and EPT taxa were examined. It is often possible to relate low relative abundance of sensitive taxonomic groups (e.g., EPT taxa) to environmental stress (e.g., Taylor and Bailey 1997). Similarly, high relative abundance of tolerant taxonomic groups (e.g., oligochaetes) may also indicate higher environmental stress (Chapman et al. 1982a; 1982b).

All benthic invertebrate community endpoints were summarized by reporting mean, median, minimum, maximum, standard deviation, standard error and sample size for each study area. Differences among effluent-exposed and reference areas were tested using ANOVA, with significance set at alpha < 0.10. Prior to ANOVA, all data were transformed as necessary to meet assumptions of normality and homogeneity of variance. If data failed the assumptions of normality and homogeneity of variance, then a Mann-Whitney U-test was conducted. All statistical comparisons were conducted using SPSS software (SPSS 2013). Following the statistical comparisons, the magnitude of difference between effluent-exposed and reference area means was calculated for each benthic invertebrate community metric where a significant difference was detected. If a significant difference between areas was not detected, then the minimum effect size that could be detected was calculated.

Benthic invertebrate community data were also evaluated in comparison to results obtained in previous years of sampling (1994, 2006, 2008 and 2010-2013). Summary metrics from earlier years were previously re-calculated (Minnow 2011) to ensure consistency and appropriate comparisons over time.

2.5 Tissue Chemistry

2.5.1 Sample Collection and Laboratory Analysis

Periphyton and benthic invertebrate tissue samples were collected from lower Minto Creek (exposed), lower Wolverine Creek (reference) and lower Big Creek (reference; Table 2.1; Figure 2.1). Periphyton samples were collected by scraping submerged cobble-size rocks using a stainless steel razor blade. Scraped material (periphyton) was placed in pre-labelled sample jars. Benthic invertebrate tissue samples were collected in areas with cobble substrate using a kick-net and by overturning rocks and collecting organisms by hand.

Benthic invertebrate samples were placed into pre-labelled Whirl-Pak™ bags until the desired sample size (2-5 grams) was achieved. A total of five periphyton and benthic invertebrate samples were collected at each area. Immediately after collection, all tissue samples were placed in a cooler, and later in a freezer until they were submitted to the ALS Laboratory Group in Burnaby, BC. Samples were analyzed for percent moisture and for metals by High-Resolution ICP-MS, and later converted to dry weight using percent moisture.

2.5.2 Data Analysis

The primary objective of the tissue collections was to support a selenium assessment reported under separate cover. Accordingly, data are reported herein for future reference with limited interpretation. Tissue quality data were interpreted by statistically comparing metal concentrations at the exposed area to those collected at the reference areas using ANOVA with post-hoc testing. Either the Bonferroni (if equal variance was achieved) or Tamhane’s (if data had unequal variance) post hoc tests were used. Data were first tested for normality and equality of variance. If normality was not achieved data were transformed by either log, square root, or inverse transformations. Some analytes could not be normalized, and a non-parametric Mann-Whitney U-test was conducted instead. All statistical tests were interpreted using alpha values of 0.05.

3.0 SUPPORTING MEASURES

3.1 Field Measures

Physico-chemical measurements were taken to support both sediment and benthic invertebrate collections. Mean temperature at the sediment sampling area of upper Minto Creek (0.7°C) was significantly lower than in lower Wolverine Creek (3.3°C; Figure 3.1; Appendix Table B.3). Specific conductance exhibited a gradient from the mine downstream and was slightly greater in upper Minto Creek (459 µS/cm) than in lower Minto Creek (303 µS/cm). In both upper and lower Minto Creek, specific conductance was significantly higher than at the respective reference areas (Figure 3.1). Dissolved oxygen was higher, but not significantly so at lower Minto Creek (94.5% saturation) than at lower Wolverine Creek (72.4% saturation). Lower dissolved oxygen at lower Wolverine Creek could be attributed to sampling locations occurring in a back eddies where dissolved oxygen might be expected to be low. Upper Minto Creek had significantly lower dissolved oxygen (83.4%) than upper McGinty Creek (90.3%). In all areas, both dissolved oxygen and pH were well within water quality guidelines as well as the WUL standard for pH.

Physico-chemical measurements were also taken in erosional areas of lower Minto Creek and lower Wolverine Creek in support of benthic invertebrate community sampling. Temperature was similar at lower Minto Creek (4.6°C) and at lower Wolverine Creek (4.9°C; Figure 3.2; Appendix Table B.4). Both areas were well oxygenated and with slightly (but significantly) lower dissolved oxygen at lower Minto Creek (95.0%) than at lower Wolverine Creek (98.0%, Figure 3.2). Specific conductance and pH were both significantly higher at lower Minto Creek (282 µS/cm and 8.12) than at lower Wolverine Creek (167 µS/cm and 7.77).

3.2 Water Chemistry and Chlorophyll *a*

At lower Minto Creek, four analytes (fluoride, aluminum, copper and iron) were present at concentrations that did not meet water quality guidelines but did meet WUL standards (Table 3.1). At upper Minto Creek, two analytes (fluoride and copper) were present at concentrations that did not meet guidelines (Table 3.1). Aluminum and iron only exceeded guidelines at reference sites. Fluoride was elevated at upper and lower Minto Creek but was also above guidelines at the reference site, upper McGinty Creek. Copper was above guidelines at upper Minto Creek and the two lower area reference sites. This suggests that the observed exceedances may not be mine related.

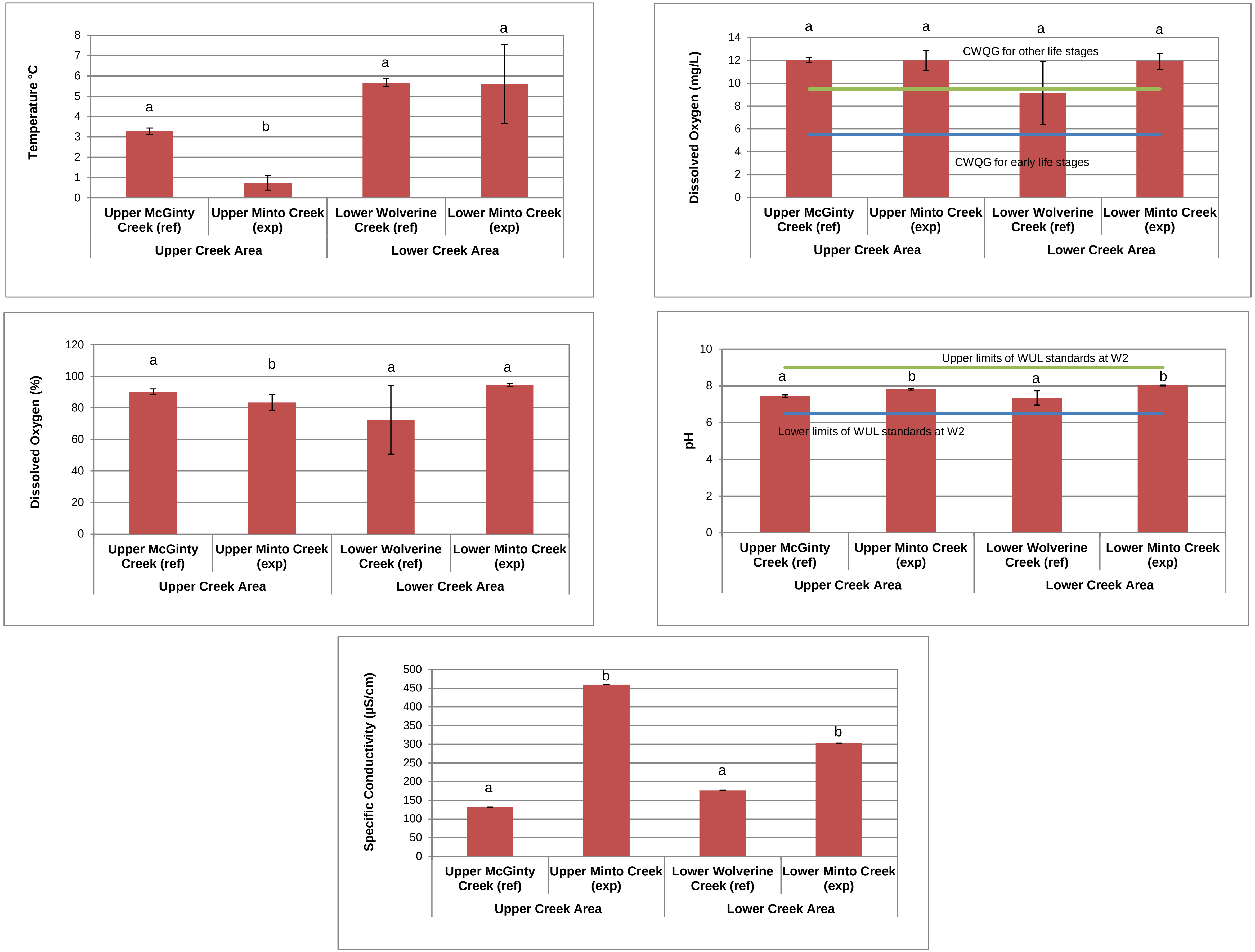


Figure 3.1: Physico-chemical measurements in depositional areas of upper and lower Minto Creek relative to reference areas, Minto Mine, 2014. Data presented as mean ± standard deviation. Sample sizes were n = 5 in all areas.

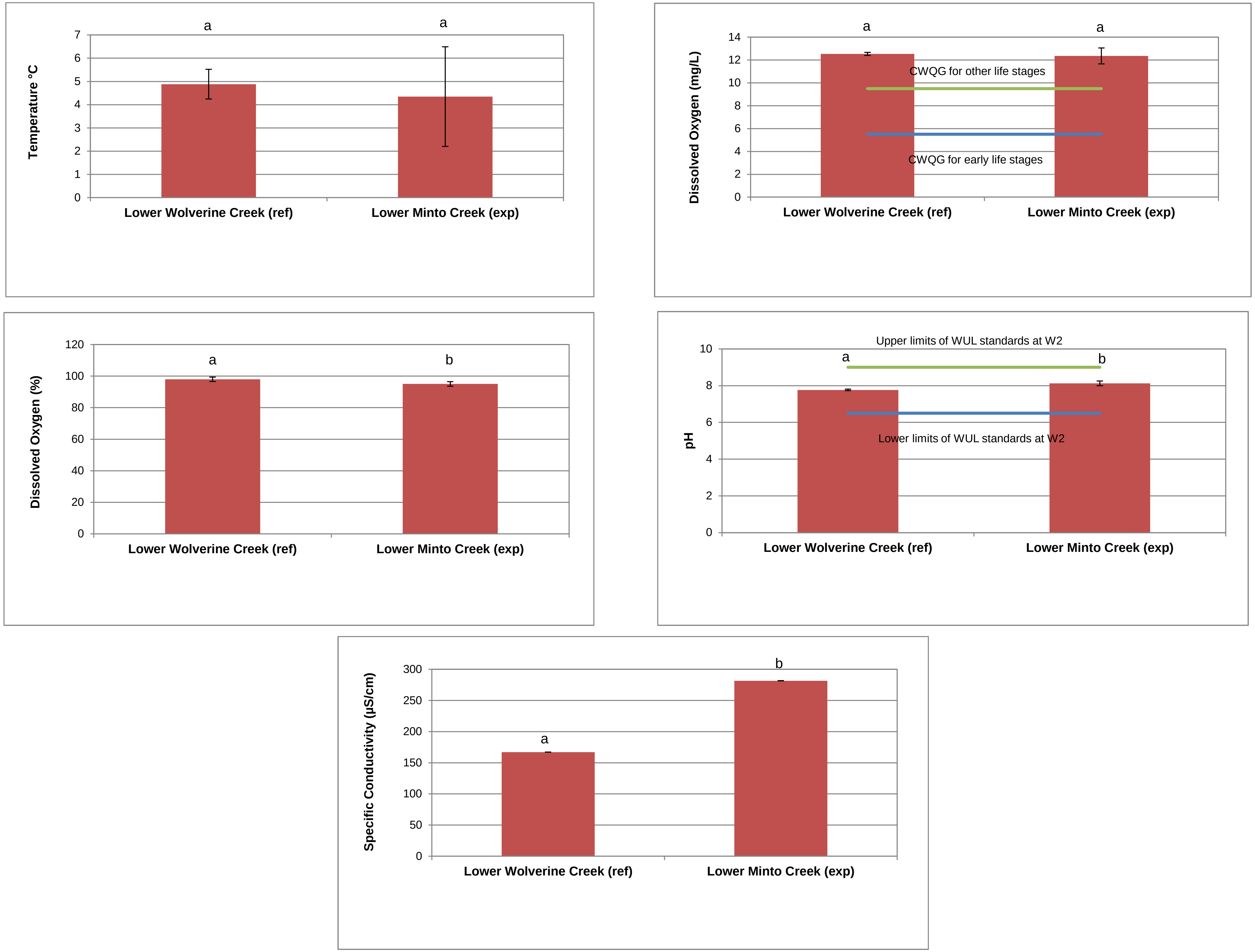


Figure 3.2: Physico-chemical measurements in erosional areas of upper and lower Minto Creek relative to reference areas, Minto Mine, 2014. Data presented as mean ± standard deviation. Sample sizes were n = 5 at all sites

Table 3.1: Water quality results at exposure and reference, Minto Mine WUL, September 2014.

	Analyte	Units	CCME Water Quality Guidelines[a]		WUL Standards at W2	Lower Wolverine Creek (reference)	Lower Big Creek (reference)	Lower Minto Creek[b] (exposure)	Upper McGinty Creek (reference)	Upper Minto Creek (exposure)
			30	Max						
Physical Tests	Conductivity	µS/cm	-	-	-	184	181	330	144	512
	Hardness (as $CaCO_3$)	mg/L	-	-	-	91.1	87.8	180	74.8	273
	pH	ph Units	-	-	6.0 - 9.0	8.0	8.1	8.2	8.0	8.2
	Total Suspended Solids	mg/L	8.3[c]	28.3[c]	-	3.3	10	3.3	< 3.0	< 3.0
	Total Dissolved Solids	mg/L	-	-	-	156	137	229	124	328
	Turbidity	NTU	3.38[d]	9.38[d]	-	1.38	9.12	1.13	1.97	0.940
Anions and Nutrients	Alkalinity, Total	mg/L	-	-	-	84.6	86.4	173	68.4	244
	Ammonia, Total (as N)	mg/L	1.3[e]	-	0.35	0.0075	< 0.0050	0.0056	0.0088	< 0.0050
	Chloride (Cl)	mg/L	120	640	-	< 0.50	< 0.50	1.2	< 0.50	4.6
	Fluoride (F)	mg/L	0.12		-	0.12	0.11	0.38	0.25	0.59
	Nitrate (as N)	mg/L	3.0	124	2.9	0.017	0.090	< 0.005	0.036	0.205
	Nitrite (as N)	mg/L	0.2	-	0.06	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	Phosphorus (P)-Total dissolved	mg/L	-	-	-	0.007	0.002	0.007	0.015	0.003
	Phosphorus (P)-Total	mg/L	-	-	0.02	0.007	0.014	0.011	0.015	0.007
	Sulfate (SO4)	mg/L	-	-	-	15	12	16	9.4	56
Other	Cyanide, Total	mg/L	-	-	-	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
	Dissolved Organic Carbon	mg/L	-	-	-	16	9.1	10	13	4.9
	Total Organic Carbon	mg/L	-	-	-	16	9.5	10	13	5.2
	Total Inorganic Carbon	mg/L	-	-	-	18	19	55	15	53
Total Metals	Total Aluminum (Al)	mg/L	0.1[f]	-	0.62	0.118	0.545	0.036	0.031	0.020
	Total Antimony (Sb)	mg/L	-	-	-	< 0.0001	0.0004	< 0.0001	0.0001	< 0.0001
	Total Arsenic (As)	mg/L	0.005	-	0.005	0.0005	0.0034	0.0006	0.0007	0.0003
	Total Barium (Ba)	mg/L	-	-	-	0.038	0.063	0.059	0.035	0.081
	Total Beryllium (Be)	mg/L	-	-	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Total Bismuth (Bi)	mg/L	-	-	-	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Total Boron (B)	mg/L	1.5	2.9	-	0.014	< 0.010	< 0.010	< 0.010	0.023
	Total Cadmium (Cd)	mg/L	0.00012[g]	0.0016[g]	0.00004	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001
	Total Calcium (Ca)	mg/L	-	-	-	19.9	21.9	43.1	20.5	57.1
	Total Chromium (Cr)	mg/L	0.001 Cr(VI)	-	0.002	0.00084	0.00087	0.00029	0.00050	0.00018
	Total Cobalt (Co)	mg/L	-	-	-	0.00013	0.00036	< 0.00010	0.00014	< 0.00010
	Total Copper (Cu)	mg/L	0.002[g]	-	0.013	0.0026	0.0042	0.0016	0.0015	0.0028
	Total Iron (Fe)	mg/L	0.3	-	1.1	0.287	0.786	0.243	0.613	0.033
	Total Lead (Pb)	mg/L	0.002[g]	-	0.004	< 0.00005	0.0009	< 0.00005	< 0.00005	< 0.00005
	Total Lithium (Li)	mg/L	-	-	-	0.0014	0.0017	0.0011	< 0.0005	0.0029
	Total Magnesium (Mg)	mg/L	-	-	-	11	8.7	15	5.7	27
	Total Manganese (Mn)	mg/L	-	-	-	0.012	0.028	0.006	0.040	0.051
	Total Mercury (Hg)	mg/L	0.00003	-	-	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Total Molybdenum (Mo)	mg/L	0.073	-	0.073	0.0005	0.0012	0.0014	0.0009	0.0047
	Total Nickel (Ni)	mg/L	0.077[g]	-	0.11	0.0019	0.0015	0.0010	0.0012	0.0009
	Total Phosphorus (P)	mg/L	-	-	-	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
	Total Potassium (K)	mg/L	-	-	-	0.62	0.83	1.3	0.56	2.4
	Total Selenium (Se)	mg/L	0.001	-	0.001	0.0001	< 0.0001	< 0.0001	0.0003	0.0003
	Total Silicon (Si)	mg/L	-	-	-	5.4	7.5	6.2	6.5	5.8
	Total Silver (Ag)	mg/L	0.0001		-	< 0.00001	0.00003	< 0.00001	0.00002	< 0.00001
	Total Sodium (Na)	mg/L	-	-	-	6.4	6.0	8.4	4.0	17
	Total Strontium (Sr)	mg/L	-	-	-	0.175	0.244	0.389	0.137	0.745
	Total Thallium (Tl)	mg/L	0.0008	-	-	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001
	Total Tin (Sn)	mg/L	-	-	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Total Titanium (Ti)	mg/L	-	-	-	< 0.01	0.03	< 0.01	< 0.01	< 0.01
	Total Uranium (U)	mg/L	0.015	0.033	-	0.0006	0.0020	0.0015	0.0003	0.0026
	Total Vanadium (V)	mg/L	-	-	-	0.0015	0.0022	< 0.001	< 0.001	< 0.001
	Total Zinc (Zn)	mg/L	0.03	-	0.03	< 0.003	0.004	< 0.003	< 0.003	< 0.003

▭ Water use licence limit exceeded

▨ Water quality guideline exceeded

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg. See Appendix Table B.6 for explanatory notes on selected water quality guidelines.

[b] Total inorganic carbon samples for LMC were collected on Sept 13, 2014 whereas the remaining analytes were collected on Sept 10, 2014

[c] Based on the median of background levels plus 5 mg/L for 30 day and 25 mg/L for max guidelines

[d] Based on the median of background levels plus 2 NTU for 30 day and 8 NTU for max guidelines

[e] Based on lowest guideline using highest temperature and pH

[f] Based on lowest guideline using highest pH

[g] Based on lowest guideline using lowest hardness

Compared to 2013, total suspended solids (TSS) concentrations were greater in 2014 in lower Big Creek (10 vs. 3.1), lower in lower Minto Creek (3.3 vs. 5.3), and remained the same or similar for all other sites. At lower Big Creek, aluminum, copper and iron were above guideline levels and elevated compared to 2013, presumably due to higher TSS. Concentrations of aluminum and iron at lower Minto Creek were well below guidelines in 2014 and lower than 2013 concentrations. These differences appear to be related to the level of TSS in the creeks.

Concentration of chlorophyll *a* in periphyton was significantly higher at lower Minto Creek than at lower Wolverine Creek (Figure 3.3). Chlorophyll *a* concentrations at both areas were well below the British Columbia Water Quality Guideline (BCWQG) of 100 mg/m^2 for the protection of aquatic life (BCMOE 1985). During 2014 sampling, it appeared that periphyton was more prevalent in lower Minto Creek than in lower Wolverine Creek, which was not evident in previous years. The production of both creeks are classified as low (oligotrophic) based on the classification system of Dodds et al. (1998), which sets the oligotrophic-mesotrophic boundary for benthic chlorophyll at 20 mg/m^2. This differs from the classification based on only total phosphorus which would define lower Minto Creek as mesotrophic and lower Wolverine Creek as oligotrophic (Dodds et al. 1998). The lower concentrations of chlorophyll *a* despite relatively high phosphorus concentrations suggest constraints on productivity other than nutrient concentrations, perhaps environmental factors associated with a northern system such as low water temperatures, limited light and a short growing season.

3.3 Summary

Specific conductance and pH were higher in upper and lower Minto Creek than at the reference areas (upper McGinty Creek and lower Wolverine Creek) and specific conductance decreased from upper Minto Creek to lower Minto Creek.

Overall, water quality results demonstrated that two analytes (fluoride and copper) did not meet water quality guidelines in at least one exposure area but were also elevated at reference creeks. All other analytes that exceeded water quality guidelines did so only at reference areas (aluminum and iron). This suggests that the observed exceedances of aluminum and iron were not mine-related. Even though concentrations of chlorophyll *a* in periphyton were significantly higher at lower Minto Creek than lower Wolverine Creek, these concentrations were below the BCWQG of 100 mg/m^2 for the protection of aquatic life (BCMOE 1985) and both creeks were oligotrophic according to the classification system of Dodds et al. (1998).

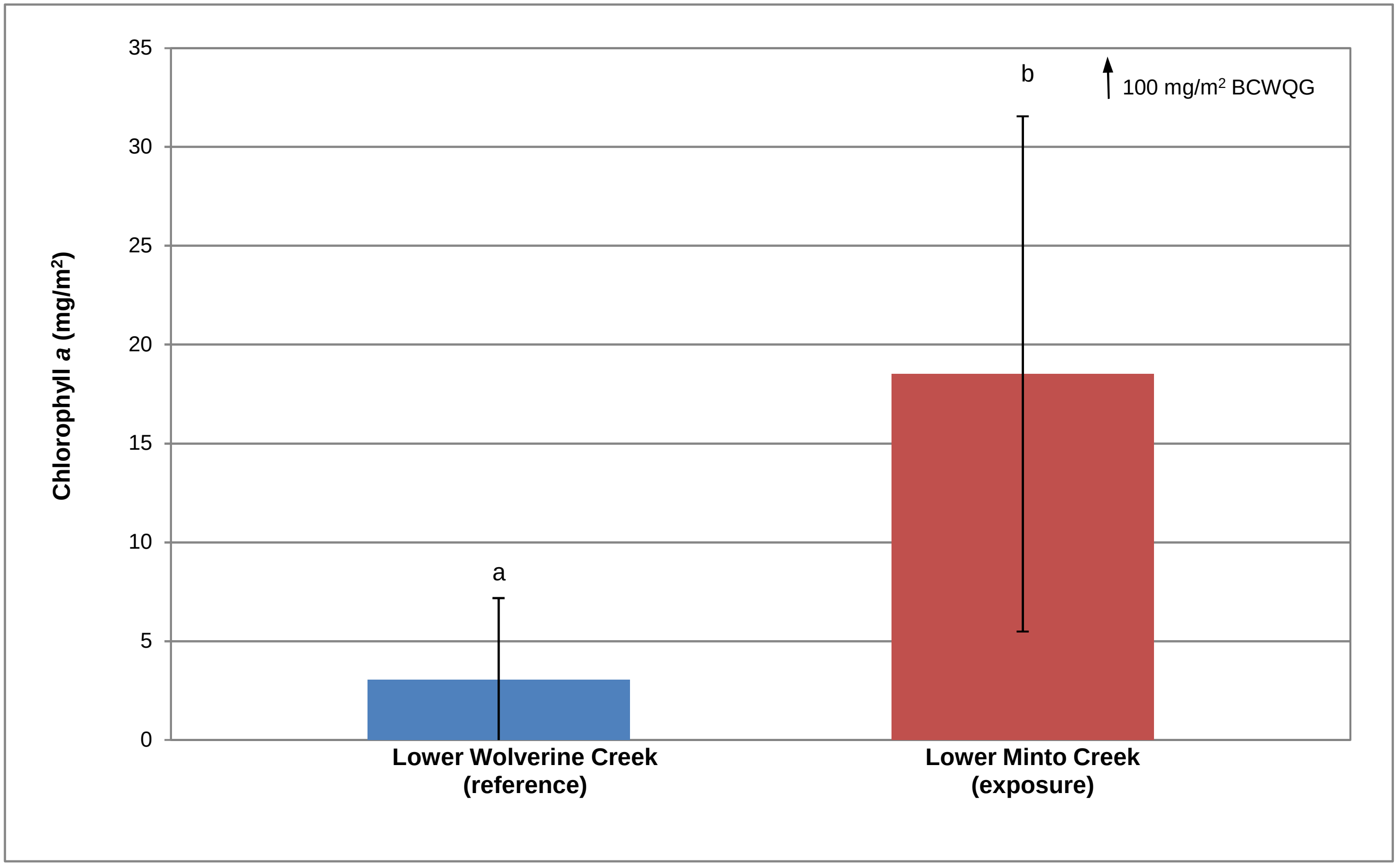


Figure 3.3: **Concentrations of chlorophyll *a* in periphyton measured at five benthic stations in lower Wolverine and lower Minto Creeks, Minto Mine WUL, 2014. Data presented as mean ± standard deviation.**

4.0 SEDIMENT QUALITY

4.1 Sediment Particle Size and Chemistry

Sediments collected in 2014 were largely composed of fine particles in the silt and sand size categories (Figure 4.1; Table 4.1; Appendix Table C.1). Mean total organic carbon (TOC) content of sediment collected from lower Minto Creek (4.2%) and upper Minto Creek (1.9%) were lower than the comparable reference areas; lower Wolverine Creek (6.8%) and upper McGinty Creek (5.4%; Table 4.1). Arsenic and copper were the only analytes with mean concentrations greater than Interim Sediment Quality Guidelines for the protection of aquatic life (ISQG; CCME 1999) in an effluent-exposed area (upper and/or lower Minto Creek; Table 4.1; Appendix Table C.1). However, Minto Creek sediment arsenic concentrations were similar to reference (reference was also greater than ISQG), suggesting that arsenic concentrations above ISQG at Minto Creek were not mine-related. Therefore, only mean copper concentrations were greater than ISQG and reference, and require consideration of temporal trends to evaluate potential mine influence (Section 4.2). With progression from upper to lower Minto Creek, sediment copper concentrations decreased from a mean of 114 to 50 mg/kg, respectively, suggesting improvement with distance downstream.

Due to the predominantly erosional habitat in upper Minto Creek, there are relatively few areas where sediment is deposited and even this occurs only in small quantities that likely wash away each year during freshet. Therefore, elevated sediment copper in fine sediment in the upper reaches of Minto Creek may be of limited importance in terms of exposure and potential effects to biota. In lower Minto Creek, fine sediment deposits are somewhat more common and therefore more relevant to aquatic life. Previous toxicity testing in 2011 indicated no adverse effects at lower Minto Creek sediment quality conditions that were generally similar to those observed in 2014 (Minnow 2012).

4.2 Temporal Comparisons

Sediment particle size distribution in 2014 was similar to 2010-2013 but was notably different from data collected prior to 2010 (Figure 4.1). The disparity between 2010-2014 and 1994-2009 data reflects the change in sediment sampling methodology initiated in 2010 (Minnow 2011). Relationships between percent TOC and analytes of concern (arsenic and copper) were evaluated and presented in Appendix Figure C.1 and C.2. Arsenic and copper concentrations were normalized to percent TOC and lithium, and ratios of analytes of concern relative to lithium were consistent over the 2010-2014 period (Appendix Figure C.3 – C.6). Mean analyte concentrations higher than guidelines in Minto Creek were compared to

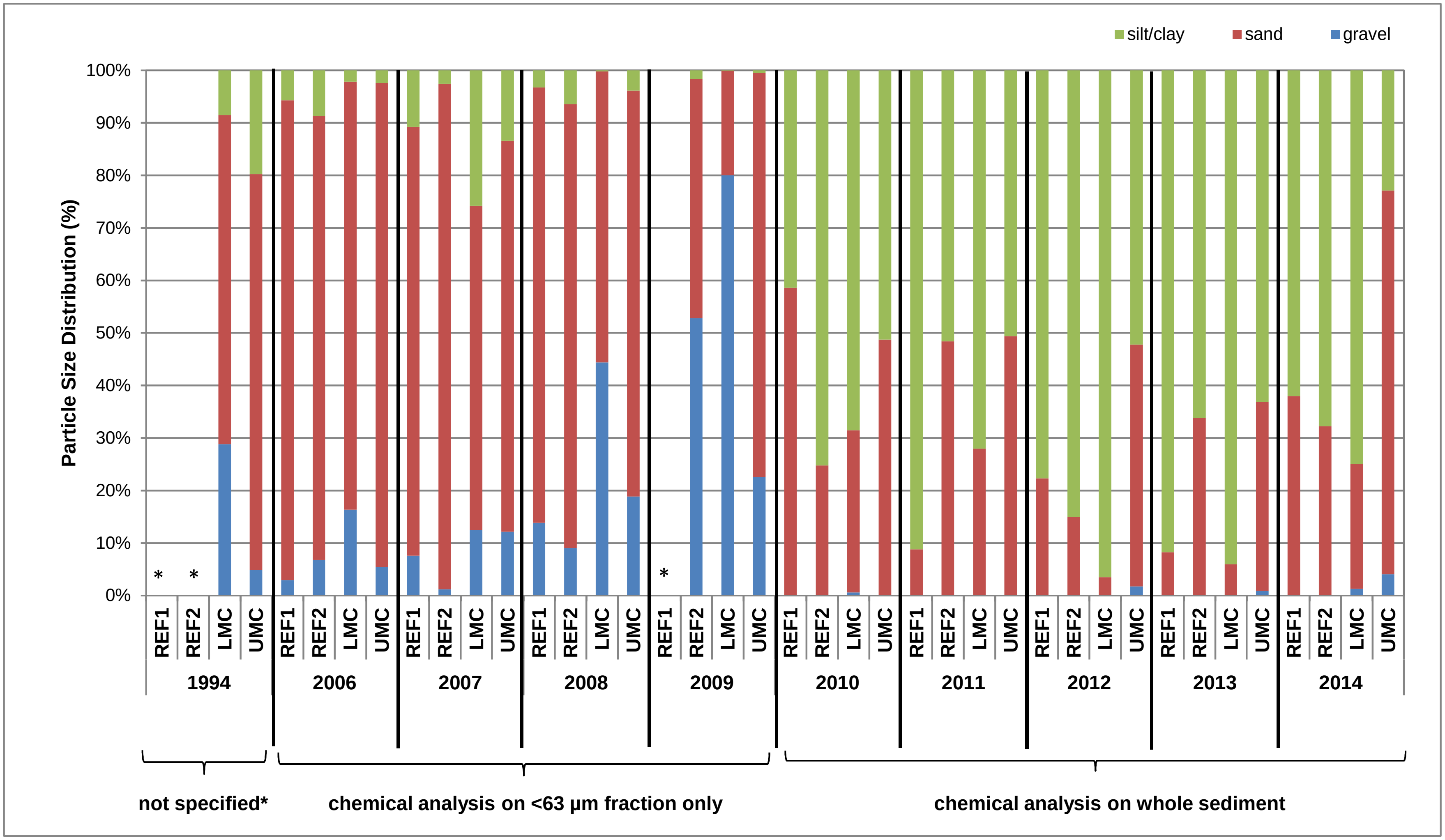


Figure 4.1: Particle size distribution of sediment collected in Minto Creek and reference locations, 1994-2014[1]

[1] UMC = Upper Minto Creek; LMC = Lower Minto Creek; REF1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2014; REF2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2014; * - no data

Table 4.1: Sediment chemistry data collected at exposed and reference areas, Minto Mine WUL, 2014.

Analytes		Units	CSQG [a]		Upper McGinty Creek (Reference)				Lower Wolverine Creek (Reference)				Upper Minto Creek (Exposure)				Lower Minto Creek (Exposure)			
			ISQG	PEL	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum	Mean	Standard Deviation	Minimum	Maximum
Particle size, TKN, carbon analytes and pH	Loss on Ignition	%	-	-	11	4.4	5.0	16	14	5.9	7.0	23	4.4	3.7	< 1.0	10	7.6	2.6	4.0	11
	pH (1:2 soil:water)	pH units	-	-	7.1	0.24	6.9	7.5	7.2	0.24	7.0	7.6	8.2	0.16	8.1	8.5	8.1	0.06	8.0	8.2
	% Gravel (>2mm)	%	-	-	-	-	-	-	< 0.10	0.0	< 0.10	< 0.10	-	-	-	-	**1.3**	1.7	0.25	**4.3**
	% Sand (2.0mm - 0.063mm)	%	-	-	-	-	-	-	32	17	7.2	50	-	-	-	-	24	6.7	17	31
	% Silt (0.063mm - 4um)	%	-	-	-	-	-	-	62	17	45	87	-	-	-	-	67	5.4	61	72
	% Clay (<4um)	%	-	-	-	-	-	-	5.6	0.6	4.8	6.1	-	-	-	-	8.4	0.7	7.8	9.4
	Total Kjeldahl Nitrogen	%	-	-	0.273	0.111	0.115	0.382	0.385	0.151	0.212	0.614	0.117	0.089	0.023	0.232	0.246	0.054	0.156	0.302
	Inorganic Carbon	%	-	-	< 0.1	0	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1
	Inorganic Carbon (as CaCO3 Equivalent)	%	-	-	< 0.8	0	< 0.8	< 0.8	< 0.8	0	< 0.8	< 0.8	< 0.8	0	< 0.8	< 0.8	< 0.8	0	< 0.8	< 0.8
	Total Carbon by Combustion	%	-	-	5.4	2.2	2.5	7.7	6.8	2.8	3.5	11	2.0	1.6	0.4	4.5	4.2	1.4	2.3	5.6
	Total Organic Carbon	%	-	-	5.4	2.2	2.5	7.7	6.8	2.8	3.5	11	1.9	1.7	0.4	4.5	4.2	1.4	2.3	5.6
Total Metals	Aluminum (Al)	mg/kg	-	-	9,464	2,613	5,250	11,300	13,160	1,760	11,100	15,500	7,840	2,844	4,980	11,700	13,840	915	12,800	14,700
	Antimony (Sb)	mg/kg	-	-	0.37	0.069	0.27	0.42	0.45	0.11	0.31	0.59	0.35	0.086	0.24	0.46	0.52	0.11	0.39	0.61
	Arsenic (As)	mg/kg	5.9	17	7.3	1.1	5.8	8.5	5.6	1.5	3.5	7.3	4.9	0.58	4.1	5.6	6.8	1.1	5.7	7.9
	Barium (Ba)	mg/kg	-	-	176	54	93	222	197	59	129	270	150	54	81	209	226	40	183	269
	Beryllium (Be)	mg/kg	-	-	0.29	0.064	< 0.20	0.35	0.71	0.18	0.50	0.94	0.67	0.75	< 0.20	**2.0**	0.47	0.069	0.38	0.54
	Bismuth (Bi)	mg/kg	-	-	< 0.2	0	< 0.2	< 0.2	< 0.2	0	< 0.2	< 0.2	< 0.2	0	< 0.2	< 0.2	< 0.2	0	< 0.2	< 0.2
	Cadmium (Cd)	mg/kg	0.6	3.5	0.13	0.034	0.084	0.15	0.27	0.14	0.12	0.46	0.14	0.062	0.059	0.21	0.19	0.062	0.12	0.26
	Calcium (Ca)	mg/kg	-	-	6,986	1,825	4,240	8,390	10,890	4,019	6,640	16,200	5,200	1,922	3,160	7,370	11,940	2,913	8,350	14,700
	Chromium (Cr)	mg/kg	37	90	18	6.3	8.0	23	43	5.5	36	50	22	7.6	14	32	32	2.9	28	35
	Cobalt (Co)	mg/kg	-	-	8.5	1.9	5.8	10	13	1.6	11	15	8.0	2.0	5.9	10	11	1.1	10	12
	Copper (Cu)	mg/kg	36	197	17	4.7	10	22	28	10	17	40	**114**	75	33	**207**	50	17	32	**67**
	Iron (Fe)	mg/kg	-	-	21,600	4,616	14,200	25,600	26,280	2,257	23,000	29,200	22,120	5,985	16,400	31,300	25,600	2,473	23,000	27,900
	Lead (Pb)	mg/kg	35	91	4.0	0.86	2.7	4.8	5.9	0.91	4.8	7.0	4.9	1.0	3.4	5.8	6.1	0.92	5.0	7.0
	Lithium (Li)	mg/kg	-	-	6.0	0.89	< 5.0	6.8	9.0	1.1	7.7	11	5.9	1.3	< 5.0	8.0	10	1.1	9.0	11
	Magnesium (Mg)	mg/kg	-	-	3,610	864	2,170	4,270	8,378	787	7,730	9,550	4,630	1,460	3,240	6,700	6,964	406	6,510	7,400
	Manganese (Mn)	mg/kg	-	-	868	250	548	1,160	564	317	212	966	1,389	820	357	2,150	772	223	521	1,010
	Mercury (Hg)	mg/kg	0.17	0.49	0.031	0.010	0.018	0.040	0.045	0.026	0.018	0.082	0.016	0.0079	0.0052	0.024	0.039	0.014	0.023	0.055
	Molybdenum (Mo)	mg/kg	-	-	0.53	0.024	< 0.50	0.56	0.55	0.046	< 0.50	0.62	**1.2**	0.39	0.66	**1.6**	0.65	0.13	< 0.50	0.81
	Nickel (Ni)	mg/kg	-	-	15	3.8	8.6	18	37	4.5	32	43	19	6.1	14	27	29	2.4	27	32
	Phosphorus (P)	mg/kg	-	-	775	130	586	932	1,031	66	955	1,100	786	164	641	1,030	848	25	826	887
	Potassium (K)	mg/kg	-	-	624	136	400	730	970	86	890	1,060	1,008	334	570	1,440	1,218	109	1,060	1,340
	Selenium (Se)	mg/kg	-	-	0.45	0.10	0.34	0.56	0.42	0.22	< 0.20	0.71	0.33	0.13	< 0.20	0.49	0.44	0.15	0.27	0.59
	Silver (Ag)	mg/kg	-	-	< 0.10	0	< 0.10	< 0.10	0.12	0.030	< 0.10	0.17	0.10	0.009	< 0.10	0.12	0.11	0.01	< 0.10	0.13
	Sodium (Na)	mg/kg	-	-	184	43	110	210	398	38	350	450	224	69	140	310	328	23	290	350
	Strontium (Sr)	mg/kg	-	-	61	10	50	68	106	40	62	159	58	21	33	82	105	24	77	128
	Thallium (Tl)	mg/kg	-	-	0.061	0.010	< 0.050	0.069	0.077	0.013	0.056	0.092	0.063	0.018	< 0.050	0.087	0.10	0.014	0.079	0.12
	Tin (Sn)	mg/kg	-	-	< 2.0	0	< 2.0	< 2.0	< 2.0	0	< 2.0	< 2.0	< 2.0	0	< 2.0	< 2.0	< 2.0	0.0	< 2.0	< 2.0
	Titanium (Ti)	mg/kg	-	-	568	158	300	678	846	100	687	950	540	151	391	702	785	67	692	864
	Uranium (U)	mg/kg	-	-	1.1	0.32	0.69	1.5	2.8	1.4	1.4	4.9	0.55	0.19	0.31	0.75	1.0	0.28	0.71	1.27
	Vanadium (V)	mg/kg	-	-	42	9.3	27	48	66	4.9	60	71	51	16	37	78	54	3.8	50	58
	Zinc (Zn)	mg/kg	123	315	39	10	22	47	55	6.0	49	63	49	14	31	64	59	5.3	53	65

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

🟦 Indicates sediment concentration exceeding CSQG ISQG.

🟩 Indicates sediment concentration exceeding CSQG PEL.

bold Indicates sediment concentration exceeding the higher reference mean by more than 2 times earlier data to detect any increasing or decreasing trends in sediment quality. Mean arsenic concentrations in 2014 were elevated relative to the guideline at lower Minto Creek and upper McGinty Creek but not at upper Minto Creek and lower Wolverine Creek, which was similar to previous years (Figure 4.2). Mean copper concentration at upper Minto Creek in 2014 was greater than the guideline, but was also greater than guideline in all previous years including the 1994 baseline (Figure 4.3). At lower Minto Creek, mean copper concentrations have been greater than guidelines in roughly half the sampling events, and the mean concentration observed in 2014 was similar to a number of previous years but greater than in the 1994 baseline (Figure 4.3; Table 4.1; Appendix Table C.1). This is not necessarily indicative of a Minto Mine influence as concentrations are within the range of historical variability. Data normalized to TOC and lithium were comparable over 2010–2014 further indicating that elevated arsenic and copper are not likely mine influenced.

4.3 Summary

Overall, concentrations of metals in Minto Creek sediments were similar to reference and lower than sediment quality guidelines with the exception of arsenic and copper. Arsenic concentration was greater than the sediment quality guideline in lower Minto Creek and at reference areas (as it was in previous sampling years), indicating naturally elevated arsenic concentrations. Copper concentrations in Minto Creek (both upper and lower) were greater than the sediment quality guideline and reference, but were similar to concentrations observed in several previous years. Minto Creek sediment quality has not shown any consistent trends over time.

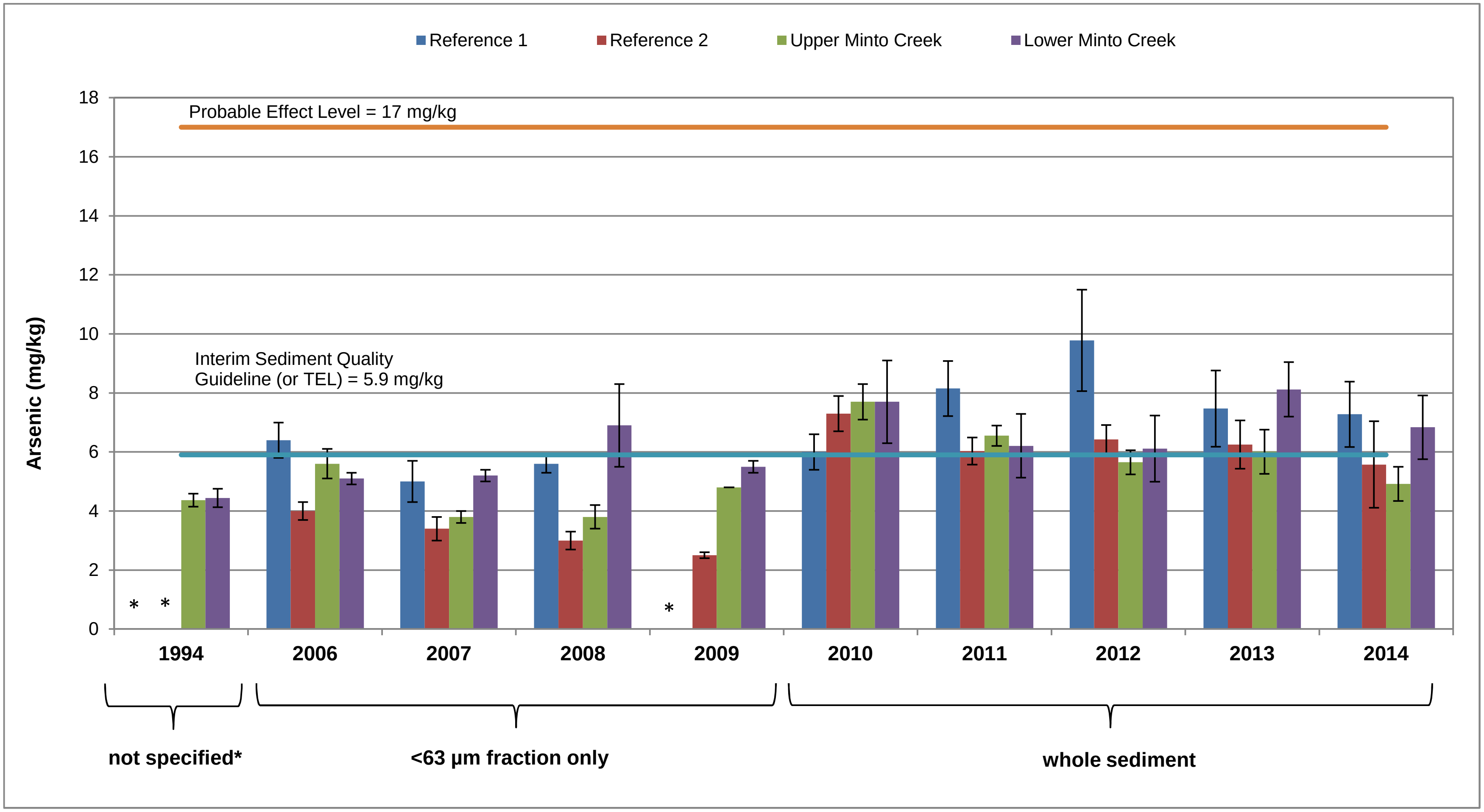


Figure 4.2: Mean arsenic concentrations in sediment collected in Minto Creek and reference locations, 1994-2014 (mean ± standard deviation)

Note: Reference 1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2014; Reference 2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2014; * = no data. TEL: Threshold Effect Levels

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

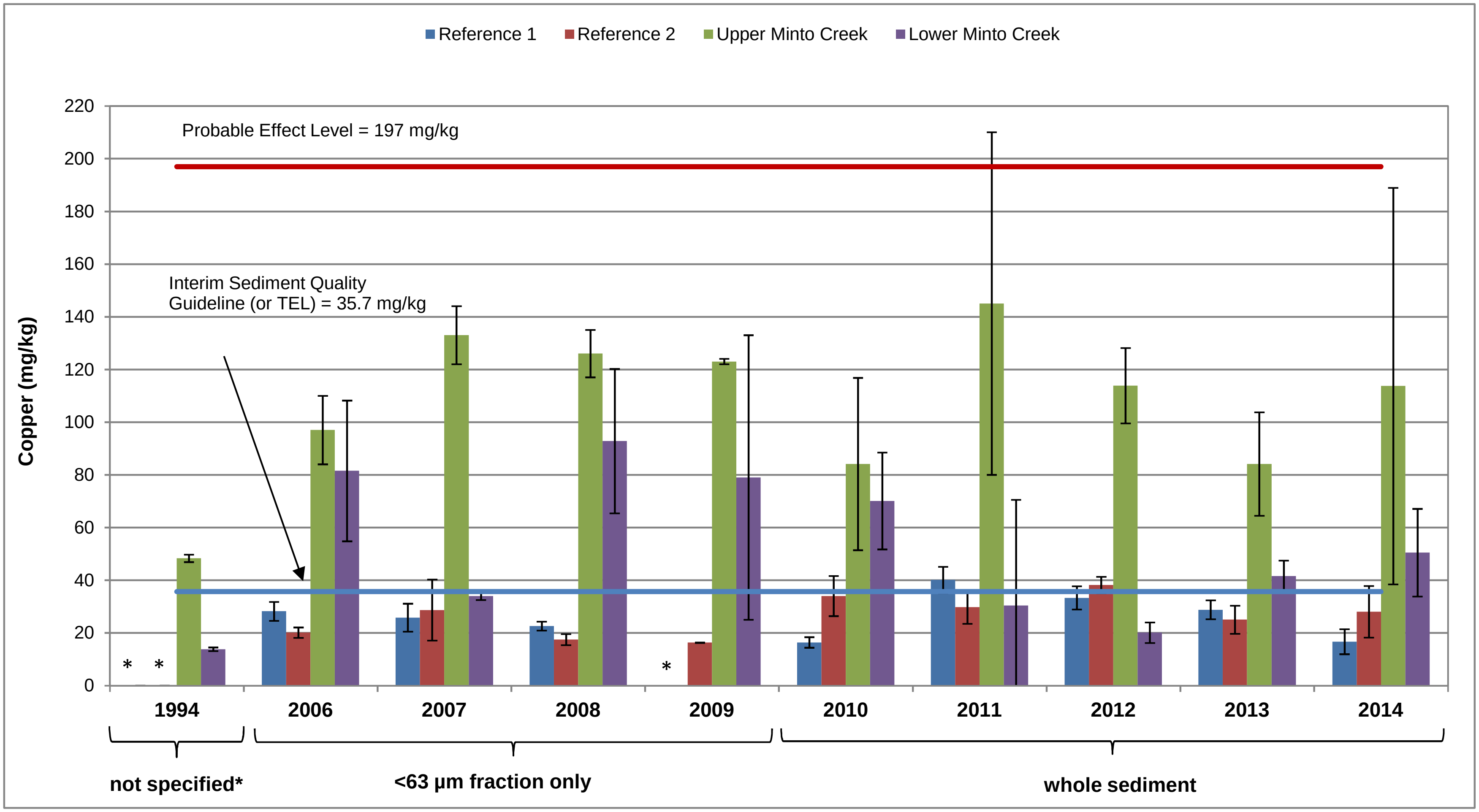


Figure 4.3: Mean copper concentrations in sediment collected in Minto Creek and reference locations, 1994-2014 (mean ± standard deviation)[1]

[1] Reference 1 = Station W6 (south-flowing tributary) in 2006 to 2008 and McGinty Creek in 2010 to 2014; Reference 2 = Station W7 (north-flowing tributary) in 2006 to 2009 and Wolverine Creek in 2010 to 2014; * = no data. TEL: Threshold Effect Levels

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

5.0 PERIPHYTON COMMUNITY

5.1 Primary Metrics and Community Composition

Analysis of the periphyton community based on cells/cm^2 indicated that four of the five periphyton community metrics (taxon richness, Simpson’s Diversity, Simpson’s Evenness and Bray-Curtis distance) differed between study areas (lower Wolverine Creek and lower Minto Creek; Table 5.1). Only density did not differ significantly between areas. Lower Minto Creek had significantly higher taxon richness (18.4 taxa) than lower Wolverine Creek (11.8 taxa; Table 5.1). Simpson’s Diversity, Simpson’s Evenness and Bray-Curtis distance were all significantly higher at lower Minto Creek than at lower Wolverine Creek (Table 5.1). Higher taxon richness, Simpson’s Diversity and Simpson’s Evenness are typically considered to be positive community attributes.

Analysis of the periphyton community based on biomass (µg/cm^2) indicated that only three out of five metrics (taxon richness, Simpson’s Diversity and Bray-Curtis distance) were significantly higher at lower Minto Creek than at lower Wolverine Creek (Table 5.2). Simpson’s Evenness was not significantly different but was still higher at lower Minto Creek than lower Wolverine as was seen with periphyton density (cells/cm^2). As indicated above, greater taxon richness and Simpson’s Diversity are typically considered to be positive community attributes.

Dominant phyla in lower Minto and Wolverine creeks were Bacillariophycae (diatoms) and Cyanophyta (blue-green algae). Bacillariophycae were the dominant phylum at both lower Minto Creek (88% of the community) and lower Wolverine Creek (81% of the community; Figure 5.1). Despite differences in taxonomic composition, little information is available regarding specific periphyton taxon group sensitivities and tolerances to mining activities (Deniseger et al. 1986; De Jonge et al. 2008) to assist in interpretation.

5.2 Temporal Comparisons

Differences in community composition were evident among samples taken in 1994 and 2011-2014. However, there was high temporal variability in periphyton community composition. For example, at lower Minto Creek, Bacillariophycae were dominant in 1994, Cyanophyta in 2011, Rhodophyta and Cyanophyta in 2012 and Bacillariophycae in 2013 and 2014 (Figure 5.1). This lack of consistency was also observed at lower Wolverine Creek, with Cyanophyta dominant in 2011 and 2013 and Bacillariophycae in 2012 and 2014 (Minnow 2013a; 2014).

Table 5.1: Periphyton density t-test results between lower Wolverine Creek (reference) and lower Minto Ceek (exposure) areas, Minto Mine WUL, 2014. All data are presented in cells/cm^2.

Metric	Significant Difference Between Areas? ($p < 0.1$)	p-value	Mean Lower Wolverine Creek	Mean Lower Minto Creek	Mean Difference (LWC-LMC)	Power[a]	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size[a] (# of SDs)[b]
Density	No	0.630	61,607	49,632	11,976	0.136	-	1.623
Number of Taxa	Yes	0.003	12	18	-6.6	0.984	2.119	-
Simpson's Diversity	Yes	0.001	0.52	0.84	-0.32	0.998	2.293	-
Simpson's Evenness	Yes	0.006	0.20	0.36	-0.16	0.954	2.304	-
Bray-Curtis Distance	Yes	0.020	0.40	0.94	-0.53	0.956	1.664	-

[a] power and minimum detectable effect size were calculated using alpha = 0.10

[b] relative to number of reference standard deviations

Table 5.2: Periphyton biomass t-test results, between lower Wolverine Creek (reference) and lower Minto Ceek (exposure) areas, Minto Mine WUL, 2014. All data are presented in µg/cm^2.

Metric	Significant Difference Between Areas? ($p < 0.1$)	p-value	Mean Lower Wolverine Creek	Mean Lower Minto Creek	Mean Difference (LWC-LMC)	Power[a]	Magnitude of Difference (# of SDs)[b]	Minimum Detectable Effect Size[a] (# of SDs)[b]
Density	No	0.571	28	38	-10	0.149	-	2.338
Number of Taxa	Yes	0.003	12	18	-6.6	0.984	2.119	-
Simpson's Diversity	Yes	0.041	0.67	0.83	-0.16	0.719	1.307	-
Simpson's Evenness	No	0.303	0.29	0.38	-0.089	0.266	-	3.593
Bray-Curtis Distance	Yes	0.032	0.52	0.94	-0.42	0.896	1.436	-

[a] power and minimum detectable effect size were calculated using alpha = 0.10

[b] relative to number of reference standard deviations

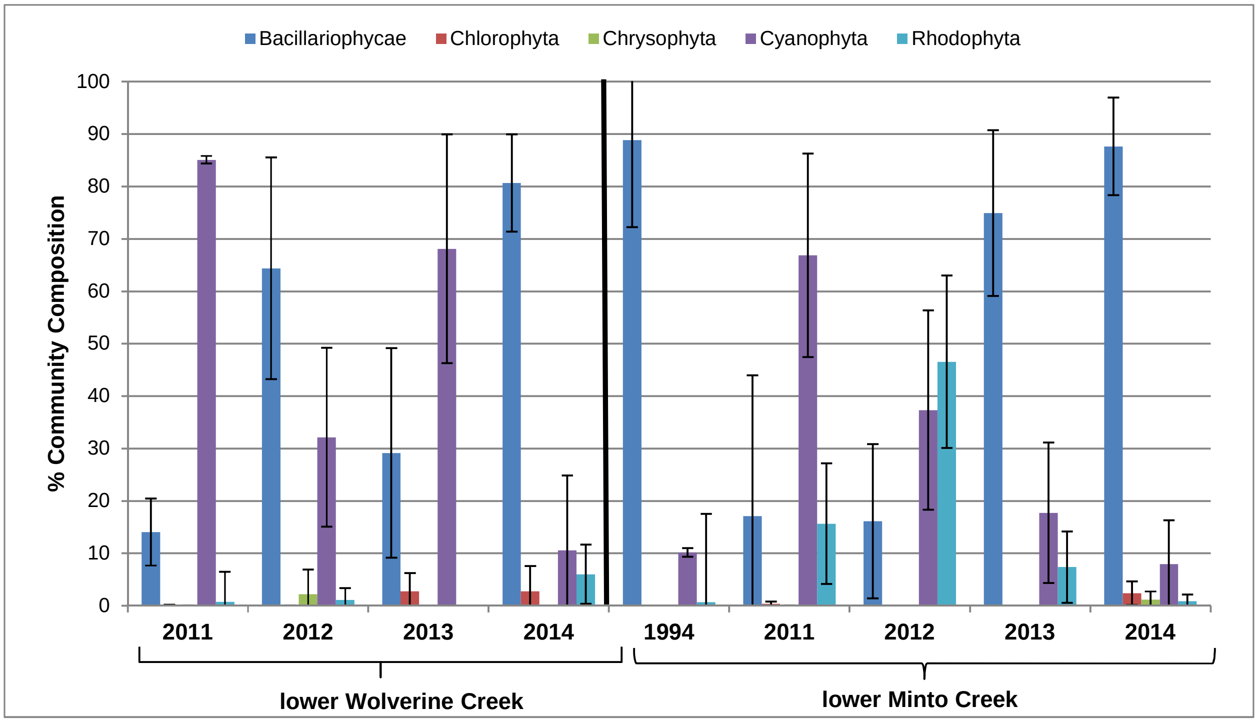


Figure 5.1: Periphyton community (cells/cm^2) composition in lower Minto Creek (1994, 2011-2014) and lower Wolverine Creek (2011-2014). Data presented as mean ± standard deviation.

5.3 Summary

Periphyton community metrics of taxon richness, Simpson's Diversity, Simpson's Evenness and Bray-Curtis distance of lower Minto Creek were significantly greater at lower Minto Creek than at lower Wolverine Creek. Of these, higher taxon richness, Simpson's Diversity and Simpson's Evenness are typically considered to be positive community attributes and suggest limited mine influence on lower Minto Creek. Differences in periphyton community summary metrics among years were apparent in lower Minto Creek but also at the reference area, lower Wolverine Creek, indicating natural variability over time.

6.0 BENTHIC INVERTEBRATE COMMUNITY

6.1 Primary Metrics and Community Composition

The benthic invertebrate community of lower Minto Creek differed significantly than that of lower Wolverine Creek in six different metrics (Table 6.1). Benthic invertebrate density and taxon richness were significantly greater at lower Minto Creek (835 organisms/m^2; 12 taxa) than lower Wolverine Creek (309 organisms/m^2; 8.6 taxa). Bray-Curtis index (distance from the reference median) was significantly higher at lower Minto Creek than at lower Wolverine Creek (Figure 6.1d; Table 6.1), indicating some differences in community composition. Simpson's Diversity and Evenness were not significantly different between areas. The combination of greater density and taxon richness are typically considered to be positive community attributes.

Dominant taxonomic groups in lower Minto and Wolverine creeks included EPT taxa, Chironomids and Oligochaetes. The relative abundance of EPT taxa was significantly greater at lower Minto Creek than at lower Wolverine Creek (Figure 6.2a, Table 6.1, Appendix Table E.2, E.3). Conversely, the relative abundance of Oligochaetes was significantly lower at lower Minto Creek than at lower Wolverine Creek (Figure 6.2c, Table 6.1, Appendix Table E.2, E.3). Given the known sensitivity of EPT taxa and the tolerance of most Oligochaete taxa to elevated concentrations of metals and nutrients (Chapman et al. 1982a; 1982b; Rosenberg and Resh 1993; Taylor and Bailey 1997), the observed taxonomic dominances in Minto Creek relative to Wolverine Creek suggest no adverse influence of the mine on the benthic invertebrate community of lower Minto Creek.

Correspondence Analysis (CA) explained 74.4 percent of the total community variance in the first three CA axes (Appendix Table E.4). The first CA axis explained 46.4 percent of the total inertia (variation) in the original benthic abundance data, and clearly and significantly separated lower Minto Creek from lower Wolverine Creek (Figures 6.3; Table 6.1). Lower Minto Creek had strong positive CA axis 1 scores, indicating high relative abundance of Nemoura stoneflies, black flies (Simuliidae), and the chironomids Diamesa and Eukiefferiella, but low relative abundance of the chironomids Pseudosmittia and Orthocladius, EPT taxa such as perlodid stoneflies and mayflies (Heptageniidae, *E. dorothea*, and baetids (Appendix Table E.4). Conversely, lower Wolverine Creek had strong negative scores, indicating the opposite taxon associations (Appendix Table E.4). The subsequent axes of the correspondence analysis summarized within-area variability and did not show further dimensions of significant difference between lower Minto Creek and lower Wolverine Creek (Table 6.1; Figures 6.3).

Table 6.1: Summary of benthic invertebrate community metrics and statistical comparisons, Minto Mine WUL, 2014.

Metric	Area Means		Statistical Contrasts		
	Lower Wolverine Creek	Lower Minto Creek	Significant Difference	Direction	p-value
Density (organisms/m^2)	309	835	YES	Minto > Wolverine	0.055
Number of Taxa	8.6	12	YES	Minto > Wolverine	0.073
Simpson's Diversity[a]	0.56	0.56	NO	-	0.960
Simpson's Evenness[a]	0.38	0.25	NO	-	0.402
Bray-Curtis Distance	0.51	0.93	YES	Minto > Wolverine	0.004
EPT (%)[b]	22	63	YES	Minto > Wolverine	0.024
Chironomidae (%)	37	29	NO	-	0.565
Oligochaetae (%)	35	3.7	YES	Minto < Wolverine	0.086
CA Axis-1 (46.4%)	-1.0	0.59	YES	Minto > Wolverine	0.000
CA Axis-2 (14.9%)	0.087	-0.017	NO	-	0.757
CA Axis-3 (13.2%)	0.054	0.045	NO	-	0.982

▨ indicates a statistically significant difference between exposed and reference areas

[a] Calculated as recommended by Environment Canada 2012

[b] Percent Ephemeroptera, Plecoptera, Trichoptera

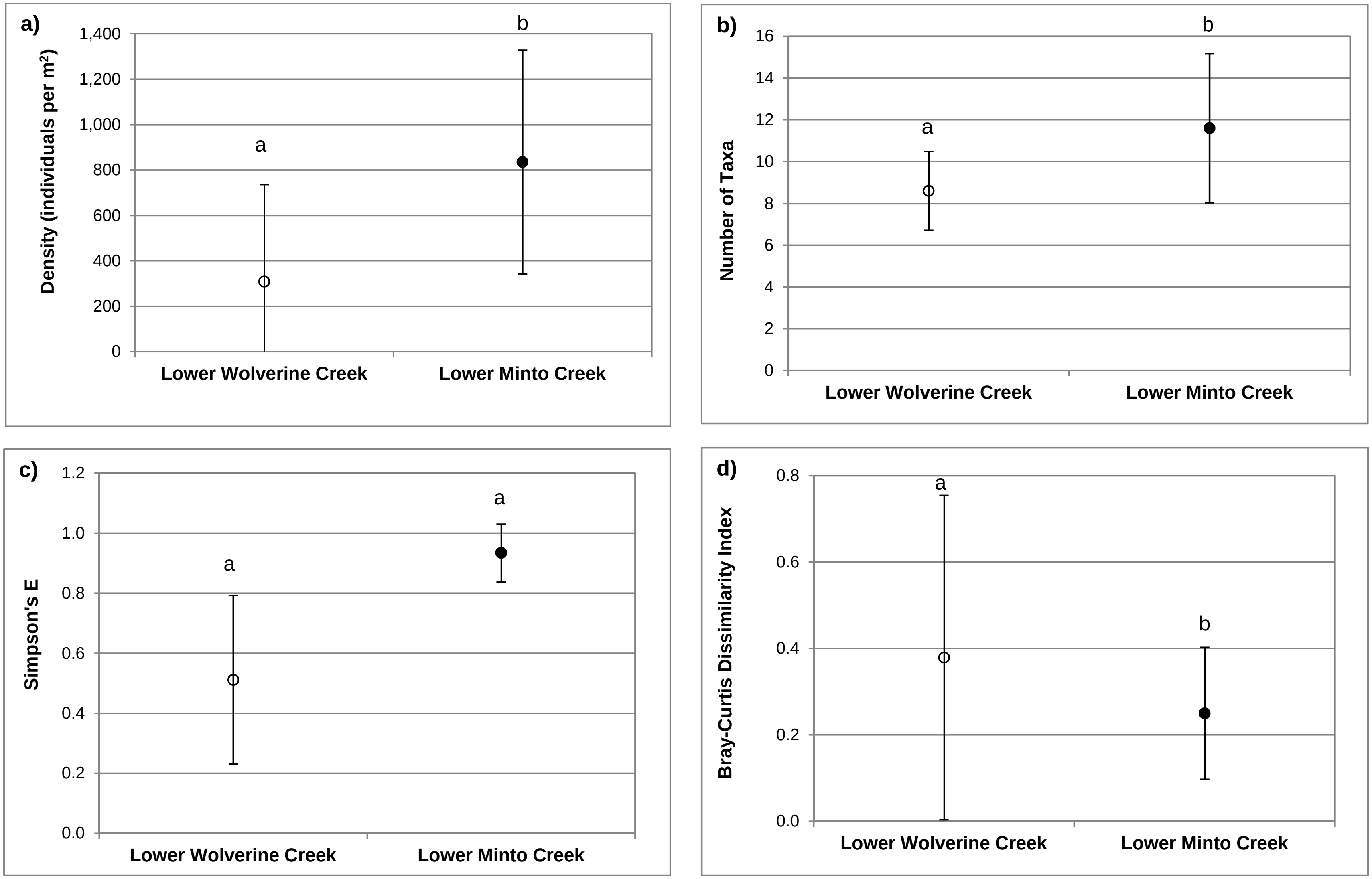


Figure 6.1: **Comparison of a) benthic invertebrate density, b) number of taxa, c) Simpson's Eveness and d) Bray-Curtis, Minto Mine WUL, 2014. Dissimilarity at the lower Minto Creek exposure area compared to the lower Wolverine Creek reference area (500 µm mesh). Data represents area means and 95% confidence intervals (n = 5 in all areas). Different letters above data points indicate areas that were significantly different ($p < 0.1$).**

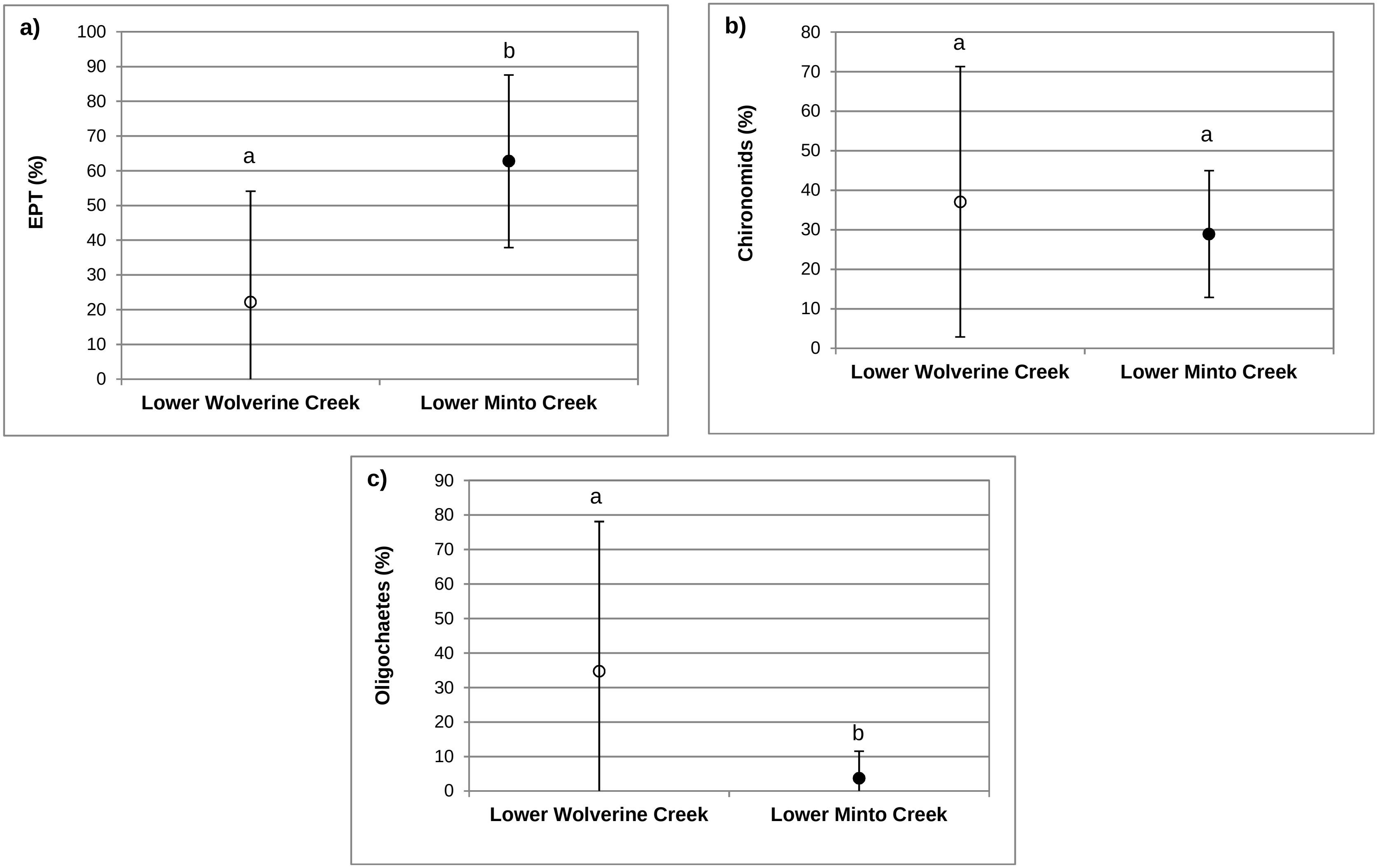


Figure 6.2: The relative abundance as percent of total organisms in an area for a) EPT, b) Chironomids and c) Oligochaetes, Minto Mine WUL, 2014. Data represents area means and 95% confidence intervals (n = 5 in all areas). Different letters above 95% confidence interval bars indicate areas that were significantly different ($p < 0.1$).

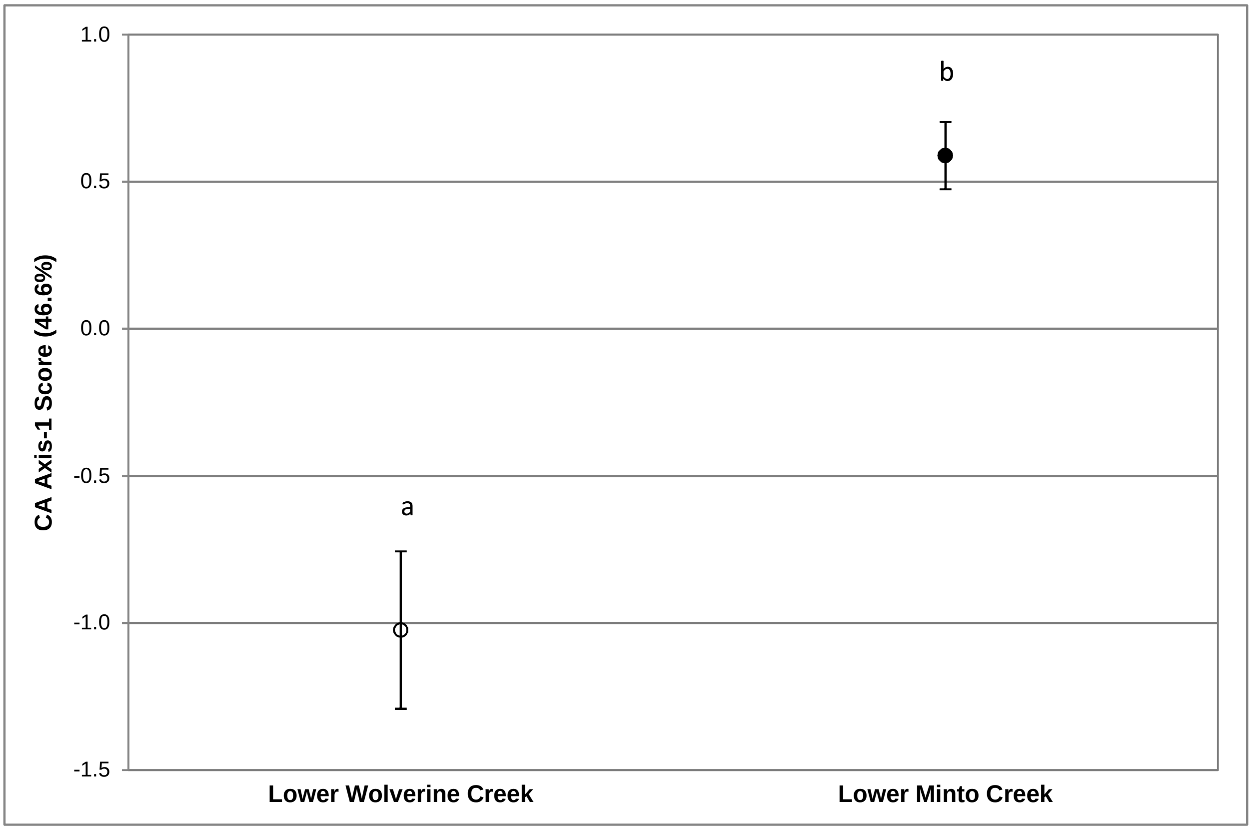


Figure 6.3: Comparison of CA Axis-1 at lower Minto Creek to lower Wolverine Creek, Minto Mine, 2014.

6.2 Correlation Analysis

Correlation analysis between benthic indices and the water chemistry and physical supporting variables was limited to those that differed among areas in order to constrain the number of correlations. Correlations between eight benthic metrics and five supporting measurements resulted in 11 significant correlations at a p-level of 0.01, of which two were significant at the Bonferroni-corrected p-level of 0.001 (Table 6.2). Due to the low number of stations (10) used in these correlations, the tests have limited power and therefore correlations significant at the more liberal p-value of 0.01 were plotted to examine associations of possible biological interest at Minto stations. It is also important to consider that illustration of a significant or suggestive degree of correlation between two variables does not necessarily imply a cause-and-effect relationship, although it is cause to investigate further and to consider known biological responses to environmental change.

The only two correlations significant at the Bonferroni-corrected p-level were the positive correlation between the percent abundance of Plecoptera and specific conductivity and the CA Axis 1 scores and specific conductivity (Table 6.2; Figure 6.4a, b). Both of these correlations are highly grouped and correlation between two variables does not necessarily imply a cause and effect relationship. Investigations of such relationships should consider known biological responses to environmental changes. High stonefly abundance at lower Minto Creek; due almost entirely to stoneflies in the genus Nemoura - was responsible for both of these relationships (and are supported by a positive relationship between proportion EPT taxa and specific conductivity that is significant at a p-level of 0.01 but not the Bonferroni-corrected p-level). Plecopteran taxa generally are intolerant of effluent or enrichment effects, so it is likely that the higher abundance of Nemoura at lower Minto Creek is attributable to habitat conditions. There is also a suggestive (non-significant after Bonferroni adjustment) negative correlation between sampling water depth and percent EPT (and Plecoptera alone) in benthic samples and a positive correlation between sampling water depth and percent oligochaetes (Table 6.2). Shallow-water stations appear to have higher percent EPT abundance and lower oligochaete abundance (Appendix Figures E.2a, b, c). This may reflect the preference for shallow, more turbulent riffle habitat for rheophilic taxa such as Heptageniidae and *E. dorothea* mayflies, and for many taxa of stoneflies. This association neither supports nor discounts an effluent exposure effect, but rather points out the strong effects of some habitat variables on benthic communities. Lastly, CA Axis 1 was also negatively correlated with dissolved oxygen (Appendix Figure E.3a). Lower Minto Creek stations had slightly lower percent oxygen saturation than the reference stations (95% versus 98%) and CA-1 scores were uniformly lower at the reference stations. Lower Minto Creek

Table 6.2: Correlations between benthic metrics and environmental supporting measurements at Minto Mine WUL, 2014.

		Depth (m)	Average Depth (cm) (Sampler pushed into substrate)	DO (%)	Specific Conductivity (µS/cm)	pH
Density (organisms/m^2)	Pearson Correlation	-0.394	0.0168	-0.492	0.740	0.523
	Sig. (2-tailed)	0.259	0.963	0.148	0.0144	0.121
	N	10	10	10	10	10
Number of Taxa	Pearson Correlation	0.0326	0.839	-0.574	0.300	0.766
	Sig. (2-tailed)	0.929	0.00244	0.0824	0.400	0.00978
	N	10	10	10	10	10
Bray-Curtis Distance	Pearson Correlation	-0.568	0.317	-0.700	0.825	0.653
	Sig. (2-tailed)	0.0870	0.371	0.0242	0.00331	0.0405
	N	10	10	10	10	10
Ephemeroptera (%)	Pearson Correlation	0.115	-0.355	0.520	-0.642	-0.668
	Sig. (2-tailed)	0.752	0.315	0.123	0.0454	0.0348
	N	10	10	10	10	10
Plecoptera (%)	Pearson Correlation	-0.800	0.190	-0.567	0.960	0.680
	Sig. (2-tailed)	0.00548	0.600	0.0873	0.0000111	0.0304
	N	10	10	10	10	10
EPT (%)[1]	Pearson Correlation	-0.851	0.0877	-0.421	0.790	0.479
	Sig. (2-tailed)	0.00180	0.810	0.225	0.00658	0.161
	N	10	10	10	10	10
Oligochaetae (%)	Pearson Correlation	0.770	-0.209	0.396	-0.572	-0.380
	Sig. (2-tailed)	0.00912	0.562	0.258	0.0842	0.279
	N	10	10	10	10	10
CA Axis-1 (46.4%)	Pearson Correlation	-0.599	0.522	-0.797	0.927	0.868
	Sig. (2-tailed)	0.0674	0.121	0.00579	0.000112	0.00112
	N	10	10	10	10	10

▨ correlation suggestive; $p < 0.05$ (NOT adjusted for False Discovery Rate)

▭ correlation scatterplot inspected: $p < 0.01$

🟨 significant; $p < 0.001$ ($p = 0.05$ adjusted for 40 comparisons)

[1] Percent Ephemeroptera, Plecoptera, Trichoptera

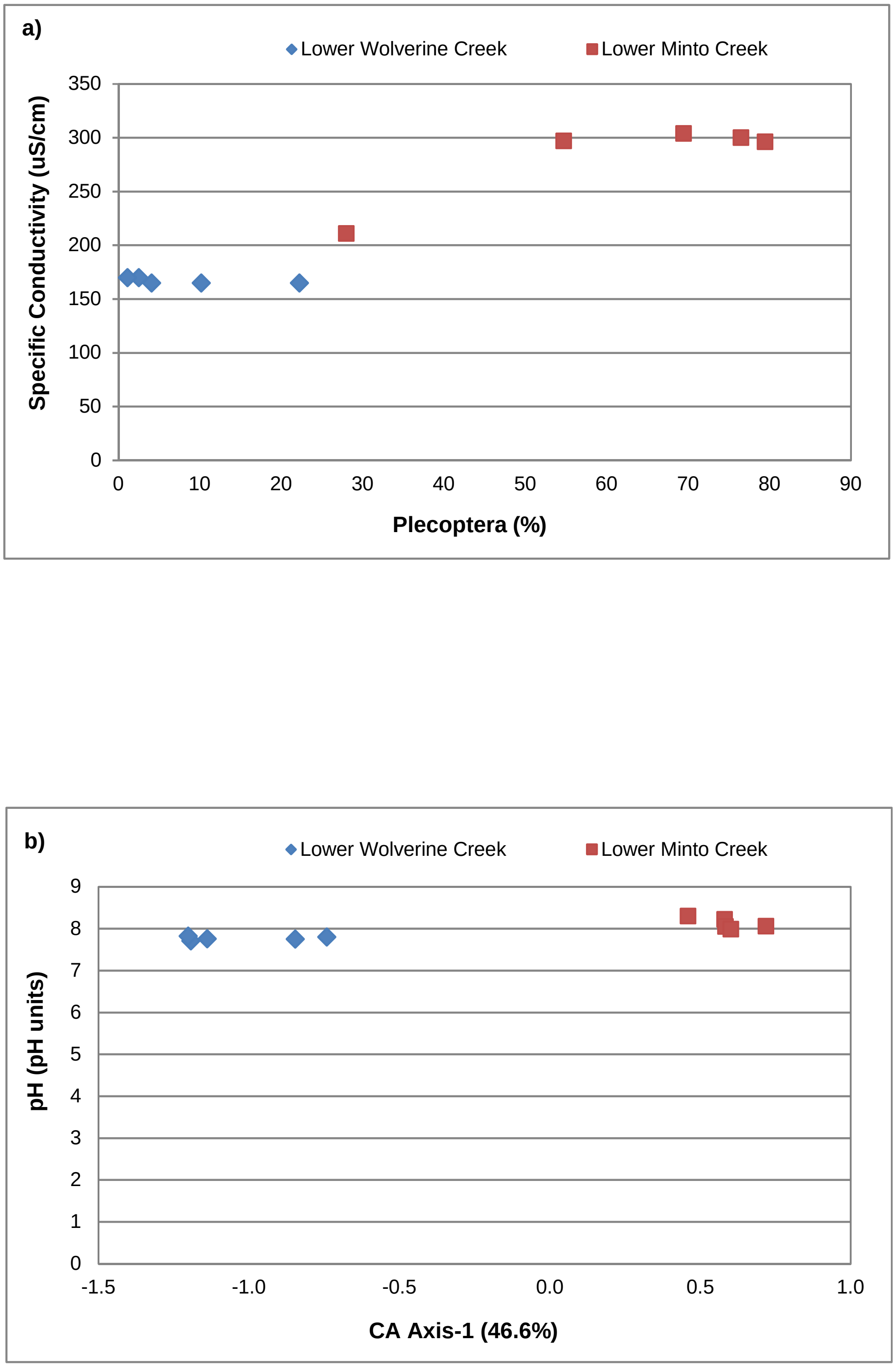


Figure 6.4: Scatterplots of significant relationships ($p < 0.001$) between a) Specific Conducvitiby ar and b) pH and CA Axis-1, Minto Mine WUL, 2014.

was characterized by low relative abundance of these taxa, and higher relative abundance of black fly larvae (Simuliidae), Diamesa and Eukiefferiella chironomids, and stoneflies in the genus Nemoura. The taxa most strongly contributing to reference CA scores were Pseudosmittia and Orthocladius chironomids, stoneflies in the family Perlodidae, and mayflies (Heptageniidae, Ephemerella dorothea/excrucians, Baetidae) (Appendix Table E.4), most of which have low tolerance scores (Barbour et al. 1999) indicating sensitivity to degraded water quality.

6.3 Temporal Comparisons

Temporal comparisons of the benthic invertebrate community condition of lower Minto Creek were made in order to augment data interpretation, but their power is tempered by temporal changes in sampling location, sampling methodology, level of replication and analytical processing techniques. For example, 1994 baseline data were collected near the mouth of Minto Creek as three single grab samples, 2006 data were collected at Station W2 in the same manner, 2008 and 2010 data were collected at Station W2 as three-grab composites whereas 2011-2014 data were collected as five replicate three-grab samples from a large area upstream of Station W2. Only in the later years (2011-2014) do data represent an area (i.e., lower Minto Creek) rather than a station. In addition, data collected in 2013 and 2014 were based collected in 500 µm mesh, whereas all years prior to 2011 used smaller mesh (both 250 µm and 500 µm were used in 2012 to assist in transition).

Benthic invertebrate density in 2014 was higher than in 2013 and was significantly higher at lower Minto Creek than at lower Wolverine Creek (Figure 6.5; Table 6.1). From 2012 to 2014 there appears to have been a decline in the number of taxa at lower Minto Creek; however, number of taxa at lower Minto Creek (12) was greater than at the lower Wolverine Creek reference (8.6; Figure 6.5, Table 6.1). Taxon richness has been significantly greater at lower Minto Creek than at lower Wolverine Creek from 2012 to 2014, except in 2013 when there was no significant difference (Minnow 2013b, 2014). Simpson’s Evenness was similar at lower Minto Creek when compared among years. Differences in density, number of taxa and evenness over time likely reflected high temporal variability of benthic invertebrate communities in the region, also evident at reference areas (Minnow 2009b; 2011, 2012, 2013b, 2014). This might be due to high inter-annual variability in environmental conditions such as flow, deep freezing, and occasional pulses of high sediment loads.

6.4 Summary

The erosional benthic invertebrate community of lower Minto Creek differed from that of lower Wolverine Creek on the basis of density (higher), number of taxa (higher), Bray-Curtis

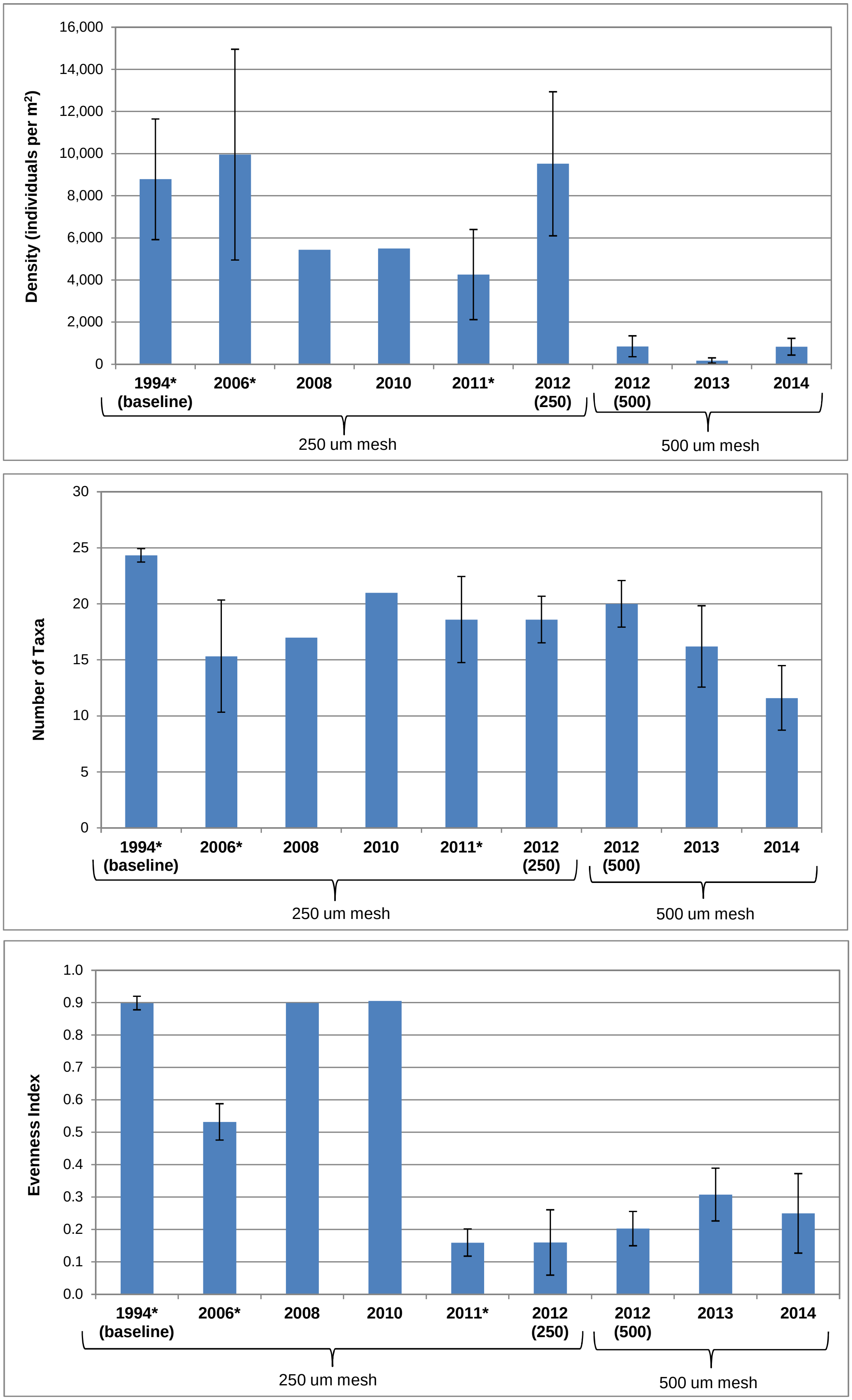


Figure 6.5: Primary benthic invertebrate community metrics at lower Minto Creek, 1994-2014. Data presented as mean ± standard deviation where replicated. Asterisk (*) indicates a year the mine was not discharging.

distance (greater), and percent EPT (higher), percent Oligochaetae (lower) and CA Axis-1 (higher). Greater diversity, greater dominance of EPT taxa and lower dominance of Oligochaetae are typically considered to be indicative of a healthy erosional benthic invertebrate community. Therefore, the benthic invertebrate community condition of lower Minto Creek suggests limited influence of the mine. However, a temporal decrease in number of taxa observed from 2012 to 2014 was observed. The reason for the decrease in unknown, and may be natural, but should be re-evaluated in the 2015 report. High temporal variability has been observed at the exposure and reference areas (Minnow 2009b; 2011, 2012, 2013b, 2014), presumably due to inter-annual variability in environmental conditions (e.g., flow, ice scour).

7.0 TISSUE CHEMISTRY

As indicated in Section 2.5, tissue chemistry data are provided here simply to report the ancillary data that were collected along with the selenium data reported under separate cover. Data interpretation is therefore limited to basic comparisons of metal concentrations in tissue collected at the exposure area (lower Minto Creek) to those collected at reference creeks.

7.1 Periphyton Tissue

Metal concentrations in periphyton tissue collected from lower Minto Creek differed significantly from both reference areas on the basis of only six analytes: bismuth, boron, calcium, nickel, selenium and strontium (Table 7.1; Appendix Table C.2). All were significantly greater at lower Minto Creek than at the reference areas, with the exception of bismuth (which was greater at lower Big Creek) and nickel (which was greater at lower Wolverine Creek). There were no significant differences between areas for copper and selenium in 2013 (Minnow 2014), whereas in 2014 selenium concentrations were significantly greater at lower Minto Creek relative to the reference areas.

7.2 Benthic Invertebrate Tissue

There were no analytes at lower Minto Creek that were significantly different at both reference areas. (Table 7.1; Appendix Table C.3). Analytes of concern, copper and selenium did not differ significantly among areas. This differs from 2013, when copper was significantly greater at lower Minto Creek compared to lower Wolverine Creek and selenium was significantly greater at lower Minto Creek compared to lower Big Creek (Minnow 2014).

Table 7.1: Tissue chemistry results, Minto Mine WUL, September 2014.

Analyte	Units	Periphyton						Benthic Invertebrates					
		Lower Wolverine Creek (Reference)		Lower Big Creek (Reference)		Lower Minto Creek (Exposed)		Lower Wolverine Creek (Reference)		Lower Big Creek (Reference)		Lower Minto Creek (Exposed)	
		n = 5		n = 5		n = 5		n = 5		n = 5		n = 5	
		Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Aluminum (Al)[a]	mg/kg dwt	9,372	2,389	8,572	374	9,814	1,011	2,466	762	1,801	642	1,340	307
Antimony (Sb)	mg/kg dwt	0.046	0.018	0.18	0.071	0.054	0.014	0.056	0.020	0.28	0.12	0.078	0.0095
Arsenic (As)[b]	mg/kg dwt	4.4	0.60	34	8.8	9.0	2.5	1.9	0.37	8.2	3.9	2.1	0.51
Barium (Ba)	mg/kg dwt	183	47	226	34	664	418	134	53	75	25	56	21
Beryllium (Be)	mg/kg dwt	0.50	0.11	0.39	0.027	0.37	0.038	0.17	0.028	0.11	0.045	0.062	0.014
Bismuth (Bi)[c]	mg/kg dwt	0.060	0.0083	0.90	0.24	0.092	0.010	0.013	0.0028	0.15	0.076	0.015	0.0026
Boron (B)[c]	mg/kg dwt	3.4	1.0	1.4	0.18	15	5.2	1.2	0.43	1.8	0.89	1.6	0.76
Cadmium (Cd)	mg/kg dwt	0.18	0.044	0.23	0.043	0.29	0.11	0.41	0.095	1.6	0.93	0.34	0.081
Calcium (Ca)	mg/kg dwt	8,279	1,372	7,935	1,507	14,358	1,688	3,971	2,066	2,669	1,070	2,715	580
Cesium (Cs)[a]	mg/kg dwt	1.3	0.48	3.5	0.95	0.86	0.090	0.24	0.10	1.1	0.53	0.14	0.027
Chromium (Cr)[d]	mg/kg dwt	81	49	36	3.8	48	10	13	4.7	6.6	2.9	5.9	1.1
Cobalt (Co)[a]	mg/kg dwt	16	5.9	10	0.42	19	7.3	3.9	1.3	2.8	1.2	1.5	0.31
Copper (Cu)	mg/kg dwt	22	3.5	29	5.2	35	6.7	26	3.5	42	15	29	7.4
Iron (Fe)[a]	mg/kg dwt	26,504	5,862	21,986	1,860	24,320	3,171	6,301	1,479	4,460	1,529	3,667	812
Lead (Pb)	mg/kg dwt	4.9	0.90	11	2.3	4.6	0.44	1.2	0.24	3.0	1.3	0.82	0.10
Lithium (Li)[c]	mg/kg dwt	9.8	3.2	8.9	0.56	9.5	0.94	2.3	1.0	1.8	0.59	1.3	0.33
Magnesium (Mg)[d,e]	mg/kg dwt	10,254	3,005	6,345	647	5,989	632	3,096	447	2,377	674	1,647	236
Manganese (Mn)	mg/kg dwt	1,205	397	657	111	10,367	7,759	414	117	375	119	353	98
Mercury (Hg)	mg/kg dwt	0.028	0.0075	0.030	0.010	0.029	0.0044	0.034	0.0070	0.060	0.014	0.023	0.0093
Molybdenum (Mo)	mg/kg dwt	0.58	0.14	1.2	0.30	0.89	0.42	0.68	0.12	2.8	2.43	1.4	0.87
Nickel (Ni)[a]	mg/kg dwt	56	17	22	0.69	34	7.2	14	3.4	10	5.6	9.0	3.7
Phosphorus (P)	mg/kg dwt	1,792	495	1,279	147	1,691	417	7,091	739	6,902	1,385	6,955	838
Potassium (K)[a]	mg/kg dwt	2,082	781	1,596	353	2,287	565	8,085	1,182	7,174	1,769	8,558	1,855
Rubidium (Rb)[a]	mg/kg dwt	9.4	2.1	13	2.4	9.1	1.0	3.9	0.83	6.0	2.7	3.0	0.60
Selenium (Se)	mg/kg dwt	0.53	0.23	0.23	0.079	1.3	0.48	1.3	0.15	1.2	0.15	1.4	0.31
Sodium (Na)	mg/kg dwt	530	250	301	13	277	21	3,746	1,676	4,402	1,658	3,538	1,299
Strontium (Sr)[b]	mg/kg dwt	72	16	60	2.5	144	33	108	142	31	11	27	5.5
Tellurium (Te)[a,c,f,g,h]	mg/kg dwt	0.018	0.013	0.037	0.010	0.022	0.007	< 0.018	0	< 0.030	0	< 0.022	0
Thallium (Tl)[e]	mg/kg dwt	0.054	0.012	0.16	0.036	0.076	0.0095	0.013	0.0015	0.049	0.026	0.011	0.0022
Tin (Sn)[c,d,h]	mg/kg dwt	0.26	0.044	0.18	0.032	0.20	0.016	< 0.090	0	< 0.15	0	< 0.11	0
Uranium (U)	mg/kg dwt	1.1	0.32	1.3	0.17	0.63	0.056	0.57	0.21	1.2	0.78	0.33	0.22
Vanadium (V)	mg/kg dwt	69	13	56	4.1	58	9.0	17	4.2	10	4.3	8.4	2.3
Zinc (Zn)	mg/kg dwt	55	11	67	5.3	58	7.5	115	11	170	39	95	21
Zirconium (Zr)	mg/kg dwt	12	2.8	6.2	0.55	8.5	1.1	3.6	0.76	2.5	1.1	2.1	0.67

▨ Indicates a mean concentration in lower Minto Creek that is significantly different than the mean concentration in lower Wolverine Creek (ANOVA; p = 0.05)

☐ Indicates a mean concentration in lower Minto Creek that is significantly different than the mean concentration in lower Big Creek (ANOVA; p = 0.05)

[a] For periphyton, data were normalized by log transformation (ANOVA, p = 0.05)

[b] For benthic, data were normalized by log transformation (ANOVA, p = 0.05)

[c] For benthic, if value was < method detection limit, statistics were calculated using detection limit, i.e. if value was < 0.0048, statistics were run using the value 0.0048

[d] For periphyton calculations, data were not normal or equal variance not met, therefore a non-parametric Mann-Whitney U-test was conducted instead, p = 0.05

[e] For benthic calculations, data were not normal or equal variance not met, therefore a non-parametric Mann-Whitney U-test was conducted instead, p = 0.05

[f] For periphyton, if value was < method detection limit, statistics were calculated using detection limit, i.e. if value was < 0.0048, statistics were run using the value 0.0048

[g] If all values at an area were < method detection limit than the average moisture was taken to calculate dry weight

[h] Statistical analysis was not possible as there was no variance within an area.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The Minto Mine sediment, periphyton and benthic assessment undertaken from September 9th to 15th, 2014 served to quantitatively compare water quality (field measures and chemistry), sediment quality, periphyton community and benthic invertebrate community condition of Minto Creek to reference creeks and also drew on previous data for interpretation.

Specific conductance and pH were higher at Minto Creek than at reference areas, and specific conductance decreased in Minto Creek with distance from the mine. Only two analytes in Minto Creek water samples (fluoride and copper) did not meet water quality guidelines and/or WUL standards. However, in all cases, elevations of the same analytes were observed at reference, suggesting that the observed exceedences were not mine-related. Lastly, Chlorophyll *a* concentrations were significantly higher at lower Minto Creek than at lower Wolverine Creek, but these concentrations were below the BCWQG of 100 mg/m^2 for the protection of aquatic life (BCMOE 1985) and the creeks were identified as oligotrophic using the classification system of Dodds et al. (1998).

Concentrations of metals in Minto Creek sediments were similar to reference and lower than sediment quality guidelines with the exception of arsenic and copper. Arsenic concentration was greater than the sediment quality guideline in lower Minto Creek and at reference areas (as it was in previous sampling years), indicating naturally elevated arsenic concentrations. Copper concentrations in Minto Creek (both upper and lower) were greater than the sediment quality guideline and reference, but were similar to concentrations observed in several previous years. Minto Creek sediment quality has not shown any consistent trends over time.

The periphyton community of lower Minto Creek differed from that of lower Wolverine Creek on the basis of greater taxon richness, Simpson's Diversity, Simpson's Evenness and Bray-Curtis distance. Higher taxon richness, Simpson's Diversity and Simpson's Evenness are typically considered to be positive community attributes and suggest limited mine influence on the periphyton community of lower Minto Creek. Differences among years were apparent in lower Minto Creek but also at the reference area (lower Wolverine Creek) indicating natural variation over time.

The erosional benthic invertebrate community of lower Minto Creek differed from that of lower Wolverine Creek on the basis of density (higher), number of taxa (higher), Bray-Curtis distance (greater), percent EPT (higher), percent Oligochaetae (lower) and CA Axis-1 (higher). Greater diversity, greater dominance of EPT taxa and lower dominance of Oligochaetae are typically considered indicative of a healthy erosional benthic invertebrate community. Therefore, the benthic invertebrate community condition of lower Minto Creek suggests limited influence of the mine. High temporal variability has been observed at the exposure and reference areas (Minnow 2009b; 2011, 2012, 2013b, 2014), presumably due to inter-annual variability in environmental conditions (e.g., flow, ice scour).

The chemical quality of biological tissues (periphyton and benthic invertebrates) collected at mine-exposed lower Minto Creek and reference areas was reported. Only six metals, bismuth, boron, calcium, nickel, selenium and strontium measured in periphyton tissue from lower Minto Creek were significantly greater than both reference areas (lower Wolverine Creek and lower Big Creek). There were no analytes measured in benthic invertebrate tissue that were found to be significantly different than both reference areas.

8.2 Recommendations

Based on the results and conclusions of the 2014 Minto Mine sediment, periphyton and benthic assessment, it is recommended that the program is repeated in 2015. It is recommended that the examination of TOC and lithium normalization continue with key analytes of concern. An additional benthic invertebrate reference site should be considered to better characterize reference area variability. Lower Big Creek could be added to provide better perspective on whether any of the observed differences in the benthic invertebrate community of Minto Creek relative to Wolverine Creek are actually due to mine influence or simply due to natural differences between these creeks.

9.0 REFERENCES

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

CABIN (Canadian Aquatic Biomonitoring Network). 2012. Field Manual: Wadeable Streams. Environment Canada. March 2012.

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

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

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

De Jonge M., B. Van de Vijver, R. Blust and L. Bervoets. 2008. Response of aquatic organisms to metal pollution in a low land river in Flanders: A comparison of diatoms and macroinvertebrates. Sci Total Environ. 407:615-629.

Deniseger, J., A. Austin and W.P. Lucey. 1986. Periphyton communities in a pristine mountain stream above and below heavy metal mining operations. Freshw Biol. 16:209-218.

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

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

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

Horowitz, A.J. 1991. A Primer on Sediment-Trace Element Chemistry. Second Edition. Lewis Publishers.

Minnow (Minnow Environmental Inc.). 2009a. Evaluation of the Background Water Quality Minto Creek and Options for the Derivation of Site-Specific Water Quality Objectives. Prepared for the Access Consulting Group and Minto Explorations Ltd, April 2009.

Minnow (Minnow Environmental Inc.). 2009b. Minto Mine Water Use Licence Benthic Invertebrate Community Survey Results. Letter Report prepared for the Access Consulting Group and Minto Explorations Ltd, January 2009.

Minnow (Minnow Environmental Inc.). 2010a. Minto Mine Annual Water Quality Monitoring Report 2010. Prepared for the Access Consulting Group, July 2010.

Minnow (Minnow Environmental Inc.). 2010b. Characterization of Baseline and Operational Water Quality of Minto Creek 2010. Prepared for Minto Explorations Ltd., August 2010.

Minnow (Minnow Environmental Inc.). 2011. Minto Creek Sediment and Benthic Invertebrate Community Assessment – 2010. Prepared for Minto Explorations Ltd., June 2011.

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

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

Minnow (Minnow Environmental Inc.) 2013b. Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment - 2012. Prepared for Minto Explorations Ltd, March 2013.

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

Minnow (Minnow Environmental Inc.) 2015. Minto Mine Phase 3 EEM – Investigation of Cause Interpretive Report. Prepared for Minto Explorations Ltd, January 2015.

Motodo, S. 1959. Devices of simple plankton apparatus. Mem. Fac. Fish., Hokkaido Univ., 7:73-94.

Smith, B. and J.B. Wilson. 1996. A consumer’s guide to evenness indices. Oikos 76: 70-82.

SPSS Version 12.0. 2003. SPSS Inc. 233 S. Wacker Drive, 11th floor, Chicago, Illinois, U.S.A.

SPSS (PASW) version 22 (2013). IBM-SPSS Inc. 233 S. Wacker Drive, 11th floor. Chicago, Illinois, U.S.A.

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

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

Van Guelpen, L., D.F. Markle, and D.J. Duggan. 1982. An evaluation of accuracy, precision, and speed of several zooplankton sub-sampling techniques. J. Cons. Int. Explor. Mer., 40:226-236. plankton apparatus. Mem. Fac. Fish., Hokkaido Univ., 7:73-94.

Wetzel, R.G. 2001. Limnology: Lake and River Ecosystems. Third Edition. Academic Press. San Diego, CA, USA. 1006 p.

APPENDIX A

DATA QUALITY ASSESSMENT

APPENDIX A: DATA QUALITY ASSESSMENT

LIST OF TABLES

A1.0 INTRODUCTION

Data Quality Assessment (DQA) was conducted on data collected as part of the 2014 Minto Creek Sediment, Periphyton and Benthic Invertebrate Community Assessment Report. The objective of DQA is to define the overall quality of the data presented in the report, and, by extension, the confidence with which the data can be used to derive conclusions.

A1.1 Background

A variety of factors can influence the chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the potential factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. DQA involves comparison of actual field and laboratory measurement performance to data quality objectives (DQOs) established for a particular study, such as evaluation of method detection limits, blank sample data, data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spike recoveries and/or analysis of standards or certified reference materials).

DQOs were established either at the outset of the field program or by the laboratory (ALS Group Environmental Laboratory) and reflect reasonable and achievable performance expectations (Table A.1). The method detection limit (MDL) and the blank analysis were set at the outset of the field program for water, sediment and tissue quality. Programs involving a large amount of samples and analytes usually result in some results that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP scans for metals) since the analytical conditions are not necessarily

Table A.1: Data quality objectives for environmental samples.

Quality Control Measure	Quality Control Sample Type	Study Component			
		Water Quality	Sediment Quality	Benthic Invertebrate Community	Tissue Quality
Method Detection Limits (MDL)	Comparison actual MDL versus target MDL	MDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline value	MDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline value	n/a	MDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline value
Blank Analysis	Field or Laboratory Blank	≤two-times the laboratory MDL	≤two-times the laboratory MDL	n/a	n/a
Accuracy	Organism Recovery	n/a	n/a	≥ 90%	n/a

n/a - not applicable

optimal for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure that any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

A1.2 Types of Quality Control Samples

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples, and a description of each, include the following:

- **Blanks** are samples of de-ionized water and/or appropriate reagent(s) that are handled and analyzed the same way as regular samples. These samples will reflect any contamination of samples occurring in the field (in the case of field or travel blanks) or the laboratory (in the case of laboratory or method blanks). Analyte concentrations should be non-detectable although a data quality objective of twice the method detection limit allows for slight “noise” around the detection limit.

- **Laboratory Duplicates** are replicate sub-samples created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.

- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks (or blank spikes) are created using laboratory control materials whereas matrix spikes are created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

The following QC was applied to benthic invertebrate community samples as follows:

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

A2.0 WATER SAMPLES

A2.1 Method Detection Limits

Most reported MDLs were at or below the target concentrations with the exception of those for five analytes: total suspended solids (TSS), cadmium, copper, mercury, and fluoride (Table A.2). Even though these MDLs were higher than targeted concentrations, they were all lower than guideline levels and these analytes were detectable. Therefore, data for this project can be reliably interpreted relative to guidelines.

A2.2 Laboratory Blank Sample Analysis

All blank samples contained non-detectable analyte concentrations indicating no inadvertent contamination of samples within the laboratory during analysis (Appendix B - analytical report).

A2.3 Data Precision

Close agreement was achieved between laboratory duplicate samples (Appendix B - analytical report). The relative percent difference for some analytes could not be calculated as the results were below method detection limits. The five analytes for which relative percent difference could not be calculated were ammonia, chloride, nitrate, nitrite and TSS (Appendix B - analytical report). This indicates that reported sample results were associated with good analytical precision.

A2.4 Data Accuracy

A2.4.1 Blank Spike Recovery Samples

Analyte recoveries for spiked blanks all met the data quality objectives indicating excellent analytical accuracy for the water sample analyses (Appendix B - analytical report).

A2.4.2 Matrix Spike Recovery Samples

Recoveries of some analytes could not be calculated by the analytical laboratory due to high analyte background in the samples (Appendix B - analytical report). Results for the following analytes could not be calculated due to high analyte background in the samples: dissolved organic carbon (DOC), total organic carbon (TOC), nitrate, total phosphorus, sulfate and the following dissolved and total metal analytes; barium, calcium, magnesium, silicon, sodium and strontium. All other samples met the DQO

Table A.2: Laboratory method detection limits (MDLs) relative to targets and water quality guidelines, Minto Mine, 2014.

Analyte		Units	Method Detection Limit		Water Use Licence	CCME Water Quality[a]	
			Target	Achieved	Limits	30 Day	Max
Physical Tests	Conductivity	µS/cm	-	2.0	-	-	-
	Hardness (as CaCO3)	mg/L	-	0.5	-	-	-
	pH	pH units	-	0.1	6.0 - 9.0	-	-
	Total Suspended Solids	mg/L	0.8	3.0	-	8.3[b]	28.3[b]
	Total Dissolved Solids	mg/L	-	10.0	-	-	-
	Turbidity	NTU	0.338	0.1	-	3.38[c]	9.38[c]
Anions and Nutrients	Alkalinity, Total	mg/L	-	1.0	-	-	-
	Ammonia, Total (as N)	mg/L	0.04	0.005	0.35	1.27[d]	-
	Chloride (Cl)	mg/L	12	0.5	-	120	640
	Fluoride (F)	mg/L	0.012	0.02	-	0.12	
	Nitrate (as N)	mg/L	0.29	0.005	2.9	3.0	124
	Nitrite (as N)	mg/L	0.006	0.001	0.06	0.197	-
	Phosphorus (P)-Total dissolved	mg/L	-	0.002	-	-	-
	Phosphorus (P)-Total	mg/L	0.002	0.002	0.02	-	-
	Sulfate (SO4)	mg/L	-	0.5	-	-	-
Cyanides	Cyanide, Total	mg/L	-	0.005	-	-	-
Organic / Inorganic Carbon	Dissolved Organic Carbon	mg/L	-	0.5 - 1.0	-	-	-
	Total Organic Carbon	mg/L	-	0.5 - 1.0	-	-	-
	Total Inorganic Carbon[e]	mg/L	-	1.0 - 2.5	-	-	-
Total Metals	Total Aluminum (Al)	mg/L	0.01	0.003	0.62	0.1[f]	-
	Total Antimony (Sb)	mg/L	-	0.0001	-	-	-
	Total Arsenic (As)	mg/L	0.0005	0.0001	0.005	0.005	-
	Total Barium (Ba)	mg/L	-	0.00005	-	-	-
	Total Beryllium (Be)	mg/L	-	0.0001	-	-	-
	Total Bismuth (Bi)	mg/L	-	0.0005	-	-	-
	Total Boron (B)	mg/L	0.15	0.01	-	1.5	2.9
	Total Cadmium (Cd)	mg/L	0.000004	0.00001	0.00004	0.00012[g]	0.0016[g]
	Total Calcium (Ca)	mg/L	-	0.05	-	-	-
	Total Chromium (Cr)	mg/L	0.0001	0.0001	0.002	0.001 Cr(VI)	-
	Total Cobalt (Co)	mg/L	-	0.0001	-	-	-
	Total Copper (Cu)	mg/L	0.0002	0.0005	0.013	0.002[g]	-
	Total Iron (Fe)	mg/L	0.03	0.01	1.1	0.3	-
	Total Lead (Pb)	mg/L	0.0002	0.00005	0.004	0.002[g]	-
	Total Lithium (Li)	mg/L	-	0.0005	-	-	-
	Total Magnesium (Mg)	mg/L	-	0.1	-	-	-
	Total Manganese (Mn)	mg/L	-	0.00005	-	-	-
	Total Mercury (Hg)	mg/L	0.000003	0.00001	-	0.00003	-
	Total Molybdenum (Mo)	mg/L	0.007	0.00005	0.073	0.073	-
	Total Nickel (Ni)	mg/L	0.008	0.0005	0.11	0.077[g]	-
	Total Phosphorus (P)	mg/L	-	0.30	-	-	-
	Total Potassium (K)	mg/L		0.05	-	-	-
	Total Selenium (Se)	mg/L	0.0001	0.0001	0.001	0.001	-
	Total Silicon (Si)	mg/L	-	0.05	-	-	-
	Total Silver (Ag)	mg/L	0.00001	0.00001	-	0.0001	
	Total Sodium (Na)	mg/L	-	0.05	-	-	-
	Total Strontium (Sr)	mg/L	-	0.0002	-	-	-
	Total Thallium (Tl)	mg/L	0.00008	0.00001	-	0.0008	-
	Total Tin (Sn)	mg/L	-	0.0001	-	-	-
	Total Titanium (Ti)	mg/L	-	0.01	-	-	-
	Total Uranium (U)	mg/L	0.0015	0.00001	-	0.015	0.033
	Total Vanadium (V)	mg/L	-	0.001	-	-	-
	Total Zinc (Zn)	mg/L	0.003	0.003	0.03	0.03	-

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

[b] Based on the median of background levels plus 5 mg/L for 30 day and 25 mg/L for max guidelines

[c] Based on the median of background levels plus 2 NTU for 30 day and 8 NTU for max guidelines

[d] Based on lowest guideline using highest temperature and pH

[e] Total inorganic carbon samples for LMC were collected on Sept 13, 2014 whereas the remaining analytes were collected on Sept 10, 2014

[f] Based on lowest guideline using highest pH

[g] Based on lowest guideline using lowest hardness

▨ value greater than DQO

set by the analytical laboratory. This indicates good analytical accuracy for the water sample analyses.

A2.4.3 Certified Reference Materials

Analyte recoveries from certified reference materials all met the data quality objectives indicating excellent analytical accuracy (Appendix B - analytical report).

A3.0 SEDIMENT SAMPLES

A3.1 Method Detection Limits

All analytes had reported MDLs that were lower than the target MDLs indicating that the data can be reliably interpreted (Table A.3).

A3.2 Laboratory Blank Sample Analysis

All blank samples contained non-detectable analyte concentrations indicating no inadvertent contamination of samples within the laboratory during analysis (Appendix C - analytical report).

A3.3 Data Precision

The laboratory duplicate sediment samples showed good agreement in most analyte concentrations. The relative percent difference for inorganic carbon, bismuth, silver and tin were not available as the results were below method detection limits (Appendix C - analytical report). All other analytes met the DQO indicating good analytical precision with the analysis of sediment samples.

A3.4 Data Accuracy

A2.4.1 Blank Spike Recovery Samples

Analyte recoveries for spiked blanks all met the data quality objectives indicating excellent analytical accuracy for the sediment sample analyses (Appendix C - analytical report).

A2.4.3 Certified Reference Materials

Recoveries of all analytes in certified reference materials met the data quality objective (Appendix C - analytical report). These data indicated excellent analytical accuracy associated with the analysis of sediment samples.

Table A.3: Laboratory method detection limits (MDL) for sediment samples relative to targets and to guidelines, Minto Mine, 2014.

Analyte		Units	Method Detection Limit		CCME Sediment Quality Guidelines[a]	
			Target	Achieved	ISQG[b]	PEL[c]
Physical Tests	Loss on Ignition @ 420°C	%	-	1.0	-	-
	pH (1:2 soil:water)	pH units	-	0.1	-	-
Particle Size	% Gravel (> 2 mm)	%	-	0.1	-	-
	% Sand (2.0 mm - 0.063 mm)	%	-	0.1	-	-
	% Silt (0.063 mm - 4 µm)	%	-	0.1	-	-
	% Clay (< 4 µm)	%	-	0.1	-	-
Non-metal	Total Kjeldahl Nitrogen (TKN)	%	-	0.02	-	-
	Inorganic Carbon	%	-	0.1	-	-
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%	-	0.8	-	-
	Total Carbon by Combustion	%	-	0.1	-	-
	Total Organic Carbon	%	-	0.1	-	-
Metals	Total Aluminum (Al)	mg/kg	-	50	-	-
	Total Antimony (Sb)	mg/kg	-	0.1	-	-
	Total Arsenic (As)	mg/kg	0.59	0.05 - 0.06	5.9	17
	Total Barium (Ba)	mg/kg	-	0.5	-	-
	Total Beryllium (Be)	mg/kg	-	0.2	-	-
	Total Bismuth (Bi)	mg/kg	-	0.2	-	-
	Total Cadmium (Cd)	mg/kg	0.06	0.05	0.6	3.5
	Total Calcium (Ca)	mg/kg	-	50	-	-
	Total Chromium (Cr)	mg/kg	3.73	0.5	37.3	90
	Total Cobalt (Co)	mg/kg	-	0.1	-	-
	Total Copper (Cu)	mg/kg	3.57	0.5	35.7	197
	Total Iron (Fe)	mg/kg	-	50	-	-
	Total Lead (Pb)	mg/kg	3.50	0.5	35.0	91.3
	Total Lithium (Li)	mg/kg	-	5.0	-	-
	Total Magnesium (Mg)	mg/kg	-	20	-	-
	Total Manganese (Mn)	mg/kg	-	1.0	-	-
	Total Mercury (Hg)	mg/kg	0.017	0.005	0.170	0.486
	Total Molybdenum (Mo)	mg/kg	-	0.5	-	-
	Total Nickel (Ni)	mg/kg	-	0.5	-	-
	Total Phosphorus (P)	mg/kg	-	50	-	-
	Total Potassium (K)	mg/kg	-	100	-	-
	Total Selenium (Se)	mg/kg	-	0.2	-	-
	Total Silver (Ag)	mg/kg	-	0.1	-	-
	Total Sodium (Na)	mg/kg	-	100	-	-
	Total Strontium (Sr)	mg/kg	-	0.5	-	
	Total Thallium (Tl)	mg/kg	-	0.05	-	-
	Total Tin (Sn)	mg/kg	-	2.0	-	-
	Total Titanium (Ti)	mg/kg	-	1.0	-	-
	Total Uranium (U)	mg/kg	-	0.05	-	-
	Total Vanadium (V)	mg/kg	-	0.2	-	-
	Total Zinc (Zn)	mg/kg	12.3	1.0	123	315

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

[b] Interim sediment quality guideline

[c] Probable effect level

▨ value greater than DQO

A4.0 PERIPHYTON COMMUNITY

One sample was re-counted and the relative percent difference (RPD) in counts was calculated. Close agreement was achieved between laboratory duplicate samples for both density (cells/cm^2; Table A.4) and biomass (µg/cm^2; Table A.5). Cyanobacteria had the highest RPD for periphyton density (29%) and biomass (29%), but these are just within the DQO. This indicates that the data can be reliably interpreted.

Table A.4: Laboratory duplicate results for analysis of periphyton group densities (cells/cm^2).
Highlighted values did not meet the data quality objective of ≤ 30% relative percent difference (RPD).

Algal Density (cells/cm^2)	LWC-2	LWC-2-R	RPD
Cyanobacteria	3,445	4,594	29%
Chlorophyte	0	0	0%
Chrysophyte	0	0	0%
Diatom	79,529	80,678	1%
Red Algae	11,484	10,336	0%
Total	94,459	95,607	1%

▨ > 30% RPD

Table A.5: Laboratory duplicate results for analysis of periphyton group biomass (µg/cm^2).
Highlighted values did not meet the data quality objective of ≤ 30% relative percent difference (RPD).

Algal Biomass (µg/cm^2)	LWC-2	LWC-2-R	RPD
Cyanobacteria	0.227	0.303	29%
Chlorophyte	0	0	0%
Chrysophyte	0	0	0%
Diatom	22.4	22.5	0%
Rhodophyte	6.49	5.84	0%
Total	29.1	28.6	2%

▨ > 30% RPD

A5.0 BENTHIC MACROINVERTEBRATE COMMUNITY

The objective for percent organism recovery was met for the re-sorted sample, with a percent recovery of 100% (Table A.6). This indicates that the data can be reliably interpreted. Records of percent sampled for each station were also maintained (Table A.7).

Table A.6: Percent recovery of benthic invertebrates, Minto Mine, 2014.

Site	Initial Sort	Re-sort	Percent sorting efficiency[a]
LMC-2	320	1	100%

[a] percent sorting efficiency = (1-(# in QA/AC re-sort / (# sorted originally + # in QA/QC re-sort)))* 100

▨ value less than 90%

Table A.7: Percent of benthic sample analyzed for each station.

Area	Station				
	1	2	3	4	5
LMC	100%	100%	100%	100%	100%
LWC	100%	100%	100%	100%	100%

A6.0 TISSUE SAMPLES

A6.1 Method Detection Limits

Benthic invertebrate tissue MDLs were above target MDLs for 12 analytes; aluminum, arsenic, cadmium, chromium, copper, iron, lead, mercury, molybdenum, selenium, strontium and zinc (Table A.8). Periphyton tissue MDLs exceeded the target MDLs for most analytes. Of these analytes, 20 were only exceeded in one sample, LWC-4. The other 11 analytes: aluminum, arsenic, cadmium, chromium copper, iron, lead, molybdenum, selenium, strontium and zinc exceeded target MDLs for all samples (Table A.9). Even though samples did exceed the target MDL they were still detectable and the results are still interpretable.

Chlorophyll a was measured in periphyton and compared to the BCWQG (BCMOE 1985). All periphyton samples had reported MDLs that were lower than the target MDLs indicating that the data can be reliably interpreted (Table A.10).

A6.2 Laboratory Blank Sample Analysis

Periphyton and benthic invertebrate tissue blank samples contained non-detectable analyte concentrations indicating no inadvertent contamination of samples within the laboratory during analysis (Appendix B - analytical report).

A6.3 Data Precision

The laboratory duplicate periphyton tissue samples showed good agreement in most analyte concentrations. The relative percent difference for tellurium and tin were not available as the results were below method detection limits (Appendix C - analytical report). Benthic tissue samples all showed good agreement in most analyte concentrations except for boron, tellurium and tin (Appendix C - analytical report). All other analytes, for both periphyton and benthic tissue, met the DQO indicating good analytical precision with the analysis of tissue samples.

A6.4 Data Accuracy

Recoveries of all analytes, for both periphyton and benthic invertebrate tissue samples, in certified reference materials met the data quality objective (Appendix C - analytical report). Overall, these data indicated good analytical accuracy associated with the analysis of tissue samples.

Table A.8: Laboratory method detection limits (MDL) for benthic tissue samples relative to targets, Minto Mine, 2014.

Analyte	Units	Method Detection Limits	
		Target	Achieved
Physical Tests			
% Moisture	%	0.1	0.1
Metals			
Total Aluminum (Al)	mg/kg wwt	0.4	1.0
Total Antimony (Sb)	mg/kg wwt	0.002	0.002
Total Arsenic (As)	mg/kg wwt	0.004	0.006
Total Barium (Ba)	mg/kg wwt	0.01	0.01
Total Beryllium (Be)	mg/kg wwt	0.002	0.002
Total Bismuth (Bi)	mg/kg wwt	0.002	0.002
Total Boron (B)	mg/kg wwt	0.2	0.2
Total Cadmium (Cd)	mg/kg wwt	0.001	0.002
Total Calcium (Ca)	mg/kg wwt	4.0	4.0
Total Cesium (Cs)	mg/kg wwt	0.001	0.001
Total Chromium (Cr)	mg/kg wwt	0.01	0.04
Total Cobalt (Co)	mg/kg wwt	0.004	0.004
Total Copper (Cu)	mg/kg wwt	0.02	0.04
Total Iron (Fe)	mg/kg wwt	0.6	1.0
Total Lead (Pb)	mg/kg wwt	0.004	0.01
Total Lithium (Li)	mg/kg wwt	0.1	0.1
Total Magnesium (Mg)	mg/kg wwt	0.4	0.4
Total Manganese (Mn)	mg/kg wwt	0.01	0.01
Total Mercury (Hg)	mg/kg wwt	0.001	0.001 - 0.002
Total Molybdenum (Mo)	mg/kg wwt	0.004	0.008
Total Nickel (Ni)	mg/kg wwt	0.04	0.04
Total Phosphorus (P)	mg/kg wwt	2.0	2.0
Total Potassium (K)	mg/kg wwt	4.0	4.0
Total Rubidium (Rb)	mg/kg wwt	0.01	0.01
Total Selenium (Se)	mg/kg wwt	0.01	0.02
Total Sodium (Na)	mg/kg wwt	4.0	4.0
Total Strontium (Sr)	mg/kg wwt	0.01	0.02
Total Tellurium (Te)	mg/kg wwt	0.004	0.004
Total Thallium (Tl)	mg/kg wwt	0.0004	0.0004
Total Tin (Sn)	mg/kg wwt	0.02	0.02
Total Uranium (U)	mg/kg wwt	0.0004	0.0004
Total Vanadium (V)	mg/kg wwt	0.02	0.02
Total Zinc (Zn)	mg/kg wwt	0.1	0.2
Total Zirconium (Zr)	mg/kg wwt	0.04	0.04

▨ target concentrations were exceeded in all samples

Table A.9: Laboratory method detection limits (MDL) for periphyton tissue samples relative to targets, Minto Mine, 2014.

Analyte	Units	Method Detection Limits	
		Target	Achieved
Physical Tests			
% Moisture	%	0.1	0.1
Metals			
Total Aluminum (Al)	mg/kg wwt	0.4	1.0 - 2.0
Total Antimony (Sb)	mg/kg wwt	0.002	0.002 - 0.004
Total Arsenic (As)	mg/kg wwt	0.004	0.006 - 0.012
Total Barium (Ba)	mg/kg wwt	0.01	0.01 - 0.02
Total Beryllium (Be)	mg/kg wwt	0.002	0.002 - 0.004
Total Bismuth (Bi)	mg/kg wwt	0.002	0.002 - 0.004
Total Boron (B)	mg/kg wwt	0.2	0.2 - 0.4
Total Cadmium (Cd)	mg/kg wwt	0.001	0.002 - 0.004
Total Calcium (Ca)	mg/kg wwt	4.0	4.0 - 8.0
Total Cesium (Cs)	mg/kg wwt	0.001	0.001 - 0.002
Total Chromium (Cr)	mg/kg wwt	0.01	0.04 - 0.08
Total Cobalt (Co)	mg/kg wwt	0.004	0.004 - 0.008
Total Copper (Cu)	mg/kg wwt	0.02	0.04 - 0.08
Total Iron (Fe)	mg/kg wwt	0.6	1.0 - 2.0
Total Lead (Pb)	mg/kg wwt	0.004	0.01 - 0.02
Total Lithium (Li)	mg/kg wwt	0.1	0.1 - 0.2
Total Magnesium (Mg)	mg/kg wwt	0.4	0.4 - 0.8
Total Manganese (Mn)	mg/kg wwt	0.01	0.01 - 0.02
Total Mercury (Hg)	mg/kg wwt	0.001	0.001 - 0.015
Total Molybdenum (Mo)	mg/kg wwt	0.004	0.008 - 0.016
Total Nickel (Ni)	mg/kg wwt	0.04	0.04 - 0.08
Total Phosphorus (P)	mg/kg wwt	2.0	2.0 - 4.0
Total Potassium (K)	mg/kg wwt	4.0	4.0 - 8.0
Total Rubidium (Rb)	mg/kg wwt	0.01	0.01 - 0.02
Total Selenium (Se)	mg/kg wwt	0.01	0.02 - 0.04
Total Sodium (Na)	mg/kg wwt	4.0	4.0 - 8.0
Total Strontium (Sr)	mg/kg wwt	0.01	0.02 - 0.04
Total Tellurium (Te)	mg/kg wwt	0.004	0.004 - 0.008
Total Thallium (Tl)	mg/kg wwt	0.0004	0.0004 - 0.0008
Total Tin (Sn)	mg/kg wwt	0.02	0.02 - 0.04
Total Uranium (U)	mg/kg wwt	0.0004	0.0004
Total Vanadium (V)	mg/kg wwt	0.02	0.02
Total Zinc (Zn)	mg/kg wwt	0.1	0.2
Total Zirconium (Zr)	mg/kg wwt	0.04	0.04

■ target concentrations were exceeded in all samples
▒ target concentrations were exceeded in one sample, LWC-4

Table A.10: Laboratory method detection limits (MDL) for chlorophyll *a* (mg/m^2) in periphtyon relative to targets and to guidelines, Minto Mine, 2014.

Chlorophyll a (mg/m^2)	Method Detection Limit		British Columbia Water Quality Guideline[a]
Area	**Target**	**Achieved[b]**	
LWC-1	10	0.015	100
LWC-2	10	0.011	100
LWC-3	10	0.20	100
LWC-4	10	0.029	100
LWC-5	10	0.0022	100
LMC-1	10	1.0	100
LMC-2	10	0.040	100
LMC-3	10	0.040	100
LMC-4	10	0.071	100
LMC-5	10	0.42	100

[a] BCMOE (British Columbia Ministry of the Environment). 1985.Water Quality Criteria for Nutrients and Algae: Technical Appendix. Water Management Branch

[b] Achieved method detection limits were converted from µg to mg/m^2 based on area of periphyton collected

▨ value greater than DQO

A7.0 DATA QUALITY STATEMENT

Water, sediment and benthic community data were all of good quality compared to DQO indicating that they can be reliably interpreted. There was close agreement between all periphyton community laboratory duplicate samples; cyanobacteria was high at 29% but did fall just within the DQO. Analytes measured in tissue samples had reported MDLs that were above target concentrations but these analytes were all detectable. The overall quality of data for this project was good to serve the project objectives.

APPENDIX B

SUPPORTING INFORMATION AND DATA

Table B.1: Habitat characteristics for benthic invertebrate areas, Minto Mine, September 2014.

Characteristics		Lower Wolverine Creek (Reference)	Lower Minto Creek (Exposure)
UTM		08V 382458 6954825	08V 392222 6948020
Approximate Length of Reach Assessed (m)		50	14
Gradient (%)		1	2
Velocity (m/s)	Mean (min-max)	0.25 - 0.35	0.18 - 0.38
Depth (m)	Mean	0.28	0.084
	Maximum	0.60	0.12
Width (m)	Wetted	14	1.0
	Bankfull	25	3.3
General Morphology	% pool	5	5
	% riffle	95	40
	% run	0	55
Bank Condition		Moderate	Moderate
Substrate Coverage	% bedrock	0	0
	% boulder	0	0
	% cobble	90	70
	% gravel	5	10
	% sand and finer	5	20
Instream Cover (% total Surface)	undercut banks	10	20
	boulder	0	0
	woody debris	5	5
	deep pool	5	0
	macrophytes	0	0
	other	0	0
Overhead Canopy (% Surface)	Dense	0	25
	Partially Open	0	50
	Open	100	25
Aquatic Vegetation (% areal coverage)	Emergent	0	0
	Submergent	0	0
	Floating	0	0
	Attached Algae	0	1
Riparian vegetation		poplar, fir, tall grasses	willow, poplar, grasses
Surrounding Land Use		forested	mining
Evidence of Anthropogenic Disturbance		none	minto mine upstream

Table B.2: Supporting information for erosional benthic invertebrate grab sample collections, Minto Mine, September 2014.

Characteristics		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
		LWC-1	**LWC-2**	**LWC-3**	**LWC-4**	**LWC-5**	**LMC-1**	**LMC-2**	**LMC-3**	**LMC-4**	**LMC-5**
Date/Time		11-Sep-14	11-Sep-14	11-Sep-14 15:48	12-Sep-14 11:20	12-Sep-14 13:53	9-Sep-14 16:15	10-Sep-14 13:04	10-Sep-14 16:35	13-Sep-14 17:05	14-Sep-14 11:31
UTM		08V 382433 6954592	08V 382431 6954741	08V 382458 6954825	08V 382548 6955018	08V 382564 6955140	08V 392106 6948042	08V 392128 6948038	08V 392222 6948020	08V 392236 6948030	08V 392262 6948080
Sampling Device		Hess	Hess	Hess	Hess	Hess	Hess	Hess	Hess	Hess	Hess
Sampler Size (m^2)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mesh Size (µm)		500	500	500	500	500	500	500	500	500	500
Grabs in Composite		3	3	3	3	3	3	3	3	3	3
Water Velocity (m/s)		0.25	0.27	0.35	0.25	0.30	0.18	0.27	0.37	0.38	0.26
Depth (m)		0.11	0.14	0.13	0.14	0.16	0.13	0.09	0.08	0.10	0.12
Number of Jars		1	1	1	1	1	1	1	1	1	1
Average Depth (cm) (Sampler pushed into substrate)		2	2	2	2	2	8	3	3	3	3
Average Depth (cm) (Substrate is sampled/cleaned)		3	5	5	3	3	5 - 8	5	5	3	2
Average Sampling Time per Grab (min)		10	10	10	10	10	7 - 10	10	10	10	10
Macrophytes (in sample)		none	none	none	none	sparse (terrestrial plants, seeds, sticks, leaves etc)	none	none	none	none	none
Algae (in sample)		none	none	none	none	none	none	none	none	none	none
Sample Texture	% cobble	90	90	90	90	85	70	95	95	85	85
	% gravel	5.0	5.0	5.0	5.0	10	20	5.0	2.5	5.0	5.0
	% sand and finer	5.0	5.0	5.0	5.0	5.0	10	0	2.5	10	10
	% organic	0	0	0	0	0	0	0	0	0	0

Table B.3: *In situ* measures at sediment stations, Minto Mine WUL, September 2014. Shade indicates value does not meet the water quality guideline.

Area	Variable	Temperature	Specific Conductance	Dissolved Oxygen	Dissolved Oxygen	pH
	Unit	**°C**	**µS/cm**	**mg/L**	**%**	**pH units**
	Water Quality Guidelines	**-**	**-**	**7**	**54**	**6.5-9.0[a]**
Lower Wolverine Creek (Reference)	LWC-1	5.72	175	8.33	67.0	7.14
	LWC-2	5.91	180	5.68	46.1	6.90
	LWC-3	5.65	170	11.85	94.1	7.70
	LWC-4	5.38	182	7.65	59.5	7.20
	LWC-5	5.66	175	12.00	95.5	7.80
	Mean	5.66	176	9.10	72.4	7.35
	Standard Deviation	0.19	5	2.76	21.7	0.39
Lower Minto Creek (Exposure)	LMC-1	2.15	300	13.15	95.6	8.06
	LMC-2	6.69	310	11.44	93.5	8.03
	LMC-3	6.58	310	11.52	94.0	8.00
	LMC-4	6.36	291	11.67	94.7	8.02
	LMC-5	6.25	305	11.75	94.9	8.01
	Mean	5.61	303	11.91	94.5	8.02
	Standard Deviation	1.94	8	0.71	0.8	0.02
Upper McGinty Creek (Reference)	URC-1	3.36	128	12.36	92.4	7.47
	URC-2	3.52	127	12.19	91.7	7.53
	URC-3	3.20	134	11.95	89.1	7.43
	URC-4	3.20	134	11.90	89.9	7.34
	URC-5	3.11	136	11.85	88.3	7.43
	Mean	3.28	132	12.05	90.3	7.44
	Standard Deviation	0.16	4	0.22	1.7	0.07
Upper Minto Creek (Exposure)	UMC-1	0.42	476	11.91	82.6	7.76
	UMC-2	0.50	476	12.21	84.7	7.86
	UMC-3	0.53	476	13.38	91.1	7.88
	UMC-4	1.07	398	11.37	80.2	7.81
	UMC-5	1.17	470	11.07	78.3	7.78
	Mean	0.74	459	11.99	83.4	7.82
	Standard Deviation	0.35	34	0.90	4.9	0.05

[a] Range for the Water Use Licence is 6.0 - 9.0

Table B.4: *In situ* measures at benthic invertebrate stations, Minto Mine WUL, September 2014. Shade indicates value does not meet the water quality guideline.

Area	Variable	Temperature	Specific Conductance	Dissolved Oxygen	Dissolved Oxygen	pH	Mean Depth	Mean Velocity
	Unit	**°C**	**µS/cm**	**mg/L**	**%**	**pH units**	**m**	**m/s**
	Water Quality Guidelines	**-**	**-**	**7**	**54**	**6.5-9.0[a]**	**-**	**-**
Lower Wolverine Creek (Reference)	LWC-1	4.55	165	12.67	98.1	7.71	0.11	0.25
	LWC-2	5.01	165	12.68	99.3	7.82	0.14	0.27
	LWC-3	5.88	165	12.38	99.3	7.76	0.13	0.35
	LWC-4	4.17	170	12.54	96.1	7.75	0.14	0.25
	LWC-5	4.80	170	12.43	97.0	7.80	0.16	0.30
	Mean	4.88	167	12.54	98.0	7.77	0.13	0.28
	Standard Deviation	0.64	3	0.14	1.4	0.04	0.02	0.04
Lower Minto Creek (Exposure)	LMC-1	1.46	211	13.25	94.5	8.30	0.13	0.18
	LMC-2	3.37	297	12.70	95.4	8.06	0.09	0.27
	LMC-3	4.42	296	12.51	96.6	8.22	0.08	0.37
	LMC-4	7.22	300	11.56	95.9	8.05	0.10	0.38
	LMC-5	5.27	304	11.76	92.8	7.99	0.12	0.26
	Mean	4.35	282	12.36	95.0	8.12	0.10	0.29
	Standard Deviation	2.14	40	0.69	1.5	0.13	0.02	0.08

[a] Range for the Water Use Licence is 6.0 - 9.0

Table B.5: Water quality results at reference and exposure areas, Minto Mine WUL, September 9th to 13th, 2014.

Analyte		Units	LWC (reference)	LBC (reference)	LMC[a] (exposure)	URC (reference)	UMC (exposure)
Sampling Dates:			11-Sep-14	13-Sep-14	10-Sep-14	13-Sep-14	9-Sep-14
Physical Tests	Conductivity	µS/cm	184	181	330	144	512
	Hardness (as $CaCO_3$)	mg/L	91.1	87.8	180	74.8	273
	pH	ph Units	7.97	8.12	8.18	7.95	8.17
	Total Suspended Solids	mg/L	3.3	10	3.3	< 3.0	< 3.0
	Total Dissolved Solids	mg/L	156	137	229	124	328
	Turbidity	NTU	1.4	9.1	1.1	2.0	0.94
Anions and Nutrients	Alkalinity, Total	mg/L	84.6	86.4	173	68.4	244
	Ammonia, Total (as N)	mg/L	0.008	< 0.005	0.006	0.009	< 0.005
	Chloride (Cl)	mg/L	< 0.50	< 0.50	1.2	< 0.50	4.6
	Fluoride (F)	mg/L	0.119	0.110	0.384	0.249	0.592
	Nitrate (as N)	mg/L	0.017	0.090	< 0.0050	0.036	0.21
	Nitrite (as N)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	Phosphorus (P)-Total dissolved	mg/L	0.0072	0.0021	0.0069	0.015	0.0026
	Phosphorus (P)-Total	mg/L	0.0068	0.014	0.011	0.015	0.0068
	Sulfate (SO4)	mg/L	15	12	16	9.4	56
Cyanides	Cyanide, Total	mg/L	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Organic/ inorganic carbon	Dissolved Organic Carbon	mg/L	16	9.1	9.8	13	4.9
	Total Inorganic Carbon	mg/L	18	19	55	15	53
	Total Organic Carbon	mg/L	16	9.5	9.7	13	5.2
Total Metals	Total Aluminum (Al)	mg/L	0.12	0.55	0.036	0.031	0.020
	Total Antimony (Sb)	mg/L	< 0.0001	0.0004	< 0.0001	0.0001	< 0.0001
	Total Arsenic (As)	mg/L	0.0005	0.003	0.0006	0.0007	0.0003
	Total Barium (Ba)	mg/L	0.038	0.063	0.059	0.035	0.081
	Total Beryllium (Be)	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Total Bismuth (Bi)	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Total Boron (B)	mg/L	0.01	< 0.01	< 0.01	< 0.01	0.02
	Total Cadmium (Cd)	mg/L	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001
	Total Calcium (Ca)	mg/L	20	22	43	21	57
	Total Chromium (Cr)	mg/L	0.0008	0.0009	0.0003	0.0005	0.0002
	Total Cobalt (Co)	mg/L	0.0001	0.0004	< 0.0001	0.0001	< 0.0001
	Total Copper (Cu)	mg/L	0.003	0.004	0.002	0.001	0.003
	Total Iron (Fe)	mg/L	0.29	0.79	0.24	0.61	0.033
	Total Lead (Pb)	mg/L	< 0.00005	0.0009	< 0.00005	< 0.00005	< 0.00005
	Total Lithium (Li)	mg/L	0.0014	0.0017	0.0011	< 0.00050	0.0029
	Total Magnesium (Mg)	mg/L	11	8.7	15	5.7	27
	Total Manganese (Mn)	mg/L	0.012	0.028	0.0063	0.040	0.051
	Total Mercury (Hg)	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Total Molybdenum (Mo)	mg/L	0.00048	0.0012	0.0014	0.00085	0.0047
	Total Nickel (Ni)	mg/L	0.002	0.001	0.001	0.001	0.001
	Total Phosphorus (P)	mg/L	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
	Total Potassium (K)	mg/L	0.62	0.83	1.3	0.56	2.4
	Total Selenium (Se)	mg/L	0.0001	< 0.0001	< 0.0001	0.0003	0.0003
	Total Silicon (Si)	mg/L	5.4	7.5	6.2	6.5	5.8
	Total Silver (Ag)	mg/L	< 0.00001	0.00003	< 0.00001	0.00002	< 0.00001
	Total Sodium (Na)	mg/L	6.4	6.0	8.4	4.0	17
	Total Strontium (Sr)	mg/L	0.175	0.244	0.389	0.137	0.745
	Total Thallium (Tl)	mg/L	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001
	Total Tin (Sn)	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Total Titanium (Ti)	mg/L	< 0.01	0.03	< 0.01	< 0.01	< 0.01
	Total Uranium (U)	mg/L	0.00061	0.0020	0.0015	0.00034	0.0026
	Total Vanadium (V)	mg/L	0.002	0.002	< 0.001	< 0.001	< 0.001
	Total Zinc (Zn)	mg/L	< 0.003	0.004	< 0.003	< 0.003	< 0.003
Dissolved Metals	Dissolved Aluminum (Al)	mg/L	0.030	0.021	0.0086	0.025	0.012
	Dissolved Antimony (Sb)	mg/L	< 0.0001	0.0001	< 0.0001	< 0.0001	< 0.0001
	Dissolved Arsenic (As)	mg/L	0.0005	0.0007	0.0005	0.0006	0.0002
	Dissolved Barium (Ba)	mg/L	0.035	0.052	0.062	0.034	0.084
	Dissolved Beryllium (Be)	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Dissolved Bismuth (Bi)	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Dissolved Boron (B)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	0.02
	Dissolved Cadmium (Cd)	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Dissolved Calcium (Ca)	mg/L	20	21	46	21	62
	Dissolved Chromium (Cr)	mg/L	0.0005	0.0002	0.0002	0.0004	< 0.0001
	Dissolved Cobalt (Co)	mg/L	< 0.0001	< 0.0001	< 0.0001	0.0001	< 0.0001
	Dissolved Copper (Cu)	mg/L	0.0022	0.0022	0.0015	0.0013	0.0023
	Dissolved Iron (Fe)	mg/L	0.15	0.040	0.17	0.49	0.016
	Dissolved Lead (Pb)	mg/L	< 0.00005	< 0.00005	< 0.00005	< 0.00005	< 0.00005
	Dissolved Lithium (Li)	mg/L	0.0018	0.0012	0.0012	< 0.00050	0.0029
	Dissolved Magnesium (Mg)	mg/L	10	8.4	16	5.7	29
	Dissolved Manganese (Mn)	mg/L	0.0085	0.0086	0.0034	0.038	0.036
	Dissolved Mercury (Hg)	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Dissolved Molybdenum (Mo)	mg/L	0.00045	0.0010	0.0014	0.00071	0.0047
	Dissolved Nickel (Ni)	mg/L	0.0017	0.0010	0.0011	0.0011	0.00086
	Dissolved Phosphorus (P)	mg/L	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
	Dissolved Potassium (K)	mg/L	0.65	0.72	1.3	0.54	2.5
	Dissolved Selenium (Se)	mg/L	< 0.0001	< 0.0001	0.0001	0.0003	0.0003
	Dissolved Silicon (Si)	mg/L	5.2	6.3	6.4	6.5	6.1
	Dissolved Silver (Ag)	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Dissolved Sodium (Na)	mg/L	6.5	6.0	8.7	3.9	17
	Dissolved Strontium (Sr)	mg/L	0.171	0.223	0.394	0.134	0.767
	Dissolved Thallium (Tl)	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Dissolved Tin (Sn)	mg/L	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Dissolved Titanium (Ti)	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
	Dissolved Uranium (U)	mg/L	0.00055	0.0018	0.0015	0.00033	0.0025
	Dissolved Vanadium (V)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	Dissolved Zinc (Zn)	mg/L	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

[a] Total inorganic carbon was collected at LMC on Sept 13, 2014

Table B.6: Explanatory notes for selected water quality guidelines, Minto Mine WUL, 2014.

Analyte		Water Quality Guidelines	Unit	CCME[a]
Physical, anion and nutrient analytes	Ammonia (Total)	**1.3**	mg/L	Ammonia guideline is based on highest field pH of 8.18 and highest temperature of 7.2°C
	Fluoride	**0.12**	mg/L	Guideline is an interm level
	Total Suspended Solids	**8.3 / 28**	mg/L	Guideline is based on the median of background of 3.3 mg/L plus 5 mg/L for 30 day and plus 25 mg/L for max
	Turbidity	**3.4 / 9.4**	NTU	Guideline is based on the median of background of 1.38 NTU plus 2 NTU for 30 day and plus 8 NTU for max
Total Metals	Aluminum	**0.10**	mg/L	Guideline is based on pH of > 6.5
	Cadmium	**0.00012 / 0.0016**	mg/L	Guideline is based on lowest hardness of 74.8 mg/L.
	Chromium	**0.0010**	mg/L	Guideline is based hexavalent chromium (Cr VI).
	Copper	**0.0020**	mg/L	Guideline is based on lowest hardness of 74.8 mg/L.
	Lead	**0.0019**	mg/L	Guideline is based on lowest hardness of 74.8 mg/L.
	Nickel	**0.077**	mg/L	Guideline is based on lowest hardness of 74.8 mg/L.

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

Table B.7: Comparison of water quality results at reference and exposure areas in 2013 and 2014, Minto Mine WUL.

Analyte		Units	CCME Water Quality[a]		WUL Standards at W2	2013					2014				
			30	Max		Lower Wolverine Creek (reference)	Little Big Creek (reference)	Lower Minto Creek (exposure)	Upper McGinty Creek (reference)	Upper Minto Creek (exposure)	Lower Wolverine Creek (reference)	Little Big Creek (reference)	Lower Minto Creek (exposure)	Upper McGinty Creek (reference)	Upper Minto Creek (exposure)
Physical Tests	Total Suspended Solids	mg/L	8.3[b]	28[b]	-	< 3.0	3.1	5.3	< 3.0	< 3.0	3.3	10	3.3	< 3.0	< 3.0
Total Metals	Total Aluminum (Al)	mg/L	0.10[c]	-	0.62	0.12	0.16	0.15	0.085	0.0063	0.12	0.55	0.036	0.031	0.020
	Total Antimony (Sb)	mg/L	-	-	-	< 0.0001	0.0002	< 0.0001	< 0.0001	< 0.0001	< 0.0001	0.0004	< 0.0001	0.0001	< 0.0001
	Total Arsenic (As)	mg/L	0.005	-	0.005	0.0005	0.0022	0.0009	0.0009	0.0003	0.0005	0.0034	0.0006	0.0007	0.0003
	Total Barium (Ba)	mg/L	-	-	-	0.039	0.065	0.073	0.039	0.084	0.038	0.063	0.059	0.035	0.081
	Total Beryllium (Be)	mg/L	-	-	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Total Bismuth (Bi)	mg/L	-	-	-	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
	Total Boron (B)	mg/L	1.5	2.9	-	0.010	< 0.010	< 0.010	< 0.010	0.023	0.014	< 0.010	< 0.010	< 0.010	0.023
	Total Cadmium (Cd)	mg/L	0.00012[d]	0.0016[d]	0.000040	< 0.000010	0.000013	< 0.000010	< 0.000010	< 0.000010	< 0.000010	0.000022	< 0.000010	< 0.000010	< 0.000010
	Total Calcium (Ca)	mg/L	-	-	-	20	23	45	18	56	20	22	43	21	57
	Total Chromium (Cr)	mg/L	0.001 Cr(VI)	-	0.002	0.0008	0.0005	0.0007	0.0006	0.0002	0.0008	0.0009	0.0003	0.0005	0.0002
	Total Cobalt (Co)	mg/L	-	-	-	0.00015	0.00012	0.00027	0.00038	< 0.00010	0.00013	0.00036	< 0.00010	0.00014	< 0.00010
	Total Copper (Cu)	mg/L	0.0020[d]	-	0.013	0.0024	0.0028	0.0019	0.0017	0.0023	0.0026	0.0042	0.0016	0.0015	0.0028
	Total Iron (Fe)	mg/L	0.30	-	1.1	0.36	0.27	0.83	1.2	0.017	0.29	0.79	0.24	0.61	0.033
	Total Lead (Pb)	mg/L	0.002[d]	-	0.004	< 0.00005	0.0002	0.00008	< 0.00005	< 0.00005	< 0.00005	0.0009	< 0.00005	< 0.00005	< 0.00005
	Total Lithium (Li)	mg/L	-	-	-	0.0014	0.0014	0.0014	< 0.00050	0.0028	0.0014	0.0017	0.0011	< 0.00050	0.0029
	Total Magnesium (Mg)	mg/L	-	-	-	9.9	9.3	13	5.3	25	11	8.7	15	5.7	27
	Total Manganese (Mn)	mg/L	-	-	-	0.013	0.020	0.040	0.095	0.042	0.012	0.028	0.0063	0.040	0.051
	Total Mercury (Hg)	mg/L	0.00003	-	-	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001
	Total Molybdenum (Mo)	mg/L	0.073	-	0.073	0.00049	0.0013	0.0015	0.00095	0.0053	0.00048	0.0012	0.0014	0.00085	0.0047
	Total Nickel (Ni)	mg/L	0.077[d]	-	0.11	0.0021	0.0013	0.0018	0.0015	0.00093	0.0019	0.0015	0.0010	0.0012	0.00087
	Total Phosphorus (P)	mg/L	-	-	-	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
	Total Potassium (K)	mg/L	-	-	-	0.66	0.88	1.2	0.52	2.3	0.62	0.83	1.3	0.56	2.4
	Total Selenium (Se)	mg/L	0.001	-	0.001	0.0001	< 0.0001	0.0001	0.0002	0.0004	0.0001	< 0.0001	< 0.0001	0.0003	0.0003
	Total Silicon (Si)	mg/L	-	-	-	5.3	5.9	7.0	6.3	5.7	5.4	7.5	6.2	6.5	5.8
	Total Silver (Ag)	mg/L	0.0001	-	-	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00003	< 0.00001	0.00002	< 0.00001
	Total Sodium (Na)	mg/L	-	-	-	6.3	6.9	7.8	3.6	17.5	6.4	6.0	8.4	4.0	17
	Total Strontium (Sr)	mg/L	-	-	-	0.17	0.26	0.35	0.12	0.63	0.18	0.24	0.39	0.14	0.75
	Total Thallium (Tl)	mg/L	0.0008	-	-	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	0.00002	< 0.00001	< 0.00001	< 0.00001
	Total Tin (Sn)	mg/L	-	-	-	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001
	Total Titanium (Ti)	mg/L	-	-	-	< 0.010	0.013	0.011	< 0.010	< 0.010	< 0.010	0.027	< 0.010	< 0.010	< 0.010
	Total Uranium (U)	mg/L	0.015	0.033	-	0.00055	0.0023	0.0012	0.00034	0.0026	0.00061	0.0020	0.0015	0.00034	0.0026
	Total Vanadium (V)	mg/L	-	-	-	0.0015	0.0014	0.0018	0.0014	< 0.0010	0.0015	0.0022	< 0.0010	< 0.0010	< 0.0010
	Total Zinc (Zn)	mg/L	0.03	-	0.03	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	0.004	< 0.003	< 0.003	< 0.003

☐ Water use licence standard not met

▨ Water quality guideline not met

[a] CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines. 1999 (plus updates), Canadian Council of Ministers of the Environment, Winnipeg. See Appendix Table B.6 for explanatory notes on selected water quality guidelines.

[b] Based on the median of background levels plus 5 mg/L for 30 day and 25 mg/L for max guidelines

[c] Based on lowest guideline using highest pH

[d] Based on lowest guideline using lowest hardness

Table B.8: Concentration of chlorophyll *a* measured at five benthic stations in lower Wolverine and lower Minto Creeks, Minto Mine WUL, 2014.

Lower Wolverine Creek (reference)		**Lower Minto Creek (exposure)**	
Station	mg/m^2	Station	mg/m^2
LWC-1	0.60	LMC-1	39
LWC-2	1.1	LMC-2	7.7
LWC-3	10	LMC-3	6.3
LWC-4	3.3	LMC-4	18
LWC-5	0.024	LMC-5	22
Mean	3.0	Mean	19
Standard Deviation	4.1	Standard Deviation	13

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 15-SEP-14
Report Date: 29-SEP-14 11:30 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: **L1518121**
Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT 2537
C of C Numbers: 1
Legal Site Desc:

Can Dang
Senior Account Manager

	Sample ID	L1518121-1	L1518121-2	L1518121-3	L1518121-4	
	Description	Water	Water	Water	Water	
	Sampled Date	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	
	Sampled Time					
	Client ID	URC	LBC	UMC	LMC	
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	144	181			
	Hardness (as CaCO3) (mg/L)	74.8	87.8			
	pH (pH)	7.95	8.12			
	Total Suspended Solids (mg/L)	<3.0	10.0			
	Total Dissolved Solids (mg/L)	124	137			
	Turbidity (NTU)	1.97	9.12			
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	68.4	86.4			
	Ammonia, Total (as N) (mg/L)	0.0088	<0.0050			
	Chloride (Cl) (mg/L)	<0.50	<0.50			
	Fluoride (F) (mg/L)	0.249	0.110			
	Nitrate (as N) (mg/L)	0.0360	0.0903			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Phosphorus (P)-Total Dissolved (mg/L)	0.0149	0.0021			
	Phosphorus (P)-Total (mg/L)	0.0150	0.0142			
	Sulfate (SO4) (mg/L)	9.40	12.1			
Cyanides	Cyanide, Total (mg/L)	<0.0050	<0.0050			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	13.0	9.08			
	Total Inorganic Carbon (mg/L)	14.6	18.8	38.9	54.7	
	Total Organic Carbon (mg/L)	13.3	9.46			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0313	0.545			
	Antimony (Sb)-Total (mg/L)	0.00013	0.00044			
	Arsenic (As)-Total (mg/L)	0.00069	0.00341			
	Barium (Ba)-Total (mg/L)	0.0349	0.0628			
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050			
	Boron (B)-Total (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Total (mg/L)	<0.000010	0.000022			
	Calcium (Ca)-Total (mg/L)	20.5	21.9			
	Chromium (Cr)-Total (mg/L)	0.00050	0.00087			
	Cobalt (Co)-Total (mg/L)	0.00014	0.00036			
	Copper (Cu)-Total (mg/L)	0.00148	0.00419			
	Iron (Fe)-Total (mg/L)	0.613	0.786			
	Lead (Pb)-Total (mg/L)	<0.000050	0.000887			
	Lithium (Li)-Total (mg/L)	<0.00050	0.00166			
	Magnesium (Mg)-Total (mg/L)	5.66	8.73			
	Manganese (Mn)-Total (mg/L)	0.0403	0.0284			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518121-1	L1518121-2	L1518121-3	L1518121-4	
	Description	Water	Water	Water	Water	
	Sampled Date	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	
	Sampled Time					
	Client ID	URC	LBC	UMC	LMC	
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Total (mg/L)	0.000852	0.00120			
	Nickel (Ni)-Total (mg/L)	0.00118	0.00148			
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
	Potassium (K)-Total (mg/L)	0.557	0.833			
	Selenium (Se)-Total (mg/L)	0.00028	<0.00010			
	Silicon (Si)-Total (mg/L)	6.51	7.52			
	Silver (Ag)-Total (mg/L)	0.000023	0.000031			
	Sodium (Na)-Total (mg/L)	4.04	6.02			
	Strontium (Sr)-Total (mg/L)	0.137	0.244			
	Thallium (Tl)-Total (mg/L)	<0.000010	0.000019			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	<0.010	0.027			
	Uranium (U)-Total (mg/L)	0.000344	0.00195			
	Vanadium (V)-Total (mg/L)	<0.0010	0.0022			
	Zinc (Zn)-Total (mg/L)	<0.0030	0.0036			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0248	0.0208			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	0.00014			
	Arsenic (As)-Dissolved (mg/L)	0.00059	0.00072			
	Barium (Ba)-Dissolved (mg/L)	0.0343	0.0524			
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050	<0.00050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010	<0.000010			
	Calcium (Ca)-Dissolved (mg/L)	20.6	21.4			
	Chromium (Cr)-Dissolved (mg/L)	0.00041	0.00024			
	Cobalt (Co)-Dissolved (mg/L)	0.00013	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00129	0.00223			
	Iron (Fe)-Dissolved (mg/L)	0.494	0.040			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	<0.00050	0.00115			
	Magnesium (Mg)-Dissolved (mg/L)	5.68	8.36			
	Manganese (Mn)-Dissolved (mg/L)	0.0384	0.00864			
	Mercury (Hg)-Dissolved (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Dissolved (mg/L)	0.000711	0.000961			

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1518121-1 Water 13-SEP-14 URC	L1518121-2 Water 13-SEP-14 LBC	L1518121-3 Water 13-SEP-14 UMC	L1518121-4 Water 13-SEP-14 LMC	
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00112	0.00096			
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30			
	Potassium (K)-Dissolved (mg/L)	0.538	0.724			
	Selenium (Se)-Dissolved (mg/L)	0.00028	<0.00010			
	Silicon (Si)-Dissolved (mg/L)	6.45	6.32			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	3.88	5.98			
	Strontium (Sr)-Dissolved (mg/L)	0.134	0.223			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010			
	Uranium (U)-Dissolved (mg/L)	0.000327	0.00178			
	Vanadium (V)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Aluminum (Al)-Dissolved	DLA	L1518121-1, -2
Duplicate	Beryllium (Be)-Dissolved	DLA	L1518121-1, -2
Duplicate	Bismuth (Bi)-Dissolved	DLA	L1518121-1, -2
Duplicate	Chromium (Cr)-Dissolved	DLA	L1518121-1, -2
Duplicate	Lead (Pb)-Dissolved	DLA	L1518121-1, -2
Duplicate	Silver (Ag)-Dissolved	DLA	L1518121-1, -2
Duplicate	Tin (Sn)-Dissolved	DLA	L1518121-1, -2
Duplicate	Zinc (Zn)-Dissolved	DLA	L1518121-1, -2
Duplicate	Bismuth (Bi)-Total	DLA	L1518121-1, -2
Duplicate	Beryllium (Be)-Dissolved	DLA	L1518121-1, -2
Duplicate	Bismuth (Bi)-Dissolved	DLA	L1518121-1, -2
Duplicate	Chromium (Cr)-Dissolved	DLA	L1518121-1, -2
Duplicate	Iron (Fe)-Dissolved	DLA	L1518121-1, -2
Duplicate	Lead (Pb)-Dissolved	DLA	L1518121-1, -2
Duplicate	Vanadium (V)-Dissolved	DLA	L1518121-1, -2
Duplicate	Cadmium (Cd)-Dissolved	DLM	L1518121-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Dissolved Organic Carbon	MS-B	L1518121-1, -2
Matrix Spike	Dissolved Organic Carbon	MS-B	L1518121-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Sulfate (SO4)	MS-B	L1518121-1, -2
Matrix Spike	Total Organic Carbon	MS-B	L1518121-1, -2
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Calcium (Ca)-Total	MS-B	L1518121-1, -2
Matrix Spike	Silicon (Si)-Total	MS-B	L1518121-1, -2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1518121-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1518121-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-CL-IC-WR	Water	Chloride by Ion Chromatography	EPA 300.1

Reference Information

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ANIONS-F-IC-WR Water Fluoride by Ion Chromatography EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ANIONS-NO2-IC-WR Water Nitrite Nitrogen by Ion Chromatography EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ANIONS-NO3-IC-WR Water Nitrate Nitrogen by Ion Chromatography EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-WR Water Sulphate by Ion Chromatography EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

CARBONS-DOC-VA Water Dissolved organic carbon by combustion APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-TIC-VA Water Total inorganic carbon by CO2 purge APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CARBONS-TOC-VA Water Total organic carbon by combustion APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CN-T-CFA-VA Water Total Cyanide in water by CFA ISO 14403:2002

This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-DIS-LOW-CVAFS-VA Water Dissolved Mercury in Water by CVAFS(Low) EPA SW-846 3005A & EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

HG-TOT-LOW-CVAFS-VA Water Total Mercury in Water by CVAFS(Low) EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-DIS-ICP-VA Water Dissolved Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the

Reference Information

American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-TOT-ICP-VA Water Total Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA Water Total P in Water by Colour APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

P-TD-COL-VA Water Total Dissolved P in Water by Colour APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-MAN-WR Water Total Suspended Solids by Gravimetric APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

TURBIDITY-VA Water Turbidity by Meter APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA Water Turbidity by Meter APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1

Reference Information

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytical R
Canada Toll Free: 1 800 6
www.alsglobal.com

L1518121-COFC

OC # ______

Page 1 of 1

Report To			
Company:	Minnow Environmental Inc.		
Contact:	Lisa Bowron		
Address:	101 - 1025 Hillside Ave.		
	Victoria, BC		
Phone:	(250)595-1627 x21	Fax:	(250) 595-1625
Invoice To	Same as Report ?	☐ Yes	☑ No
Hardcopy of Invoice with Report?		☑ Yes	☐ No
Company:	Minto Explorations Ltd		
Contact:	Elvina Wong		
Address:	Suite 900-999 West Hastings St., Vancouver, BC		
Phone:	604-684-8894	Fax:	604-688-2120
Lab Work Order # (lab use only)			

Report Format / Distribution

☑ Standard ☐ Other

☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca

Email 2: pstecko@minnow.ca

Email 3:

Client / Project Information

Job #: Minnow Project 2537

PO / AFE:

LSD:

Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)

○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT

○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT

○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals by CCMS & ICPOES	Mercury by CVAFS (Low)	Alkalinity by Auto Titration	Phosphorus in water by colour	Organic/Inorganic Carbon	Cyanide	Conductivity, Hardness and pH	TDS & TSS by Gravimetric	Turbidity by Meter	Anions by Ion Chromatography	Ammonia by Fluorescence	**See Complete Quote #Q41650	Number of Containers
	UMC	13-Sep-14		Water	X	X	X	X	X	X	X	X	X	X	X		9
	LBC	13-Sep-14		Water	X	X	X	X	X	X	X	X	X	X	X		9
	UMC	13-Sep-14		Water					X								1
	LMC	13-Sep-14		Water					X								1

TIC only

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 14-Sept-14	Time (hh-mm) 8:05 am	Received by:	Date: 16-Sep-14	Time: 5:15	Temperature: 5.0, 5.4, 4.4, 4.4 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received:	12-SEP-14
Report Date:	22-SEP-14 15:15 (MT)
Version:	FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #:	**L1517202**
Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT 2537
C of C Numbers:	1
Legal Site Desc:	

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517202-1				
	Description	Water				
	Sampled Date					
	Sampled Time					
	Client ID	UMC				
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	512				
	Hardness (as CaCO3) (mg/L)	273				
	pH (pH)	8.17				
	Total Suspended Solids (mg/L)	<3.0				
	Total Dissolved Solids (mg/L)	328				
	Turbidity (NTU)	0.94				
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	244				
	Ammonia, Total (as N) (mg/L)	<0.0050				
	Bromide (Br) (mg/L)	<0.050				
	Chloride (Cl) (mg/L)	4.58				
	Fluoride (F) (mg/L)	0.592				
	Nitrate (as N) (mg/L)	0.205				
	Nitrite (as N) (mg/L)	<0.0010				
	Phosphorus (P)-Total Dissolved (mg/L)	0.0026				
	Phosphorus (P)-Total (mg/L)	0.0068				
	Sulfate (SO4) (mg/L)	56.1				
Cyanides	Cyanide, Total (mg/L)	<0.0050				
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	4.87				
	Total Inorganic Carbon (mg/L)	53.0				
	Total Organic Carbon (mg/L)	5.23				
Total Metals	Aluminum (Al)-Total (mg/L)	0.0204				
	Antimony (Sb)-Total (mg/L)	<0.00010				
	Arsenic (As)-Total (mg/L)	0.00027				
	Barium (Ba)-Total (mg/L)	0.0809				
	Beryllium (Be)-Total (mg/L)	<0.00010				
	Bismuth (Bi)-Total (mg/L)	<0.00050				
	Boron (B)-Total (mg/L)	0.023				
	Cadmium (Cd)-Total (mg/L)	<0.000010				
	Calcium (Ca)-Total (mg/L)	57.1				
	Chromium (Cr)-Total (mg/L)	0.00018				
	Cobalt (Co)-Total (mg/L)	<0.00010				
	Copper (Cu)-Total (mg/L)	0.00277				
	Iron (Fe)-Total (mg/L)	0.033				
	Lead (Pb)-Total (mg/L)	<0.000050				
	Lithium (Li)-Total (mg/L)	0.00291				
	Magnesium (Mg)-Total (mg/L)	27.2				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517202-1				
	Description	Water				
	Sampled Date					
	Sampled Time					
	Client ID	UMC				
Grouping	**Analyte**					
WATER						
Total Metals	Manganese (Mn)-Total (mg/L)	0.0510				
	Mercury (Hg)-Total (mg/L)	<0.000010				
	Molybdenum (Mo)-Total (mg/L)	0.00468				
	Nickel (Ni)-Total (mg/L)	0.00087				
	Phosphorus (P)-Total (mg/L)	<0.30				
	Potassium (K)-Total (mg/L)	2.42				
	Selenium (Se)-Total (mg/L)	0.00034				
	Silicon (Si)-Total (mg/L)	5.76				
	Silver (Ag)-Total (mg/L)	<0.000010				
	Sodium (Na)-Total (mg/L)	17.2				
	Strontium (Sr)-Total (mg/L)	0.745				
	Thallium (Tl)-Total (mg/L)	<0.000010				
	Tin (Sn)-Total (mg/L)	<0.00010				
	Titanium (Ti)-Total (mg/L)	<0.010				
	Uranium (U)-Total (mg/L)	0.00255				
	Vanadium (V)-Total (mg/L)	<0.0010				
	Zinc (Zn)-Total (mg/L)	<0.0030				
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD				
	Dissolved Metals Filtration Location	FIELD				
	Aluminum (Al)-Dissolved (mg/L)	0.0123				
	Antimony (Sb)-Dissolved (mg/L)	<0.00010				
	Arsenic (As)-Dissolved (mg/L)	0.00024				
	Barium (Ba)-Dissolved (mg/L)	0.0840				
	Beryllium (Be)-Dissolved (mg/L)	<0.00010				
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050				
	Boron (B)-Dissolved (mg/L)	0.019				
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010				
	Calcium (Ca)-Dissolved (mg/L)	61.7				
	Chromium (Cr)-Dissolved (mg/L)	<0.00010				
	Cobalt (Co)-Dissolved (mg/L)	<0.00010				
	Copper (Cu)-Dissolved (mg/L)	0.00234				
	Iron (Fe)-Dissolved (mg/L)	0.016				
	Lead (Pb)-Dissolved (mg/L)	<0.000050				
	Lithium (Li)-Dissolved (mg/L)	0.00291				
	Magnesium (Mg)-Dissolved (mg/L)	28.9				
	Manganese (Mn)-Dissolved (mg/L)	0.0355				
	Mercury (Hg)-Dissolved (mg/L)	<0.000010				

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517202-1				
	Description	Water				
	Sampled Date					
	Sampled Time					
	Client ID	UMC				
Grouping	**Analyte**					
WATER						
Dissolved Metals	Molybdenum (Mo)-Dissolved (mg/L)	0.00469				
	Nickel (Ni)-Dissolved (mg/L)	0.00086				
	Phosphorus (P)-Dissolved (mg/L)	<0.30				
	Potassium (K)-Dissolved (mg/L)	2.49				
	Selenium (Se)-Dissolved (mg/L)	0.00033				
	Silicon (Si)-Dissolved (mg/L)	6.05				
	Silver (Ag)-Dissolved (mg/L)	<0.000010				
	Sodium (Na)-Dissolved (mg/L)	17.4				
	Strontium (Sr)-Dissolved (mg/L)	0.767				
	Thallium (Tl)-Dissolved (mg/L)	<0.000010				
	Tin (Sn)-Dissolved (mg/L)	<0.00010				
	Titanium (Ti)-Dissolved (mg/L)	<0.010				
	Uranium (U)-Dissolved (mg/L)	0.00252				
	Vanadium (V)-Dissolved (mg/L)	<0.0010				
	Zinc (Zn)-Dissolved (mg/L)	<0.0010				

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1517202-1
Matrix Spike	Nitrate (as N)	MS-B	L1517202-1
Matrix Spike	Barium (Ba)-Total	MS-B	L1517202-1
Matrix Spike	Manganese (Mn)-Total	MS-B	L1517202-1
Matrix Spike	Sodium (Na)-Total	MS-B	L1517202-1
Matrix Spike	Strontium (Sr)-Total	MS-B	L1517202-1

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-BR-IC-VA	Water	Bromide by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-F-IC-VA	Water	Fluoride by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

ANIONS-NO2-IC-VA	Water	Nitrite in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrite is detected by UV absorbance.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.

This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-TIC-VA	Water	Total inorganic carbon by CO2 purge	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CN-T-CFA-VA	Water	Total Cyanide in water by CFA	ISO 14403:2002

This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.

EC-PCT-VA	Water	Conductivity (Automated)	APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Reference Information

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-DIS-LOW-CVAFS-VA Water Dissolved Mercury in Water by CVAFS(Low) EPA SW-846 3005A & EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

HG-TOT-LOW-CVAFS-VA Water Total Mercury in Water by CVAFS(Low) EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-DIS-ICP-VA Water Dissolved Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-TOT-ICP-VA Water Total Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA Water Total P in Water by Colour APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

P-TD-COL-VA Water Total Dissolved P in Water by Colour APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

TDS-VA Water Total Dissolved Solids by Gravimetric APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

Reference Information

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1517202-COFC

Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878
www.alsglobal.com

COC #

Page 1 of 1

Report To
Company: Minnow Environmental Inc.
Contact: Lisa Bowron
Address: 101 - 1025 Hillside Ave.
Victoria, BC
Phone: (250)595-1627 x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report? ☑ Yes ☐ No
Company: Minto Explorations Ltd
Contact: Elvina Wong
Address: Suite 900-999 West Hastings St., Vancouver, BC
Phone: 604-684-8894 Fax: 604-688-2120

Lab Work Order # (lab use only)

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information
Job #: Minnow Project 2537
PO / AFE:
LSD:

Quote #: Q41650

ALS Contact: Can Dang
Sampler: Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)
● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals by CCMS & ICPOES	Mercury by CVAFS (Low)	Alkalinity by Auto Titration	Phosphorus in water by colour	Organic/Inorganic Carbon	Cyanide	Conductivity, Hardness and pH	TDS & TSS by Gravimetric	Turbidity by Meter	Anions by Ion Chromatography	Ammonia by Fluorescence	**See Complete Quote #Q41650	Number of Containers
	UMC			Water	X	X	X	X	X	X	X	X	X	X	X		

Short Holding Time

Rush Processing

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)
Released by:
Date (dd-mmm-yy)
Time (hh-mm)

SHIPMENT RECEPTION (lab use only)
Received by:
Date:
Time:
Temperature: °C

SHIPMENT VERIFICATION (lab use only)
Verified by: DJ
Date: Sep12/14
Time: 14:55
Observations: Yes / No ? If Yes add SIF

6.5°C

GENF 20.00 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received:	15-SEP-14
Report Date:	29-SEP-14 15:49 (MT)
Version:	FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #:	**L1517600**
Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT 2537
C of C Numbers:	1
Legal Site Desc:	

Can Dang
Senior Account Manager

	Sample ID	L1517600-1	L1517600-2			
	Description	Water	Water			
	Sampled Date	10-SEP-14	11-SEP-14			
	Sampled Time					
	Client ID	LMC	LWC			
Grouping	**Analyte**					
WATER						
Physical Tests	Conductivity (uS/cm)	330	184			
	Hardness (as CaCO3) (mg/L)	180	91.1			
	pH (pH)	8.18	7.97			
	Total Suspended Solids (mg/L)	3.3	3.3			
	Total Dissolved Solids (mg/L)	229	156			
	Turbidity (NTU)	1.13	1.38			
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	173	84.6			
	Ammonia, Total (as N) (mg/L)	0.0056	0.0075			
	Chloride (Cl) (mg/L)	1.24	<0.50			
	Fluoride (F) (mg/L)	0.384	0.119			
	Nitrate (as N) (mg/L)	<0.0050	0.0167			
	Nitrite (as N) (mg/L)	<0.0010	<0.0010			
	Phosphorus (P)-Total Dissolved (mg/L)	0.0069	0.0072			
	Phosphorus (P)-Total (mg/L)	0.0105	0.0068			
	Sulfate (SO4) (mg/L)	15.7	15.0			
Cyanides	Cyanide, Total (mg/L)	<0.0050	<0.0050			
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	9.78 HTP	15.8			
	Total Inorganic Carbon (mg/L)		17.5			
	Total Organic Carbon (mg/L)	9.71	16.0			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0358	0.118			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00057	0.00050			
	Barium (Ba)-Total (mg/L)	0.0585	0.0378			
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050			
	Boron (B)-Total (mg/L)	<0.010	0.014			
	Cadmium (Cd)-Total (mg/L)	<0.000010	<0.000010			
	Calcium (Ca)-Total (mg/L)	43.1	19.9			
	Chromium (Cr)-Total (mg/L)	0.00029	0.00084			
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00013			
	Copper (Cu)-Total (mg/L)	0.00157	0.00258			
	Iron (Fe)-Total (mg/L)	0.243	0.287			
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Total (mg/L)	0.00109	0.00137			
	Magnesium (Mg)-Total (mg/L)	14.7	10.5			
	Manganese (Mn)-Total (mg/L)	0.00634	0.0118			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1517600-1 Water 10-SEP-14 LMC	L1517600-2 Water 11-SEP-14 LWC			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Total (mg/L)	0.00141	0.000476			
	Nickel (Ni)-Total (mg/L)	0.00100	0.00186			
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
	Potassium (K)-Total (mg/L)	1.31	0.621			
	Selenium (Se)-Total (mg/L)	<0.00010	0.00011			
	Silicon (Si)-Total (mg/L)	6.18	5.44			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	8.44	6.38			
	Strontium (Sr)-Total (mg/L)	0.389	0.175			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
	Uranium (U)-Total (mg/L)	0.00150	0.000611			
	Vanadium (V)-Total (mg/L)	<0.0010	0.0015			
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0086	0.0300			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00053	0.00046			
	Barium (Ba)-Dissolved (mg/L)	0.0616	0.0350			
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050	<0.00050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010	<0.000010			
	Calcium (Ca)-Dissolved (mg/L)	46.4	19.5			
	Chromium (Cr)-Dissolved (mg/L)	0.00022	0.00050			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00151	0.00218			
	Iron (Fe)-Dissolved (mg/L)	0.167	0.147			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.00123	0.00176			
	Magnesium (Mg)-Dissolved (mg/L)	15.6	10.3			
	Manganese (Mn)-Dissolved (mg/L)	0.00341	0.00849			
	Mercury (Hg)-Dissolved (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00142	0.000448			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517600-1	L1517600-2			
	Description	Water	Water			
	Sampled Date	10-SEP-14	11-SEP-14			
	Sampled Time					
	Client ID	LMC	LWC			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00108	0.00174			
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30			
	Potassium (K)-Dissolved (mg/L)	1.33	0.647			
	Selenium (Se)-Dissolved (mg/L)	0.00010	<0.00010			
	Silicon (Si)-Dissolved (mg/L)	6.39	5.23			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	8.73	6.49			
	Strontium (Sr)-Dissolved (mg/L)	0.394	0.171			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010			
	Uranium (U)-Dissolved (mg/L)	0.00146	0.000553			
	Vanadium (V)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1517600-1	LMC	WSMT	Water sample(s) for total mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Total Organic Carbon	MS-B	L1517600-1, -2
Matrix Spike	Dissolved Organic Carbon	MS-B	L1517600-2
Matrix Spike	Phosphorus (P)-Total	MS-B	L1517600-1, -2
Matrix Spike	Silicon (Si)-Total	MS-B	L1517600-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Barium (Ba)-Total	MS-B	L1517600-1, -2
Matrix Spike	Sodium (Na)-Total	MS-B	L1517600-1, -2
Matrix Spike	Strontium (Sr)-Total	MS-B	L1517600-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
HTP	Sample preparation or preservation hold time was exceeded.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-CL-IC-WR	Water	Chloride by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ANIONS-F-IC-WR	Water	Fluoride by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ANIONS-NO2-IC-WR	Water	Nitrite Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ANIONS-NO3-IC-WR	Water	Nitrate Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ANIONS-SO4-IC-WR	Water	Sulphate by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

Reference Information

CARBONS-TIC-VA Water Total inorganic carbon by CO2 purge APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CARBONS-TOC-VA Water Total organic carbon by combustion APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CN-T-CFA-VA Water Total Cyanide in water by CFA ISO 14403:2002

This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-DIS-LOW-CVAFS-VA Water Dissolved Mercury in Water by CVAFS(Low) EPA SW-846 3005A & EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

HG-TOT-LOW-CVAFS-VA Water Total Mercury in Water by CVAFS(Low) EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-DIS-ICP-VA Water Dissolved Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-TOT-ICP-VA Water Total Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA Water Total P in Water by Colour APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

P-TD-COL-VA Water Total Dissolved P in Water by Colour APHA 4500-P Phosphorous

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytical Requ
Canada Toll Free: 1 800 668 9
www.alsglobal.com

L1517600-COFC

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Page 1 of 1

Report To			
Company:	Minnow Environmental Inc.		
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Invoice To	Same as Report ?	☐ Yes	☑ No
Hardcopy of Invoice with Report?		☑ Yes	☐ No
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Lab Work Order # (lab use only)	L1517600		

Report Format / Distribution

☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax

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Client / Project Information

Job #: Minnow Project 2537
PO / AFE:
LSD:
Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

…nalysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals by CCMS & ICPOES	Mercury by CVAFS (Low)	Alkalinity by Auto Titration	Phosphorus in water by colour	Organic/Inorganic Carbon	Cyanide	Conductivity, Hardness and pH	TDS & TSS by Gravimetric	Turbidity by Meter	Anions by Ion Chromatography	Ammonia by Fluorescence	**See Complete Quote #Q41650	Number of Containers
	LMC	Sept 10/14		Water	X	X	X	X	X	X	X	X	X	X	X		8
	LWC	Sept 11/14		Water	X	X	X	X	X	X	X	X	X	X	X		10
							no TIC for LMC - Sep 10/14										

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 12-Sept-14	Time (hh-mm) 8:00am	Received by:	Date: 15-Sep-14	Time: 9:30	Temperature: °C	Verified by: 1.1	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

APPENDIX C

SEDIMENT, PERIPHYTON AND BENTHIC INVERTEBRATE QUALITY DATA

Table C.1: Sediment chemistry data collected at reference and exposed areas, Minto Mine WUL, 2014.

	Analyte	Units	CSQG[a]		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
					LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
			ISQG	PEL	12-SEP-14	12-SEP-14	12-SEP-14	13-SEP-14	13-SEP-14	09-SEP-14	14-SEP-14	14-SEP-14	14-SEP-14	14-SEP-14
Particle size, TKN, carbon analytes and pH	Loss on Ignition @ 550 °C	%			23	14	7.0	11	15	7.0	9.0	7.0	11	4.0
	pH (1:2 soil:water)	pH units			7.0	7.2	7.1	7.1	7.6	8.1	8.1	8.0	8.0	8.2
	% Gravel (>2mm)	%			< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.94	0.57	4.3	0.51	0.25
	% Sand (2.0mm - 0.063mm)	%			7.2	28	47	50	28	31	22	17	18	31
	% Silt (0.063mm - 4um)	%			87	66	47	45	66	61	70	70	72	61
	% Clay (<4um)	%			5.6	6.1	6.1	4.8	5.4	7.9	8.0	8.8	9.4	7.8
	Total Kjeldahl Nitrogen (TKN)	%			0.61	0.38	0.21	0.30	0.42	0.24	0.27	0.30	0.26	0.16
	Inorganic Carbon	%			< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%			< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
	Total Carbon by Combustion	%			11	6.5	3.5	5.2	8.1	3.5	5.6	3.9	5.5	2.3
	Total Organic Carbon	%			11	6.5	3.5	5.2	8.1	3.5	5.6	3.9	5.5	2.3
Total Metals	Aluminum (Al)	mg/kg			13,100	14,200	11,100	11,900	15,500	12,900	14,500	14,700	14,300	12,800
	Antimony (Sb)	mg/kg			0.59	0.42	0.31	0.40	0.53	0.41	0.60	0.61	0.59	0.39
	Arsenic (As)	mg/kg	5.9	17	7.3	5.1	3.5	5.5	6.6	5.7	7.1	7.8	7.9	5.8
	Barium (Ba)	mg/kg			270	181	129	161	245	184	238	269	254	183
	Beryllium (Be)	mg/kg			0.94	0.68	0.50	0.57	0.84	0.42	0.52	0.54	0.50	0.38
	Bismuth (Bi)	mg/kg			< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Cadmium (Cd)	mg/kg	0.60	3.5	0.46	0.24	0.12	0.17	0.34	0.12	0.22	0.26	0.23	0.13
	Calcium (Ca)	mg/kg			16,200	10,400	6,640	7,610	13,600	9,250	13,700	14,700	13,700	8,350
	Chromium (Cr)	mg/kg	37	90	43	44	36	38	50	29	33	35	34	28
	Cobalt (Co)	mg/kg			14	13	11	12	15	9.7	11	12	12	9.9
	Copper (Cu)	mg/kg	36	197	40	28	17	20	35	33	58	67	62	32
	Iron (Fe)	mg/kg			27,000	26,600	23,000	25,600	29,200	23,000	26,200	27,900	27,900	23,000
	Lead (Pb)	mg/kg	35	91	6.6	6.1	4.8	5.3	7.0	5.2	6.5	7.0	6.8	5.0
	Lithium (Li)	mg/kg			8.4	9.6	7.7	8.6	10.5	9.1	11	11	11	9.0
	Magnesium (Mg)	mg/kg			7,930	8,830	7,730	7,850	9,550	6,510	7,060	7,400	7,280	6,570
	Manganese (Mn)	mg/kg			966	354	212	474	816	548	878	904	1,010	521
	Mercury (Hg)	mg/kg	0.17	0.49	0.082	0.041	0.018	0.025	0.057	0.023	0.042	0.055	0.049	0.026
	Molybdenum (Mo)	mg/kg			0.56	0.55	< 0.50	0.52	0.62	0.54	0.68	0.81	0.74	< 0.50
	Nickel (Ni)	mg/kg			39	38	32	32	43	27	29	32	31	27
	Phosphorus (P)	mg/kg			1,100	999	1,000	955	1,100	826	887	851	848	828
	Potassium (K)	mg/kg			890	1,060	890	950	1,060	1,170	1,340	1,230	1,290	1,060
	Selenium (Se)	mg/kg			0.71	0.40	< 0.20	0.22	0.57	0.27	0.44	0.59	0.57	0.31
	Silver (Ag)	mg/kg			0.17	< 0.10	< 0.10	< 0.10	0.12	< 0.10	0.10	0.13	0.11	< 0.10
	Sodium (Na)	mg/kg			350	450	380	390	420	350	340	290	330	330
	Strontium (Sr)	mg/kg			159	96	62	77	134	80	116	128	122	77
	Thallium (Tl)	mg/kg			0.079	0.077	0.056	0.079	0.092	0.10	0.12	0.10	0.10	0.079
	Tin (Sn)	mg/kg			< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
	Titanium (Ti)	mg/kg			687	950	893	880	818	830	864	692	751	788
	Uranium (U)	mg/kg			4.9	2.7	1.4	1.7	3.3	0.74	1.2	1.3	1.3	0.71
	Vanadium (V)	mg/kg			71	67	60	63	71	50	56	56	58	50
	Zinc (Zn)	mg/kg	123	315	52	60	49	52	63	53	61	65	63	54

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

🟦 Indicates sediment concentration exceeding CSQG ISQG.

🟩 Indicates sediment concentration exceeding CSQG PEL.

Table C.1: Sediment chemistry data collected at reference and exposed areas, Minto Mine WUL, 2014.

Analyte		Units	CSQG^a		Upper McGinty Creek (Reference)					Upper Minto Creek (Exposure)				
					URC-1	URC-2	URC-3	URC-4	URC-5	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5
			ISQG	PEL	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14
Particle size, TKN, carbon analytes and pH	Loss on Ignition @ 550 °C	%			14	16	8.0	10	5.0	5.0	5.0	10	1.0	< 1.0
	pH (1:2 soil:water)	pH units			7.1	6.9	7.2	6.9	7.5	8.1	8.1	8.2	8.2	8.5
	% Gravel (>2mm)	%			-	-	-	-	-	-	-	-	-	-
	% Sand (2.0mm - 0.063mm)	%			-	-	-	-	-	-	-	-	-	-
	% Silt (0.063mm - 4um)	%			-	-	-	-	-	-	-	-	-	-
	% Clay (<4um)	%			-	-	-	-	-	-	-	-	-	-
	Total Kjeldahl Nitrogen (TKN)	%			0.36	0.38	0.21	0.30	0.12	0.17	0.13	0.23	0.032	0.023
	Inorganic Carbon	%			< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Inorganic Carbon (as $CaCO_3$ Equivalent)	%			< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
	Total Carbon by Combustion	%			7.2	7.7	3.8	5.9	2.5	2.3	2.1	4.5	0.60	0.40
	Total Organic Carbon	%			7.2	7.7	3.8	5.9	2.5	2.3	2.1	4.5	0.55	0.36
Total Metals	Aluminum (Al)	mg/kg			11,000	11,200	8,570	11,300	5,250	5,770	11,700	9,860	6,890	4,980
	Antimony (Sb)	mg/kg			0.41	0.42	0.32	0.42	0.27	0.31	0.41	0.46	0.33	0.24
	Arsenic (As)	mg/kg	5.9	17	7.0	8.5	6.9	8.3	5.8	4.1	5.2	5.6	5.2	4.5
	Barium (Ba)	mg/kg			199	222	151	217	93	153	195	209	111	81
	Beryllium (Be)	mg/kg			0.31	0.35	0.26	0.35	< 0.20	0.26	0.41	0.40	0.28	< 0.20
	Bismuth (Bi)	mg/kg			< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
	Cadmium (Cd)	mg/kg	0.60	3.5	0.15	0.15	0.094	0.15	0.084	0.17	0.18	0.21	0.10	0.059
	Calcium (Ca)	mg/kg			8,210	8,390	5,970	8,120	4,240	4,350	7,370	7,130	3,990	3,160
	Chromium (Cr)	mg/kg	37	90	21	23	17	22	8.0	14	27	32	17	17
	Cobalt (Co)	mg/kg			9.7	10	7.3	9.5	5.8	6.4	9.9	10	7.4	5.9
	Copper (Cu)	mg/kg	36	197	18	20	14	22	10	95	176	207	58	33
	Iron (Fe)	mg/kg			23,300	25,600	20,200	24,700	14,200	19,400	24,800	31,300	18,700	16,400
	Lead (Pb)	mg/kg	35	91	4.4	4.5	3.5	4.8	2.7	5.2	5.7	5.8	4.3	3.4
	Lithium (Li)	mg/kg			6.5	6.7	5.1	6.8	< 5.0	< 5.0	8.0	6.5	< 5.0	< 5.0
	Magnesium (Mg)	mg/kg			4,000	4,160	3,450	4,270	2,170	3,550	6,700	5,560	4,100	3,240
	Manganese (Mn)	mg/kg			1,040	1,160	688	903	548	2,150	1,560	2,150	729	357
	Mercury (Hg)	mg/kg	0.17	0.49	0.034	0.040	0.023	0.038	0.018	0.012	0.023	0.024	0.017	0.0052
	Molybdenum (Mo)	mg/kg			0.52	0.55	< 0.50	0.56	0.54	1.6	1.4	1.5	1.0	0.66
	Nickel (Ni)	mg/kg			17	17	14	18	8.6	14	27	25	17	14
	Phosphorus (P)	mg/kg			805	932	718	832	586	710	1,030	876	641	672
	Potassium (K)	mg/kg			700	730	590	700	400	880	1,440	1,220	930	570
	Selenium (Se)	mg/kg			0.51	0.48	0.36	0.56	0.34	0.38	0.39	0.49	< 0.20	< 0.20
	Silver (Ag)	mg/kg			< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	0.10	0.12	< 0.10	< 0.10
	Sodium (Na)	mg/kg			210	210	180	210	110	140	310	260	240	170
	Strontium (Sr)	mg/kg			68	68	50	68	50	49	78	82	49	33
	Thallium (Tl)	mg/kg			0.069	0.069	< 0.050	0.066	0.050	< 0.050	0.087	0.076	< 0.050	< 0.050
	Tin (Sn)	mg/kg			< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
	Titanium (Ti)	mg/kg			675	678	550	635	300	409	702	695	504	391
	Uranium (U)	mg/kg			1.5	1.2	0.79	1.2	0.69	0.52	0.75	0.75	0.45	0.31
	Vanadium (V)	mg/kg			48	48	38	47	27	43	55	78	42	37
	Zinc (Zn)	mg/kg	123	315	43	47	36	47	22	49	64	61	41	31

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

🟦 Indicates sediment concentration exceeding CSQG ISQG.

🟩 Indicates sediment concentration exceeding CSQG PEL.

Table C.2: Periphyton tissue quality results at reference and exposure areas, Minto Mine WUL, 2014.

Analyte		Units	Lowre Wolverine Creek (Reference)							Lower Big Creek (Reference)							Lower Minto Creek (Exposure)						
			LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	Mean	Standard Deviation	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	Mean	Standard Deviation	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	Mean	Standard Deviation
Physical Tests	Moisture	%	56	61	90	18	3	46	35	49	49	21	54	50	45	13	75	66	77	71	71	72	4
Total Metals	Total Aluminum (Al)	mg/kg dw	8,440	8,804	10,700	6,306	12,607	9,372	2,389	8,848	8,241	8,258	9,079	8,433	8,572	374	10,916	9,043	10,909	9,288	8,915	9,814	1,011
	Total Antimony (Sb)	mg/kg dw	0.024	0.033	0.063	0.065	0.046	0.046	0.018	0.29	0.17	0.10	0.19	0.16	0.18	0.071	0.057	0.041	0.076	0.054	0.044	0.054	0.014
	Total Arsenic (As)	mg/kg dw	4.4	3.9	5.1	3.8	4.9	4.4	0.60	47	34	22	34	35	34	8.8	11	6.9	12	8.3	6.5	9.0	2.5
	Total Barium (Ba)	mg/kg dw	149	170	209	136	250	183	47	271	223	178	216	242	226	34	1,231	357	957	536	238	**664**	418
	Total Beryllium (Be)	mg/kg dw	0.52	0.49	0.52	0.34	0.63	0.50	0.11	0.43	0.38	0.36	0.39	0.38	0.39	0.027	0.41	0.35	0.42	0.35	0.34	0.37	0.038
	Total Bismuth (Bi)	mg/kg dw	0.054	0.060	0.072	0.051	0.064	0.060	0.0083	1.0	0.71	0.63	0.91	1.2	0.90	0.24	0.10	0.082	0.11	0.084	0.090	0.092	0.010
	Total Boron (B)	mg/kg dw	2.3	3.8	4.9	3.3	2.5	3.4	1.0	1.7	1.3	1.3	1.4	1.4	1.4	0.18	16	8.0	22	18	12	**15**	5.2
	Total Cadmium (Cd)	mg/kg dw	0.15	0.17	0.21	0.13	0.24	0.18	0.044	0.30	0.22	0.18	0.22	0.23	0.23	0.043	0.40	0.19	0.41	0.28	0.16	0.29	0.11
	Total Calcium (Ca)	mg/kg dw	7,546	7,786	9,690	6,646	9,724	8,279	1,372	10,527	7,213	6,755	7,917	7,262	7,935	1,507	14,622	12,725	13,290	14,068	17,085	14,358	1,688
	Total Cesium (Cs)	mg/kg dw	0.88	0.96	1.8	0.96	1.9	1.3	0.48	4.9	3.3	2.2	3.7	3.3	3.5	0.95	0.91	0.78	0.99	0.81	0.80	0.86	0.090
	Total Chromium (Cr)	mg/kg dw	65	57	57	168	57	81	49	39	38	30	36	35	36	3.8	62	47	52	48	33	48	10.3
	Total Cobalt (Co)	mg/kg dw	13	16	13	11	26	16	5.9	11	9.8	9.8	10	10	10	0.42	27	14	25	17	10	19	7.3
	Total Copper (Cu)	mg/kg dw	22	21	24	18	27	22	3.5	37	26	24	30	27	29	5.2	41	28	43	34	30	35	6.7
	Total Iron (Fe)	mg/kg dw	22,638	25,216	25,500	22,479	36,685	26,504	5,862	25,000	20,751	20,202	22,149	21,825	21,986	1,860	26,813	22,116	28,571	22,678	21,424	24,320	3,171
	Total Lead (Pb)	mg/kg dw	4.0	4.0	6.0	4.8	5.7	4.9	0.90	15	11	8.0	11	11	11	2.3	5.0	4.3	5.1	4.2	4.4	4.6	0.44
	Total Lithium (Li)	mg/kg dw	8.6	8.4	11	6.2	15	9.8	3.2	9.5	8.9	8.0	9.2	8.9	8.9	0.56	11	8.8	10	8.8	9.0	9.5	0.94
	Total Magnesium (Mg)	mg/kg dw	8,761	9,975	8,870	8,165	15,501	10,254	3,005	7,461	5,830	6,086	6,316	6,032	6,345	647	6,773	5,507	6,580	5,593	5,492	5,989	632
	Total Manganese (Mn)	mg/kg dw	901	1,173	1,080	979	1,891	1,205	397	842	581	606	579	679	657	111	20,438	4,783	15,974	8,915	1,725	**10,367**	7,759
	Total Mercury (Hg)	mg/kg dw	0.021	0.025	0.039	0.022	0.031	0.028	0.0075	0.029	0.040	0.019	0.021	0.040	0.030	0.010	0.029	0.023	0.035	0.028	0.029	0.029	0.0044
	Total Molybdenum (Mo)	mg/kg dw	0.44	0.47	0.55	0.76	0.70	0.58	0.14	1.6	1.1	0.78	1.1	1.2	1.2	0.30	1.5	0.59	1.1	0.80	0.47	0.89	0.42
	Total Nickel (Ni)	mg/kg dw	53	56	41	46	84	56	17	23	22	21	23	23	22	0.69	41	27	40	34	26	34	7.2
	Total Phosphorus (P)	mg/kg dw	1,443	1,809	2,570	1,847	1,292	1,792	495	1,455	1,332	1,052	1,305	1,250	1,279	147	1,586	1,435	2,411	1,644	1,380	1,691	417
	Total Potassium (K)	mg/kg dw	1,578	1,847	3,450	1,944	1,591	2,082	781	2,129	1,559	1,140	1,531	1,621	1,596	353	2,291	1,733	3,216	2,227	1,969	2,287	565
	Total Rubidium (Rb)	mg/kg dw	8.1	8.2	12	7.5	12	9.4	2.1	16	12	9.5	14	13	13	2.4	10	8.1	10	8.4	8.5	9.1	1.0
	Total Selenium (Se)	mg/kg dw	0.37	0.53	0.91	0.46	0.36	0.53	0.23	0.34	0.20	0.15	0.17	0.27	0.23	0.079	1.4	0.69	2.0	1.2	1.1	**1.3**	0.48
	Total Sodium (Na)	mg/kg dw	300	356	851	397	747	530	250	289	294	318	309	292	301	13	269	265	313	260	277	277	21
	Total Strontium (Sr)	mg/kg dw	61	68	88	54	89	72	16	63	58	61	62	58	60	2.5	185	111	174	129	121	144	33
	Total Tellurium (Te)[a]	mg/kg dw	0.010	0.011	< 0.040	0.012	0.016	0.018	0.013	0.051	0.034	0.024	0.043	0.034	0.037	0.010	0.029	0.016	0.029	0.020	0.016	0.022	0.0066
	Total Thallium (Tl)	mg/kg dw	0.048	0.050	0.065	0.040	0.068	0.054	0.012	0.21	0.16	0.11	0.16	0.15	0.16	0.036	0.087	0.067	0.084	0.069	0.070	0.076	0.010
	Total Tin (Sn)	mg/kg dw	0.20	0.23	0.26	0.30	0.30	0.26	0.044	0.24	0.17	0.17	0.18	0.17	0.18	0.032	0.22	0.19	0.19	0.20	0.18	0.20	0.016
	Total Uranium (U)	mg/kg dw	0.96	0.92	1.4	0.81	1.5	1.1	0.32	1.5	1.3	1.1	1.5	1.3	1.3	0.17	0.69	0.58	0.68	0.61	0.57	0.63	0.056
	Total Vanadium (V)	mg/kg dw	59	60	77	60	88	69	13	61	54	51	59	55	56	4.1	69	52	66	55	48	58	9.0
	Total Zinc (Zn)	mg/kg dw	58	60	54	37	66	55	11	73	65	59	70	68	67	5.3	64	50	68	56	52	58	7.5
	Total Zirconium (Zr)	mg/kg dw	11	12	14	7.8	15	12	2.8	6.8	6.6	5.4	5.9	6.4	6.2	0.55	9.8	7.6	9.6	8.0	7.7	8.5	1.1

bold Indicates periphyton tissue concentration exceeding the higher reference mean by more than 2 times

[a] If value was < method detection limit, statistics were calculated using detection limit, i.e. if value was < 0.0048, statistics were run using the value 0.0048

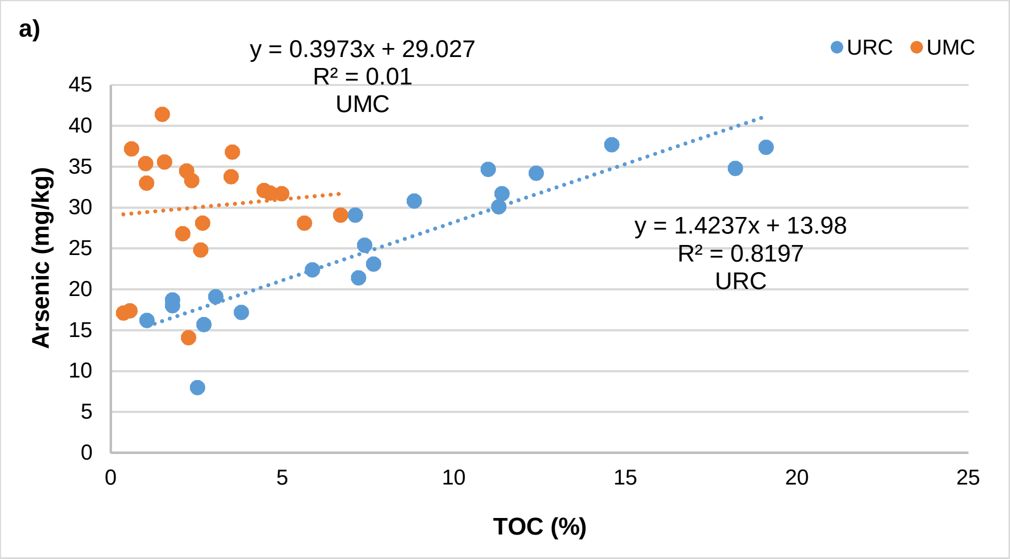
Table C.3: Benthic tissue quality results at reference and exposure areas, Minto Mine WUL, 2014.

Analyte		Units	Lowre Wolverine Creek (Reference)							Lower Big Creek (Reference)							Lower Minto Creek (Exposure)						
			LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	Mean	Standard Deviation	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5	Mean	Standard Deviation	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5	Mean	Standard Deviation
Physical Tests	Moisture	%	81	71	76	84	78	78	5.1	84	89	94	88	78	87	6.0	77	82	89	77	82	81	5.0
Total Metals	Total Aluminum (Al)	mg/kg dw	1,433	2,740	3,224	1,917	3,018	2,466	762	2,280	750	2,361	1,780	1,832	1,801	642	1,100	934	1,654	1,509	1,503	1,340	307
	Total Antimony (Sb)	mg/kg dw	0.089	0.050	0.053	0.053	0.036	0.056	0.020	0.36	0.088	0.38	0.32	0.24	0.28	0.12	0.087	0.067	0.089	0.073	0.073	0.078	0.0095
	Total Arsenic (As)	mg/kg dw	1.7	2.0	2.5	1.7	1.7	1.9	0.37	11	3.1	13	7.9	6.0	8.2	3.9	2.8	1.5	2.4	1.9	2.1	2.1	0.51
	Total Barium (Ba)	mg/kg dw	116	209	76	105	164	134	53	106	44	86	83	55	75	25	91	41	59	40	47	56	21
	Total Beryllium (Be)	mg/kg dw	0.16	0.18	0.21	0.13	0.17	0.17	0.028	0.14	0.039	0.15	0.10	0.10	0.11	0.045	0.059	0.045	0.082	0.059	0.064	0.062	0.014
	Total Bismuth (Bi)[a]	mg/kg dw	0.014	0.016	0.015	< 0.013	0.0089	0.013	0.0028	0.20	0.047	0.24	0.15	0.12	0.15	0.076	0.013	0.015	< 0.019	0.013	0.014	0.015	0.0026
	Total Boron (B)[a]	mg/kg dw	2.0	1.2	0.91	< 1.3	< 0.89	1.2	0.43	1.5	< 1.9	< 3.3	< 1.6	< 0.91	1.8	0.89	2.7	< 1.1	2.1	1.0	< 1.1	1.6	0.76
	Total Cadmium (Cd)	mg/kg dw	0.43	0.43	0.39	0.54	0.28	0.41	0.095	2.7	0.25	2.2	1.4	1.5	1.6	0.93	0.24	0.44	0.29	0.32	0.39	0.34	0.081
	Total Calcium (Ca)	mg/kg dw	7,526	2,507	3,963	3,186	2,674	3,971	2,066	3,835	1,131	3,328	2,959	2,091	2,669	1,070	2,552	2,105	3,664	2,500	2,754	2,715	580
	Total Cesium (Cs)	mg/kg dw	0.14	0.38	0.32	0.18	0.18	0.24	0.10	1.4	0.23	1.6	1.3	0.90	1.1	0.53	0.10	0.11	0.16	0.15	0.16	0.14	0.027
	Total Chromium (Cr)	mg/kg dw	7.5	13	14	20	11	13	4.7	9.5	2.4	8.9	5.4	6.8	6.6	2.9	5.6	4.2	6.6	7.0	6.0	5.9	1.1
	Total Cobalt (Co)	mg/kg dw	3.0	3.4	6.0	3.1	3.9	3.9	1.3	4.2	1.0	3.7	2.4	2.8	2.8	1.2	1.8	1.1	1.8	1.4	1.3	1.5	0.31
	Total Copper (Cu)	mg/kg dw	26	30	27	28	20	26	3.5	51	22	61	33	42	42	15	36	17	29	28	35	29	7.4
	Total Iron (Fe)	mg/kg dw	5,773	6,986	8,548	5,288	4,911	6,301	1,479	5,256	1,813	5,623	4,561	5,045	4,460	1,529	3,387	2,724	4,953	3,549	3,721	3,667	812
	Total Lead (Pb)	mg/kg dw	1.1	1.3	1.5	0.94	1.3	1.2	0.24	3.5	0.98	4.6	3.2	2.6	3.0	1.3	0.71	0.72	0.93	0.86	0.87	0.82	0.10
	Total Lithium (Li)[a]	mg/kg dw	1.1	2.7	3.9	2.2	1.8	2.3	1.0	2.1	< 0.93	2.0	1.5	2.5	1.8	0.59	1.0	0.88	1.4	1.6	1.5	1.3	0.33
	Total Magnesium (Mg)	mg/kg dw	2,809	2,945	3,880	3,019	2,826	3,096	447	2,927	1,243	2,705	2,293	2,718	2,377	674	1,565	1,370	2,019	1,619	1,661	1,647	236
	Total Manganese (Mn)	mg/kg dw	424	613	363	321	352	414	117	512	267	497	315	286	375	119	483	306	427	301	248	353	98
	Total Mercury (Hg)	mg/kg dw	0.044	0.028	0.027	0.038	0.033	0.034	0.0070	0.051	0.075	0.075	0.052	0.046	0.060	0.014	0.013	0.015	0.024	0.024	0.037	0.023	0.0093
	Total Molybdenum (Mo)	mg/kg dw	0.82	0.71	0.54	0.59	0.75	0.68	0.12	1.8	5.5	5.3	0.74	0.60	2.8	2.4	1.3	0.60	2.9	0.91	1.3	1.4	0.87
	Total Nickel (Ni)	mg/kg dw	15	13	18	16	9.3	14	3.4	9.0	6.6	9.5	5.8	20	10	5.6	8.6	4.4	6.9	11	14	9.0	3.7
	Total Phosphorus (P)	mg/kg dw	7,062	7,842	6,722	7,756	6,071	7,091	739	9,207	6,047	5,639	6,707	6,909	6,902	1,385	7,000	5,580	6,935	7,611	7,650	6,955	838
	Total Potassium (K)	mg/kg dw	8,711	9,384	6,224	8,205	7,902	8,085	1,182	10,061	5,271	7,230	6,764	6,545	7,174	1,769	11,130	6,519	9,720	7,389	8,033	8,558	1,855
	Total Rubidium (Rb)	mg/kg dw	2.9	4.7	4.0	4.7	3.1	3.9	0.83	8.2	1.7	8.5	6.1	5.7	6.0	2.7	2.1	3.4	3.6	2.9	3.1	3.0	0.60
	Total Selenium (Se)	mg/kg dw	1.3	1.4	1.3	1.4	1.0	1.3	0.15	1.3	1.1	1.3	1.0	1.1	1.2	0.15	1.7	0.99	1.6	1.3	1.7	1.4	0.31
	Total Sodium (Na)	mg/kg dw	6,546	2,103	2,971	3,442	3,670	3,746	1,676	4,732	6,897	4,574	3,171	2,636	4,402	1,658	2,335	2,696	5,551	3,035	4,071	3,538	1,299
	Total Strontium (Sr)	mg/kg dw	79	27	42	32	360	108	142	39	15	43	35	24	31	11	23	24	36	22	29	27	5.5
	Total Tellurium (Te)[a,b]	mg/kg dw	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	< 0.018	0	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	< 0.030	0	< 0.022	< 0.022	< 0.022	< 0.022	< 0.022	< 0.022	0
	Total Thallium (Tl)	mg/kg dw	0.012	0.016	0.013	0.012	0.012	0.013	0.0015	0.050	0.022	0.091	0.047	0.035	0.049	0.026	0.0077	0.012	0.014	0.011	0.012	0.011	0.0022
	Total Tin (Sn)[a,b]	mg/kg dw	< 0.090	< 0.090	< 0.090	< 0.090	< 0.090	< 0.090	0	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	0	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	< 0.11	0
	Total Uranium (U)	mg/kg dw	0.92	0.52	0.51	0.54	0.36	0.57	0.21	1.4	0.45	2.4	0.77	0.81	1.2	0.78	0.37	0.14	0.68	0.20	0.24	0.33	0.22
	Total Vanadium (V)	mg/kg dw	15	18	24	14	14	17	4.2	13	3.1	12	9.8	13	10	4.3	7.7	5.1	11	9.0	8.8	8.4	2.3
	Total Zinc (Zn)	mg/kg dw	98	125	111	119	121	115	11	198	105	170	202	177	170	39	117	60	101	96	102	95	21
	Total Zirconium (Zr)	mg/kg dw	4.2	3.4	4.2	2.4	3.7	3.6	0.76	3.5	0.96	3.4	1.9	2.7	2.5	1.1	2.4	1.1	3.0	1.9	2.2	2.1	0.67

bold Indicates periphyton tissue concentration exceeding the higher reference mean by more than 2 times

[a] If value was < method detection limit, statistics were calculated using detection limit, i.e. if value was < 0.0048, statistics were run using the value 0.0048

[b] If all values at an area were < method detection limit than the average moisture was taken to calculate dry weight



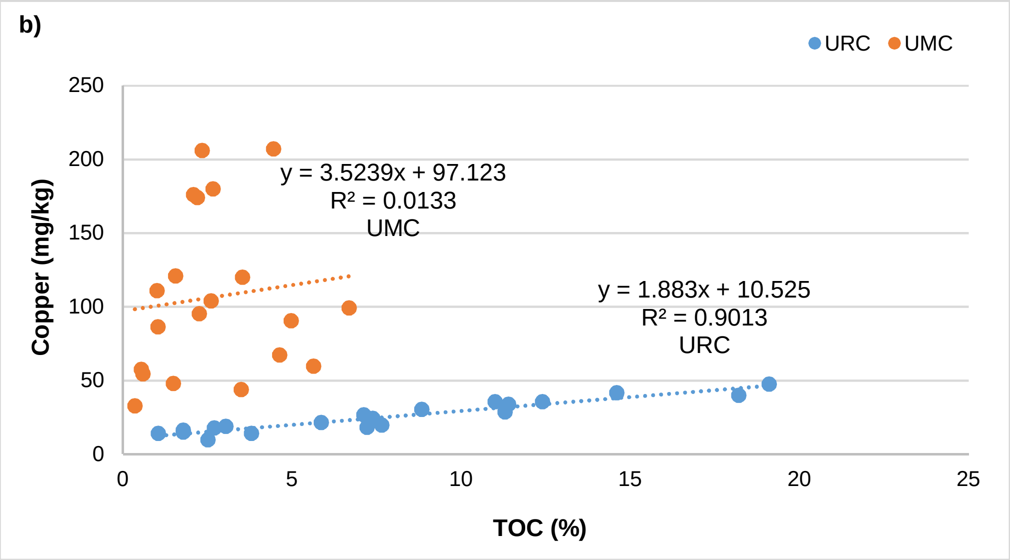
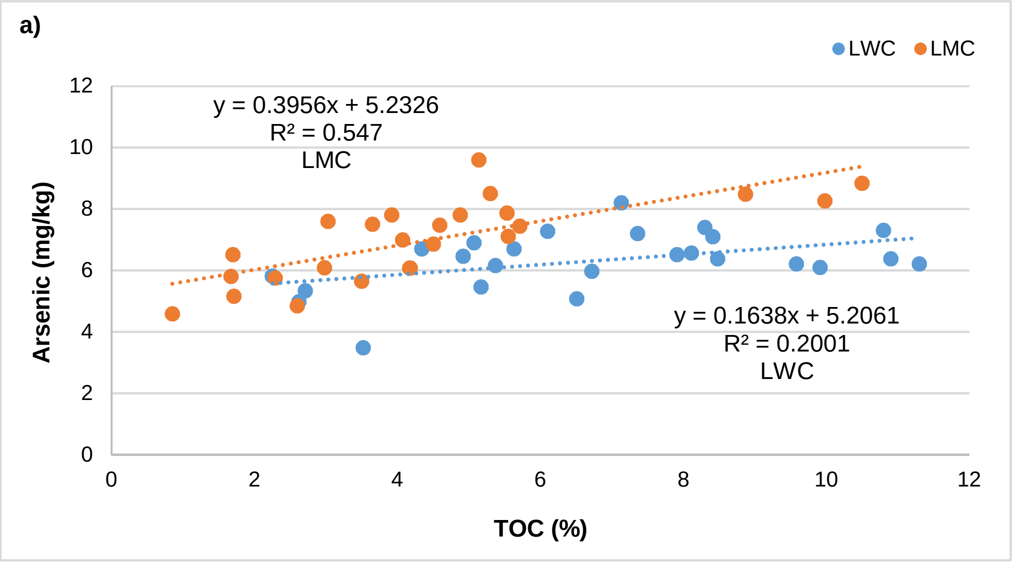


Figure C.1: Relationship between analytes of concern a) Arsenic and b) Copper and percent TOC, upper McGinty Creek and upper Minto Creek, 2010-2014 (TOC was not collected in 2012).



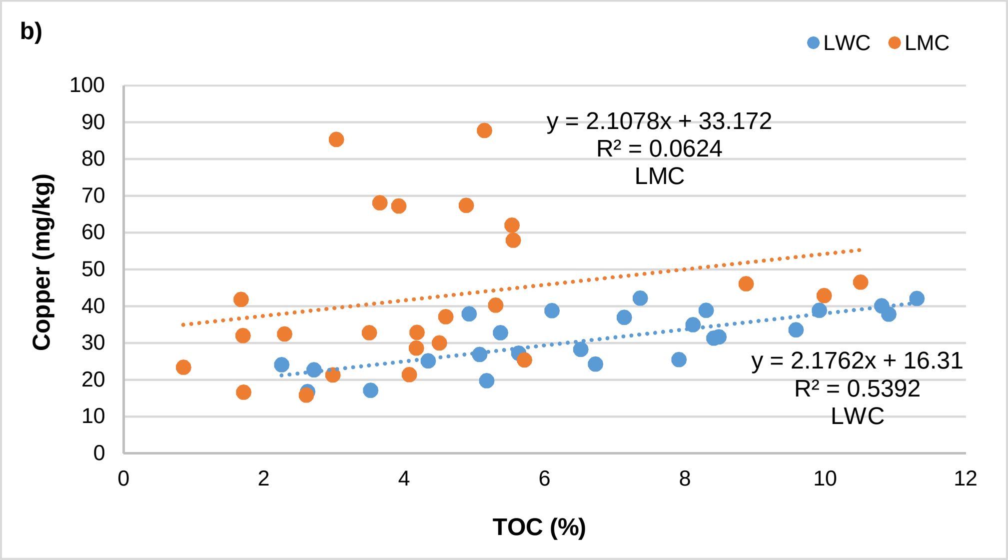
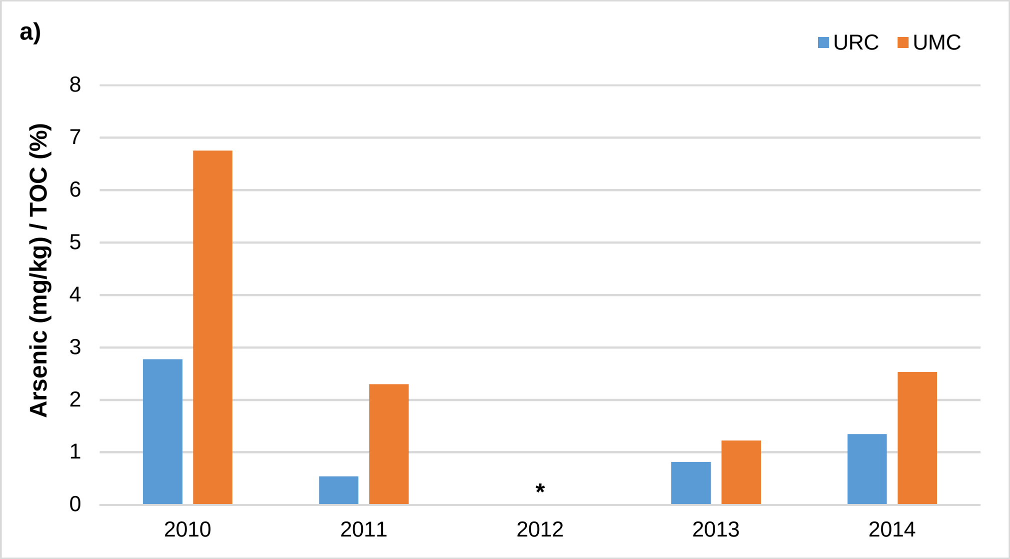


Figure C.2: Relationship between analytes of concern a) Arsenic and b) Copper and percent TOC, lower Wolverine Creek and lower Minto Creek, 2010-2014.



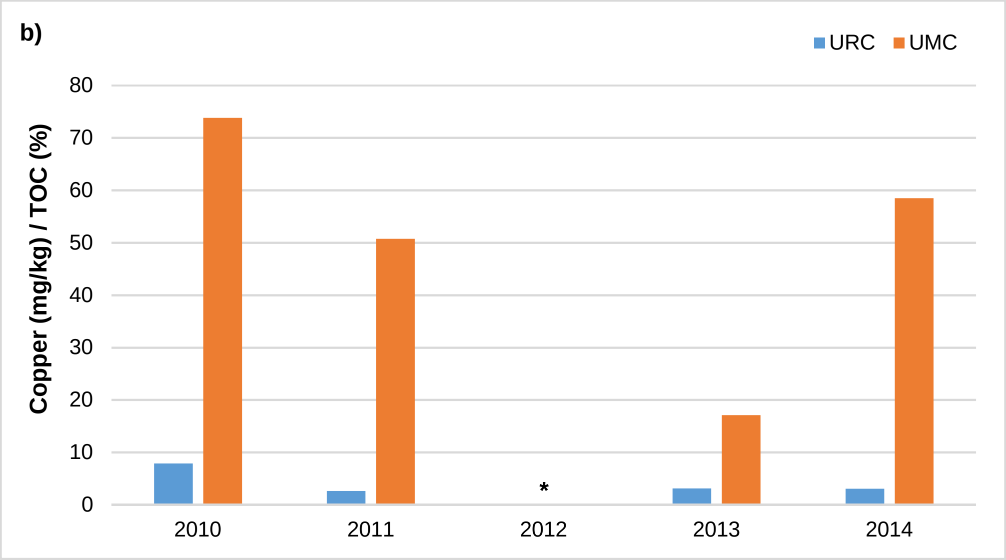
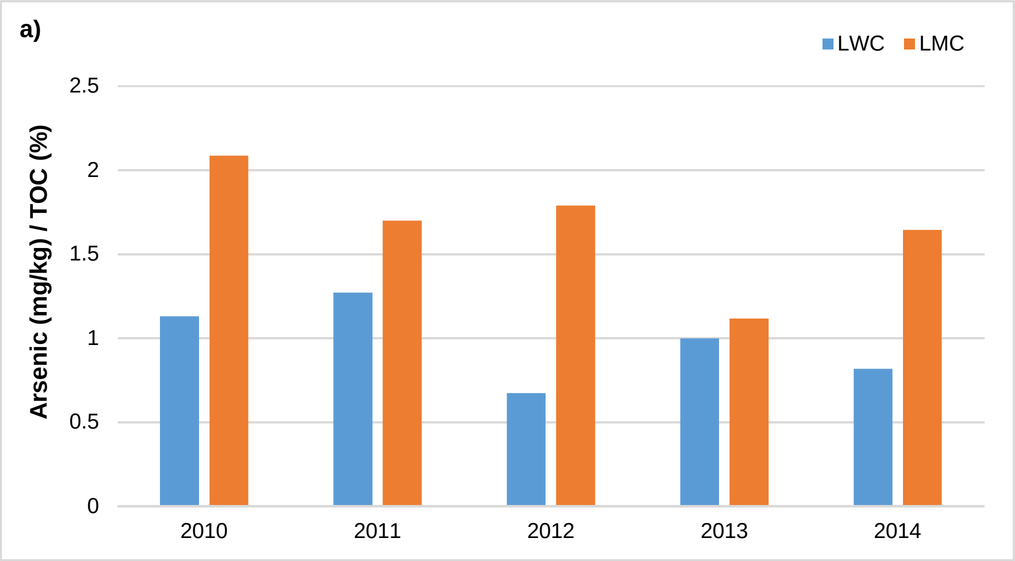


Figure C.3: Analytes of concern a) Arsenic and b) Copper normalized to percent TOC at upper McGinty Creek and upper Minto Creek, 2010-2014.

* TOC was not collected in 2012



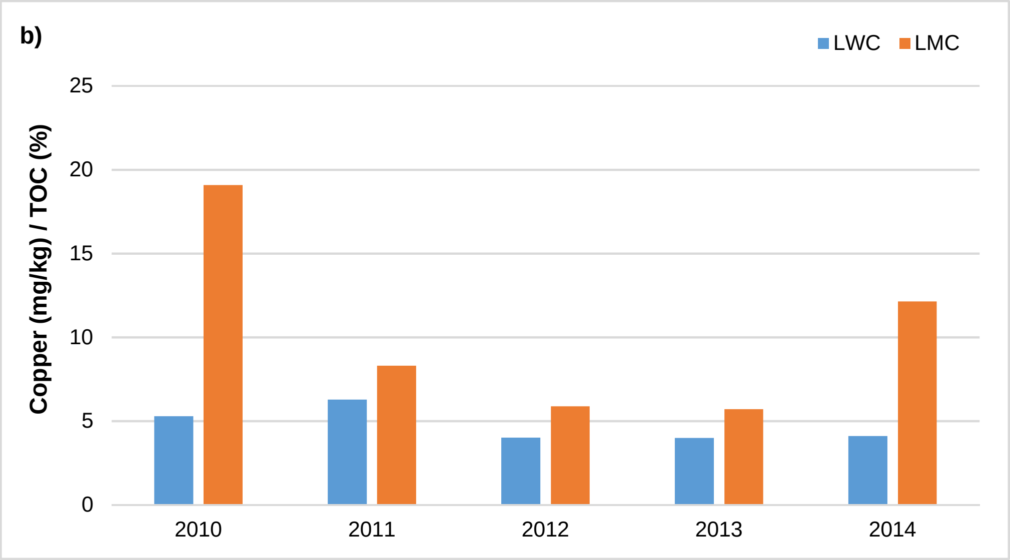
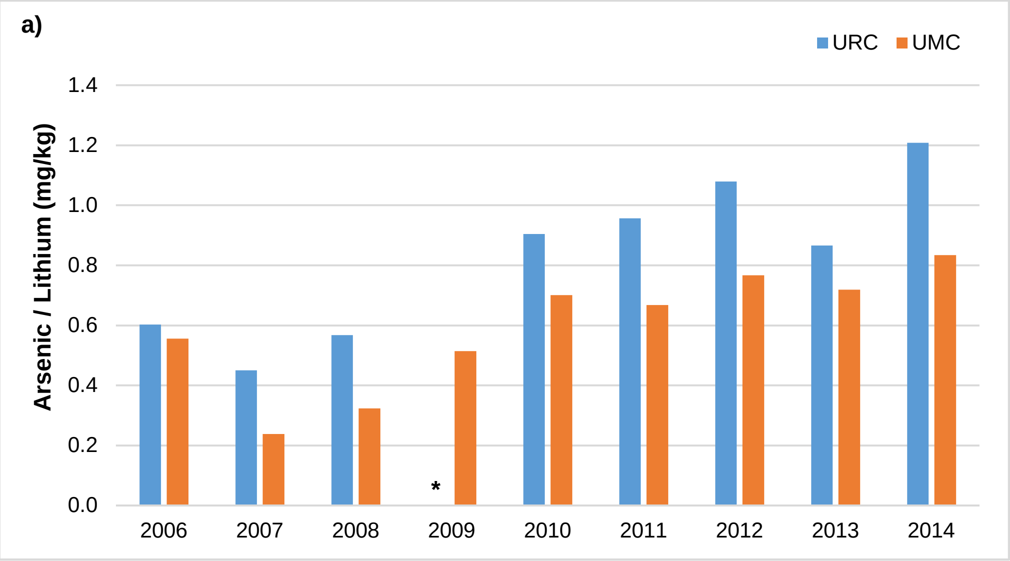


Figure C.4: Analytes of concern a) Arsenic and b) Copper normalized to percent TOC at lower Wolverine Creek and lower Minto Creek, 2010-2014.



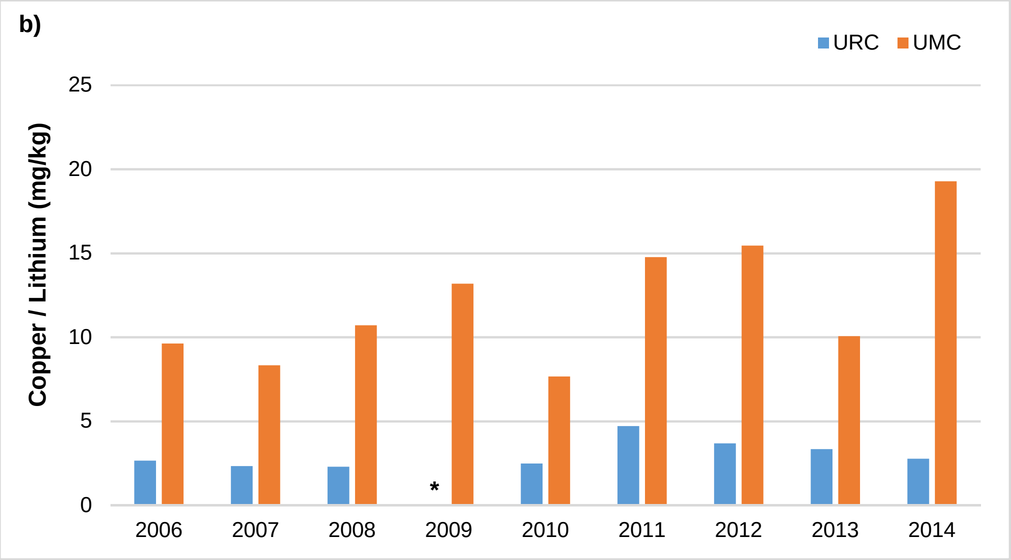


Figure C.5: Analytes of concern a) Arsenic and b) Copper normalized to lithium at upper McGinty Creek and upper Minto Creek, 2006-2014.

* no data available for URC

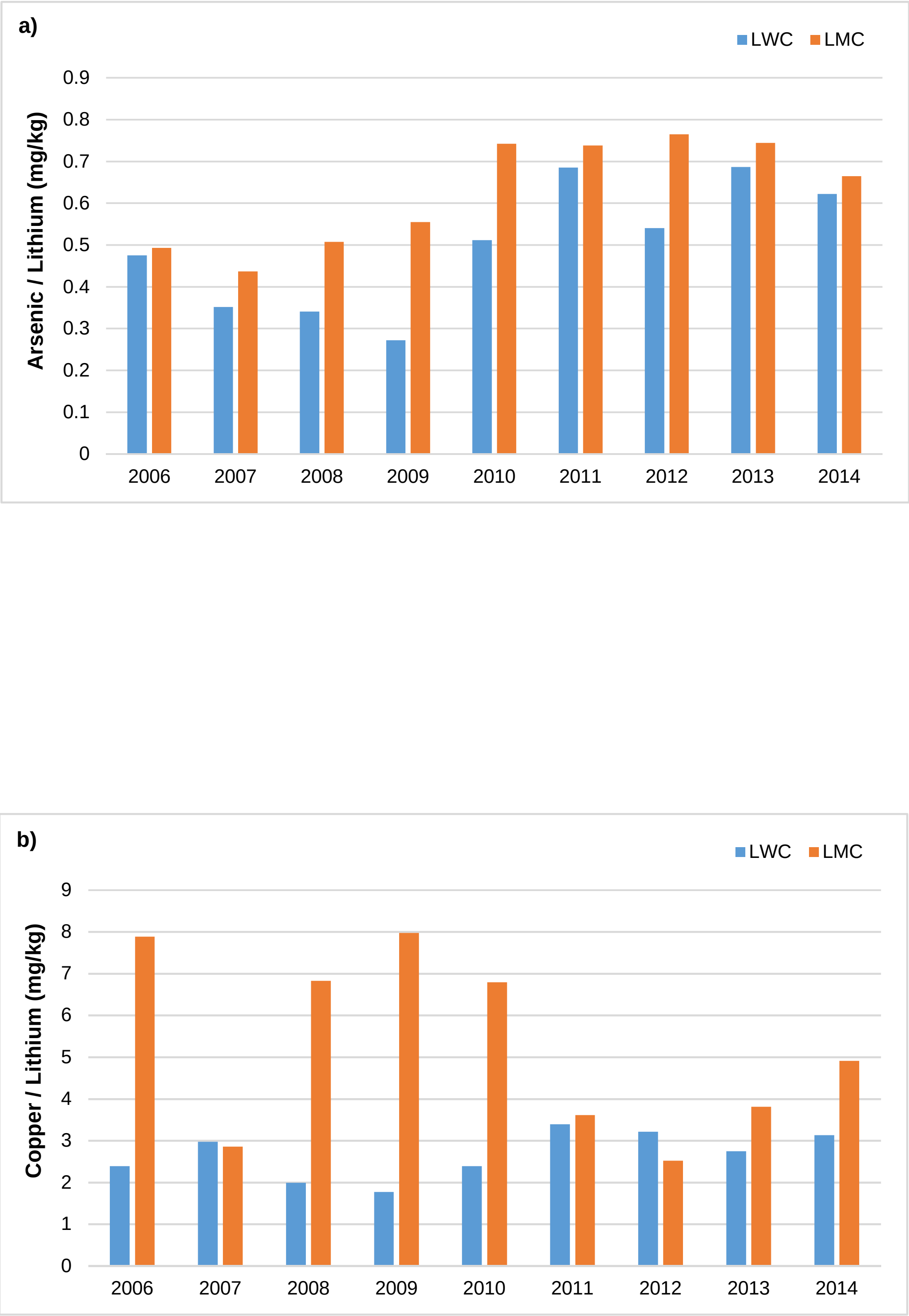


Figure C.6: Analytes of concern a) Arsenic and b) Copper normalized to lithiu at lower Wolverine Creek and lower Minto Creek, 2010-2014.

* no data available for URC

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received:	15-SEP-14
Report Date:	30-SEP-14 11:00 (MT)
Version:	FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #:	**L1518258**
Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT 2537
C of C Numbers:	1, 2
Legal Site Desc:	

Can Dang
Senior Account Manager

	Sample ID	L1518258-1	L1518258-2	L1518258-3	L1518258-4	L1518258-5
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	09-SEP-14	14-SEP-14	14-SEP-14	14-SEP-14	14-SEP-14
	Sampled Time					
	Client ID	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	7	9	7	11	4
	pH (1:2 soil:water) (pH)	8.10	8.06	7.99	8.03	8.15
Particle Size	% Gravel (>2mm) (%)	0.94	0.57	4.26	0.51	0.25
	% Sand (2.0mm - 0.063mm) (%)	30.7	21.8	17.4	17.8	30.8
	% Silt (0.063mm - 4um) (%)	60.6	69.7	69.6	72.3	61.1
	% Clay (<4um) (%)	7.85	7.95	8.79	9.41	7.84
	Texture	Silt loam	Silt loam	Silt loam	Silt loam	Silt loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.244	0.266	0.302	0.260	0.156
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Inorganic Carbon (%)	<0.10	<0.10	<0.10	<0.10	<0.10
	Inorganic Carbon (as CaCO3 Equivalent) (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Total Carbon by Combustion (%)	3.5	5.6	3.9	5.5	2.3
	Total Organic Carbon (%)	3.50	5.55	3.92	5.53	2.29
Metals	Aluminum (Al) (mg/kg)	12900	14500	14700	14300	12800
	Antimony (Sb) (mg/kg)	0.41	0.60	0.61	0.59	0.39
	Arsenic (As) (mg/kg)	5.65	7.11	7.80	7.87	5.75
	Barium (Ba) (mg/kg)	184	238	269	254	183
	Beryllium (Be) (mg/kg)	0.42	0.52	0.54	0.50	0.38
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.124	0.220	0.261	0.232	0.131
	Calcium (Ca) (mg/kg)	9250	13700	14700	13700	8350
	Chromium (Cr) (mg/kg)	28.9	32.6	34.8	33.7	28.2
	Cobalt (Co) (mg/kg)	9.74	11.2	12.0	12.0	9.86
	Copper (Cu) (mg/kg)	32.8	57.9	67.2	62.0	32.4
	Iron (Fe) (mg/kg)	23000	26200	27900	27900	23000
	Lead (Pb) (mg/kg)	5.22	6.52	7.01	6.82	5.04
	Lithium (Li) (mg/kg)	9.1	11.1	11.4	10.8	9.0
	Magnesium (Mg) (mg/kg)	6510	7060	7400	7280	6570
	Manganese (Mn) (mg/kg)	548	878	904	1010	521
	Mercury (Hg) (mg/kg)	0.0227	0.0417	0.0546	0.0494	0.0257
	Molybdenum (Mo) (mg/kg)	0.54	0.68	0.81	0.74	<0.50
	Nickel (Ni) (mg/kg)	26.6	29.0	31.8	30.9	26.6
	Phosphorus (P) (mg/kg)	826	887	851	848	828
	Potassium (K) (mg/kg)	1170	1340	1230	1290	1060
	Selenium (Se) (mg/kg)	0.27	0.44	0.59	0.57	0.31
	Silver (Ag) (mg/kg)	<0.10	0.10	0.13	0.11	<0.10

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1518258-6	L1518258-7	L1518258-8	L1518258-9	L1518258-10
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	12-SEP-14	12-SEP-14	12-SEP-14	13-SEP-14	13-SEP-14
	Sampled Time					
	Client ID	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	23	14	7	11	15
	pH (1:2 soil:water) (pH)	6.99	7.17	7.12	7.05	7.60
Particle Size	% Gravel (>2mm) (%)	<0.10	<0.10	<0.10	<0.10	<0.10
	% Sand (2.0mm - 0.063mm) (%)	7.20	28.1	46.9	50.2	28.2
	% Silt (0.063mm - 4um) (%)	87.2	65.8	47.0	45.1	66.4
	% Clay (<4um) (%)	5.63	6.13	6.05	4.78	5.35
	Texture	Silt	Silt loam	Sandy loam	Sandy loam	Silt loam
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.614	0.377	0.212	0.298	0.424
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Inorganic Carbon (%)	<0.10	<0.10	<0.10	<0.10	<0.10
	Inorganic Carbon (as CaCO3 Equivalent) (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Total Carbon by Combustion (%)	10.8	6.5	3.5	5.2	8.1
	Total Organic Carbon (%)	10.8	6.51	3.52	5.17	8.11
Metals	Aluminum (Al) (mg/kg)	13100	14200	11100	11900	15500
	Antimony (Sb) (mg/kg)	0.59	0.42	0.31	0.40	0.53
	Arsenic (As) (mg/kg)	7.30	5.07	3.48	5.46	6.56
	Barium (Ba) (mg/kg)	270	181	129	161	245
	Beryllium (Be) (mg/kg)	0.94	0.68	0.50	0.57	0.84
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.463	0.242	0.116	0.171	0.344
	Calcium (Ca) (mg/kg)	16200	10400	6640	7610	13600
	Chromium (Cr) (mg/kg)	43.4	44.4	36.3	38.3	50.2
	Cobalt (Co) (mg/kg)	13.7	12.9	10.6	12.0	14.9
	Copper (Cu) (mg/kg)	40.1	28.3	17.1	19.7	35.0
	Iron (Fe) (mg/kg)	27000	26600	23000	25600	29200
	Lead (Pb) (mg/kg)	6.59	6.06	4.75	5.30	6.98
	Lithium (Li) (mg/kg)	8.4	9.6	7.7	8.6	10.5
	Magnesium (Mg) (mg/kg)	7930	8830	7730	7850	9550
	Manganese (Mn) (mg/kg)	966	354	212	474	816
	Mercury (Hg) (mg/kg)	0.0823	0.0410	0.0184	0.0254	0.0572
	Molybdenum (Mo) (mg/kg)	0.56	0.55	<0.50	0.52	0.62
	Nickel (Ni) (mg/kg)	39.2	38.1	32.4	32.4	42.7
	Phosphorus (P) (mg/kg)	1100	999	1000	955	1100
	Potassium (K) (mg/kg)	890	1060	890	950	1060
	Selenium (Se) (mg/kg)	0.71	0.40	<0.20	0.22	0.57
	Silver (Ag) (mg/kg)	0.17	<0.10	<0.10	<0.10	0.12

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518258-11	L1518258-12	L1518258-13	L1518258-14	L1518258-15
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14
	Sampled Time					
	Client ID	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	5	5	10	1	<1
	pH (1:2 soil:water) (pH)	8.14	8.12	8.16	8.19	8.50
Particle Size	% Gravel (>2mm) (%)					
	% Sand (2.0mm - 0.063mm) (%)					
	% Silt (0.063mm - 4um) (%)					
	% Clay (<4um) (%)					
	Texture					
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.168	0.128	0.232	0.032	0.023
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Inorganic Carbon (%)	<0.10	<0.10	<0.10	<0.10	<0.10
	Inorganic Carbon (as CaCO3 Equivalent) (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Total Carbon by Combustion (%)	2.3	2.1	4.5	0.6	0.4
	Total Organic Carbon (%)	2.26	2.09	4.46	0.55	0.36
Metals	Aluminum (Al) (mg/kg)	5770	11700	9860	6890	4980
	Antimony (Sb) (mg/kg)	0.31	0.41	0.46	0.33	0.24
	Arsenic (As) (mg/kg)	4.14	5.19	5.58	5.17	4.52
	Barium (Ba) (mg/kg)	153	195	209	111	81.0
	Beryllium (Be) (mg/kg)	0.26	0.41	0.40	0.28	<0.20
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.174	0.179	0.209	0.100	0.059
	Calcium (Ca) (mg/kg)	4350	7370	7130	3990	3160
	Chromium (Cr) (mg/kg)	14.1	26.8	32.1	17.4	17.1
	Cobalt (Co) (mg/kg)	6.39	9.93	10.2	7.40	5.88
	Copper (Cu) (mg/kg)	95.2	176	207	57.6	32.7
	Iron (Fe) (mg/kg)	19400	24800	31300	18700	16400
	Lead (Pb) (mg/kg)	5.15	5.74	5.81	4.32	3.39
	Lithium (Li) (mg/kg)	<5.0	8.0	6.5	<5.0	<5.0
	Magnesium (Mg) (mg/kg)	3550	6700	5560	4100	3240
	Manganese (Mn) (mg/kg)	2150	1560	2150	729	357
	Mercury (Hg) (mg/kg)	0.0118	0.0225	0.0243	0.0173	0.0052
	Molybdenum (Mo) (mg/kg)	1.60	1.41	1.46	1.00	0.66
	Nickel (Ni) (mg/kg)	14.2	27.2	24.7	17.1	14.1
	Phosphorus (P) (mg/kg)	710	1030	876	641	672
	Potassium (K) (mg/kg)	880	1440	1220	930	570
	Selenium (Se) (mg/kg)	0.38	0.39	0.49	<0.20	<0.20
	Silver (Ag) (mg/kg)	<0.10	0.10	0.12	<0.10	<0.10

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518258-16	L1518258-17	L1518258-18	L1518258-19	L1518258-20
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	09-SEP-14
	Sampled Time					
	Client ID	URC-1	URC-2	URC-3	URC-4	URC-5
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)	14	16	8	10	5
	pH (1:2 soil:water) (pH)	7.10	6.92	7.22	6.94	7.51
Particle Size	% Gravel (>2mm) (%)					
	% Sand (2.0mm - 0.063mm) (%)					
	% Silt (0.063mm - 4um) (%)					
	% Clay (<4um) (%)					
	Texture					
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)	0.360	0.382	0.207	0.300	0.115
Organic / Inorganic Carbon	CaCO3 Equivalent (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Inorganic Carbon (%)	<0.10	<0.10	<0.10	<0.10	<0.10
	Inorganic Carbon (as CaCO3 Equivalent) (%)	<0.80	<0.80	<0.80	<0.80	<0.80
	Total Carbon by Combustion (%)	7.2	7.7	3.8	5.9	2.5
	Total Organic Carbon (%)	7.22	7.65	3.80	5.87	2.52
Metals	Aluminum (Al) (mg/kg)	11000	11200	8570	11300	5250
	Antimony (Sb) (mg/kg)	0.41	0.42	0.32	0.42	0.27
	Arsenic (As) (mg/kg)	6.98	8.49	6.87	8.26	5.79
	Barium (Ba) (mg/kg)	199	222	151	217	93.4
	Beryllium (Be) (mg/kg)	0.31	0.35	0.26	0.35	<0.20
	Bismuth (Bi) (mg/kg)	<0.20	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd) (mg/kg)	0.145	0.150	0.094	0.154	0.084
	Calcium (Ca) (mg/kg)	8210	8390	5970	8120	4240
	Chromium (Cr) (mg/kg)	21.4	23.1	17.2	22.4	7.99
	Cobalt (Co) (mg/kg)	9.65	10.3	7.34	9.52	5.76
	Copper (Cu) (mg/kg)	18.2	19.8	14.2	21.5	9.73
	Iron (Fe) (mg/kg)	23300	25600	20200	24700	14200
	Lead (Pb) (mg/kg)	4.38	4.46	3.52	4.79	2.67
	Lithium (Li) (mg/kg)	6.5	6.7	5.1	6.8	<5.0
	Magnesium (Mg) (mg/kg)	4000	4160	3450	4270	2170
	Manganese (Mn) (mg/kg)	1040	1160	688	903	548
	Mercury (Hg) (mg/kg)	0.0344	0.0404	0.0231	0.0376	0.0176
	Molybdenum (Mo) (mg/kg)	0.52	0.55	<0.50	0.56	0.54
	Nickel (Ni) (mg/kg)	16.6	17.3	13.6	17.9	8.59
	Phosphorus (P) (mg/kg)	805	932	718	832	586
	Potassium (K) (mg/kg)	700	730	590	700	400
	Selenium (Se) (mg/kg)	0.51	0.48	0.36	0.56	0.34
	Silver (Ag) (mg/kg)	<0.10	<0.10	<0.10	<0.10	<0.10

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1518258-21 Sediment 13-SEP-14 UMC	L1518258-22 Sediment 13-SEP-14 URC			
Grouping	**Analyte**					
SOIL						
Physical Tests	Loss On Ignition @ 420 C (%)					
	pH (1:2 soil:water) (pH)					
Particle Size	% Gravel (>2mm) (%)	4.02	<0.10			
	% Sand (2.0mm - 0.063mm) (%)	73.1	37.9			
	% Silt (0.063mm - 4um) (%)	17.9	57.4			
	% Clay (<4um) (%)	5.01	4.71			
	Texture	Loamy sand	Silt loam			
Leachable Anions & Nutrients	Total Kjeldahl Nitrogen (%)					
Organic / Inorganic Carbon	CaCO3 Equivalent (%)					
	Inorganic Carbon (%)					
	Inorganic Carbon (as CaCO3 Equivalent) (%)					
	Total Carbon by Combustion (%)					
	Total Organic Carbon (%)					
Metals	Aluminum (Al) (mg/kg)					
	Antimony (Sb) (mg/kg)					
	Arsenic (As) (mg/kg)					
	Barium (Ba) (mg/kg)					
	Beryllium (Be) (mg/kg)					
	Bismuth (Bi) (mg/kg)					
	Cadmium (Cd) (mg/kg)					
	Calcium (Ca) (mg/kg)					
	Chromium (Cr) (mg/kg)					
	Cobalt (Co) (mg/kg)					
	Copper (Cu) (mg/kg)					
	Iron (Fe) (mg/kg)					
	Lead (Pb) (mg/kg)					
	Lithium (Li) (mg/kg)					
	Magnesium (Mg) (mg/kg)					
	Manganese (Mn) (mg/kg)					
	Mercury (Hg) (mg/kg)					
	Molybdenum (Mo) (mg/kg)					
	Nickel (Ni) (mg/kg)					
	Phosphorus (P) (mg/kg)					
	Potassium (K) (mg/kg)					
	Selenium (Se) (mg/kg)					
	Silver (Ag) (mg/kg)					

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518258-1	L1518258-2	L1518258-3	L1518258-4	L1518258-5
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	09-SEP-14	14-SEP-14	14-SEP-14	14-SEP-14	14-SEP-14
	Sampled Time					
	Client ID	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	350	340	290	330	330
	Strontium (Sr) (mg/kg)	80.2	116	128	122	76.5
	Thallium (Tl) (mg/kg)	0.102	0.118	0.104	0.102	0.079
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	830	864	692	751	788
	Uranium (U) (mg/kg)	0.738	1.15	1.25	1.27	0.705
	Vanadium (V) (mg/kg)	49.9	56.4	56.2	57.5	49.6
	Zinc (Zn) (mg/kg)	52.8	60.9	64.9	62.5	54.0

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1518258-6 Sediment 12-SEP-14 LWC-1	L1518258-7 Sediment 12-SEP-14 LWC-2	L1518258-8 Sediment 12-SEP-14 LWC-3	L1518258-9 Sediment 13-SEP-14 LWC-4	L1518258-10 Sediment 13-SEP-14 LWC-5
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	350	450	380	390	420
	Strontium (Sr) (mg/kg)	159	96.0	62.3	76.5	134
	Thallium (Tl) (mg/kg)	0.079	0.077	0.056	0.079	0.092
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	687	950	893	880	818
	Uranium (U) (mg/kg)	4.85	2.68	1.35	1.73	3.30
	Vanadium (V) (mg/kg)	70.7	67.3	59.8	63.1	71.3
	Zinc (Zn) (mg/kg)	51.7	60.1	49.0	52.0	62.9

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518258-11	L1518258-12	L1518258-13	L1518258-14	L1518258-15
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14
	Sampled Time					
	Client ID	UMC-1	UMC-2	UMC-3	UMC-4	UMC-5
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	140	310	260	240	170
	Strontium (Sr) (mg/kg)	48.9	77.7	81.5	49.0	33.2
	Thallium (Tl) (mg/kg)	<0.050	0.087	0.076	<0.050	<0.050
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	409	702	695	504	391
	Uranium (U) (mg/kg)	0.517	0.747	0.745	0.447	0.309
	Vanadium (V) (mg/kg)	42.9	54.9	77.6	41.9	37.4
	Zinc (Zn) (mg/kg)	48.7	64.4	60.9	40.7	30.5

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

	Sample ID	L1518258-16	L1518258-17	L1518258-18	L1518258-19	L1518258-20
	Description	Sediment	Sediment	Sediment	Sediment	Sediment
	Sampled Date	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	09-SEP-14
	Sampled Time					
	Client ID	URC-1	URC-2	URC-3	URC-4	URC-5
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)	210	210	180	210	110
	Strontium (Sr) (mg/kg)	67.6	68.4	49.8	68.4	49.5
	Thallium (Tl) (mg/kg)	0.069	0.069	<0.050	0.066	0.050
	Tin (Sn) (mg/kg)	<2.0	<2.0	<2.0	<2.0	<2.0
	Titanium (Ti) (mg/kg)	675	678	550	635	300
	Uranium (U) (mg/kg)	1.45	1.21	0.789	1.20	0.686
	Vanadium (V) (mg/kg)	48.1	48.3	37.5	47.2	27.1
	Zinc (Zn) (mg/kg)	42.6	46.7	35.6	46.6	22.3

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID Description Sampled Date Sampled Time Client ID	L1518258-21 Sediment 13-SEP-14 UMC	L1518258-22 Sediment 13-SEP-14 URC			
Grouping	**Analyte**					
SOIL						
Metals	Sodium (Na) (mg/kg)					
	Strontium (Sr) (mg/kg)					
	Thallium (Tl) (mg/kg)					
	Tin (Sn) (mg/kg)					
	Titanium (Ti) (mg/kg)					
	Uranium (U) (mg/kg)					
	Vanadium (V) (mg/kg)					
	Zinc (Zn) (mg/kg)					

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Calcium (Ca)	DUP-H	L1518258-16, -17, -18, -19

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
C-INORG-ORG-SK	Soil	Inorganic and Organic Carbon	SSSA (1996) P455-456

When carbonates are decomposed with acid in an open system, carbon dioxide is released to the atmosphere. The decrease in sample weight resulting from CO2 loss is proportional to the carbonate content of the soil.

Reference:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

C-INORG-SK	Soil	Inorganic Carbon / Calcium Carbonate	SSSA (1996) P455-456

When carbonates are decomposed with acid in an open system, carbon dioxide is released to the atmosphere. The decrease in sample weight resulting from CO2 loss is proportional to the carbonate content of the soil.

Reference:
Loeppert, R.H. and Suarez, D.L. 1996. Gravimetric Method for Loss of Carbon Dioxide. P. 455-456 In: J.M. Bartels et al. (ed.) Methods of soil analysis: Part 3 Chemical methods. (3rd ed.) ASA and SSSA, Madison, WI. Book series no. 5

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAFS	EPA 200.2/245.7

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent	Calculation
LOI-420-SK	Soil	Loss on Ignition @ 420 C	CSSS (1978) METHOD 3.81

The dry-ash method involves the removal of organic matter by combustion at 420OC for 2 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 3.81

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A

This analysis is carried out using procedures from CSR Analytical Method: "Strong Acid Leachable Metals (SALM) in Soil", BC Ministry of Environment, 26 June 2009, and procedures adapted from EPA Method 200.2. The sample is manually homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve (this sieve step is omitted for international soil samples), and a representative subsample of the dry material is weighed. The sample is then digested at 95 degrees Celsius for 2 hours by block digester using concentrated nitric and hydrochloric acids. Instrumental analysis of the digested extract is by collision cell inductively coupled plasma - mass spectrometry (modifed from EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (1993) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)	BC WLAP METHOD: PH, ELECTROMETRIC, SOIL

Reference Information

This analysis is carried out in accordance with procedures described in the pH, Electrometric in Soil and Sediment method - Section B Physical/Inorganic and Misc. Constituents, BC Environmental Laboratory Manual 2007. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

PSA-PIPET+GRAVEL-SK	Soil	Particle size - Sieve and Pipette	SSIR-51 METHOD 3.2.1

Particle size distribution is determined by a combination of techniques. Dry sieving is performed for coarse particles, wet sieving for sand particles and the pipette sedimentation method for clay particles.

Reference:

Burt, R. (2009). Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States Department of Agriculture Natural Resources Conservation Service.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS

Chain of Custody / Analytical Requ
Canada Toll Free: 1 800 668 9
www.alsglobal.com

L1518258-COFC

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Page 1 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 X2 Fax: (250) 595-1625
Invoice To	Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Elvina Wong
Address:	Suite 900-999 West Hastings Street, Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2120
Lab Work Order # (lab use only)	

Report Format / Distribution

☑ Standard ☐ Other

☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information

Job #: Minnow Project 2537
PO / AFE:
LSD:

Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

alysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Rescan Low Level Sediments	Inorganic Carbon	Total Carbon by combustion	Mercury by CVAFS	Loss on Ignition	pH in soil	Particle Size	Total Organic Carbon	Total Kjeldahl Nitrogen	**See Complete Quote #Q41650			Number of Containers
	LMC-1	Sept 9/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LMC-2	Sept 14/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LMC-3	Sept 14/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LMC-4	Sept 14/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LMC-5	Sept 14/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LWC-1	Sept 12/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LWC-2	Sept 12/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LWC-3	Sept 12/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LWC-4	Sept 13/14		Sediment	X	X	X	X	X	X	X	X	X				2
	LWC-5	Sept 13/14		Sediment	X	X	X	X	X	X	X	X	X				2
	UMC-1	Sept 9/14		Sediment	X	X	X	X	X	X	[illegible]	X	X			1 →	[illegible]
	UMC-2	Sept 9/14		Sediment	X	X	X	X	X	X	[illegible]	X	X			1 →	[illegible]

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 15-Sept-14	Time (hh-mm) 7:45 am	Received by:	Date: 16-SEP-14	Time: 5:15	Temperature: 5.0, 5.4 4.4, 4.4 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

ALS

Chain of Custody / Analytical Req

Canada Toll Free: 1 800 668

www.alsglobal.com

L1518258-COFC

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Page 2 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21
Fax:	(250) 595-1625
Invoice To Same as Report ?	☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Elvina Wong
Address:	Suite 900-999 West Hastings Street, Vancouver, BC
Phone:	604-684-8894
Fax:	604-688-2120
Lab Work Order # (lab use only)	

Report Format / Distribution

☑ Standard ☐ Other

☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca

Email 2: pstecko@minnow.ca

Email 3:

Client / Project Information

Job #: Minnow Project 2537

PO / AFE:

LSD:

Quote #: Q41650

ALS Contact: Victoria Jung

Sampler: Pierre Stecko

alysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)

○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT

○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT

○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Rescan Low Level Sediments	Inorganic Carbon	Total Carbon by combustion	Mercury by CVAFS	Loss on Ignition	pH in soil	Particle Size	Total Organic Carbon	Total Kjeldahl Nitrogen	**See Complete Quote #Q41650		# of Containers	~~Number of Containers~~
	UMC-3	Sept 9/14		Sediment	X	X	X	X	X	X		X	X			1	
	UMC-4	Sept 9/14		Sediment	X	X	X	X	X	X		X	X			1	
	UMC-5	Sept 9/14		Sediment	X	X	X	X	X	X		X	X			1	
	URC-1	Sept 13/14		Sediment	X	X	X	X	X	X		X	X			1	
	URC-2	Sept 13/14		Sediment	X	X	X	X	X	X		X	X			1	
	URC-3	Sept 13/14		Sediment	X	X	X	X	X	X		X	X			1	
	URC-4	Sept 13/14		Sediment	X	X	X	X	X	X		X	X			1	
	URC-5	Sept 9/14		Sediment	X	X	X	X	X	X		X	X			1	
	UMC	Sept 13/14		Sediment							X					1	
	URC			Sediment							X					1	

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date: 16-SEP-14	Time: 5:15	Temperature: 5.0,5.4 4.4,4.4°C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received:	15-SEP-14
Report Date:	10-NOV-14 17:09 (MT)
Version:	FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #:	**L1518415**
Project P.O. #:	NOT SUBMITTED
Job Reference:	MINNOW PROJECT 2537
C of C Numbers:	1, 2
Legal Site Desc:	

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518415-1	L1518415-2	L1518415-3	L1518415-4	L1518415-5
	Description	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue
	Sampled Date	10-SEP-14	09-SEP-14	10-SEP-14	14-SEP-14	14-SEP-14
	Sampled Time					
	Client ID	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Grouping	**Analyte**					
BIOTA						
Field Tests	Area Sampled (cm2)	0	0	0	0	0
Plant Pigments	Chlorophyll a (ug)	38.5	19.2	15.7	25.2	53.1

	Sample ID	L1518415-1	L1518415-2	L1518415-3	L1518415-4	L1518415-5
	Description	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue
	Sampled Date	10-SEP-14	09-SEP-14	10-SEP-14	14-SEP-14	14-SEP-14
	Sampled Time					
	Client ID	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	74.9	65.5	76.9	70.5	70.5
Metals	Aluminum (Al)-Total (mg/kg wwt)	2740	3120	2520	2740	2630
	Antimony (Sb)-Total (mg/kg wwt)	0.0142	0.0141	0.0175	0.0160	0.0131
	Arsenic (As)-Total (mg/kg wwt)	2.86	2.38	2.78	2.45	1.93
	Barium (Ba)-Total (mg/kg wwt)	309	123	221	158	70.2
	Beryllium (Be)-Total (mg/kg wwt)	0.103	0.121	0.0963	0.103	0.0995
	Bismuth (Bi)-Total (mg/kg wwt)	0.0251	0.0283	0.0243	0.0247	0.0265
	Boron (B)-Total (mg/kg wwt)	3.90	2.76	4.98	5.23	3.66
	Cadmium (Cd)-Total (mg/kg wwt)	0.100	0.0647	0.0941	0.0837	0.0482
	Calcium (Ca)-Total (mg/kg wwt)	3670	4390	3070	4150	5040
	Cesium (Cs)-Total (mg/kg wwt)	0.228	0.269	0.229	0.239	0.236
	Chromium (Cr)-Total (mg/kg wwt)	15.5	16.2	11.9	14.1	9.73
	Cobalt (Co)-Total (mg/kg wwt)	6.87	4.87	5.87	4.89	3.07
	Copper (Cu)-Total (mg/kg wwt)	10.4	9.76	9.98	9.95	8.81
	Iron (Fe)-Total (mg/kg wwt)	6730	7630	6600	6690	6320
	Lead (Pb)-Total (mg/kg wwt)	1.26	1.47	1.18	1.23	1.30
	Lithium (Li)-Total (mg/kg wwt)	2.71	3.02	2.38	2.61	2.65
	Magnesium (Mg)-Total (mg/kg wwt)	1700	1900	1520	1650	1620
	Manganese (Mn)-Total (mg/kg wwt)	5130	1650	3690	2630	509
	Mercury (Hg)-Total (mg/kg wwt)	0.0074	0.0078	0.0081	0.0084	0.0086
	Molybdenum (Mo)-Total (mg/kg wwt)	0.376	0.202	0.258	0.236	0.139
	Nickel (Ni)-Total (mg/kg wwt)	10.4	9.25	9.24	9.99	7.65
	Phosphorus (P)-Total (mg/kg wwt)	398	495	557	485	407
	Potassium (K)-Total (mg/kg wwt)	575	598	743	657	581
	Rubidium (Rb)-Total (mg/kg wwt)	2.52	2.78	2.36	2.49	2.51
	Selenium (Se)-Total (mg/kg wwt)	0.360	0.239	0.458	0.363	0.316
	Sodium (Na)-Total (mg/kg wwt)	67.5	91.3	72.3	76.7	81.7
	Strontium (Sr)-Total (mg/kg wwt)	46.4	38.3	40.1	38.0	35.8
	Tellurium (Te)-Total (mg/kg wwt)	0.0072	0.0055	0.0068	0.0060	0.0048
	Thallium (Tl)-Total (mg/kg wwt)	0.0219	0.0231	0.0195	0.0203	0.0207
	Tin (Sn)-Total (mg/kg wwt)	0.056	0.067	0.045	0.060	0.053
	Uranium (U)-Total (mg/kg wwt)	0.173	0.199	0.158	0.181	0.169
	Vanadium (V)-Total (mg/kg wwt)	17.3	17.9	15.2	16.1	14.2
	Zinc (Zn)-Total (mg/kg wwt)	16.0	17.4	15.6	16.4	15.3
	Zirconium (Zr)-Total (mg/kg wwt)	2.45	2.62	2.22	2.35	2.26

	Sample ID	L1518415-6	L1518415-7	L1518415-8	L1518415-9	L1518415-10
	Description	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue
	Sampled Date	11-SEP-14	11-SEP-14	11-SEP-14	12-SEP-14	12-SEP-14
	Sampled Time					
	Client ID	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	56.4	60.7	90.0	17.7	3.23
Metals	Aluminum (Al)-Total (mg/kg wwt)	3680	3460	1070	5190	12200
	Antimony (Sb)-Total (mg/kg wwt)	0.0103	0.0128	0.0063	0.0535	0.0442
	Arsenic (As)-Total (mg/kg wwt)	1.90	1.53	0.513	3.13	4.79
	Barium (Ba)-Total (mg/kg wwt)	65.1	66.7	20.9	112	242
	Beryllium (Be)-Total (mg/kg wwt)	0.225	0.194	0.0517	0.276	0.608
	Bismuth (Bi)-Total (mg/kg wwt)	0.0237	0.0236	0.0072	0.0417	0.0616
	Boron (B)-Total (mg/kg wwt)	1.00	1.49	0.49	2.68	2.44
	Cadmium (Cd)-Total (mg/kg wwt)	0.0651	0.0684	0.0211	0.110	0.233
	Calcium (Ca)-Total (mg/kg wwt)	3290	3060	969	5470	9410
	Cesium (Cs)-Total (mg/kg wwt)	0.384	0.378	0.177	0.793	1.80
	Chromium (Cr)-Total (mg/kg wwt)	28.4	22.4	5.65	138	55.0
	Cobalt (Co)-Total (mg/kg wwt)	5.86	6.48	1.26	9.41	25.1
	Copper (Cu)-Total (mg/kg wwt)	9.39	8.28	2.41	14.5	26.2
	Iron (Fe)-Total (mg/kg wwt)	9870	9910	2550	18500	35500
	Lead (Pb)-Total (mg/kg wwt)	1.75	1.58	0.595	3.94	5.47
	Lithium (Li)-Total (mg/kg wwt)	3.74	3.30	1.14	5.11	14.1
	Magnesium (Mg)-Total (mg/kg wwt)	3820	3920	887	6720	15000
	Manganese (Mn)-Total (mg/kg wwt)	393	461	108	806	1830
	Mercury (Hg)-Total (mg/kg wwt)	0.0090	0.0100	0.0039	0.018	0.030
	Molybdenum (Mo)-Total (mg/kg wwt)	0.191	0.184	0.0550	0.628	0.674
	Nickel (Ni)-Total (mg/kg wwt)	23.1	22.2	4.09	38.0	81.1
	Phosphorus (P)-Total (mg/kg wwt)	629	711	257	1520	1250
	Potassium (K)-Total (mg/kg wwt)	688	726	345	1600	1540
	Rubidium (Rb)-Total (mg/kg wwt)	3.55	3.21	1.17	6.17	11.3
	Selenium (Se)-Total (mg/kg wwt)	0.161	0.208	0.091	0.377	0.349
	Sodium (Na)-Total (mg/kg wwt)	131	140	85.1	327	723
	Strontium (Sr)-Total (mg/kg wwt)	26.7	26.8	8.82	44.2	86.0
	Tellurium (Te)-Total (mg/kg wwt)	0.0042	0.0044	<0.0040	0.0098	0.0153
	Thallium (Tl)-Total (mg/kg wwt)	0.0211	0.0198	0.00649	0.0326	0.0654
	Tin (Sn)-Total (mg/kg wwt)	0.086	0.090	0.026	0.248	0.287
	Uranium (U)-Total (mg/kg wwt)	0.418	0.363	0.144	0.663	1.44
	Vanadium (V)-Total (mg/kg wwt)	25.8	23.7	7.68	49.4	85.6
	Zinc (Zn)-Total (mg/kg wwt)	25.2	23.4	5.42	30.8	63.9
	Zirconium (Zr)-Total (mg/kg wwt)	4.60	4.87	1.35	6.42	14.4

	Sample ID	L1518415-11	L1518415-12	L1518415-13	L1518415-14	L1518415-15
	Description	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue	Periphyton Tissue
	Sampled Date	15-SEP-14	15-SEP-14	15-SEP-14	15-SEP-14	15-SEP-14
	Sampled Time					
	Client ID	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	48.8	49.4	20.8	54.4	49.6
Metals	Aluminum (Al)-Total (mg/kg wwt)	4530	4170	6540	4140	4250
	Antimony (Sb)-Total (mg/kg wwt)	0.151	0.0843	0.0791	0.0846	0.0829
	Arsenic (As)-Total (mg/kg wwt)	24.2	17.1	17.7	15.7	17.4
	Barium (Ba)-Total (mg/kg wwt)	139	113	141	98.6	122
	Beryllium (Be)-Total (mg/kg wwt)	0.219	0.190	0.283	0.179	0.189
	Bismuth (Bi)-Total (mg/kg wwt)	0.528	0.359	0.498	0.415	0.620
	Boron (B)-Total (mg/kg wwt)	0.87	0.64	1.00	0.63	0.73
	Cadmium (Cd)-Total (mg/kg wwt)	0.154	0.113	0.144	0.0989	0.117
	Calcium (Ca)-Total (mg/kg wwt)	5390	3650	5350	3610	3660
	Cesium (Cs)-Total (mg/kg wwt)	2.50	1.67	1.77	1.67	1.68
	Chromium (Cr)-Total (mg/kg wwt)	20.2	19.2	23.5	16.6	17.6
	Cobalt (Co)-Total (mg/kg wwt)	5.52	4.95	7.73	4.57	5.15
	Copper (Cu)-Total (mg/kg wwt)	19.1	13.2	19.3	13.9	13.4
	Iron (Fe)-Total (mg/kg wwt)	12800	10500	16000	10100	11000
	Lead (Pb)-Total (mg/kg wwt)	7.44	5.45	6.37	4.99	5.42
	Lithium (Li)-Total (mg/kg wwt)	4.85	4.50	6.33	4.19	4.47
	Magnesium (Mg)-Total (mg/kg wwt)	3820	2950	4820	2880	3040
	Manganese (Mn)-Total (mg/kg wwt)	431	294	480	264	342
	Mercury (Hg)-Total (mg/kg wwt)	0.0149	0.0201	0.0149	0.0097	0.0200
	Molybdenum (Mo)-Total (mg/kg wwt)	0.824	0.581	0.620	0.494	0.583
	Nickel (Ni)-Total (mg/kg wwt)	11.8	11.1	17.0	10.3	11.6
	Phosphorus (P)-Total (mg/kg wwt)	745	674	833	595	630
	Potassium (K)-Total (mg/kg wwt)	1090	789	903	698	817
	Rubidium (Rb)-Total (mg/kg wwt)	8.29	6.19	7.54	6.22	6.63
	Selenium (Se)-Total (mg/kg wwt)	0.176	0.101	0.119	0.078	0.134
	Sodium (Na)-Total (mg/kg wwt)	148	149	252	141	147
	Strontium (Sr)-Total (mg/kg wwt)	32.3	29.1	48.1	28.4	29.3
	Tellurium (Te)-Total (mg/kg wwt)	0.0262	0.0174	0.0190	0.0195	0.0173
	Thallium (Tl)-Total (mg/kg wwt)	0.109	0.0786	0.0876	0.0724	0.0778
	Tin (Sn)-Total (mg/kg wwt)	0.123	0.084	0.131	0.082	0.085
	Uranium (U)-Total (mg/kg wwt)	0.759	0.651	0.846	0.669	0.651
	Vanadium (V)-Total (mg/kg wwt)	31.2	27.4	40.1	26.9	27.6
	Zinc (Zn)-Total (mg/kg wwt)	37.5	33.1	46.7	31.7	34.1
	Zirconium (Zr)-Total (mg/kg wwt)	3.48	3.34	4.30	2.71	3.24

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CHLOROA-F-VA	Biota	Chlorophyll a in Biota by Fluorometer	EPA 445.0

This analysis is done using procedures adapted from EPA Method 445.0. Chlorophyll-a is determined by a routine acetone extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b. Note: Biota samples are typically submitted as scrapings on a filter.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-WET-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (WET)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-WET-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (WET)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on wet weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1 2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS

Chain of Custody / Analytical Re
Canada Toll Free: 1 800 668
www.alsglobal.com

L1518415-COFC

C # ____

Page 1 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21 Fax: (250) 595-1625
Invoice To Same as Report ?	☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Elvina Wong
Address:	Suite 900-999 West Hastings St, Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2120
Lab Work Order # (lab use only)	

Report Format / Distribution	
☑ Standard	☐ Other
☑ PDF ☑ Excel	☐ Digital ☐ Fax
Email 1:	lbowron@minnow.ca
Email 2:	pstecko@minnow.ca
Email 3:	
Client / Project Information	
Job #:	Minnow Project 2537
PO / AFE:	
LSD:	
Quote #:	Q41650
ALS Contact:	Can Dang
Sampler:	Lisa Bowron

analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	**Sample Identification** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS	Chlorophyll a		**See Complete Quote #Q41650							Number of Containers
	LMC-1			Tissue	X	X	X	X									2
	LMC-2			Tissue	X	X	X	X									2
	LMC-3			Tissue	X	X	X	X									2
	LMC-4			Tissue	X	X	X	X									2
	LMC-5			Tissue	X	X	X	X									2
	LWC-1			Tissue	X	X	X	X									2
	LWC-2			Tissue	X	X	X	X									2
	LWC-3			Tissue	X	X	X	X									2
	LWC-4			Tissue	X	X	X	X									2
	LWC-5			Tissue	X	X	X	X									2
	LBC-1			Tissue	X	X	X										1
	LBC-2			Tissue	X	X	X										1

If not will hand deliver
to ALS Whitehorse on 16-Sept-14
-Trying to collect samples before truck
leaves @ [illegible]

may or may not be included

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Periphyton samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 15-Sept-14	Time (hh-mm) 07:50	Received by:	Date: 16-SEP-14	Time: 5:15	Temperature: 5.0, 5.4 4.4, 4.4 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

Chain of Custody / Analytical F
Canada Toll Free: 1 800 6
www.alsglobal.com

L1518415-COFC

COC # ______

Page 2 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No

Hardcopy of Invoice with Report? ☑ Yes ☐ No

Company: Mato Explorations Ltd
Contact: Elvina Wong
Address: Suite 900 - 999 West Hastings St, Vancouver, BC
Phone: 604-684-8894 Fax: 604-688-2120

Lab Work Order # (lab use only)

Report Format / Distribution

☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information

Job #: Minnow Project 2537
PO / AFE:
LSD:
Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

e analysis subject to availability)

○ Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
● Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS	Chlorophyll a		**See Complete Quote #Q41650							Number of Containers
	LBC-3			Tissue	X	X	X										1
	LBC-4			Tissue	X	X	X										1
	LBC-5			Tissue	X	X	X										1

may or may not be included. (see front

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Periphyton samples.

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Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Lisa Bowron	15-Sept-16	07:50		16-SEP-14	5:15	5.0,5.4 4.4,4.4 °C				

GENF 20.00 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 23-SEP-14
Report Date: 02-OCT-14 13:33 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: **L1521781**
Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT 2537
C of C Numbers:
Legal Site Desc:

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID **Description** **Sampled Date** **Sampled Time** **Client ID**	L1521781-1 Tissue LWC-1	L1521781-2 Tissue LWC-2	L1521781-3 Tissue LWC-3	L1521781-4 Tissue LWC-4	L1521781-5 Tissue LWC-5
Grouping	**Analyte**					
BIOTA						
Field Tests	Area Sampled (cm2)	0	0	0	0	0
Plant Pigments	Chlorophyll a (ug)	4.01	1.03	5.05	11.6	0.110

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
CHLOROA-F-VA	Biota	Chlorophyll a in Biota by Fluorometer	EPA 445.0

This analysis is done using procedures adapted from EPA Method 445.0. Chlorophyll-a is determined by a routine acetone extraction followed with analysis by fluorometry using the non-acidification procedure. This method is not subject to interferences from chlorophyll b. Note: Biota samples are typically submitted as scrapings on a filter.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Enui

L1521781-COFC

Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

COC #

Page 1 of 1

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627 x21 Fax: (250) 595-1625
Invoice To	Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Elvina Wong
Address:	Suite 900-999 West Hastings St., Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2120
Lab Work Order # (lab use only)	L1521781

Report Format / Distribution

☑ Standard ☐ Other

☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca

Email 2: pstecko@minnow.ca

Email 3:

Client / Project Information

Job #: Minnow Project 2537

PO / AFE:

LSD:

Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

Service Requested (Rush for routine analysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)

○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT

○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT

○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Chlorophyll a					**See Complete Quote #Q41650							Number of Containers
	LWC-1			Tissue	X												1
	LWC-2			Tissue	X												1
	LWC-3			Tissue	X												1
	LWC-4			Tissue	X												1
	LWC-5			Tissue	X												1

Short Holding Time

Rush Processing

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Periphyton samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

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Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 17-Sep-14	Time (hh-mm) 12:20	Received by: JN	Date: Sep23	Time: 10:30	Temperature: 18 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 15-SEP-14
Report Date: 18-NOV-14 15:57 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: **L1518377**
Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT 2537
C of C Numbers: 1, 2
Legal Site Desc:

Can Dang
Senior Account Manager

	Sample ID	L1518377-1	L1518377-2	L1518377-3	L1518377-4	L1518377-5
	Description	Benthic Tissue	Benthic Tissue	Benthic Tissue	Benthic Tissue	Benthic Tissue
	Sampled Date	10-SEP-14	10-SEP-14	10-SEP-14	13-SEP-14	14-SEP-14
	Sampled Time					
	Client ID	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	77.0	81.9	89.3	77.4	81.7
Metals	Aluminum (Al)-Total (mg/kg wwt)	253	169	177	341	275
	Antimony (Sb)-Total (mg/kg wwt)	0.0199	0.0121	0.0095	0.0165	0.0134
	Arsenic (As)-Total (mg/kg wwt)	0.644	0.263	0.261	0.434	0.387
	Barium (Ba)-Total (mg/kg wwt)	21.0	7.51	6.33	9.00	8.51
	Beryllium (Be)-Total (mg/kg wwt)	0.0136	0.0081	0.0088	0.0133	0.0118
	Bismuth (Bi)-Total (mg/kg wwt)	0.0029	0.0028	<0.0020	0.0029	0.0026
	Boron (B)-Total (mg/kg wwt)	0.62	<0.20	0.23	0.23	<0.20
	Cadmium (Cd)-Total (mg/kg wwt)	0.0545	0.0798	0.0311	0.0730	0.0717
	Calcium (Ca)-Total (mg/kg wwt)	587	381	392	565	504
	Cesium (Cs)-Total (mg/kg wwt)	0.0237	0.0206	0.0173	0.0350	0.0287
	Chromium (Cr)-Total (mg/kg wwt)	1.29	0.764	0.708	1.59	1.09
	Cobalt (Co)-Total (mg/kg wwt)	0.411	0.193	0.191	0.323	0.246
	Copper (Cu)-Total (mg/kg wwt)	8.28	3.15	3.05	6.39	6.35
	Iron (Fe)-Total (mg/kg wwt)	779	493	530	802	681
	Lead (Pb)-Total (mg/kg wwt)	0.163	0.130	0.099	0.195	0.160
	Lithium (Li)-Total (mg/kg wwt)	0.23	0.16	0.15	0.37	0.28
	Magnesium (Mg)-Total (mg/kg wwt)	360	248	216	366	304
	Manganese (Mn)-Total (mg/kg wwt)	111	55.3	45.7	68.1	45.4
	Mercury (Hg)-Total (mg/kg wwt)	0.0031	0.0027	0.0026	0.0054	0.0067
	Molybdenum (Mo)-Total (mg/kg wwt)	0.299	0.108	0.305	0.206	0.235
	Nickel (Ni)-Total (mg/kg wwt)	1.97	0.805	0.742	2.56	2.52
	Phosphorus (P)-Total (mg/kg wwt)	1610	1010	742	1720	1400
	Potassium (K)-Total (mg/kg wwt)	2560	1180	1040	1670	1470
	Rubidium (Rb)-Total (mg/kg wwt)	0.474	0.622	0.386	0.660	0.559
	Selenium (Se)-Total (mg/kg wwt)	0.381	0.179	0.173	0.283	0.312
	Sodium (Na)-Total (mg/kg wwt)	537	488	594	686	745
	Strontium (Sr)-Total (mg/kg wwt)	5.39	4.41	3.83	5.04	5.26
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00176	0.00213	0.00145	0.00245	0.00218
	Tin (Sn)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
	Uranium (U)-Total (mg/kg wwt)	0.0860	0.0252	0.0732	0.0443	0.0443
	Vanadium (V)-Total (mg/kg wwt)	1.77	0.926	1.23	2.03	1.61
	Zinc (Zn)-Total (mg/kg wwt)	27.0	10.9	10.8	21.6	18.6
	Zirconium (Zr)-Total (mg/kg wwt)	0.550	0.207	0.316	0.422	0.404

	Sample ID	L1518377-6	L1518377-7	L1518377-8	L1518377-9	L1518377-10
	Description	Benthic Tissue	Benthic Tissue	Benthic Tissue	Benthic Tissue	Benthic Tissue
	Sampled Date	11-SEP-14	11-SEP-14	11-SEP-14	12-SEP-14	12-SEP-14
	Sampled Time					
	Client ID	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	80.6	70.8	75.9	84.4	77.6
Metals	Aluminum (Al)-Total (mg/kg wwt)	278	800	777	299	676
	Antimony (Sb)-Total (mg/kg wwt)	0.0172	0.0146	0.0127	0.0083	0.0080
	Arsenic (As)-Total (mg/kg wwt)	0.328	0.588	0.614	0.262	0.385
	Barium (Ba)-Total (mg/kg wwt)	22.5	61.1	18.3	16.4	36.7
	Beryllium (Be)-Total (mg/kg wwt)	0.0307	0.0522	0.0499	0.0205	0.0376
	Bismuth (Bi)-Total (mg/kg wwt)	0.0027	0.0048	0.0035	<0.0020	0.0020
	Boron (B)-Total (mg/kg wwt)	0.38	0.34	0.22	<0.20	<0.20
	Cadmium (Cd)-Total (mg/kg wwt)	0.0838	0.127	0.0939	0.0839	0.0616
	Calcium (Ca)-Total (mg/kg wwt)	1460	732	955	497	599
	Cesium (Cs)-Total (mg/kg wwt)	0.0280	0.111	0.0779	0.0282	0.0392
	Chromium (Cr)-Total (mg/kg wwt)	1.45	3.85	3.38	3.18	2.53
	Cobalt (Co)-Total (mg/kg wwt)	0.576	0.991	1.45	0.480	0.870
	Copper (Cu)-Total (mg/kg wwt)	5.03	8.64	6.57	4.35	4.56
	Iron (Fe)-Total (mg/kg wwt)	1120	2040	2060	825	1100
	Lead (Pb)-Total (mg/kg wwt)	0.206	0.382	0.373	0.147	0.295
	Lithium (Li)-Total (mg/kg wwt)	0.22	0.78	0.94	0.34	0.40
	Magnesium (Mg)-Total (mg/kg wwt)	545	860	935	471	633
	Manganese (Mn)-Total (mg/kg wwt)	82.2	179	87.4	50.0	78.9
	Mercury (Hg)-Total (mg/kg wwt)	0.0085	0.0083	0.0065	0.0059	0.0073
	Molybdenum (Mo)-Total (mg/kg wwt)	0.160	0.208	0.129	0.0919	0.167
	Nickel (Ni)-Total (mg/kg wwt)	2.89	3.74	4.43	2.45	2.09
	Phosphorus (P)-Total (mg/kg wwt)	1370	2290	1620	1210	1360
	Potassium (K)-Total (mg/kg wwt)	1690	2740	1500	1280	1770
	Rubidium (Rb)-Total (mg/kg wwt)	0.571	1.36	0.960	0.738	0.703
	Selenium (Se)-Total (mg/kg wwt)	0.250	0.409	0.321	0.216	0.232
	Sodium (Na)-Total (mg/kg wwt)	1270	614	716	537	822
	Strontium (Sr)-Total (mg/kg wwt)	15.4	7.98	10.2	4.96	80.7
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00231	0.00455	0.00302	0.00193	0.00272
	Tin (Sn)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
	Uranium (U)-Total (mg/kg wwt)	0.179	0.151	0.123	0.0836	0.0801
	Vanadium (V)-Total (mg/kg wwt)	2.92	5.26	5.77	2.17	3.21
	Zinc (Zn)-Total (mg/kg wwt)	19.0	36.5	26.8	18.5	27.1
	Zirconium (Zr)-Total (mg/kg wwt)	0.824	0.992	1.02	0.372	0.821

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518377-11	L1518377-12	L1518377-13	L1518377-14	L1518377-15
	Description	Benthic Tissue	Benthic Tissue	Benthic Tissue	Benthic Tissue	Benthic Tissue
	Sampled Date	15-SEP-14	15-SEP-14	15-SEP-14	15-SEP-14	15-SEP-14
	Sampled Time					
	Client ID	LBC-1	LBC-2	LBC-3	LBC-4	LBC-5
Grouping	**Analyte**					
TISSUE						
Physical Tests	% Moisture (%)	83.6	89.3	93.9	87.7	78.0
Metals	Aluminum (Al)-Total (mg/kg wwt)	374	80.3	144	219	403
	Antimony (Sb)-Total (mg/kg wwt)	0.0589	0.0094	0.0233	0.0396	0.0531
	Arsenic (As)-Total (mg/kg wwt)	1.87	0.337	0.772	0.975	1.33
	Barium (Ba)-Total (mg/kg wwt)	17.4	4.74	5.25	10.2	12.2
	Beryllium (Be)-Total (mg/kg wwt)	0.0227	0.0042	0.0094	0.0118	0.0225
	Bismuth (Bi)-Total (mg/kg wwt)	0.0327	0.0050	0.0148	0.0189	0.0253
	Boron (B)-Total (mg/kg wwt)	0.25	<0.20	<0.20	<0.20	<0.20
	Cadmium (Cd)-Total (mg/kg wwt)	0.439	0.0270	0.137	0.172	0.330
	Calcium (Ca)-Total (mg/kg wwt)	629	121	203	364	460
	Cesium (Cs)-Total (mg/kg wwt)	0.228	0.0251	0.0955	0.160	0.198
	Chromium (Cr)-Total (mg/kg wwt)	1.56	0.259	0.541	0.666	1.50
	Cobalt (Co)-Total (mg/kg wwt)	0.695	0.110	0.223	0.300	0.623
	Copper (Cu)-Total (mg/kg wwt)	8.44	2.40	3.74	4.10	9.23
	Iron (Fe)-Total (mg/kg wwt)	862	194	343	561	1110
	Lead (Pb)-Total (mg/kg wwt)	0.582	0.105	0.281	0.389	0.564
	Lithium (Li)-Total (mg/kg wwt)	0.35	<0.10	0.12	0.19	0.54
	Magnesium (Mg)-Total (mg/kg wwt)	480	133	165	282	598
	Manganese (Mn)-Total (mg/kg wwt)	83.9	28.6	30.3	38.7	62.9
	Mercury (Hg)-Total (mg/kg wwt)	0.0083	0.0080	0.0046	0.0064	0.0101
	Molybdenum (Mo)-Total (mg/kg wwt)	0.300	0.590	0.324	0.0916	0.133
	Nickel (Ni)-Total (mg/kg wwt)	1.48	0.711	0.578	0.713	4.33
	Phosphorus (P)-Total (mg/kg wwt)	1510	647	344	825	1520
	Potassium (K)-Total (mg/kg wwt)	1650	564	441	832	1440
	Rubidium (Rb)-Total (mg/kg wwt)	1.35	0.179	0.519	0.746	1.25
	Selenium (Se)-Total (mg/kg wwt)	0.212	0.113	0.082	0.124	0.250
	Sodium (Na)-Total (mg/kg wwt)	776	738	279	390	580
	Strontium (Sr)-Total (mg/kg wwt)	6.39	1.59	2.60	4.33	5.34
	Tellurium (Te)-Total (mg/kg wwt)	<0.0040	<0.0040	<0.0040	<0.0040	<0.0040
	Thallium (Tl)-Total (mg/kg wwt)	0.00815	0.00240	0.00557	0.00582	0.00762
	Tin (Sn)-Total (mg/kg wwt)	<0.020	<0.020	<0.020	<0.020	<0.020
	Uranium (U)-Total (mg/kg wwt)	0.236	0.0484	0.148	0.0942	0.179
	Vanadium (V)-Total (mg/kg wwt)	2.19	0.332	0.741	1.20	2.95
	Zinc (Zn)-Total (mg/kg wwt)	32.5	11.2	10.4	24.8	38.9
	Zirconium (Zr)-Total (mg/kg wwt)	0.578	0.103	0.209	0.229	0.600

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
HG-WET-MICR-CVAF-VA	Tissue	Mercury in Tissue by CVAFS Micro (WET)	EPA 200.3, EPA 245.7

This method is adapted from US EPA Method 200.3 "Sample Procedures for Spectrochemical Determination of Total Recoverable Elements in Biological Tissues" (1996). Tissue samples are homogenized and sub-sampled prior to hotblock digestion with nitric and hydrochloric acids, in combination with repeated additions of hydrogen peroxide. Analysis is by atomic fluorescence spectrophotometry or atomic absorption spectrophotometry, adapted from US EPA Method 245.7.

ALS Test Code	Matrix	Test Description	Method Reference**
MET-WET-MICR-HRMS-VA	Tissue	Metals in Tissue by HR-ICPMS Micro (WET)	EPA 200.3/200.8

Trace metals in tissue are analyzed by high resolution inductively coupled plasma mass spectrometry (HR-ICPMS) modified from US EPA Method 200.8, (Revision 5.5). The sample preparation procedure is modified from US EPA 200.3. Analytical results are reported on wet weight basis.

Method Limitation: This method employs a strong acid/peroxide digestion, and is intended to provide a conservative estimate of bio-available metals. Near complete recoveries are achieved for most toxicologically important metals, but elements associated with recalcitrant minerals may be only partially recovered.

ALS Test Code	Matrix	Test Description	Method Reference**
MOISTURE-TISS-VA	Tissue	% Moisture in Tissues	ASTM D2974-00 Method A

This analysis is carried out gravimetrically by drying the sample at 105 C for a minimum of six hours.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1	2

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS

Chain of Custody / Analytical Re
Canada Toll Free: 1 800 668
www.alsglobal.com

L1518377-COFC

C # ____________

Page 1 of 2

Report To
Company: Minnow Environmental Inc.
Contact: Lisa Bowron
Address: 101 - 1025 Hillside Ave.
Victoria, BC
Phone: (250)595-1627x21 Fax: (250) 595-1625

Invoice To Same as Report ? ☐ Yes ☑ No
Hardcopy of Invoice with Report? ☑ Yes ☐ No
Company: Minto Explorations Ltd.
Contact: Elvina Wong
Address: Suite 900-999 West Hastings St, Vancouver BC
Phone: 604-684-8894 Fax: 604-688-2120

Lab Work Order # (lab use only)

Report Format / Distribution
☑ Standard ☐ Other
☑ PDF ☑ Excel ☐ Digital ☐ Fax
Email 1: lbowron@minnow.ca
Email 2: pstecko@minnow.ca
Email 3:

Client / Project Information
Job #: Minnow Project 2537
PO / AFE:
LSD:
Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

analysis subject to availability)
● Regular (Standard Turnaround Times - Business Days)
○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request
Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Moisture (%)	High Resolution ICP-MS scan	Mercury in Tissue by CVAFS		**See Complete Quote #Q41650								Number of Containers
	LMC-1			Tissue	X	X	X										1
	LMC-2			Tissue	X	X	X										1
	LMC-3			Tissue	X	X	X										1
	LMC-4			Tissue	X	X	X										1
	LMC-5			Tissue	X	X	X										1
	LWC-1			Tissue	X	X	X										1
	LWC-2			Tissue	X	X	X										1
	LWC-3			Tissue	X	X	X										1
	LWC-4			Tissue	X	X	X										1
	LWC-5			Tissue	X	X	X										1
	LBC-1			Tissue	X	X	X										1
	LBC-2			Tissue	X	X	X										1

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Benthic samples.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
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Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 15-Sept-14	Time (hh-mm) 07:48	Received by:	Date: 16-SEP-14	Time: 5:15	Temperature: 5.0, 5.4 4.4, 4.4 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

ALS

Chain of Custody / Analytical Re
Canada Toll Free: 1 800 66
www.alsglobal.com

L1518377-COFC

C # ____________

Page 2 of 2

Report To	
Company:	Minnow Environmental Inc.
Contact:	Lisa Bowron
Address:	101 - 1025 Hillside Ave. Victoria, BC
Phone:	(250)595-1627x21 Fax: (250) 595-1625
Invoice To Same as Report ?	☐ Yes ☑ No
Hardcopy of Invoice with Report?	☑ Yes ☐ No
Company:	Minto Explorations Ltd
Contact:	Elvina Wong
Address:	Suite 900-999 West Hastings St, Vancouver, BC
Phone:	604-684-8894 Fax: 604-688-2120
Lab Work Order # (lab use only)	

Report Format / Distribution	
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Email 1:	lbowron@minnow.ca
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Email 3:	
Client / Project Information	
Job #:	Minnow Project 2537
PO / AFE:	
LSD:	
Quote #:	Q41650
ALS Contact:	Can Dang
Sampler:	Lisa Bowron

analysis subject to availability)

- ○ Regular (Standard Turnaround Times - Business Days)
- ○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT
- ○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT
- ● Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	**Sample Identification** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	Moisture (%)	Se High Resolution ICP-MS sca	Mercury in Tissue by CVAFS		**See Complete Quote #Q41650								Number of Containers
	LBC-3			Tissue	X	X	X										1
	LBC-4			Tissue	X	X	X										1
	LBC-5			Tissue	X	X	X										1

may or may not be included
- if not will be hand delivered to
ALS Whitehorse. Trying to collect
samples before Truck leaves with policy
Hand deliver on 16-Sept-14

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs. Benthic samples

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.
By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.
Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: Lisa Bowron	Date (dd-mmm-yy) 15-Sept-14	Time (hh-mm) 07:48	Received by:	Date: 16-Sep-14	Time: 5:15	Temperature: 5.0, 5.4 4.4, 4.4°C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

GENF 20.00 Front

APPENDIX D

PERIPHYTON COMMUNITY DATA

Table D.1: Density of periphyton community sampled at lower Wolverine Creek (reference) and lower Minto Creek (exposure), Minto Mine WUL, 2014. All data are presented as cells/cm^2.

Sample Location		Lower Wolverine Creek					Lower Minto Creek				
		LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Sample Date		11-Sep-14	11-Sep-14	11-Sep-14	12-Sep-14	12-Sep-14	10-Sep-14	10-Sep-14	10-Sep-14	14-Sep-14	14-Sep-14
Group	Genera and species										
Cyanophyte	Pseudoanabaena sp.	13,207	-	-	-	-	-	-	-	-	6,202
	Phormidium autumnale Agardh	-	-	-	-	-	-	1,507	1,053	57	1,034
	Heteroleibeinia profunda Komarek	-	3,445	1,723	-	1,302	3,015	-	2,297	-	13,781
	Chamaesiphon incrustans Smith	-	-	-	-	115	-	-	-	-	-
Chlorophyte	Closteriopsis longissima Lemmermann	-	-	287	-	-	-	-	-	-	-
	Ulothrix sp.	-	-	-	1,723	-	-	2,046	2,105	-	-
	Ulothrix zonata Kutzing	-	-	1,723	861	-	-	-	-	-	2,756
Chrysophate	Tribonema sp.	-	-	-	-	-	1,292	1,292	-	-	-
Diatoms	Navicula minima Grunow	-	-	-	-	19	-	-	-	-	-
	Cymbella minuta Kutzing	-	574	574	108	-	754	1,184	1,244	345	2,756
	Tabellaria flocculsa (Roth) Kutzing	-	-	-	-	-	-	-	96	-	-
	Synedra acus v. radians (Kutzing) Hustedt	5,168	-	-	108	-	2,476	431	287	230	8,441
	Synedra ulna (Nitzsch) Ehrenberg	-	-	287	538	-	-	-	383	57	-
	Gyrosigma sp	-	-	-	108	-	-	108	-	-	-
	Achnanthes minutissima Kutzing	-	1,148	5,168	431	613	11,628	11,090	11,293	6,431	19,638
	Nitzschia linearis W. Smith	-	4,881	-	108	96	2,692	6,137	9,475	3,388	11,025
	Pinnularia flexuosa Cleve	-	-	-	-	-	108	-	-	-	-
	Fragilaria pinata Ehrenberg	-	-	-	-	-	-	-	96	-	-
	Cymbella gracilis (Rabhorst) Cleve	-	-	-	-	-	215	215	-	115	-
	Encyonema silesiacum (Bleisch) D.G. Mann	1,723	-	-	431	115	2,261	8,936	6,412	1,665	14,643
	Pinnularia borealis Ehrenberg	-	-	-	-	-	-	-	-	57	-
	Nitzschia filiformis (W. Smith) Hustedt	-	861	-	215	38	-	-	-	-	-
	Diatoma vulgare Bory	74,648	68,906	54,264	17,873	1,397	3,984	-	-	-	689
	Surirella ovata Kutzing	-	-	574	-	38	323	-	287	172	345
	Navicula radiosa Kutzing	-	-	-	-	-	969	323	96	402	689
	Cymbella lapponica	-	-	287	-	-	-	215	287	-	-
	Gomphonema minutum	-	-	-	-	38	2,476	323	1,053	-	172
	Cocconies disculus Schum.	287	-	287	-	-	538	-	96	57	-
	Diatoma elongatum Agardh	-	861	-	-	-	-	-	-	-	-
	Anomoenies vitrea Ross	-	-	287	-	38	8,613	2,907	6,891	1,493	1,895
	Gomphonema angustum Agardh	-	-	-	-	-	215	-	-	230	-
	Navicula pupula Kutzing	-	-	-	-	-	-	-	96	-	-
	Diatoma mesodon Grun.	-	-	-	-	-	-	-	-	-	172
	Navicula exigua (Greg.) Muller	-	-	-	-	-	-	108	-	919	1,895
	Fragilaria capucina Grunow	-	2,297	7,178	431	96	-	538	383	804	517
	Hannaea arcus Patrick	574	-	287	-	115	-	-	191	-	-
	Meridion circulare Agardh	574	-	574	215	77	1,077	9,259	1,340	230	7,407
Red Algae	Audouinella / Chantransia stage. Red alga	9,187	11,484	7,465	-	-	1,184	-	-	-	1,550

Table D.2: Biomass of periphyton community sampled at lower Wolverine Creek (reference) and lower Minto Creek (exposure), Minto Mine WUL, 2014. All data are presented as µg/cm^2.

Sample Location		Lower Wolverine Creek					Lower Minto Creek				
		LWC-1	**LWC-2**	**LWC-3**	**LWC-4**	**LWC-5**	**LMC-1**	**LMC-2**	**LMC-3**	**LMC-4**	**LMC-5**
Sample Date		11-Sep-14	11-Sep-14	11-Sep-14	12-Sep-14	12-Sep-14	10-Sep-14	10-Sep-14	10-Sep-14	14-Sep-14	14-Sep-14
Group	**Genera and species**										
Cyanophyte	Pseudoanabaena sp.	0.15	-	-	-	-	-	-	-	-	0.071
	Phormidium autumnale Agardh	-	-	-	-	-	-	4.5	3.1	0.16	2.7
	Heteroleibeinia profunda Komarek	-	0.23	0.087	-	0.086	0.18	-	0.12	-	0.98
	Chamaesiphon incrustans Smith	-	-	-	-	0.0046	-	-	-	-	-
Chlorophyte	Closteriopsis longissima Lemmermann	-	-	5.0	-	-	-	-	-	-	-
	Ulothrix sp.	-	-	-	1.2	-	-	2.6	3.0	-	-
	Ulothrix zonata Kutzing	-	-	22	11	-	-	-	-	-	35
Chrysophate	Tribonema sp.	-	-	-	-	-	1.4	1.6	-	-	-
Diatoms	Navicula minima Grunow	-	-	-	-	0.0039	-	-	-	-	-
	Cymbella minuta Kutzing	-	0.11	0.21	0.022	-	0.22	0.36	0.49	0.13	1.1
	Tabellaria flocculsa (Roth) Kutzing	-	-	-	-	-	-	-	0.12	-	-
	Synedra acus v. radians (Kutzing) Hustedt	4.5	-	-	0.0058	-	2.9	0.043	0.021	0.017	0.57
	Synedra ulna (Nitzsch) Ehrenberg	-	-	0.72	1.1	-	-	-	0.94	0.13	-
	Gyrosigma sp	-	-	-	0.062	-	-	0.059	-	-	-
	Achnanthes minutissima Kutzing	-	0.074	0.13	0.029	0.039	0.93	0.88	0.90	0.44	1.4
	Nitzschia linearis W. Smith	-	1.3	-	0.019	0.028	0.90	2.0	3.0	1.0	3.5
	Pinnularia flexuosa Cleve	-	-	-	-	-	1.4	-	-	-	-
	Fragilaria pinata Ehrenberg	-	-	-	-	-	-	-	0.0040	-	-
	Cymbella gracilis (Rabhorst) Cleve	-	-	-	-	-	0.41	0.39	-	0.41	-
	Encyonema silesiacum (Bleisch) D.G. Mann	1.8	-	-	0.51	0.14	2.5	11	6.5	2.0	17
	Pinnularia borealis Ehrenberg	-	-	-	-	-	-	-	-	0.13	-
	Nitzschia filiformis (W. Smith) Hustedt	-	0.10	-	0.030	0.0042	-	-	-	-	-
	Diatoma vulgare Bory	18	18	14	5.2	0.40	1.2	-	-	-	0.52
	Surirella ovata Kutzing	-	-	5.4	-	0.12	0.32	-	1.3	0.35	1.1
	Navicula radiosa Kutzing	-	-	-	-	-	3.8	1.3	0.27	1.2	2.0
	Cymbella lapponica	-	-	0.27	-	-	-	0.23	0.31	-	-
	Gomphonema minutum	-	-	-	-	0.017	1.1	0.16	0.51	-	0.075
	Cocconies disculus Schum.	0.38	-	0.44	-	-	0.75	-	0.15	0.077	-
	Diatoma elongatum Agardh	-	0.36	-	-	-	-	-	-	-	-
	Anomoenies vitrea Ross	-	-	0.088	-	0.013	3.1	0.93	2.1	0.46	0.59
	Gomphonema angustum Agardh	-	-	-	-	-	0.26	-	-	0.25	-
	Navicula pupula Kutzing	-	-	-	-	-	-	-	0.011	-	-
	Diatoma mesodon Grun.	-	-	-	-	-	-	-	-	-	0.36
	Navicula exigua (Greg.) Muller	-	-	-	-	-	-	0.017	-	0.26	0.54
	Fragilaria capucina Grunow	-	2.3	7.0	0.39	0.11	-	0.63	0.29	0.84	0.59
	Hannaea arcus Patrick	0.34	-	0.17	-	0.058	-	-	0.11	-	-
	Meridion circulare Agardh	0.88	-	1.1	0.20	0.066	1.1	22	2.1	0.42	15
Red Algae	Audouinella / Chantransia stage. Red alga	3.6	6.5	5.3	-	-	0.45	-	-	-	3.0

Table D.3: Summary statistics for periphyton density collected at lower Wolverine Creek and lower Minto Creek stations, Minto Mine WUL, 2014. All data are presented as cells/cm^2.

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
		Mean	Median	Minimum	Maximum	Standard Deviation	Mean	Median	Minimum	Maximum	Standard Deviation
Group	**Genera and species**										
Cyanophyte	Pseudoanabaena sp.	2,641	0	0	13,207	5,906	1,240	0	0	6,202	2,773
	Phormidium autumnale Agardh	0	0	0	0	0	730	1,034	0	1,507	668
	Heteroleibeinia profunda Komarek	1,294	1,302	0	3,445	1,428	3,819	2,297	0	13,781	5,731
	Chamaesiphon incrustans Smith	23	0	0	115	51	0	0	0	0	0
Chlorophyte	Closteriopsis longissima Lemmermann	57	0	0	287	128	0	0	0	0	0
	Ulothrix sp.	345	0	0	1,723	770	830	0	0	2,105	1,137
	Ulothrix zonata Kutzing	517	0	0	1,723	770	551	0	0	2,756	1,233
Chrysophate	Tribonema sp.	0	0	0	0	0	517	0	0	1,292	708
Diatoms	Navicula minima Grunow	3.8	0	0	19	8.6	0	0	0	0	0
	Cymbella minuta Kutzing	251	108	0	574	298	1,257	1,184	345	2,756	914
	Tabellaria flocculsa (Roth) Kutzing	0	0	0	0	0	19	0	0	96	43
	Synedra acus v. radians (Kutzing) Hustedt	1,055	0	0	5,168	2,300	2,373	431	230	8,441	3,520
	Synedra ulna (Nitzsch) Ehrenberg	165	0	0	538	243	88	0	0	383	167
	Gyrosigma sp	22	0	0	108	48	22	0	0	108	48
	Achnanthes minutissima Kutzing	1,472	613	0	5,168	2,107	12,016	11,293	6,431	19,638	4,765
	Nitzschia linearis W. Smith	1,017	96	0	4,881	2,161	6,543	6,137	2,692	11,025	3,662
	Pinnularia flexuosa Cleve	0	0	0	0	0	22	0	0	108	48
	Fragilaria pinata Ehrenberg	0	0	0	0	0	19	0	0	96	43
	Cymbella gracilis (Rabhorst) Cleve	0	0	0	0	0	109	115	0	215	108
	Encyonema silesiacum (Bleisch) D.G. Mann	454	115	0	1,723	731	6,783	6,412	1,665	14,643	5,319
	Pinnularia borealis Ehrenberg	0	0	0	0	0	11	0	0	57	26
	Nitzschia filiformis (W. Smith) Hustedt	223	38	0	861	368	0	0	0	0	0
	Diatoma vulgare Bory	43,418	54,264	1,397	74,648	32,253	935	0	0	3,984	1,730
	Surirella ovata Kutzing	123	0	0	574	253	225	287	0	345	142
	Navicula radiosa Kutzing	0	0	0	0	0	496	402	96	969	339
	Cymbella lapponica	57	0	0	287	128	100	0	0	287	140
	Gomphonema minutum	7.7	0	0	38	17	805	323	0	2,476	1,017
	Cocconies disculus Schum.	115	0	0	287	157	138	57	0	538	227
	Diatoma elongatum Agardh	172	0	0	861	385	0	0	0	0	0
	Anomoenies vitrea Ross	65	0	0	287	125	4,360	2,907	1,493	8,613	3,198
	Gomphonema angustum Agardh	0	0	0	0	0	89	0	0	230	122
	Navicula pupula Kutzing	0	0	0	0	0	19	0	0	96	43
	Diatoma mesodon Grun.	0	0	0	0	0	34	0	0	172	77
	Navicula exigua (Greg.) Muller	0	0	0	0	0	584	108	0	1,895	828
	Fragilaria capucina Grunow	2,000	431	0	7,178	3,041	448	517	0	804	293
	Hannaea arcus Patrick	195	115	0	574	242	38	0	0	191	86
	Meridion circulare Agardh	288	215	0	574	272	3,863	1,340	230	9,259	4,154
Red Algae	Audouinella / Chantransia stage. Red alga	5,627	7,465	0	11,484	5,331	547	0	0	1,550	760

Table D.4: Summary statistics for periphyton biomass collected at lower Wolverine Creek and lower Minto Creek stations, Minto Mine WUL, 2014. All data are presented as µg/cm^2.

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
		Mean	Median	Minimum	Maximum	Standard Deviation	Mean	Median	Minimum	Maximum	Standard Deviation
Group	**Genera and species**										
Cyanophyte	Pseudoanabaena sp.	0.030	0	0	0.15	0.067	0.014	0	0	0.071	0.032
	Phormidium autumnale Agardh	-	-	-	-	-	2.1	2.7	0	4.5	2.0
	Heteroleibeinia profunda Komarek	0.080	0.086	0	0.23	0.093	0.26	0.12	0	0.98	0.41
	Chamaesiphon incrustans Smith	0.00092	0	0	0.0046	0.0020	-	-	-	-	-
Chlorophyte	Closteriopsis longissima Lemmermann	0.99	0	0	5.0	2.2	-	-	-	-	-
	Ulothrix sp.	0.24	0	0	1.2	0.54	1.1	0	0	3.0	1.5
	Ulothrix zonata Kutzing	6.5	0	0	22	9.7	6.9	0	0	35	15
Chrysophate	Tribonema sp.	-	-	-	-	-	0.61	0	0	1.6	0.84
Diatoms	Navicula minima Grunow	0.00077	0	0	0.0039	0.0017	-	-	-	-	-
	Cymbella minuta Kutzing	0.069	0.022	0	0.21	0.091	0.46	0.36	0.13	1.1	0.37
	Tabellaria flocculsa (Roth) Kutzing	-	-	-	-	-	0.025	0	0	0.12	0.056
	Synedra acus v. radians (Kutzing) Hustedt	0.90	0	0	4.5	2.0	0.71	0.043	0.017	2.9	1.2
	Synedra ulna (Nitzsch) Ehrenberg	0.36	0	0	1.1	0.50	0.21	0	0	0.94	0.41
	Gyrosigma sp	0.012	0	0	0.062	0.028	0.012	0	0	0.059	0.027
	Achnanthes minutissima Kutzing	0.054	0.039	0	0.13	0.050	0.92	0.90	0.44	1.4	0.35
	Nitzschia linearis W. Smith	0.27	0.019	0	1.3	0.57	2.1	2.0	0.90	3.5	1.2
	Pinnularia flexuosa Cleve	-	-	-	-	-	0.27	0	0	1.4	0.61
	Fragilaria pinata Ehrenberg	-	-	-	-	-	0.00080	0	0	0.0040	0.0018
	Cymbella gracilis (Rabhorst) Cleve	-	-	-	-	-	0.24	0.39	0	0.41	0.22
	Encyonema silesiacum (Bleisch) D.G. Mann	0.48	0.14	0	1.8	0.74	7.8	6.5	2.0	17	6.3
	Pinnularia borealis Ehrenberg	-	-	-	-	-	0.026	0	0	0.13	0.058
	Nitzschia filiformis (W. Smith) Hustedt	0.027	0.0042	0	0.10	0.043	-	-	-	-	-
	Diatoma vulgare Bory	11	14	0.40	18	8.1	0.34	0	0	1.2	0.51
	Surirella ovata Kutzing	1.1	0	0	5.4	2.4	0.61	0.35	0	1.3	0.56
	Navicula radiosa Kutzing	-	-	-	-	-	1.7	1.3	0.27	3.8	1.3
	Cymbella lapponica	0.055	0	0	0.27	0.12	0.11	0	0	0.31	0.15
	Gomphonema minutum	0.0033	0	0	0.017	0.0075	0.38	0.16	0	1.1	0.47
	Cocconies disculus Schum.	0.16	0	0	0.44	0.23	0.19	0.077	0	0.75	0.31
	Diatoma elongatum Agardh	0.071	0	0	0.36	0.16	-	-	-	-	-
	Anomoenies vitrea Ross	0.020	0	0	0.088	0.038	1.4	0.93	0.46	3.1	1.1
	Gomphonema angustum Agardh	-	-	-	-	-	0.10	0	0	0.26	0.14
	Navicula pupula Kutzing	-	-	-	-	-	0.0022	0	0	0.011	0.0048
	Diatoma mesodon Grun.	-	-	-	-	-	0.072	0	0	0.36	0.16
	Navicula exigua (Greg.) Muller	-	-	-	-	-	0.16	0.017	0	0.54	0.24
	Fragilaria capucina Grunow	2.0	0.39	0	7.0	3.0	0.47	0.59	0	0.84	0.33
	Hannaea arcus Patrick	0.11	0.058	0	0.34	0.14	0.022	0	0	0.11	0.049
	Meridion circulare Agardh	0.44	0.20	0	1.1	0.49	8.2	2.1	0.42	22	10
Red Algae	Audouinella / Chantransia stage. Red alga	3.1	3.6	0	6.5	3.0	0.70	0	0	3.0	1.3

Table D.5: Presence/absence of periphyton taxa at lower Wolverine Creek (reference) and lower Minto Creek (exposure), Minto Mine WUL, 2014.

Sample Location		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
		LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Group	**Genera and species**										
Cyanophyte	Pseudoanabaena sp.	1	0	0	0	0	0	0	0	0	1
	Phormidium autumnale Agardh	0	0	0	0	0	0	1	1	1	1
	Heteroleibeinia profunda Komarek	0	1	1	0	1	1	0	1	0	1
	Chamaesiphon incrustans Smith	0	0	0	0	1	0	0	0	0	0
Chlorophyte	Closteriopsis longissima Lemmermann	0	0	1	0	0	0	0	0	0	0
	Ulothrix sp.	0	0	0	1	0	0	1	1	0	0
	Ulothrix zonata Kutzing	0	0	1	1	0	0	0	0	0	1
Chrysophate	Tribonema sp.	0	0	0	0	0	1	1	0	0	0
Diatoms	Navicula minima Grunow	0	0	0	0	1	0	0	0	0	0
	Cymbella minuta Kutzing	0	1	1	1	0	1	1	1	1	1
	Tabellaria flocculsa (Roth) Kutzing	0	0	0	0	0	0	0	1	0	0
	Synedra acus v. radians (Kutzing) Hustedt	1	0	0	1	0	1	1	1	1	1
	Synedra ulna (Nitzsch) Ehrenberg	0	0	1	1	0	0	0	1	1	0
	Gyrosigma sp	0	0	0	1	0	0	1	0	0	0
	Achnanthes minutissima Kutzing	0	1	1	1	1	1	1	1	1	1
	Nitzschia linearis W. Smith	0	1	0	1	1	1	1	1	1	1
	Pinnularia flexuosa Cleve	0	0	0	0	0	1	0	0	0	0
	Fragilaria pinata Ehrenberg	0	0	0	0	0	0	0	1	0	0
	Cymbella gracilis (Rabhorst) Cleve	0	0	0	0	0	1	1	0	1	0
	Encyonema silesiacum (Bleisch) D.G. Mann	1	0	0	1	1	1	1	1	1	1
	Pinnularia borealis Ehrenberg	0	0	0	0	0	0	0	0	1	0
	Nitzschia filiformis (W. Smith) Hustedt	0	1	0	1	1	0	0	0	0	0
	Diatoma vulgare Bory	1	1	1	1	1	1	0	0	0	1
	Surirella ovata Kutzing	0	0	1	0	1	1	0	1	1	1
	Navicula radiosa Kutzing	0	0	0	0	0	1	1	1	1	1
	Cymbella lapponica	0	0	1	0	0	0	1	1	0	0
	Gomphonema minutum	0	0	0	0	1	1	1	1	0	1
	Cocconies disculus Schum.	1	0	1	0	0	1	0	1	1	0
	Diatoma elongatum Agardh	0	1	0	0	0	0	0	0	0	0
	Anomoenies vitrea Ross	0	0	1	0	1	1	1	1	1	1
	Gomphonema angustum Agardh	0	0	0	0	0	1	0	0	1	0
	Navicula pupula Kutzing	0	0	0	0	0	0	0	1	0	0
	Diatoma mesodon Grun.	0	0	0	0	0	0	0	0	0	1
	Navicula exigua (Greg.) Muller	0	0	0	0	0	0	1	0	1	1
	Fragilaria capucina Grunow	0	1	1	1	1	0	1	1	1	1
	Hannaea arcus Patrick	1	0	1	0	1	0	0	1	0	0
	Meridion circulare Agardh	1	0	1	1	1	1	1	1	1	1
Red Algae	Audouinella / Chantransia stage. Red alga	1	1	1	0	0	1	0	0	0	1
	Taxa Total	8	9	15	13	14	18	17	21	17	19

PERIPHYTON COMMUNITY ANALYSIS

PROVIDED BY:

PLANKTON R US INC.

(WINNIPEG, MB)

Epilithic algal biomass (µg/cm2) for project 2537 for Minnow Environmental Inc. for 2014

Q = QAQC recount **Calculations based on samples area of 125 cm^2**

Project	Location	date	Cyanobacteria µg/cm^2	Chlorophyte µg/cm^2	Chrysophyte µg/cm^2	Diatom µg/cm^2	Red Algae µg/cm^2	Total µg/cm^2	comments
2537	LMC-1	10/Sep/14	0.18	0.00	1.42	20.83	0.45	22.88	
2537	LMC-2	10/Sep/14	4.52	2.57	1.62	39.83	0.00	48.54	
2537	LMC-3	10/Sep/14	3.19	2.98	0.00	19.25	0.00	25.41	
2537	LMC-4	14/Sep/14	0.16	0.00	0.00	8.05	0.00	8.21	
2537	LMC-5	14/Sep/14	3.80	34.64	0.00	44.72	3.04	86.19	
2537	LWC-1	11/Sep/14	0.15	0.00	0.00	26.16	3.64	29.95	
2537	LWC-2	11/Sep/14	0.23	0.00	0.00	22.41	6.49	29.13	
2537	LWC-2-R	11/Sep/14	0.30	0.00	0.00	22.47	5.84	28.61	
2537	LWC-3	11/Sep/14	0.09	26.61	0.00	29.78	5.35	61.83	
2537	LWC-4	12/Sep/14	0.00	12.04	0.00	7.56	0.00	19.59	
2537	LWC-5	12/Sep/14	0.09	0.00	0.00	0.99	0.00	1.08	

Epilithic algal density (cells/cm2) for project 2537 for Minnow Environmental Inc. for 2014

Q = QAQC recount

Project	Location	date	Cyanobacteria cells/cm^2	Chlorophyte cells/cm^2	Chrysophyte cells/cm^2	Diatom cells/cm^2	Red Algae cells/cm^2	Total cells/cm^2
2537	LMC-1	10/Sep/14	3015	0	1292	38329	1184	43820
2537	LMC-2	10/Sep/14	1507	2046	1292	41774	0	46619
2537	LMC-3	10/Sep/14	3350	2105	0	40004	0	45459
2537	LMC-4	14/Sep/14	57	0	0	16595	0	16652
2537	LMC-5	14/Sep/14	21016	2756	0	70284	1550	95607
2537	LWC-1	11/Sep/14	13207	0	0	82974	9187	105369
2537	LWC-2	11/Sep/14	3445	0	0	79529	11484	94459
2537	LWC-2-R	11/Sep/14	4594	0	0	80678	10336	95607
2537	LWC-3	11/Sep/14	1723	2010	0	69767	7465	80965
2537	LWC-4	12/Sep/14	0	2584	0	20564	0	23148
2537	LWC-5	12/Sep/14	1416	0	0	2680	0	4096

Epilithic algal species data for project 2537 for Minnow Environmental Inc. for 2014

**** 1st number in species code = group 1=cyanophyte 2=chlorophyte 4=chrysophyte 5=diatoms 8= red algae**
**** total daily biomass is sum of all species on a date**

Q = QAQC recount

Project	Location	Date	Species code	Speceis name	density cells/cm^2	biomass µg/cm^2	length µ	width µ	cell volume µ^3
2537	LMC-1	10-Sep-14	1131	Heteroleibeinia profunda Komarek	3015	0.18	19.40	2.00	60.90
2537	LMC-1	10-Sep-14	4242	Tribonema sp.	1292	1.42	14.00	10.00	1099.60
2537	LMC-1	10-Sep-14	5311	Cymbella minuta Kutzing	754	0.22	15.10	7.00	290.60
2537	LMC-1	10-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	2476	2.89	124.00	6.00	1168.70
2537	LMC-1	10-Sep-14	5702	Achnanthes minutissima Kutzing	11628	0.93	19.20	4.00	80.40
2537	LMC-1	10-Sep-14	5768	Nitzschia linearis W. Smith	2692	0.90	80.00	4.00	335.10
2537	LMC-1	10-Sep-14	5794	Pinnularia flexuosa Cleve	108	1.37	110.00	21.00	12699.90
2537	LMC-1	10-Sep-14	5826	Cymbella gracilis (Rabhorst) Cleve	215	0.41	49.00	10.00	1924.20
2537	LMC-1	10-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	2261	2.49	28.00	10.00	1099.60
2537	LMC-1	10-Sep-14	5860	Diatoma vulgare Bory	3984	1.16	31.00	6.00	292.20
2537	LMC-1	10-Sep-14	5866	Surirella ovata Kutzing	323	0.32	38.00	10.00	994.80
2537	LMC-1	10-Sep-14	5870	Navicula radiosa Kutzing	969	3.78	76.00	14.00	3899.80
2537	LMC-1	10-Sep-14	5873	Gomphonema minutum	2476	1.13	27.30	8.00	457.40
2537	LMC-1	10-Sep-14	5875	Cocconies disculus Schum.	538	0.75	27.00	14.00	1385.40
2537	LMC-1	10-Sep-14	5882	Anomoenies vitrea Ross	8613	3.08	38.00	6.00	358.10
2537	LMC-1	10-Sep-14	5884	Gomphonema angustum Agardh	215	0.26	46.00	10.00	1204.30
2537	LMC-1	10-Sep-14	5986	Meridion circulare Agardh	1077	1.13	40.00	10.00	1047.20
2537	LMC-1	10-Sep-14	8001	Audouinella / Chantransia stage. Red alga	1184	0.45	11.30	8.00	378.70
2537	LMC-2	10-Sep-14	1122	Phormidium autumnale Agardh	1507	4.52	106.00	6.00	2997.10
2537	LMC-2	10-Sep-14	2226	Ulothrix sp.	2046	2.57	16.00	10.00	1256.60
2537	LMC-2	10-Sep-14	4242	Tribonema sp.	1292	1.62	16.00	10.00	1256.60
2537	LMC-2	10-Sep-14	5311	Cymbella minuta Kutzing	1184	0.36	16.00	7.00	307.90
2537	LMC-2	10-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	431	0.04	96.00	2.00	100.50
2537	LMC-2	10-Sep-14	5546	Gyrosigma sp	108	0.06	39.00	6.00	551.30
2537	LMC-2	10-Sep-14	5702	Achnanthes minutissima Kutzing	11090	0.88	19.00	4.00	79.60
2537	LMC-2	10-Sep-14	5768	Nitzschia linearis W. Smith	6137	2.00	78.00	4.00	326.70
2537	LMC-2	10-Sep-14	5826	Cymbella gracilis (Rabhorst) Cleve	215	0.39	46.00	10.00	1806.40
2537	LMC-2	10-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	8936	10.53	30.00	10.00	1178.10
2537	LMC-2	10-Sep-14	5870	Navicula radiosa Kutzing	323	1.26	76.00	14.00	3899.80
2537	LMC-2	10-Sep-14	5871	Cymbella lapponica	215	0.23	41.00	10.00	1073.40
2537	LMC-2	10-Sep-14	5873	Gomphonema minutum	323	0.16	29.20	8.00	489.30
2537	LMC-2	10-Sep-14	5882	Anomoenies vitrea Ross	2907	0.93	34.00	6.00	320.40
2537	LMC-2	10-Sep-14	5910	Navicula exigua (Greg.) Muller	108	0.02	17.00	6.00	160.20
2537	LMC-2	10-Sep-14	5916	Fragilaria capucina Grunow	538	0.63	124.00	6.00	1168.70
2537	LMC-2	10-Sep-14	5986	Meridion circulare Agardh	9259	22.33	47.00	14.00	2411.70
2537	LMC-3	10-Sep-14	1122	Phormidium autumnale Agardh	1053	3.07	103.00	6.00	2912.30
2537	LMC-3	10-Sep-14	1131	Heteroleibeinia profunda Komarek	2297	0.12	17.00	2.00	53.40
2537	LMC-3	10-Sep-14	2226	Ulothrix sp.	2105	2.98	18.00	10.00	1413.70
2537	LMC-3	10-Sep-14	5311	Cymbella minuta Kutzing	1244	0.49	15.80	8.00	397.10
2537	LMC-3	10-Sep-14	5514	Tabellaria flocculsa (Roth) Kutzing	96	0.12	25.30	14.00	1298.20
2537	LMC-3	10-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	287	0.02	69.00	2.00	72.30
2537	LMC-3	10-Sep-14	5523	Synedra ulna (Nitzsch) Ehrenberg	383	0.94	260.00	6.00	2450.40
2537	LMC-3	10-Sep-14	5702	Achnanthes minutissima Kutzing	11293	0.90	19.00	4.00	79.60
2537	LMC-3	10-Sep-14	5768	Nitzschia linearis W. Smith	9475	3.02	76.00	4.00	318.30
2537	LMC-3	10-Sep-14	5825	Fragilaria pinata Ehrenberg	96	0.00	10.00	4.00	41.90
2537	LMC-3	10-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	6412	6.55	26.00	10.00	1021.00
2537	LMC-3	10-Sep-14	5866	Surirella ovata Kutzing	287	1.34	31.00	24.00	4674.70
2537	LMC-3	10-Sep-14	5870	Navicula radiosa Kutzing	96	0.27	76.00	12.00	2865.10
2537	LMC-3	10-Sep-14	5871	Cymbella lapponica	287	0.31	41.50	10.00	1086.50
2537	LMC-3	10-Sep-14	5873	Gomphonema minutum	1053	0.51	29.00	8.00	485.90
2537	LMC-3	10-Sep-14	5875	Cocconies disculus Schum.	96	0.15	30.00	14.00	1539.40
2537	LMC-3	10-Sep-14	5882	Anomoenies vitrea Ross	6891	2.14	33.00	6.00	311.00
2537	LMC-3	10-Sep-14	5887	Navicula pupula Kutzing	96	0.01	12.00	6.00	113.10
2537	LMC-3	10-Sep-14	5916	Fragilaria capucina Grunow	383	0.29	79.00	6.00	744.60
2537	LMC-3	10-Sep-14	5917	Hannaea arcus Patrick	191	0.11	61.00	6.00	574.90
2537	LMC-3	10-Sep-14	5986	Meridion circulare Agardh	1340	2.07	41.00	12.00	1545.70
2537	LMC-4	14-Sep-14	1122	Phormidium autumnale Agardh	57	0.16	99.00	6.00	2799.20
2537	LMC-4	14-Sep-14	5311	Cymbella minuta Kutzing	345	0.13	14.90	8.00	374.50
2537	LMC-4	14-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	230	0.02	71.00	2.00	74.40
2537	LMC-4	14-Sep-14	5523	Synedra ulna (Nitzsch) Ehrenberg	57	0.13	240.00	6.00	2261.90
2537	LMC-4	14-Sep-14	5702	Achnanthes minutissima Kutzing	6431	0.44	16.20	4.00	67.90
2537	LMC-4	14-Sep-14	5768	Nitzschia linearis W. Smith	3388	1.02	72.00	4.00	301.60
2537	LMC-4	14-Sep-14	5826	Cymbella gracilis (Rabhorst) Cleve	115	0.41	63.00	12.00	3562.60
2537	LMC-4	14-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1665	1.96	30.00	10.00	1178.10
2537	LMC-4	14-Sep-14	5854	Pinnularia borealis Ehrenberg	57	0.13	60.00	12.00	2261.90
2537	LMC-4	14-Sep-14	5866	Surirella ovata Kutzing	172	0.35	30.00	16.00	2010.60
2537	LMC-4	14-Sep-14	5870	Navicula radiosa Kutzing	402	1.15	76.00	12.00	2865.10

Epilithic algal species data for project 2537 for Minnow Environmental Inc. for 2014

**** 1st number in species code = group 1=cyanophyte 2=chlorophyte 4=chrysophyte 5=diatoms 8= red algae**
**** total daily biomass is sum of all species on a date**

Q = QAQC recount

Project	Location	Date	Species code	Speceis name	density cells/cm^2	biomass µg/cm^2	length µ	width µ	cell volume µ^3
2537	LMC-4	14-Sep-14	5875	Cocconies disculus Schum.	57	0.08	26.00	14.00	1334.10
2537	LMC-4	14-Sep-14	5882	Anomoenies vitrea Ross	1493	0.46	33.00	6.00	311.00
2537	LMC-4	14-Sep-14	5884	Gomphonema angustum Agardh	230	0.25	41.00	10.00	1073.40
2537	LMC-4	14-Sep-14	5910	Navicula exigua (Greg.) Muller	919	0.26	30.00	6.00	282.70
2537	LMC-4	14-Sep-14	5916	Fragilaria capucina Grunow	804	0.84	111.00	6.00	1046.20
2537	LMC-4	14-Sep-14	5986	Meridion circulare Agardh	230	0.42	36.00	14.00	1847.30
2537	LMC-5	14-Sep-14	1077	Pseudoanabaena sp.	6202	0.07	3.00	2.20	11.40
2537	LMC-5	14-Sep-14	1122	Phormidium autumnale Agardh	1034	2.75	94.00	6.00	2657.80
2537	LMC-5	14-Sep-14	1131	Heteroleibeinia profunda Komarek	13781	0.98	22.60	2.00	71.00
2537	LMC-5	14-Sep-14	2511	Ulothrix zonata Kutzing	2756	34.64	40.00	20.00	12566.40
2537	LMC-5	14-Sep-14	5311	Cymbella minuta Kutzing	2756	1.07	15.50	8.00	389.60
2537	LMC-5	14-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	8441	0.57	64.00	2.00	67.00
2537	LMC-5	14-Sep-14	5702	Achnanthes minutissima Kutzing	19638	1.42	17.30	4.00	72.50
2537	LMC-5	14-Sep-14	5768	Nitzschia linearis W. Smith	11025	3.51	76.00	4.00	318.30
2537	LMC-5	14-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	14643	17.25	30.00	10.00	1178.10
2537	LMC-5	14-Sep-14	5860	Diatoma vulgare Bory	689	0.52	80.00	6.00	754.00
2537	LMC-5	14-Sep-14	5866	Surirella ovata Kutzing	345	1.05	36.00	18.00	3053.60
2537	LMC-5	14-Sep-14	5870	Navicula radiosa Kutzing	689	1.97	76.00	12.00	2865.10
2537	LMC-5	14-Sep-14	5873	Gomphonema minutum	172	0.08	26.00	8.00	435.60
2537	LMC-5	14-Sep-14	5882	Anomoenies vitrea Ross	1895	0.59	33.00	6.00	311.00
2537	LMC-5	14-Sep-14	5890	Diatoma mesodon Grun.	172	0.36	20.00	20.00	2094.40
2537	LMC-5	14-Sep-14	5910	Navicula exigua (Greg.) Muller	1895	0.54	30.00	6.00	282.70
2537	LMC-5	14-Sep-14	5916	Fragilaria capucina Grunow	517	0.59	121.00	6.00	1140.40
2537	LMC-5	14-Sep-14	5986	Meridion circulare Agardh	7407	15.20	40.00	14.00	2052.50
2537	LMC-5	14-Sep-14	8001	Audouinella / Chantransia stage. Red alga	1550	3.04	26.00	12.00	1960.40
2537	LWC-1	11-Sep-14	1077	Pseudoanabaena sp.	13207	0.15	3.00	2.20	11.40
2537	LWC-1	11-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	574	0.05	81.00	2.00	84.80
2537	LWC-1	11-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	4594	4.46	103.00	6.00	970.80
2537	LWC-1	11-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	1723	1.76	26.00	10.00	1021.00
2537	LWC-1	11-Sep-14	5860	Diatoma vulgare Bory	74648	18.29	26.00	6.00	245.00
2537	LWC-1	11-Sep-14	5875	Cocconies disculus Schum.	287	0.38	26.00	14.00	1334.10
2537	LWC-1	11-Sep-14	5917	Hannaea arcus Patrick	574	0.34	63.00	6.00	593.80
2537	LWC-1	11-Sep-14	5986	Meridion circulare Agardh	574	0.88	30.00	14.00	1539.40
2537	LWC-1	11-Sep-14	8001	Audouinella / Chantransia stage. Red alga	9187	3.64	21.00	6.00	395.80
2537	LWC-2	11-Sep-14	1131	Heteroleibeinia profunda Komarek	3445	0.23	21.00	2.00	66.00
2537	LWC-2	11-Sep-14	5311	Cymbella minuta Kutzing	574	0.11	14.00	6.00	197.90
2537	LWC-2	11-Sep-14	5702	Achnanthes minutissima Kutzing	1148	0.07	15.30	4.00	64.10
2537	LWC-2	11-Sep-14	5768	Nitzschia linearis W. Smith	4881	1.29	63.00	4.00	263.90
2537	LWC-2	11-Sep-14	5857	Nitzschia filiformis (W. Smith) Hustedt	861	0.10	28.00	4.00	117.30
2537	LWC-2	11-Sep-14	5860	Diatoma vulgare Bory	68906	18.18	28.00	6.00	263.90
2537	LWC-2	11-Sep-14	5881	Diatoma elongatum Agardh	861	0.36	44.00	6.00	414.70
2537	LWC-2	11-Sep-14	5916	Fragilaria capucina Grunow	2297	2.29	106.00	6.00	999.00
2537	LWC-2	11-Sep-14	8001	Audouinella / Chantransia stage. Red alga	11484	6.49	30.00	6.00	565.50
2537	LWC-2-R	11-Sep-14	1131	Heteroleibeinia profunda Komarek	4594	0.30	21.00	2.00	66.00
2537	LWC-2-R	11-Sep-14	5311	Cymbella minuta Kutzing	574	0.11	14.00	6.00	197.90
2537	LWC-2-R	11-Sep-14	5702	Achnanthes minutissima Kutzing	1723	0.11	15.30	4.00	64.10
2537	LWC-2-R	11-Sep-14	5768	Nitzschia linearis W. Smith	4307	1.14	63.00	4.00	263.90
2537	LWC-2-R	11-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	574	0.68	30.00	10.00	1178.10
2537	LWC-2-R	11-Sep-14	5857	Nitzschia filiformis (W. Smith) Hustedt	1148	0.13	28.00	4.00	117.30
2537	LWC-2-R	11-Sep-14	5860	Diatoma vulgare Bory	70629	18.64	28.00	6.00	263.90
2537	LWC-2-R	11-Sep-14	5916	Fragilaria capucina Grunow	1723	1.66	102.00	6.00	961.30
2537	LWC-2-R	11-Sep-14	8001	Audouinella / Chantransia stage. Red alga	10336	5.84	30.00	6.00	565.50
2537	LWC-3	11-Sep-14	1131	Heteroleibeinia profunda Komarek	1723	0.09	16.10	2.00	50.60
2537	LWC-3	11-Sep-14	2218	Closteriopsis longissima Lemmermann	287	4.96	110.00	20.00	17278.80
2537	LWC-3	11-Sep-14	2511	Ulothrix zonata Kutzing	1723	21.65	40.00	20.00	12566.40
2537	LWC-3	11-Sep-14	5311	Cymbella minuta Kutzing	574	0.21	14.40	8.00	361.90
2537	LWC-3	11-Sep-14	5523	Synedra ulna (Nitzsch) Ehrenberg	287	0.72	265.00	6.00	2497.60
2537	LWC-3	11-Sep-14	5702	Achnanthes minutissima Kutzing	5168	0.13	6.00	4.00	25.10
2537	LWC-3	11-Sep-14	5860	Diatoma vulgare Bory	54264	14.32	28.00	6.00	263.90
2537	LWC-3	11-Sep-14	5866	Surirella ovata Kutzing	574	5.41	40.00	30.00	9424.80
2537	LWC-3	11-Sep-14	5871	Cymbella lapponica	287	0.27	36.30	10.00	950.30
2537	LWC-3	11-Sep-14	5875	Cocconies disculus Schum.	287	0.44	26.00	15.00	1531.50
2537	LWC-3	11-Sep-14	5882	Anomoenies vitrea Ross	287	0.09	32.60	6.00	307.20
2537	LWC-3	11-Sep-14	5916	Fragilaria capucina Grunow	7178	6.97	103.00	6.00	970.80
2537	LWC-3	11-Sep-14	5917	Hannaea arcus Patrick	287	0.17	62.00	6.00	584.30
2537	LWC-3	11-Sep-14	5986	Meridion circulare Agardh	574	1.06	49.00	12.00	1847.30
2537	LWC-3	11-Sep-14	8001	Audouinella / Chantransia stage. Red alga	7465	5.35	38.00	6.00	716.30

Epilithic algal species data for project 2537 for Minnow Environmental Inc. for 2014

**** 1st number in species code = group 1=cyanophyte 2=chlorophyte 4=chrysophyte 5=diatoms 8= red algae**
**** total daily biomass is sum of all species on a date**

Q = QAQC recount

Project	Location	Date	Species code	Speceis name	density cells/cm^2	biomass µg/cm^2	length µ	width µ	cell volume µ^3
2537	LWC-4	12-Sep-14	2226	Ulothrix sp.	1723	1.21	14.00	8.00	703.70
2537	LWC-4	12-Sep-14	2511	Ulothrix zonata Kutzing	861	10.82	40.00	20.00	12566.40
2537	LWC-4	12-Sep-14	5311	Cymbella minuta Kutzing	108	0.02	14.20	6.00	200.70
2537	LWC-4	12-Sep-14	5519	Synedra acus v. radians (Kutzing) Hustedt	108	0.01	51.00	2.00	53.40
2537	LWC-4	12-Sep-14	5523	Synedra ulna (Nitzsch) Ehrenberg	538	1.07	210.00	6.00	1979.20
2537	LWC-4	12-Sep-14	5546	Gyrosigma sp	108	0.06	41.00	6.00	579.60
2537	LWC-4	12-Sep-14	5702	Achnanthes minutissima Kutzing	431	0.03	15.90	4.00	66.60
2537	LWC-4	12-Sep-14	5768	Nitzschia linearis W. Smith	108	0.02	43.00	4.00	180.10
2537	LWC-4	12-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	431	0.51	30.00	10.00	1178.10
2537	LWC-4	12-Sep-14	5857	Nitzschia filiformis (W. Smith) Hustedt	215	0.03	33.00	4.00	138.20
2537	LWC-4	12-Sep-14	5860	Diatoma vulgare Bory	17873	5.22	31.00	6.00	292.20
2537	LWC-4	12-Sep-14	5916	Fragilaria capucina Grunow	431	0.39	96.30	6.00	907.60
2537	LWC-4	12-Sep-14	5986	Meridion circulare Agardh	215	0.20	36.00	10.00	942.50
2537	LWC-5	12-Sep-14	1131	Heteroleibeinia profunda Komarek	1302	0.09	21.00	2.00	66.00
2537	LWC-5	12-Sep-14	1223	Chamaesiphon incrustans Smith	115	0.00	7.00	3.30	39.90
2537	LWC-5	12-Sep-14	5306	Navicula minima Grunow	19	0.00	12.00	8.00	201.10
2537	LWC-5	12-Sep-14	5702	Achnanthes minutissima Kutzing	613	0.04	15.30	4.00	64.10
2537	LWC-5	12-Sep-14	5768	Nitzschia linearis W. Smith	96	0.03	69.00	4.00	289.00
2537	LWC-5	12-Sep-14	5836	Encyonema silesiacum (Bleisch) D.G. Mann	115	0.14	30.00	10.00	1178.10
2537	LWC-5	12-Sep-14	5857	Nitzschia filiformis (W. Smith) Hustedt	38	0.00	26.00	4.00	108.90
2537	LWC-5	12-Sep-14	5860	Diatoma vulgare Bory	1397	0.40	30.00	6.00	282.70
2537	LWC-5	12-Sep-14	5866	Surirella ovata Kutzing	38	0.12	30.00	20.00	3141.60
2537	LWC-5	12-Sep-14	5873	Gomphonema minutum	38	0.02	26.00	8.00	435.60
2537	LWC-5	12-Sep-14	5882	Anomoenies vitrea Ross	38	0.01	35.00	6.00	329.90
2537	LWC-5	12-Sep-14	5916	Fragilaria capucina Grunow	96	0.11	71.00	8.00	1189.60
2537	LWC-5	12-Sep-14	5917	Hannaea arcus Patrick	115	0.06	54.00	6.00	508.90
2537	LWC-5	12-Sep-14	5986	Meridion circulare Agardh	77	0.07	33.00	10.00	863.90

All samples were taken to a constant volume using distilled water. Replicate counts were performed on 10% of the samples as a QA/QC protocol. Replicate samples were chosen at random and processed at different times from the original analysis to reduce biased.

Enumeration and identification method

Depending on the density of algal and silt/detritus material, 1 to 2 mL subsamples of epilithon suspension were sonicated for 10-20 s using a Sonifer Cell Disruptor (model w140) (Findlay et al.1999) and gravity settled for 24 h in an Ütermohl chamber (1963). Cells were identified, counted and measured from random fields until 100 cells of the dominant species were found. Only cells that were intact and contained viable chloroplasts, identifiable by staining from the Lugol's, were enumerated. Cell counts were converted to biomass (wet weight µg cm^{-2}) by estimating cell volumes and assuming a specific gravity of 1. Estimates of cell volume for each species were obtained by measurements of up to 50 cells of an individual species and applying the geometric formula best fitted to the shape of the cell (Rott, 1981).

References

Findlay, D.L., S.E.M. Kasian, M.T. Turner, and M.P. Stainton .1999. Responses of phytoplankton and epilithon during acidification and early recovery. Freshwater Biology. 42: 159-175.

Nauwerck A. 1963. Die Beziehungen zwischen Zooplankton und Phytoplankton in See Erken. Symbolae Botanicae Upsaliensis, 17, 1-163.

Rott E. 1981. Some results from phytoplankton counting intercalibrations. Schweiz. Z. Hydrobiologia, 43, 43-62.

APPENDIX E

BENTHIC INVERTEBRATE COMMUNITY DATA

Table E.1: Benthic Invertebrates collected by Hess sampler and screened through a 500 μM sieve. Values reported as number of organisms per sample, Minto Mine WUL, 2014.

Invertebrate	Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Phylum: Arthropoda										
Subphylum: Hexapoda										
Class: Insecta										
Order: Ephemeroptera	1									
Family: Baetidae	1				1					
Baetis flavistriga						1				
Baetis tricaudatus		1	1							
Family: Ephemerellidae										
Drunella doddsii			1							
Ephemerella dorothea/exrucians		1		1	1					
Family: Heptageniidae		4	2	3						
Order: Plecoptera	1						1			
Family: Capniidae			1			3	1	1	1	1
Family: Chloroperlidae				1						
Family: Nemouridae						2	170	225	56	139
Nemoura						23	1	72	57	76
Podmosta sp.							1			
Zapada oregonensis group		1								
Family: Perlodidae	1									
Isoperla sp.		6	2		3					
Order: Trichoptera						1				
Family: Hydropsychidae										
Hydropsyche						1	2			
Family: Limnephilidae							1			
Ecclisomyia sp.	2	1			1			1		4
Order: Diptera									5	
Family: Ceratopogonidae				1						
Family: Chironomidae										
Subfamily: Chironominae										
Tribe: Tanytarsini										
Micropsectra						7				7
Subfamily: Diamesinae										
Tribe: Diamesini										
Diamesa sp.							6	4		2
Pagastia sp.			1	1	1	1		1		
Pseudodiamesa sp.						1			1	
Subfamily: Orthocladiinae										
Eukiefferiella sp.						5	121	54	22	67
Heleniella sp.						1		1		
Hydrobaenus sp.						12				
Orthocladius complex	1	17	53	21	12				3	1
Parakiefferiella						18			2	
Pseudosmittia sp.	1	3	1							
Family: Empididae					3	1		1		1
Chelifera/ Metachela								2		
Clinocera sp.							5			
Family: Psychodidae						1				
Family: Simuliidae							1			1
Family: Tipulidae					6					
Dicranota sp.				8		4		5		8
Subphylum: Chelicerata										
Class: Arachnida				1						
Order: Trombidiformes										
Family: Hygrobatidae										
Hygrobates sp.		1								
Family: Sperchontidae										
Sperchon sp.						2	4	3	1	3
Order: Oribatei										
Family: Oribatidae										
Oribatida						1				
Phylum: Annelida										
Subphylum: Clitellata										
Class: Oligochaeta										1
Order: Lumbriculida										
Family: Lumbriculidae			5		243			1		
Order: Tubificida										
Family: Enchytraeidae			7	3			4	4		
Enchytraeus	1	34								
Fridericia						15				
Family: Naididae									1	
Totals:	**9**	**69**	**74**	**40**	**271**	**100**	**318**	**375**	**149**	**311**

Table E.2: Benthic invertebrate community metrics by station for samples collected by Hess sampler, Minto Mine WUL, 2014.

Area	Station	Density	Number of Taxa	BC Distance to LWC Median	Simpson's D	Simpson's E[a]	Ephemeroptera (%)	Plecoptera (%)	Trichoptera (%)	EPT (%)	Chironomids (%)	Oligochaetes (%)	CA Axis-1 (46.4%)	CA Axis-2 (14.9%)	CA Axis-3 (13.2%)	CA Axis-4 (8.6%)
Lower Wolverine Creek (Reference)	LWC-1	30	6	0.70	0.81	0.90	22	22	22	67	22	11	-1.2	0.86	1.3	-0.26
	LWC-2	230	10	0.31	0.68	0.30	8.7	10	1.4	20	29	49	-1.2	0.20	0.19	0.26
	LWC-3	247	9	0.36	0.46	0.20	5.4	4.1	0	9.5	74	16	-1.1	-0.11	0.019	0.41
	LWC-4	133	9	0.38	0.67	0.30	10	2.5	0	13	55	7.5	-0.85	-0.50	-0.98	0.10
	LWC-5	903	9	0.81	0.19	0.10	0.7	1.1	0	2.2	4.8	90	-0.74	-0.011	-0.22	-0.61
Lower Minto Creek (Exposure)	LMC-1	333	16	0.80	0.86	0.40	1.0	28	2.0	31	45	15	0.46	-0.78	0.45	-0.26
	LMC-2	1060	11	0.97	0.71	0.30	0	55	0.9	56	40	1.3	0.72	0.52	-0.10	0.074
	LMC-3	1250	11	0.97	0.35	0.10	0	79	0	80	16	1.3	0.58	0.25	-0.25	-0.06
	LMC-4	497	8	0.95	0.39	0.20	0	77	0	77	19	0.7	0.58	-0.32	0.23	0.67
	LMC-5	1037	12	0.98	0.47	0.20	0	69	1.3	71	25	0	0.60	0.25	-0.10	-0.10

[a] calculated as recommended by Environment Canada 2012.

Table E.3: Summary of Benthic Invertebrate Community Characteristics, and Statistical Comparisons Among Areas Minto Mine WUL, 2014.

	Comparison	2-group ANOVA for Estimation of Effect Size						
Metric	**Planned Comparison**	**Mean Square**	**F (ANOVA)**	**Significant Difference Among Areas? (p-value)[a]**		**Power**	**Magnitude of Difference (# of SDs)[b]**	**Minimum Detectable Effect Size (# of SDs)[c]**
Density (Ind./m^2)	Wolverine Creek Reference vs. Minto Creek Exposure	693,444	5.0	YES	0.055	0.66	1.5	~
Number of Taxa	Wolverine Creek Reference vs. Minto Creek Exposure	23	4.2	YES	0.073	0.59	2.0	~
EPT (%)	Wolverine Creek Reference vs. Minto Creek Exposure	4,101	7.7	YES	0.024	0.81	1.6	~
Chironomids (%)	Wolverine Creek Reference vs. Minto Creek Exposure	167	0.36	NO	0.565	0.15	~	1.7
Oligochaetes (%)	Wolverine Creek Reference vs. Minto Creek Exposure	2,408	3.8	YES	0.086	0.56	-0.9	~
BC Distance to Median Ref.	Wolverine Creek Reference vs. Minto Creek Exposure	0.45	16	YES	0.004	0.97	1.9	~
Simpson's D	Wolverine Creek Reference vs. Minto Creek Exposure	0.00014	0.0026	NO	0.960	0.10	~	2.1
Simpson's E[d]	Wolverine Creek Reference vs. Minto Creek Exposure	0.042	0.78	NO	0.402	0.21	~	1.7
CA Axis-1 (46.4%)	Wolverine Creek Reference vs. Minto Creek Exposure	6.5	237	YES	0.000	1.00	7.5	~
CA Axis-2 (14.9%)	Wolverine Creek Reference vs. Minto Creek Exposure	0.027	0.10	NO	0.757	0.11	~	2.2
CA Axis-3 (13.2%)	Wolverine Creek Reference vs. Minto Creek Exposure	0.00021	0.00056	NO	0.982	0.10	~	1.6

[a] p-value obtained from 1-way ANOVA

[b] Magnitude calculated by comparing the difference between the reference and exposure area means to the reference area standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]

[c] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

[d] Calculated as recommended by Environment Canada 2012

Table E.4: Benthic Taxon Scores from Correspondence Analysis of Samples Collected at Minto Mine WUL, 2014.

Invertebrate	CA Axis-1 (46.4%)	CA Axis-2 (14.9%)	CA Axis-3 (13.2%)	CA Axis-4 (8.6%)
Family: Baetidae	-1.0	0.27	1.1	-0.33
Ephemerella dorothea/excrucians	-1.2	-0.24	-0.81	-0.26
Family: Heptageniidae	-1.4	-0.28	-0.61	0.73
Family: Capniidae	0.42	-0.32	0.24	0.20
Nemoura	0.77	0.10	0.01	0.23
Family: Perlodidae	-1.4	0.49	0.64	-0.10
Hydropsyche	0.76	-0.30	0.42	-0.28
Family: Limnephilidae	-0.19	0.83	0.42	-0.37
Micropsectra	0.68	-0.60	0.41	-0.53
Diamesa	0.83	0.82	-0.36	-0.04
Pagastia	-0.43	-0.53	-0.47	-0.26
Pseudodiamesa sp.	0.68	-1.2	0.80	0.69
Eukiefferiella	0.79	0.26	-0.05	0.24
Heleniella sp.	0.67	-0.60	0.24	-0.48
Orthocladius complex	-1.0	-0.17	-0.29	0.36
Parakiefferiella	0.64	-1.5	0.93	0.03
Pseudosmittia sp.	-1.5	0.65	1.0	0.50
Family: Empididae	0.39	0.34	-0.24	-0.53
Family: Simuliidae	0.85	0.87	-0.25	-0.03
Family: Tipulidae, probably Dicranota	-0.03	-0.32	-0.63	-0.53
Class: Arachnida	0.40	0.00	-0.13	0.10
Class: Oligochaeta: incl. F. Enchytraeidae, F. Naididae	-0.54	-0.07	-0.03	-0.25

▨ Indicates heavy negatively-weighted variable on respective CA axis

Table E.5: Benthic Analyses - ANOVA results, Minto Mine WUL, 2014.

Dependent Variable	Mean Square	F (ANOVA)	p-value	Observed Power
Density (Ind./m^2)	693,444	5.0	0.06	0.66
Number of Taxa	23	4.2	0.07	0.59
EPT Pct.	4,101	7.7	0.02	0.81
Chironomids Pct.	167	0.36	0.56	0.15
Oligochaetes Pct.	2,408	3.8	0.09	0.56
Simpson's D	0.00014	0.0026	0.96	0.10
Simpson's E	0.042	0.78	0.40	0.21
BC Distance to Median Ref.	0.45	16	0.00	0.97
CA Axis-1 (46.4%)	6.5	237	0.00	1.0
CA Axis-2 (14.9%)	0.027	0.10	0.76	0.11
CA Axis-3 (13.2%)	0.00021	0.00056	0.98	0.10
Median Intermediate Axis Length (cm)	0.036	0.18	0.68	0.067
Median Embeddedness (%)	0	0	1.00	0.050
Water Velocity (m/s)	0.00016	0.037	0.85	0.053
Depth (m)	0.0023	5.7	0.04	0.56
Temperature (°C)	0.71	0.28	0.61	0.076
DO (%)	21	10	0.01	0.80
Specific Conductivity (µS/cm)	32,833	42	0.00	1.0
pH	0.32	34	0.00	1.0
% cobble	23	0.41	0.54	0.087
% gravel	5.6	0.20	0.66	0.069
% sand and finer	5.6	0.47	0.51	0.093

▨ Indicates p value < 0.1

Table E.6: Eigenvalues of Correspondence Analysis for samples collected by Hess sampler (500 µm mesh). Minto Mine WUL, 2014.

	CA Axis-1 (46.4%)	CA Axis-2 (14.9%)	CA Axis-3 (13.2%)	CA Axis-4 (8.6%)
Eigenvalue	0.605	0.194	0.171	0.111
Relative Inertia (%)	46.4	14.9	13.2	8.6
Cumulative Inertia (%)	46.4	61.3	74.4	83.0

Table E.7: Intermediate axis length and embededdness of 100 rocks washed during Hess sampling at benthic invertebrate stations, Minto Mine WUL, 2014.

Rock Number	LWC-1		LWC-2		LWC-3		LWC-4	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	3.9		8.6		8.0		3.7	
2	5.2		6.2		5.4		6.9	
3	3.3		10.6		5.9		5.1	
4	10.6		6.4		7.6		7.2	
5	3.2		4.0		9.0		4.9	
6	4.4		5.3		4.6		4.9	
7	4.8		2.8		6.2		4.1	
8	4.5		2.2		3.7		8.3	
9	4.4		3.8		4.6		7.4	
10	4.3	0	6.4	0	3.9	0	7.2	25
11	3.3		4.1		4.0		6.3	
12	5.2		2.6		3.0		6.0	
13	5.1		5.0		3.2		4.3	
14	6.1		2.9		5.2		4.7	
15	4.3		4.4		4.8		4.0	
16	5.7		4.7		5.6		4.3	
17	4.7		7.1		2.2		3.5	
18	3.5		4.1		4.6		4.2	
19	6.4		3.9		2.5		5.7	
20	5.6	25	2.0	0	8.6	25	9.5	0
21	3.5		7.0		4.1		6.8	
22	5.2		5.0		3.6		7.7	
23	6.0		5.2		3.7		7.3	
24	9.3		3.9		3.0		6.8	
25	5.7		4.5		7.1		7.9	
26	7.1		4.5		3.1		5.8	
27	7.8		3.7		3.4		9.0	
28	3.2		2.5		6.8		5.3	
29	3.6		4.8		3.6		6.1	
30	3.9	25	5.1	50	3.2	0	6.4	0
31	4.3		4.1		3.5		6.6	
32	2.8		3.8		4.2		5.9	
33	7.0		2.9		4.8		6.3	
34	4.1		4.0		2.4		7.6	
35	2.6		3.5		3.2		5.8	
36	2.9		7.8		2.3		4.9	
37	4.0		5.2		6.6		6.8	
38	3.0		7.7		4.1		3.6	
39	6.0		5.6		7.8		4.3	
40	2.9	75	6.1	50	7.6	25	5.8	50
41	4.7		7.3		2.5		5.8	
42	2.6		6.2		4.7		7.4	
43	5.7		7.3		5.0		5.5	
44	3.2		5.0		4.8		5.8	
45	2.7		6.5		4.8		4.9	
46	2.8		4.9		4.9		5.7	
47	2.6		3.6		5.0		5.9	
48	3.0		4.7		3.2		5.5	
49	2.7		6.2		3.8		5.3	
50	2.5	0	6.5	0	6.1	25	4.9	0
51	2.5		4.2		3.1		5.0	
52	8.3		3.0		2.9		4.1	
53	6.4		3.4		3.0		3.6	
54	5.5		5.1		6.0		4.0	
55	3.7		5.0		2.9		4.2	
56	4.9		2.9		6.9		4.0	
57	8.5		4.0		4.9		4.3	
58	4.8		2.9		3.1		3.3	
59	3.1		2.9		2.9		3.0	
60	3.6	25	5.1	25	4.6	0	4.1	25
61	3.7		3.6		5.8		4.8	
62	3.2		5.0		3.2		4.2	
63	9.8		7.5		4.6		6.2	
64	5.5		3.3		2.7		4.5	
65	3.3		4.7		4.6		3.0	
66	3.2		2.6		2.5		4.0	
67	3.0		3.6		2.6		4.0	
68	4.7		6.6		6.7		3.3	
69	6.0		4.5		5.1		3.2	
70	5.3	25	2.6	0	3.4	50	3.4	0
71	3.9		2.5		2.9		3.5	
72	4.4		3.0		3.1		5.6	
73	3.7		3.5		2.7		3.1	
74	3.0		2.1		4.6		3.5	
75	5.2		2.3		7.4		4.0	
76	3.8		3.1		3.8		3.0	
77	4.6		3.0		3.5		2.5	
78	7.0		2.8		3.6		3.2	
79	2.9		2.7		4.5		4.0	
80	3.2	25	5.5	25	4.4	75	3.9	25
81	2.5		2.9		3.4		3.3	
82	3.1		3.2		3.8		2.8	
83	2.9		2.7		4.4		2.9	
84	3.2		2.9		3.7		3.8	
85	2.7		3.2		2.9		3.5	
86	2.3		2.6		3.1		2.9	
87	3.3		2.1		3.4		2.8	
88	3.5		3.0		3.9		2.2	
89	3.2		2.6		4.6		2.2	
90	2.3	25	3.0	25	3.4	50	2.5	0
91	10.8		5.1		2.7		2.9	
92	7.2		6.2		2.7		2.6	
93	4.0		6.6		3.0		2.5	
94	2.9		2.3		3.3		7.6	
95	6.5		1.9		2.3		6.1	
96	4.6		3.2		3.5		3.4	
97	5.5		2.5		2.8		5.4	
98	3.7		2.8		3.2		5.0	
99	8.6		4.1		2.6		5.3	
100	4.8	0	3.1	0	2.3	25	5.3	25
Minimum	**2.3**		**1.9**		**2.2**		**2.2**	
Maximum	**10.8**		**10.6**		**9.0**		**9.5**	
Mean	**4.5**		**4.3**		**4.2**		**4.9**	
Geometric mean	**4.2**		**4.0**		**4.0**		**4.6**	
Median	**4.0**	**25**	**4.0**	**13**	**3.8**	**25**	**4.8**	**13**

Note: intermediate axis length is the second longest axis on a rock. Embeddedness refers to how deeply the rock is surrounded or buried by other substrate.

Table E.7: Intermediate axis length and embededdness of 100 rocks washed during Hess sampling at benthic invertebrate stations, Minto Mine WUL, 2014.

Rock Number	**LWC-5**		**LMC-1**		**LMC-2**		**LMC-3**	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	5.1		5.8		8.6		5.3	
2	8.0		7.4		5.7		4.0	
3	9.1		2.7		8.4		5.0	
4	3.8		3.3		6.3		2.9	
5	4.9		2.5		8.4		4.5	
6	9.6		4.3		6.1		5.9	
7	5.7		3.6		4.4		3.5	
8	6.0		4.4		2.6		3.6	
9	3.4		5.7		4.2		3.5	
10	5.4	0	10.0	25	6.8	0	3.7	0
11	7.1		7.0		5.5		8.0	
12	7.8		4.8		6.2		4.8	
13	5.6		5.5		3.7		4.8	
14	4.4		5.9		5.0		3.6	
15	6.3		7.9		9.9		3.8	
16	6.9		4.3		4.2		4.9	
17	5.1		8.0		3.2		5.5	
18	3.0		9.5		1.9		4.0	
19	4.6		6.4		7.0		6.7	
20	6.6	0	11.5	25	5.2	75	5.6	75
21	2.3		8.7		1.9		3.6	
22	4.1		5.4		8.4		5.8	
23	7.0		4.2		4.3		3.0	
24	7.2		5.0		3.9		3.2	
25	4.2		7.1		13.1		3.2	
26	3.0		4.7		4.5		3.4	
27	7.6		6.1		2.8		4.2	
28	5.9		6.8		5.0		2.9	
29	7.0		5.2		3.1		2.7	
30	4.7	25	7.0	25	2.4	75	2.8	
31	4.6		3.7		3.5		2.5	
32	2.6		3.7		10.1		3.5	
33	9.0		4.2		3.4		3.0	
34	3.0		3.4		2.4		3.5	
35	2.9		3.9		2.5		3.5	
36	2.7		3.1		2.7		9.9	
37	6.8		4.0		2.8		4.0	
38	3.7		4.3		2.9		2.5	
39	4.2		6.6		4.6		2.9	
40	2.2	50	5.0	25	7.2	0	3.6	0
41	3.0		3.6		2.8		4.9	
42	3.0		6.0		4.0		3.9	
43	2.5		3.5		9.9		3.8	
44	2.5		6.1		3.3		4.2	
45	3.5		7.0		3.3		3.0	
46	3.9		4.6		4.4		2.2	
47	5.1		3.5		3.6		4.6	
48	7.7		2.8		2.0		3.4	
49	3.9		5.7		4.0		6.0	
50	6.5	0	3.1	50	3.3	25	8.5	
51	4.3		5.6		8.7		4.1	
52	3.6		6.2		5.9		4.1	
53	3.1		5.5		5.0		3.2	
54	2.6		6.5		4.9		3.9	
55	4.7		7.2		4.8		4.3	
56	3.6		7.5		5.3		3.9	
57	2.7		3.1		3.5		3.7	
58	3.0		3.8		5.0		7.0	
59	5.0		6.0		4.1		6.5	
60	5.1	75	3.7	25	3.0	0	6.0	25
61	2.5		2.4		5.1		2.4	
62	4.2		3.5		4.8		3.2	
63	2.0		3.5		3.5		5.2	
64	3.4		3.0		3.6		2.9	
65	3.5		4.0		3.7		3.2	
66	3.6		3.4		5.4		8.4	
67	4.3		3.2		6.1		4.5	
68	2.5		2.9		3.3		3.2	
69	6.2		4.4		8.4		3.5	
70	3.0	75	6.1	50	4.6	75	3.8	0
71	3.7		2.5		4.3		2.3	
72	5.5		3.6		3.5		5.0	
73	2.0		3.9		6.0		2.3	
74	3.3		3.3		5.5		4.5	
75	3.2		3.0		4.9		3.7	
76	4.0		3.2		2.6		3.8	
77	2.7		3.1		2.2		3.2	
78	3.0		3.6		4.7		2.7	
79	4.0		4.8		5.0		3.5	
80	9.1	25	4.5	25	7.0	0	3.5	75
81	9.2		3.4		5.4		3.8	
82	3.2		2.5		5.8		3.4	
83	7.3		3.0		6.4		3.2	
84	4.2		4.0		2.8		2.9	
85	6.4		3.7		6.5		8.2	
86	8.0		4.9		3.6		8.0	
87	9.2		6.1		3.2		5.8	
88	5.1		8.2		6.7		4.0	
89	5.0		3.4		6.6		4.5	
90	2.6	0	2.6	25	2.8	75	4.9	25
91	6.5		3.1		5.4		4.0	
92	6.3		2.4		3.0		2.7	
93	4.7		8.2		2.3		3.5	
94	5.4		5.6		7.6		3.2	
95	5.2		5.5		5.8		3.0	
96	4.7		5.1		5.9		3.1	
97	7.2		3.6		5.8		2.4	
98	4.6		2.9		5.0		3.6	
99	8.0		3.2		4.2		3.0	
100	4.0	25	3.8	25	7.6	75	3.2	0
Minimum	**2.0**		**2.4**		**1.9**		**2.2**	
Maximum	**9.6**		**11.5**		**13.1**		**9.9**	
Mean	**4.8**		**4.8**		**4.9**		**4.1**	
Geometric mean	**4.5**		**4.5**		**4.5**		**3.9**	
Median	**4.5**	**25**	**4.3**	**25**	**4.7**	**50**	**3.7**	**13**

Note: intermediate axis length is the second longest axis on a rock. Embeddedness refers to how deeply the rock is surrounded or buried by other substrate.

Table E.7: Intermediate axis length and embededdness of 100 rocks washed during Hess sampling at benthic invertebrate stations, Minto Mine WUL, 2014.

Rock Number	**LMC-4**		**LMC-5**	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	2.2		6.0	
2	2.5		5.1	
3	4.1		6.2	
4	5.0		5.8	
5	2.0		5.6	
6	1.6		6.3	
7	2.1		5.8	
8	6.0		5.0	
9	2.5		4.7	
10	2.9	0	7.0	0
11	2.4		4.2	
12	3.8		6.9	
13	3.6		10.0	
14	2.3		6.8	
15	2.6		6.8	
16	3.5		5.3	
17	2.4		3.6	
18	1.8		3.5	
19	2.9		6.3	
20	2.3	0	6.8	25
21	2.3		4.3	
22	1.9		7.5	
23	2.6		4.3	
24	2.3		3.5	
25	2.5		8.0	
26	2.0		4.0	
27	1.9		6.0	
28	2.4		3.5	
29	3.8		5.2	
30	1.6	0	4.1	0
31	1.6		7.5	
32	3.6		7.5	
33	3.0		5.1	
34	3.5		3.4	
35	6.4		5.5	
36	3.2		3.1	
37	4.0		4.5	
38	3.4		4.5	
39	10.9		3.8	
40	6.2	25	4.0	25
41	4.4		4.1	
42	5.9		5.0	
43	3.9		4.6	
44	3.6		4.0	
45	5.9		4.2	
46	6.9		3.6	
47	6.7		4.4	
48	3.9		3.3	
49	5.2		4.5	
50	5.5	25	4.5	0
51	4.5		5.4	
52	4.1		3.8	
53	3.0		5.1	
54	3.5		3.2	
55	4.1		4.9	
56	4.5		2.5	
57	3.3		3.5	
58	3.4		3.5	
59	3.8		3.4	
60	3.3	25	4.0	0
61	5.9		3.5	
62	1.8		3.3	
63	3.5		4.1	
64	4.7		3.4	
65	6.5		3.0	
66	3.0		3.3	
67	3.8		3.0	
68	5.0		2.5	
69	3.4		3.2	
70	2.7	50	3.5	25
71	2.1		2.5	
72	7.2		3.8	
73	3.0		3.5	
74	2.2		3.7	
75	10.7		4.2	
76	2.1		3.9	
77	2.2		3.6	
78	3.5		3.3	
79	4.6		2.8	
80	3.0	0	3.4	50
81	3.1		2.6	
82	2.8		3.0	
83	5.0		3.1	
84	3.3		3.0	
85	3.0		2.8	
86	5.0		3.5	
87	2.4		6.5	
88	4.8		7.6	
89	4.3		6.6	
90	4.7	50	6.1	0
91	7.9		6.0	
92	4.9		5.5	
93	4.8		5.8	
94	5.0		7.6	
95	4.7		6.8	
96	3.0		6.5	
97	3.2		4.3	
98	4.8		5.0	
99	5.5		3.8	
100	3.6	0	4.5	0
Minimum	**1.6**		**2.5**	
Maximum	**10.9**		**10.0**	
Mean	**3.8**		**4.7**	
Geometric mean	**3.5**		**4.4**	
Median	**3.5**	**13**	**4.3**	**0**

Note: intermediate axis length is the second longest axis on a rock. Embeddedness refers to how deeply the rock is surrounded or buried by other substrate.

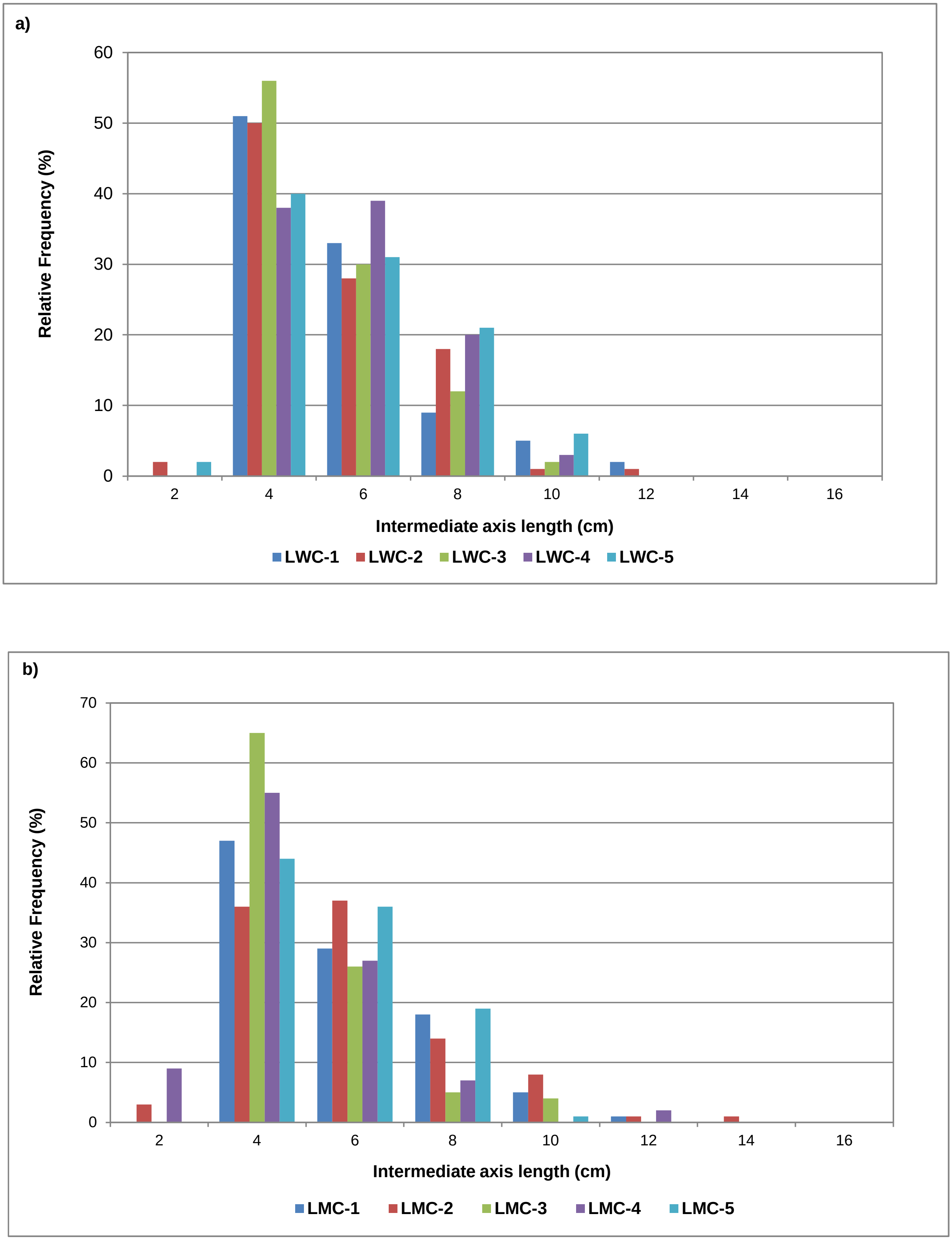

Figure E.1: Intermediate axis length of 100 rocks measured at five benthic stations in a) lower Wolverine Creek and b) lower Minto Creek.

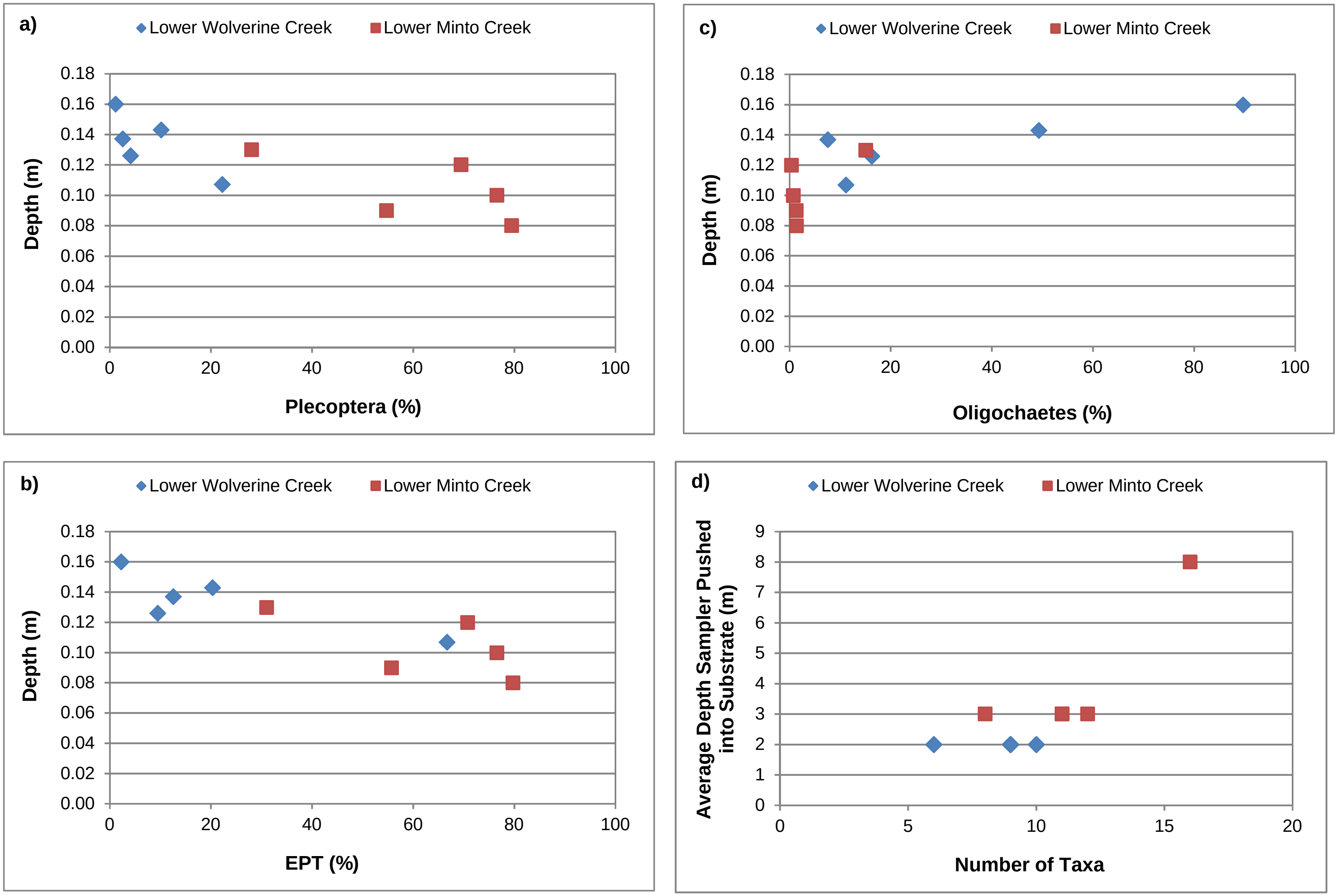

Figure E.2: Scatterplots of relationships (correlation scatterplot inspected [$p < 0.01$]) between selected benthic invertebrate community metrics and a - c) depth, d) average depth sampler pushed in, e) dissolved oxygen, f) pH and g-h) specific conductivity, Minto Mine WUL, 2014.

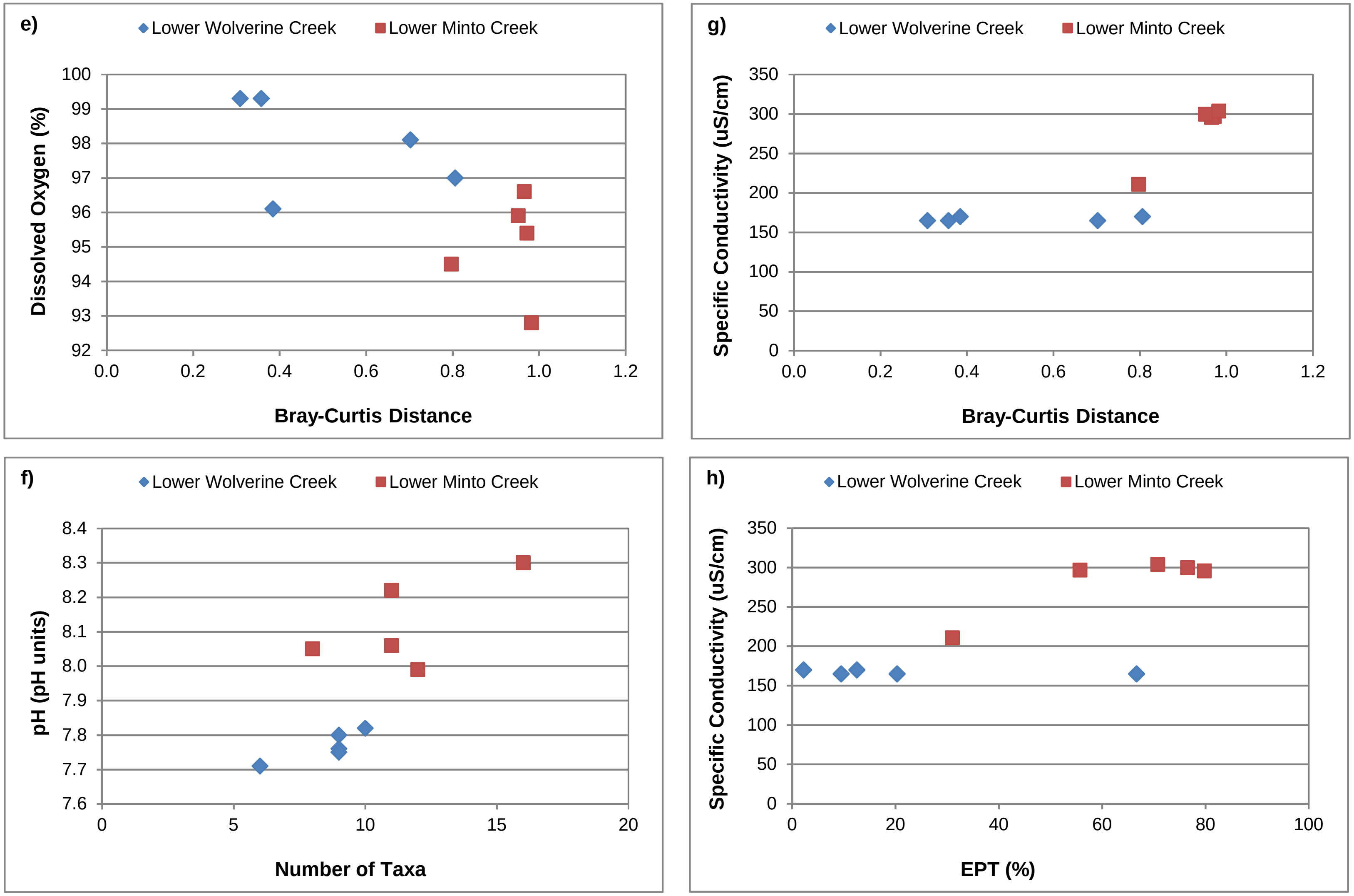

Figure E.2: Scatterplots of relationships (correlation scatterplot inspected [$p < 0.01$]) between selected benthic invertebrate community metrics and a - c) depth, d) average depth sampler pushed in, e) dissolved oxygen, f) pH and g-h) specific conductivity, Minto Mine WUL, 2014.

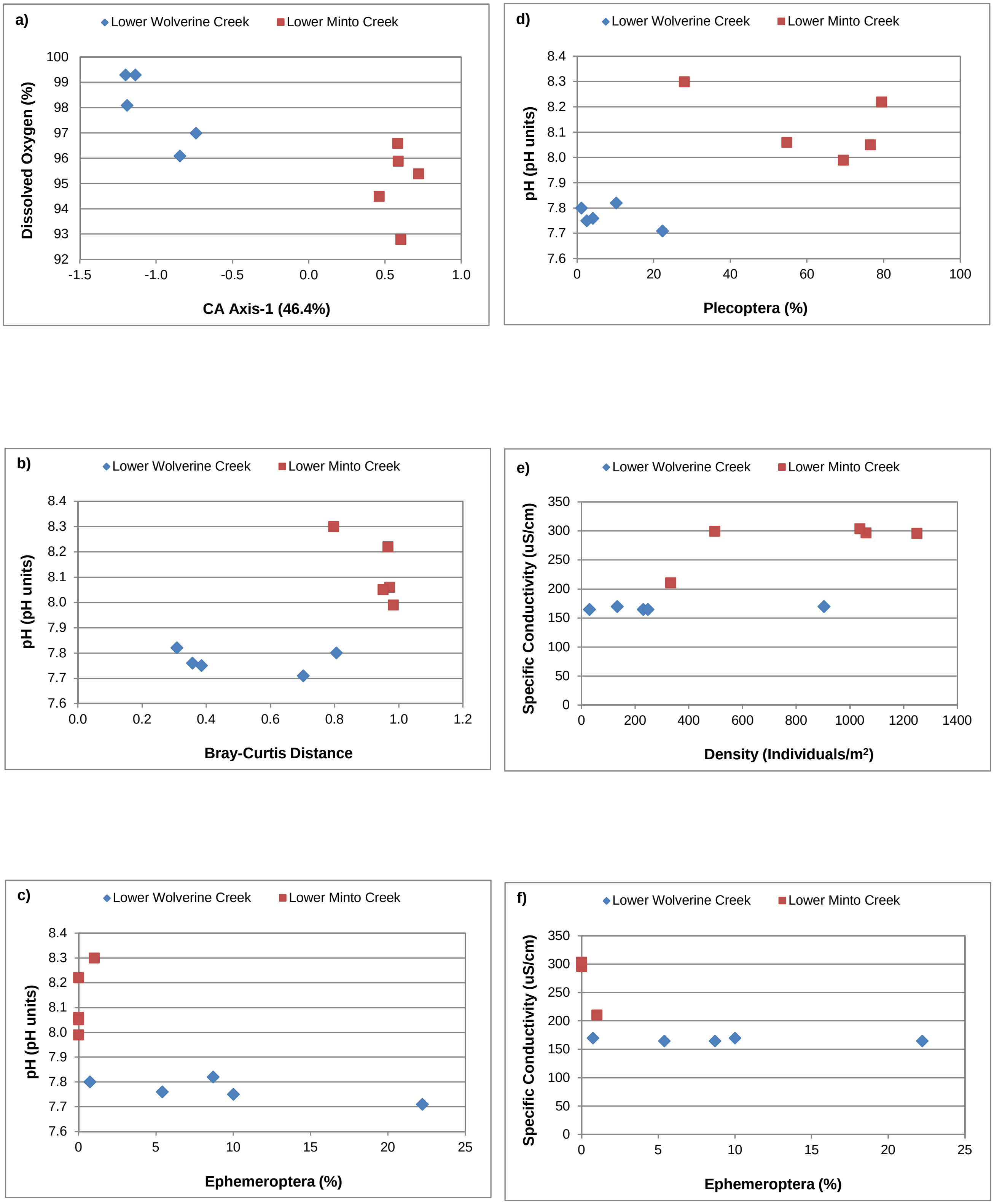

Figure E.3: Scatterplots of relationships (correlation sugestive [$p < 0.05$]) between selected benthic invertebrate community metrics and a) dissolved oxygen, b-d) pH and e-f) specific conductivity, Minto Mine WUL, 2014.

BENTHIC INVERTEBRATE COMMUNITY ANALYSIS

PROVIDED BY:

CORDILLERA CONSULTING

(SUMMERLAND, BC)

Cordillera Consulting

Project: Minto WUL (2537)
Minnow (Victoria), Shari Weech Pierre Stecko; Lisa Bowron
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Site:	LMC	LMC	LMC	LMC	LMC	LWC	LWC	LWC	LWC	LWC
Sample:	1	2	3	4	5	1	2	3	4	5
CC#:	CC150700	CC150701	CC150702	CC150703	CC150704	CC150705	CC150706	CC150707	CC150708	CC150709
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	1	0	0	0	0
| Family: Baetidae	0	0	0	0	0	1	0	0	0	1
Baetis flavistriga	1	0	0	0	0	0	0	0	0	0
Baetis tricaudatus	0	0	0	0	0	0	1	1	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	0	0	0	0
Drunella doddsii	0	0	0	0	0	0	0	1	0	0
Ephemerella dorothea/excrucians	0	0	0	0	0	0	1	0	1	1
| Family: Heptageniidae	0	0	0	0	0	0	4	2	3	0
	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	1	0	0	0	1	0	0	0	0
| Family: Capniidae	3	1	1	1	1	0	0	1	0	0
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	1	0
| Family: Nemouridae	2	170	225	56	139	0	0	0	0	0
Nemoura	23	1	72	57	76	0	0	0	0	0
Podmosta sp.	0	1	0	0	0	0	0	0	0	0
Zapada oregonensis group	0	0	0	0	0	0	1	0	0	0
| Family: Perlodidae	0	0	0	0	0	1	0	0	0	0
Isoperla sp.	0	0	0	0	0	0	6	2	0	3
	0	0	0	0	0	0	0	0	0	0
| Order: Trichoptera	1	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0
Hydropsyche	1	2	0	0	0	0	0	0	0	0
| Family: Limnephilidae	0	1	0	0	0	0	0	0	0	0
Ecclisomyia sp.	0	0	1	0	4	2	1	0	0	1
	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	5	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	1	0
| Family: Chironomidae	0	0	0	0	0	0	0	0	0	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0
Micropsectra	7	0	0	0	7	0	0	0	0	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0
Diamesa	0	6	4	0	2	0	0	0	0	0
Pagastia	1	0	1	0	0	0	0	1	1	1
Pseudodiamesa sp.	1	0	0	1	0	0	0	0	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	5	121	54	22	67	0	0	0	0	0
Heleniella sp.	1	0	1	0	0	0	0	0	0	0
Hydrobaenus	12	0	0	0	0	0	0	0	0	0
Orthocladius complex	0	0	0	3	1	1	17	53	21	12
Parakiefferiella	18	0	0	2	0	0	0	0	0	0
Pseudosmittia sp.	0	0	0	0	0	1	3	1	0	0
| Family: Empididae	1	0	1	0	1	0	0	0	0	3
Chelifera/ Metachela	0	0	2	0	0	0	0	0	0	0
Clinocera sp.	0	5	0	0	0	0	0	0	0	0
| Family: Psychodidae	1	0	0	0	0	0	0	0	0	0
| Family: Simuliidae	0	1	0	0	1	0	0	0	0	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0	6
Dicranota	4	0	5	0	8	0	0	0	8	0
	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	1	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	1	0	0	0
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0
Sperchon	2	4	3	1	3	0	0	0	0	0

Cordillera
Consulting

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Taxonomist: Sue Salter
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250-494-7553

Site:	LMC	LMC	LMC	LMC	LMC	LWC	LWC	LWC	LWC	LWC
Sample:	1	2	3	4	5	1	2	3	4	5
CC#:	CC150700	CC150701	CC150702	CC150703	CC150704	CC150705	CC150706	CC150707	CC150708	CC150709
	0	0	0	0	0	0	0	0	0	0
| Order: Oribatei	0	0	0	0	0	0	0	0	0	0
| Family: Oribatidae	0	0	0	0	0	0	0	0	0	0
Oribatida	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	1	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	1	0	0	0	0	5	0	243
	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	4	4	0	0	0	0	7	3	0
Enchytraeus	0	0	0	0	0	1	34	0	0	0
Fridericia	15	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	1	0	0	0	0	0	0
Totals:	**100**	**318**	**375**	**149**	**311**	**9**	**69**	**74**	**40**	**271**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	20	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	1	0	0	0	20	0	0	0	1	0
| Class: Copepoda	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	0	2	0	6	5	0	0	0	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	2	0	0	0	0	0	0
Totals:	**22**	**2**	**1**	**8**	**25**	**0**	**0**	**0**	**1**	**0**

Cordillera Consulting

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Site:	LMC	LMC	LMC	LMC	LMC	LWC	LWC	LWC	LWC	LWC
Sample:	1	2	3	4	5	1	2	3	4	5
CC#:	CC150700	CC150701	CC150702	CC150703	CC150704	CC150705	CC150706	CC150707	CC150708	CC150709
EMS:										
Richness Measures										
Species Richness	19	13	14	10	13	8	10	10	9	9
EPT Richness	6	7	4	3	4	5	6	5	3	4
Ephemeroptera Richness	1					2	3	3	2	2
Plecoptera Richness	3	5	3	3	3	2	2	2	1	1
Trichoptera Richness	2	2	1		1	1	1			1
Chironomidae Richness	7	2	4	4	4	2	2	3	2	2
Oligochaeta Richness	1	1	2	1	1	1	1	2	1	1
Non-Chiro. Non-Olig. Richness										
Abundance Measures										
Corrected Abundance	100	318	375	149	311	9	69	74	40	271
EPT Abundance	31	177	299	114	220	6	14	7	5	6
Dominance Measures										
1st Dominant Taxon	Nemoura	Nemouridae	Nemouridae	Nemoura	Nemouridae	Ecclisomyia sp.	Enchytraeus	Orthocladius complex	Orthocladius complex	Lumbriculidae
1st Dominant Abundance	23	170	225	57	139	2	34	53	21	243
2nd Dominant Taxon	Parakiefferiella	Eukiefferiella	Nemoura	Nemouridae	Nemoura	Enchytraeus	Orthocladius complex	Enchytraeidae	Dicranota	Orthocladius complex
2nd Dominant Abundance	18	121	72	56	76	1	17	7	8	12
3rd Dominant Taxon	Fridericia	Diamesa	Eukiefferiella	Eukiefferiella	Eukiefferiella	Ephemeroptera	Isoperla sp.	Lumbriculidae	Enchytraeidae	Tipulidae
3rd Dominant Abundance	15	6	54	22	67	1	6	5	3	6
% 1 Dominant Taxon	23.00%	53.46%	60.00%	38.26%	44.69%	22.22%	49.28%	71.62%	52.50%	89.67%
% 2 Dominant Taxa	18.00%	38.05%	19.20%	37.58%	24.44%	11.11%	24.64%	9.46%	20.00%	4.43%
% 3 Dominant Taxa	15.00%	1.89%	14.40%	14.77%	21.54%	11.11%	8.70%	6.76%	7.50%	2.21%
Community Composition										
% Ephemeroptera	1.00%					22.22%	8.70%	5.41%	10.00%	0.74%
% Plecoptera	28.00%	54.72%	79.47%	76.51%	69.45%	22.22%	10.14%	4.05%	2.50%	1.11%
% Trichoptera	2.00%	0.94%	0.27%		1.29%	22.22%	1.45%			0.37%
% EPT	31.00%	55.66%	79.73%	76.51%	70.74%	66.67%	20.29%	9.46%	12.50%	2.21%
% Diptera	51.00%	41.82%	18.13%	22.15%	27.97%	22.22%	28.99%	74.32%	77.50%	8.12%
% Oligochaeta	15.00%	1.26%	1.33%	0.67%	0.32%	11.11%	49.28%	16.22%	7.50%	89.67%
% Baetidae	1.00%					11.11%	1.45%	1.35%		0.37%
% Chironomidae	45.00%	39.94%	16.00%	18.79%	24.76%	22.22%	28.99%	74.32%	55.00%	4.80%
% Odonata										

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Site:	LMC	LMC	LMC	LMC	LMC	LWC	LWC	LWC	LWC	LWC
Sample:	1	2	3	4	5	1	2	3	4	5
CC#:	CC150700	CC150701	CC150702	CC150703	CC150704	CC150705	CC150706	CC150707	CC150708	CC150709
EMS:										
Functional Group Composition										
% Predators	8.00%	2.83%	2.93%	0.67%	3.86%	11.11%	10.14%	2.70%	22.50%	2.21%
% Shredder-Herbivores	25.00%	54.09%	79.20%	75.84%	69.13%		1.45%			
% Collector-Gatherers	41.00%	3.14%	2.93%	4.70%	3.54%	44.44%	81.16%	93.24%	65.00%	95.20%
% Scrapers										
% MH										
% CF	1.00%	0.94%			0.32%					
% OM	5.00%	38.05%	14.67%	14.77%	22.83%	22.22%	1.45%			0.37%
% PA										
% Piercer-Herbivore										
% Gatherer										
% Unclassified	20.00%	0.94%	0.27%	4.03%	0.32%	22.22%	5.80%	4.05%	12.50%	2.21%
Functional Group Richness										
Predators Richness	4	2	4	1	3	1	2	1	2	2
Shredder-Herbivores Richness	2	3	2	2	2		1			
Collector-Gatherers Richness	7	2	5	4	4	4	5	7	4	5
Scrapers Richness										
MH Richness										
CF Richness	1	2			1					
OM Richness	1	1	2	1	2	1	1			1
PA Richness										
Piercer-Herbivore Richness										
Gatherer Richness										
Unclassified	4	3	1	2	1	2	1	2	3	1
Diversity/Evenness Measures										
Shannon-Weiner H' (log 10)	1.01	0.47	0.53	0.61	0.63	0.89	0.66	0.49	0.66	0.22
Shannon-Weiner H' (log 2)	3.36	1.58	1.76	2.02	2.08	2.95	2.18	1.63	2.18	0.73
Shannon-Weiner H' (log e)	2.33	1.09	1.22	1.40	1.44	2.04	1.51	1.13	1.51	0.50
Simpson's Index (D)	0.13	0.43	0.42	0.31	0.31	0.03	0.31	0.52	0.31	0.81
Simpson's Index of Diversity (1 - D)	0.87	0.57	0.58	0.69	0.69	0.97	0.69	0.48	0.69	0.19
Simpson's Reciprocal Index (1/D)	8.00	2.33	2.40	3.26	3.28	36.00	3.25	1.91	3.20	1.24
Biotic Indices										
Hilsenhoff Biotic Index	3.40	3.51	1.70	1.90	2.41	2.89	6.86	5.93	4.83	7.56

Cordillera
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Site:	LMC	LMC	LMC	LMC	LMC	LWC	LWC	LWC	LWC	LWC
Sample:	1	2	3	4	5	1	2	3	4	5
CC#:	CC150700	CC150701	CC150702	CC150703	CC150704	CC150705	CC150706	CC150707	CC150708	CC150709
EMS:										
Sieve Size:	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	1	0	0	0	0
| Family: Baetidae	0	0	0	0	0	1	0	0	0	1
Baetis flavistriga	1	0	0	0	0	0	0	0	0	0
Baetis tricaudatus	0	0	0	0	0	0	1	1	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	0	0	0	0
Drunella doddsii	0	0	0	0	0	0	0	1	0	0
Ephemerella dorothea/excrucians	0	0	0	0	0	0	1	0	1	1
| Family: Heptageniidae	0	0	0	0	0	0	4	2	3	0
	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	0	1	0	0	0	1	0	0	0	0
| Family: Capniidae	3	1	1	1	1	0	0	1	0	0
| Family: Chloroperlidae	0	0	0	0	0	0	0	0	1	0
| Family: Nemouridae	2	170	225	56	139	0	0	0	0	0
Nemoura	23	1	72	57	76	0	0	0	0	0
Podmosta sp.	0	1	0	0	0	0	0	0	0	0
Zapada oregonensis group	0	0	0	0	0	0	1	0	0	0
| Family: Perlodidae	0	0	0	0	0	1	0	0	0	0
Isoperla sp.	0	0	0	0	0	0	6	2	0	3
	0	0	0	0	0	0	0	0	0	0
| Order: Trichoptera	1	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0
Hydropsyche	1	2	0	0	0	0	0	0	0	0
| Family: Limnephilidae	0	1	0	0	0	0	0	0	0	0
Ecclisomyia sp.	0	0	1	0	4	2	1	0	0	1
	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	5	0	0	0	0	0	0
| Family: Ceratopogonidae	0	0	0	0	0	0	0	0	1	0
| Family: Chironomidae	0	0	0	0	0	0	0	0	0	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0
Micropsectra	7	0	0	0	7	0	0	0	0	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0
Diamesa	0	6	4	0	2	0	0	0	0	0
Pagastia	1	0	1	0	0	0	0	1	1	1
Pseudodiamesa sp.	1	0	0	1	0	0	0	0	0	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	5	121	54	22	67	0	0	0	0	0
Heleniella sp.	1	0	1	0	0	0	0	0	0	0
Hydrobaenus	12	0	0	0	0	0	0	0	0	0
Orthocladius complex	0	0	0	3	1	1	17	53	21	12
Parakiefferiella	18	0	0	2	0	0	0	0	0	0
Pseudosmittia sp.	0	0	0	0	0	1	3	1	0	0
| Family: Empididae	1	0	1	0	1	0	0	0	0	3
Chelifera/ Metachela	0	0	2	0	0	0	0	0	0	0
Clinocera sp.	0	5	0	0	0	0	0	0	0	0
| Family: Psychodidae	1	0	0	0	0	0	0	0	0	0
| Family: Simuliidae	0	1	0	0	1	0	0	0	0	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0	6
Dicranota	4	0	5	0	8	0	0	0	8	0
	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	0	0	0	0	0	1	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	1	0	0	0
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0
Sperchon	2	4	3	1	3	0	0	0	0	0

Cordillera
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Site:	LMC	LMC	LMC	LMC	LMC	LWC	LWC	LWC	LWC	LWC
Sample:	1	2	3	4	5	1	2	3	4	5
CC#:	CC150700	CC150701	CC150702	CC150703	CC150704	CC150705	CC150706	CC150707	CC150708	CC150709
EMS:										
Sieve Size:	500	500	500	500	500	500	500	500	500	500
SubSample %:	100	100	100	100	100	100	100	100	100	100
	0	0	0	0	0	0	0	0	0	0
| Order: Oribatei	0	0	0	0	0	0	0	0	0	0
| Family: Oribatidae	0	0	0	0	0	0	0	0	0	0
Oribatida	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	1	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	1	0	0	0	0	5	0	243
	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	4	4	0	0	0	0	7	3	0
Enchytraeus	0	0	0	0	0	1	34	0	0	0
Fridericia	15	0	0	0	0	0	0	0	0	0
| Family: Naididae	0	0	0	1	0	0	0	0	0	0
Totals:	**100**	**318**	**375**	**149**	**311**	**9**	**69**	**74**	**40**	**271**

Taxa present but not included:

Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0
| Class: Entognatha	0	0	0	0	0	0	0	0	0	0
| Order: Collembola	20	0	1	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Subphylum: Crustacea	0	0	0	0	0	0	0	0	0	0
| Class: Ostracoda	1	0	0	0	20	0	0	0	1	0
| Class: Copepoda	1	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Phylum: Nemata	0	2	0	6	5	0	0	0	0	0
Phylum: Platyhelminthes	0	0	0	0	0	0	0	0	0	0
| Class: Turbellaria	0	0	0	2	0	0	0	0	0	0
Totals:	**22**	**2**	**1**	**8**	**25**	**0**	**0**	**0**	**1**	**0**

Cordillera
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Site - LMC Sample - 1, CC# - CC150700, Percent sampled = 100, Sieve size = 500

Capniidae	None	3	
Nemouridae	None	2	
Hydropsyche	None	1	
Baetis flavistriga	None	1	
Empididae	None	1	
Psychodidae	None	1	Telmatoscopus?
Nemoura	None	23	
Trichoptera	None	1	
Micropsectra	None	7	
Hydrobaenus	None	12	
Pseudodiamesa sp.	None	1	
Pagastia	None	1	
Parakiefferiella	None	18	
Eukiefferiella	None	5	
Heleniella sp.	None	1	
Oribatida	None	1	
Sperchon	None	2	
Dicranota	None	4	
Fridericia	None	15	
Total:		**100**	

Site - LMC Sample - 2, CC# - CC150701, Percent sampled = 100, Sieve size = 500

Diamesa	None	6	
Eukiefferiella	None	121	
Simuliidae	None	1	
Clinocera sp.	None	5	
Sperchon	None	4	
Enchytraeidae	None	4	
Hydropsyche	None	2	
Nemoura	None	1	
Nemouridae	None	170	
Capniidae	None	1	
Podmosta sp.	None	1	
Plecoptera	None	1	
Limnephilidae	None	1	
Total:		**318**	

Site - LMC Sample - 3, CC# - CC150702, Percent sampled = 100, Sieve size = 500

Nemouridae	None	225	
Capniidae	None	1	
Nemoura	None	72	
Pagastia	None	1	
Eukiefferiella	None	54	
Diamesa	None	4	
Heleniella sp.	None	1	
Dicranota	None	5	
Chelifera/ Metachela	None	2	
Sperchon	None	3	
Lumbriculidae	None	1	
Enchytraeidae	None	4	
Empididae	None	1	Rhamphomyia
Ecclisomyia sp.	None	1	
Total:		**375**	

Site - LMC Sample - 4, CC# - CC150703, Percent sampled = 100, Sieve size = 500

Pseudodiamesa sp.	None	1	
Orthocladius complex	None	3	
Parakiefferiella	None	2	
Eukiefferiella	None	22	
Naididae	None	1	
Sperchon	None	1	
Nemouridae	None	56	
Nemoura	None	57	
Capniidae	None	1	
Diptera	None	5	
Total:		**149**	

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Site - LMC Sample - 5, CC# - CC150704, Percent sampled = 100, Sieve size = 500

Nemoura	None	76
Capniidae	None	1
Orthocladius complex	None	1
Diamesa	None	2
Micropsectra	None	7
Eukiefferiella	None	67
Sperchon	None	3
Dicranota	None	8
Empididae	None	1
Simuliidae	None	1
Nemouridae	None	139
Ecclisomyia sp.	None	4
Oligochaeta	None	1
	Total:	**311**

Site - LWC Sample - 1, CC# - CC150705, Percent sampled = 100, Sieve size = 500

Pseudosmittia sp.	None	1
Orthocladius complex	None	1
Enchytraeus	None	1
Baetidae	None	1
Perlodidae	None	1
Ephemeroptera	None	1
Ecclisomyia sp.	None	2
Plecoptera	None	1
	Total:	**9**

Site - LWC Sample - 2, CC# - CC150706, Percent sampled = 100, Sieve size = 500

Isoperla sp.	None	6
Ecclisomyia sp.	None	1
Zapada oregonensis group	None	1
Baetis tricaudatus	None	1
Heptageniidae	None	4
Ephemerella dorothea/excrucians	None	1
Pseudosmittia sp.	None	3
Orthocladius complex	None	17
Hygrobates	None	1
Enchytraeus	None	34
	Total:	**69**

Site - LWC Sample - 3, CC# - CC150707, Percent sampled = 100, Sieve size = 500

Pagastia	None	1
Orthocladius complex	None	53
Pseudosmittia sp.	None	1
Lumbriculidae	None	5
Enchytraeidae	None	7
Baetis tricaudatus	None	1
Drunella doddsii	None	1
Capniidae	None	1
Heptageniidae	None	2
Isoperla sp.	None	2
	Total:	**74**

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Site - LWC Sample - 4, CC# - CC150708, Percent sampled = 100, Sieve size = 500

Chloroperlidae	None	1
Arachnida	None	1
Ephemerella dorothea/excrucians	None	1
Heptageniidae	None	3
Ceratopogonidae	None	1
Pagastia	None	1
Orthocladius complex	None	21
Enchytraeidae	None	3
Dicranota	None	8
	Total:	**40**

Site - LWC Sample - 5, CC# - CC150709, Percent sampled = 100, Sieve size = 500

Pagastia	None	1
Orthocladius complex	None	12
Lumbriculidae	None	243
Isoperla sp.	None	3
Ecclisomyia sp.	None	1
Ephemerella dorothea/excrucians	None	1
Baetidae	None	1
Empididae	None	3
Tipulidae	None	6
	Total:	**271**

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Client	**Project**	**Site**	**Sample**	**EMS**	**CC#**	**500 micron fraction**	
						% Sampled	**# Invertebrates**
Minnow (\	Minto WU	LMC	1		CC150700	100%	122
Minnow (\	Minto WU	LMC	2		CC150701	100%	320
Minnow (\	Minto WU	LMC	3		CC150702	100%	376
Minnow (\	Minto WU	LMC	4		CC150703	100%	157
Minnow (\	Minto WU	LMC	5		CC150704	100%	336
Minnow (\	Minto WU	LWC	1		CC150705	100%	9
Minnow (\	Minto WU	LWC	2		CC150706	100%	69
Minnow (\	Minto WU	LWC	3		CC150707	100%	74
Minnow (\	Minto WU	LWC	4		CC150708	100%	41
Minnow (\	Minto WU	LWC	5		CC150709	100%	271

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	Functional Feeding Groups	**ITIS Number**	**Tolerance**
Phylum: Arthropoda	Unclassified	82696	
Subphylum: Hexapoda	Unclassified	563886	
| Class: Insecta	Unclassified	99208	
| Order: Ephemeroptera	Unclassified	100502	
| Family: Baetidae	Collector-Gatherer	100755	4
Baetis flavistriga	Collector-Gatherer	100835	4
Baetis tricaudatus	Collector-Gatherer	100817	6
| Family: Ephemerellidae	Unclassified	101232	
Drunella doddsii	Collector-Gatherer	101365	
Ephemerella dorothea/excrucians	Collector-Gatherer	101233	1
| Family: Heptageniidae	Unclassified	100504	
| Order: Plecoptera	Unclassified	102467	
| Family: Capniidae	Unclassified	102643	
| Family: Chloroperlidae	Unclassified	103202	
| Family: Nemouridae	Shredder-Herbivore	102517	
Nemoura	Shredder-Herbivore	102526	1
Podmosta sp.	Shredder-Herbivore	102605	2
Zapada oregonensis group	Shredder-Herbivore	102597	2
| Family: Perlodidae	Predator	102994	2
Isoperla sp.	Predator	102995	2
| Order: Trichoptera	Unclassified	115095	
| Family: Hydropsychidae	Collector-Filterer	115398	4
Hydropsyche	Collector-Filterer	115453	4
| Family: Limnephilidae	Unclassified	115933	
Ecclisomyia sp.	Omnivore	116025	2
| Order: Diptera	Unclassified	118831	
| Family: Ceratopogonidae	Unclassified	127076	6
| Family: Chironomidae	Unclassified	127917	7
| Subfamily: Chironominae	Collector-Gatherer	129228	7
| Tribe: Tanytarsini	Collector-Gatherer	129872	7
Micropsectra	Collector-Gatherer	129890	7
| Subfamily: Diamesinae	Collector-Gatherer	128341	5
| Tribe: Diamesini	Unclassified	128351	5
Diamesa	Collector-Gatherer	128355	5
Pagastia	Collector-Gatherer	128401	1
Pseudodiamesa sp.	Collector-Gatherer	128416	6

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	Functional Feeding Groups	ITIS Number	Tolerance
| Subfamily: Orthocladiinae	Unclassified	128457	8
Eukiefferiella	Omnivore	128689	8
Heleniella sp.	Collector-Gatherer	128730	6
Hydrobaenus	Collector-Gatherer	128750	8
Orthocladius complex	Collector-Gatherer	128874	6
Parakiefferiella	Collector-Gatherer	128968	4
Pseudosmittia sp.	Collector-Gatherer	129071	
| Family: Empididae	Predator	135830	6
Chelifera/ Metachela	Predator	135830	6
Clinocera sp.	Predator	135849	6
| Family: Psychodidae	Unclassified	125351	
| Family: Simuliidae	Collector-Filterer	126640	6
| Family: Tipulidae	Unclassified	118840	
Dicranota	Predator	121027	3
Subphylum: Chelicerata	Unclassified	82697	5
| Class: Arachnida	Predator	82708	5
| Order: Trombidiformes	Predator	82769	8
| Family: Hygrobatidae	Unclassified	83281	8
Hygrobates	Predator	83297	8
| Family: Sperchontidae	Unclassified	895710	8
Sperchon	Predator	83006	8
| Order: Oribatei	Predator	83544	5
| Family: Oribatidae	Predator		5
Oribatida	Predator	733326	5
Phylum: Annelida	Unclassified	64357	5
Subphylum: Clitellata	Unclassified	568832	5
| Class: Oligochaeta	Collector-Gatherer	68422	5
| Order: Lumbriculida	Unclassified	68439	8
| Family: Lumbriculidae	Collector-Gatherer	68440	8
| Order: Tubificida	Unclassified	68498	10
| Family: Enchytraeidae	Collector-Gatherer	68510	10
Enchytraeus	Collector-Gatherer	68531	10
Fridericia	Unclassified	204785	
| Family: Naididae	Collector-Gatherer	68854	10

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Phylum	Sub Phylum	Class	Order	Family	Subfamily	Tribe	Taxonomy	Ecoscape Code A	Ecoscape Code B	ITIS Code	Functional Feeding Group	Maturity	Name	Site	Sample	CC#	Count	Percent Sampled	Seive Size	Season	Reach	Site	Transect	Parent
Arthropoda	Hexapoda	Insecta	Plecoptera	Capniidae				B004		102643		None	Capniidae	LMC	1	CC150700	3	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae				B161	L210	102517	SH	None	Nemouridae	LMC	1	CC150700	2	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Hydropsychidae			Hydropsyche	B201	L068	115453	CF	None	Hydropsyche	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Baetidae			Baetis flavistriga			100835	CG	None	Baetis flavistriga	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Empididae				B103	L202	135830	P	None	Empididae	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Psychodidae						125351		None	Psychodidae	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Nemoura			102526	SH	None	Nemoura	LMC	1	CC150700	23	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera					B086	L161	115095		None	Trichoptera	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Chironominae	Tanytarsini	Micropsectra	B013	L236	129890	CG	None	Micropsectra	LMC	1	CC150700	7	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Hydrobaenus	B177	L237	128750	CG	None	Hydrobaenus	LMC	1	CC150700	12	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pseudodiamesa sp.			128416	CG	None	Pseudodiamesa sp.	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pagastia	B019	L107	128401	CG	None	Pagastia	LMC	1	CC150700	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Parakiefferiella	B096	L109	128968	CG	None	Parakiefferiella	LMC	1	CC150700	18	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Eukiefferiella	B024	L053	128689	OM	None	Eukiefferiella	LMC	1	CC150700	5	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Heleniella sp.			128730	CG	None	Heleniella sp.	LMC	1	CC150700	1	100	500					
Arthropoda	Chelicerata	Arachnida	Oribatei	Oribatidae			Oribatida		L101	733326	P	None	Oribatida	LMC	1	CC150700	1	100	500					
Arthropoda	Chelicerata	Arachnida	Trombidiformes	Sperchontidae			Sperchon	B042	L144	83006	P	None	Sperchon	LMC	1	CC150700	2	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Tipulidae			Dicranota	B194	L239	121027	P	None	Dicranota	LMC	1	CC150700	4	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae			Fridericia			204785		None	Fridericia	LMC	1	CC150700	15	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Diamesa	B018	L034	128355	CG	None	Diamesa	LMC	2	CC150701	6	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Eukiefferiella	B024	L053	128689	OM	None	Eukiefferiella	LMC	2	CC150701	121	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Simuliidae				B106	L139	126640	CF	None	Simuliidae	LMC	2	CC150701	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Empididae			Clinocera sp.			135849	P	None	Clinocera sp.	LMC	2	CC150701	5	100	500					
Arthropoda	Chelicerata	Arachnida	Trombidiformes	Sperchontidae			Sperchon	B042	L144	83006	P	None	Sperchon	LMC	2	CC150701	4	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae				B049	L041	68510	CG	None	Enchytraeidae	LMC	2	CC150701	4	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Hydropsychidae			Hydropsyche	B201	L068	115453	CF	None	Hydropsyche	LMC	2	CC150701	2	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Nemoura			102526	SH	None	Nemoura	LMC	2	CC150701	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae				B161	L210	102517	SH	None	Nemouridae	LMC	2	CC150701	170	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Capniidae				B004		102643		None	Capniidae	LMC	2	CC150701	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Podmosta sp.	B076		102605	SH	None	Podmosta sp.	LMC	2	CC150701	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera					B003	L120	102467		None	Plecoptera	LMC	2	CC150701	1	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Limnephilidae				B186	L212	115933		None	Limnephilidae	LMC	2	CC150701	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae				B161	L210	102517	SH	None	Nemouridae	LMC	3	CC150702	225	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Capniidae				B004		102643		None	Capniidae	LMC	3	CC150702	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Nemoura			102526	SH	None	Nemoura	LMC	3	CC150702	72	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pagastia	B019	L107	128401	CG	None	Pagastia	LMC	3	CC150702	1	100	500					

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Phylum	Sub Phylum	Class	Order	Family	Subfamily	Tribe	Taxonomy	Ecoscape Code A	Ecoscape Code B	ITIS Code	Functional Feeding Group	Maturity	Name	Site	Sample	CC#	Count	Percent Sampled	Seive Size	Season	Reach	Site	Transect	Parent
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Eukiefferiella	B024	L053	128689	OM	None	Eukiefferiella	LMC	3	CC150702	54	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Diamesa	B018	L034	128355	CG	None	Diamesa	LMC	3	CC150702	4	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Heleniella sp.			128730	CG	None	Heleniella sp.	LMC	3	CC150702	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Tipulidae			Dicranota	B194	L239	121027	P	None	Dicranota	LMC	3	CC150702	5	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Empididae			Chelifera/ Metachela	B103		135830	P	None	Chelifera/ Metachela	LMC	3	CC150702	2	100	500					
Arthropoda	Chelicerata	Arachnida	Trombidiformes	Sperchontidae			Sperchon	B042	L144	83006	P	None	Sperchon	LMC	3	CC150702	3	100	500					
Annelida	Clitellata	Oligochaeta	Lumbriculida	Lumbriculidae				B048	L081	68440	CG	None	Lumbriculidae	LMC	3	CC150702	1	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae				B049	L041	68510	CG	None	Enchytraeidae	LMC	3	CC150702	4	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Empididae				B103	L202	135830	P	None	Empididae	LMC	3	CC150702	1	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Limnephilidae			Ecclisomyia sp.	B128		116025	OM	None	Ecclisomyia sp.	LMC	3	CC150702	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pseudodiamesa sp.			128416	CG	None	Pseudodiamesa sp.	LMC	4	CC150703	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LMC	4	CC150703	3	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Parakiefferiella	B096	L109	128968	CG	None	Parakiefferiella	LMC	4	CC150703	2	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Eukiefferiella	B024	L053	128689	OM	None	Eukiefferiella	LMC	4	CC150703	22	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Naididae				B052	L088	68854	CG	None	Naididae	LMC	4	CC150703	1	100	500					
Arthropoda	Chelicerata	Arachnida	Trombidiformes	Sperchontidae			Sperchon	B042	L144	83006	P	None	Sperchon	LMC	4	CC150703	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae				B161	L210	102517	SH	None	Nemouridae	LMC	4	CC150703	56	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Nemoura			102526	SH	None	Nemoura	LMC	4	CC150703	57	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Capniidae				B004		102643		None	Capniidae	LMC	4	CC150703	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera					B008	L220	118831		None	Diptera	LMC	4	CC150703	5	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Nemoura			102526	SH	None	Nemoura	LMC	5	CC150704	76	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Capniidae				B004		102643		None	Capniidae	LMC	5	CC150704	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LMC	5	CC150704	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Diamesa	B018	L034	128355	CG	None	Diamesa	LMC	5	CC150704	2	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Chironominae	Tanytarsini	Micropsectra	B013	L236	129890	CG	None	Micropsectra	LMC	5	CC150704	7	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Eukiefferiella	B024	L053	128689	OM	None	Eukiefferiella	LMC	5	CC150704	67	100	500					
Arthropoda	Chelicerata	Arachnida	Trombidiformes	Sperchontidae			Sperchon	B042	L144	83006	P	None	Sperchon	LMC	5	CC150704	3	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Tipulidae			Dicranota	B194	L239	121027	P	None	Dicranota	LMC	5	CC150704	8	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Empididae				B103	L202	135830	P	None	Empididae	LMC	5	CC150704	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Simuliidae				B106	L139	126640	CF	None	Simuliidae	LMC	5	CC150704	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae				B161	L210	102517	SH	None	Nemouridae	LMC	5	CC150704	139	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Limnephilidae			Ecclisomyia sp.	B128		116025	OM	None	Ecclisomyia sp.	LMC	5	CC150704	4	100	500					
Annelida	Clitellata	Oligochaeta						B047	L217	68422	CG	None	Oligochaeta	LMC	5	CC150704	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Pseudosmittia sp.	B028		129071	CG	None	Pseudosmittia sp.	LWC	1	CC150705	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LWC	1	CC150705	1	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae			Enchytraeus	B050	L192	68531	CG	None	Enchytraeus	LWC	1	CC150705	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Baetidae				B159	L180	100755	CG	None	Baetidae	LWC	1	CC150705	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Perlodidae				B079	L115	102994	P	None	Perlodidae	LWC	1	CC150705	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera					B001	L209	100502		None	Ephemeroptera	LWC	1	CC150705	1	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Limnephilidae			Ecclisomyia sp.	B128		116025	OM	None	Ecclisomyia sp.	LWC	1	CC150705	2	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera					B003	L120	102467		None	Plecoptera	LWC	1	CC150705	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Perlodidae			Isoperla sp.	B126		102995	P	None	Isoperla sp.	LWC	2	CC150706	6	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Limnephilidae			Ecclisomyia sp.	B128		116025	OM	None	Ecclisomyia sp.	LWC	2	CC150706	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Nemouridae			Zapada oregonensis group	B162		102597	SH	None	Zapada oregonensis group	LWC	2	CC150706	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Baetidae			Baetis tricaudatus	B066	L014	100817	CG	None	Baetis tricaudatus	LWC	2	CC150706	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Heptageniidae				B124	L063	100504		None	Heptageniidae	LWC	2	CC150706	4	100	500					

Cordillera
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Phylum	Sub Phylum	Class	Order	Family	Subfamily	Tribe	Taxonomy	Ecoscape Code A	Ecoscape Code B	ITIS Code	Functional Feeding Group	Maturity	Name	Site	Sample	CC#	Count	Percent Sampled	Seive Size	Season	Reach	Site	Transect	Parent
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Ephemerellidae			Ephemerella dorothea/excrucians	B170	L042	101233	CG	None	Ephemerella dorothea/excrucians	LWC	2	CC150706	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Pseudosmittia sp.	B028		129071	CG	None	Pseudosmittia sp.	LWC	2	CC150706	3	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LWC	2	CC150706	17	100	500					
Arthropoda	Chelicerata	Arachnida	Trombidiformes	Hygrobatidae			Hygrobates	B112	L071	83297	P	None	Hygrobates	LWC	2	CC150706	1	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae			Enchytraeus	B050	L192	68531	CG	None	Enchytraeus	LWC	2	CC150706	34	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pagastia	B019	L107	128401	CG	None	Pagastia	LWC	3	CC150707	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LWC	3	CC150707	53	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Pseudosmittia sp.	B028		129071	CG	None	Pseudosmittia sp.	LWC	3	CC150707	1	100	500					
Annelida	Clitellata	Oligochaeta	Lumbriculida	Lumbriculidae				B048	L081	68440	CG	None	Lumbriculidae	LWC	3	CC150707	5	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae				B049	L041	68510	CG	None	Enchytraeidae	LWC	3	CC150707	7	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Baetidae			Baetis tricaudatus	B066	L014	100817	CG	None	Baetis tricaudatus	LWC	3	CC150707	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Ephemerellidae			Drunella doddsii	B069	L196	101365	CG	None	Drunella doddsii	LWC	3	CC150707	1	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Capniidae				B004		102643		None	Capniidae	LWC	3	CC150707	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Heptageniidae				B124	L063	100504		None	Heptageniidae	LWC	3	CC150707	2	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Perlodidae			Isoperla sp.	B126		102995	P	None	Isoperla sp.	LWC	3	CC150707	2	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Chloroperlidae				B160		103202		None	Chloroperlidae	LWC	4	CC150708	1	100	500					
Arthropoda	Chelicerata	Arachnida						B181		82708	P	None	Arachnida	LWC	4	CC150708	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Ephemerellidae			Ephemerella dorothea/excrucians	B170	L042	101233	CG	None	Ephemerella dorothea/excrucians	LWC	4	CC150708	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Heptageniidae				B124	L063	100504		None	Heptageniidae	LWC	4	CC150708	3	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Ceratopogonidae				B188		127076		None	Ceratopogonidae	LWC	4	CC150708	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pagastia	B019	L107	128401	CG	None	Pagastia	LWC	4	CC150708	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LWC	4	CC150708	21	100	500					
Annelida	Clitellata	Oligochaeta	Tubificida	Enchytraeidae				B049	L041	68510	CG	None	Enchytraeidae	LWC	4	CC150708	3	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Tipulidae			Dicranota	B194	L239	121027	P	None	Dicranota	LWC	4	CC150708	8	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Diamesinae	Diamesini	Pagastia	B019	L107	128401	CG	None	Pagastia	LWC	5	CC150709	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Chironomidae	Orthocladiinae		Orthocladius complex	B026	L105	128874	CG	None	Orthocladius complex	LWC	5	CC150709	12	100	500					
Annelida	Clitellata	Oligochaeta	Lumbriculida	Lumbriculidae				B048	L081	68440	CG	None	Lumbriculidae	LWC	5	CC150709	243	100	500					
Arthropoda	Hexapoda	Insecta	Plecoptera	Perlodidae			Isoperla sp.	B126		102995	P	None	Isoperla sp.	LWC	5	CC150709	3	100	500					
Arthropoda	Hexapoda	Insecta	Trichoptera	Limnephilidae			Ecclisomyia sp.	B128		116025	OM	None	Ecclisomyia sp.	LWC	5	CC150709	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Ephemerellidae			Ephemerella dorothea/excrucians	B170	L042	101233	CG	None	Ephemerella dorothea/excrucians	LWC	5	CC150709	1	100	500					
Arthropoda	Hexapoda	Insecta	Ephemeroptera	Baetidae				B159	L180	100755	CG	None	Baetidae	LWC	5	CC150709	1	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Empididae				B103	L202	135830	P	None	Empididae	LWC	5	CC150709	3	100	500					
Arthropoda	Hexapoda	Insecta	Diptera	Tipulidae						118840		None	Tipulidae	LWC	5	CC150709	6	100	500					

Cordillera
Consulting

Project: Minto WUL (2537)
Minnow (Victoria), Shari Weech Pierre Stecko; Lisa Bowron
Taxonomist: Sue Salter
suesalter@shaw.ca
250-494-7553

			Total from Sample	**Percent Efficiency**
Site - QC Sample - QC 1, CC# - CC150701, Percent sampled = 100, Sieve size = 500				
Diptera	None	1		
	Total:	**1**	**320**	**100%**

Appendix I – Fisheries Monitoring Program, Minto Creek, 2014 Summary Report

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FISHERIES MONITORING PROGRAM, MINTO CREEK

2014 SUMMARY REPORT

FINAL

December 2014

Prepared for:

MINTO EXPLORATIONS LTD

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1 INTRODUCTION

Minto Explorations Ltd. (MintoEx), a wholly owned subsidiary of Capstone Mining Corp. (Capstone), owns and operates the Minto Mine, a high-grade copper mine, located approximately 240 km northwest of Whitehorse, Yukon Territory (Figure 1-1). The project is located within Selkirk First Nation (Selkirk) Category A Settlement Land Parcel R6A, and is centered at approximately 62°37'N latitude and 137°15'W longitude. The Minto Mine commenced commercial operation in October 2007 and is permitted to conduct mining and milling operations at a rate of 4,200 tonnes of ore per day (tpd). The Minto orebody (copper/gold/silver) currently being mined is located in the upper reaches of the Minto Creek watershed approximately 12 km to the west of the Minto Creek confluence with the Yukon River (Figure 1-2). MintoEx is required, under the terms of its water use license #QZ96-006 (Amendment 8), to conduct an annual biological monitoring program, of which this fisheries monitoring program in Minto Creek is a component. This current report provides details of the monitoring conducted during the open water season in 2014 and the results of the work undertaken. This program was carried out under DFO Scientific Collection Licence number XR 169 2014.

MINTO MINE

MINTO EXPLORATIONS LTD.
A Subsidiary of Capstone Mining Corp.

FISHERIES MONITORING PROGRAM, MINTO CREEK - 2014 SUMMARY REPORT

FIGURE 1-1
PROJECT LOCATION

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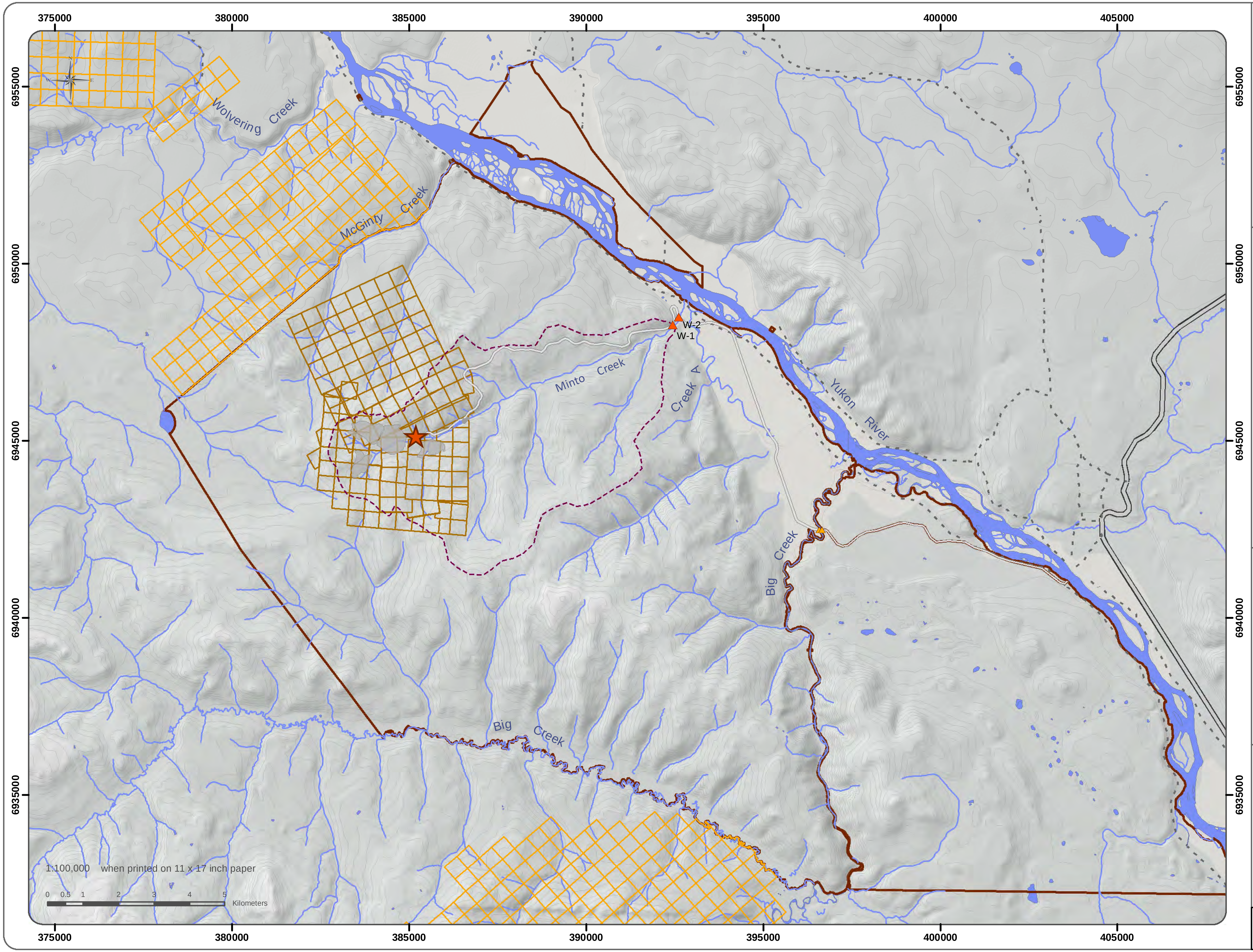
MINTO MINE

FISHERIES MONITORING PROGRAM,
MINTO CREEK - 2014
SUMMARY REPORT

FIGURE 1-2
AREA OVERVIEW



- ★ Minto Mine Site
- ▲ Fish Monitoring Station
- ▲ Water Quality Station
- ═ Mine Access Road
- ━ Road
- - - Trail
- ─ Watercourse
- ■ Waterbody
- ■ Existing Minto Mine Footprints
- ⬚ Minto Creek Catchment
- ☐ Other Quartz Claims
- ☐ Minto Explorations Ltd. Quartz Claims
- ☐ First Nation Settlement Land

National Topographic Data Base (NTDB) and Canvec compiled by Natural Resources Canada at a scale of 1:50,000.Reproduced under license from Her Majesty the Queen in Right of Canada, as represented by the Minister of Natural Resources Canada. All rights reserved.

Quartz claims data obtained from Energy, Mines and Ressources, YTG. Data currrent as of August 1st 2011.

NAD 83 UTM Zone 8N

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(*Last edited by: jlindeman;14/02/2013/15:54 PM*)

2 PREVIOUS STUDIES

Attempts to collect fish in lower Minto Creek while conducting the Phase 1 Metal Mining Effluent Regulation, Environmental Effects Monitoring (EEM) study in 2008 resulted in the capture of no fish during the month of June and very few fish during the month of September. This is consistent with the findings of previous fish investigations conducted in the creek (HKP 1994; R&D 2006, 2007). Fish use of Minto Creek is transient and likely short-lived as has been found in other non-natal Chinook rearing creeks (Walker 1976; Scrivener et al. 1994). Minto Creek does not provide preferred spawning habitat for fish and the fact that it completely freezes during winter months, with no winter flow in lower Minto Creek, negates its suitability for spawning by Chinook salmon. Accordingly, there is no evidence of spawning in Minto Creek (HKP 1994; R&D 2006, 2007), nor is there traditional knowledge indicating spawning occurring in the system (HKP 1994).

Although water flows are adequate to support fish during the spring it appears that fish do not enter Minto Creek until early summer (late June to early July), once water temperature in the creek rises and equilibrates with that of the Yukon River. Lower Minto Creek is also subject to low or zero flow conditions during periods in the summer when a portion (or all) of the flow sometimes infiltrates the ground following passage through a canyon located approximately 2.0 km upstream of the Yukon River.

In the past, when fish have been captured in the creek, the majority of them tended to be juvenile Chinook salmon (*Onchoryhnchus tshawytscha*). Other species that have been found in the creek in low numbers include round whitefish (*Prosopium cylindraceum*), Arctic grayling (*Thymallus arcticus*), Slimy sculpin (*Cottus cognatus*) and Burbot (*Lota lota*). Fish sampling events conducted in 1994, 2006, 2007 (summarized in the Phase 1 EEM study design; Minnow/Access 2007) and as part of the Phase II EEM study design in 2008 (Minnow/Access 2009; Table 2.6) yielded both low numbers of fish and catch-per-unit-effort (CPUE).

During the summer of 2009, the Minto Mine was given authorization to discharge effluent from the site under an amendment to its Water Use License. This resulted in a substantial increase in water flow rate in Minto Creek for a sustained period from June 26th through October 30th. Fish sampling conducted during this discharge period indicated that fish (juvenile Chinook salmon in particular), were possibly being attracted by the higher flow in Minto Creek and/or the temperature differential between Minto Creek and the Yukon River resulting from the discharge. This was apparent in a marked increase in CPUE using minnow traps. The numbers of fish entering Minto Creek as a result of the discharge were substantial enough for Fisheries and Oceans Canada (DFO), Whitehorse Office, to direct the company to undertake a fish re-location program on lower Minto Creek and establish a fish barrier near the Yukon River confluence in order to prevent additional fish from moving into Minto Creek. DFO was concerned that the fish could become stranded in Minto Creek following cessation of the discharge. The fish re-location project was undertaken from late September through early October and resulted in the capture of 987 juvenile Chinook salmon. At the beginning of the relocation, some minnow traps were yielding catches as high as 80 individuals per minnow trap in an overnight set. Prior to this, the most salmon captured in a sampling event (excluding those captured at the Yukon River confluence), including the application of both electrofishing and multiple minnow trapping effort was 17 (Minnow/Access 2009).

In 2010, a mark-recapture study was undertaken to better understand the dynamics of the juvenile Chinook salmon (JCS) population using Minto Creek. The study was developed to determine how use of the system by JCS changes throughout the open-water season and to determine how long individual fish may stay in the creek system (i.e. residency time). No juvenile Chinook salmon or other species were encountered in Minto Creek during a late June sampling event. This is consistent with previous studies in that few fish if any have been encountered in the creek prior to July. During this study fish were still present in the system in early November. Numbers of JCS increased on subsequent events from July 14 until August 11 when the peak number were captured. The estimated population of JCS in the creek at this time was 1,500 after what the numbers declined. The number of fish captured in 2009 and 2010 were much higher on a "catch per unit effort" basis than in years previous to 2009. As in 2009, Minto Mine was influencing the flow regime in Minto Creek through a controlled water discharge from the mine site throughout much of the summer until early November 2010. This likely influenced an increased use of the system by juvenile Chinook salmon. Analysis of marked fish recaptured indicates that much of the population does not remain in the creek for an extended period of time and that there is a high degree of immigration and emigration of the population in the creek. The data suggests that 90% of the population may only spend up to approximately two weeks in the system. Only a few individuals (1%) spent an extended period of time (> 12 weeks) in the system. JCS growth leveled off towards the end of August, likely a reflection of cooling water temperatures. Overall, the growth of individuals in the system is consistent with JCS populations in other tributaries of the Yukon River.

In 2011, 2012 and 2013, Minnow trapping was conducted at the same sites as in 2010, from July to October in 2011, June to September in 2012 and May to October in 2013. The 2012 and 2013 sampling programs also included electrofishing in Minto Creek in May/June, as well as the use of Big Creek as a reference site. In comparison to 2010 when some trapping events returned over 400 juvenile Chinook salmon in Minto Creek, a very small number of fish were captured in 2011, 2012 and 2013. The 2011 and 2012 capture numbers are consistent with fish usage numbers in the creek during the years the mine was not discharging into the creek, and prior to mine operations (no mine water discharge occurred in 2011 and discharge occurred only during freshet in 2012). Very few fish (3 out of total of 29) were captured during the first 2011 sampling event in mid-July indicating, as determined in previous studies, that fish do not likely enter the creek until after June. A total of 13 fish were captured in Minto Creek in 2012, including three juvenile Chinook salmon which were all captured in September, nine slimy sculpins and one Arctic grayling. In 2013, a total of 132 fish were captured, 121 of which were JCS. All JCS were captured through Minnow trapping in August, September and October. All but one of the fish captured earlier in the season were caught through electrofishing, and included slimy sculpins, arctic grayling and one burbot. No fish were captured upstream of the natural barrier identified in Minto Creek during the 2010 assessment work. No adult fish were observed spawning in the vicinity of the Minto Creek/Yukon River confluence, or no signs that this area is used for spawning (such as redds or carcasses) were observed during 2011, 2012 or 2013. Bottom substrate in the confluence area consists primarily of silt and mud which is not considered suitable substrate for salmon spawning.

A summary of past fish sampling results in Minto Creek is presented in Table 2-1.

Table 2-1 Summary of Fish captures in Minto Creek between 2008 and 2013.

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
2008	Backpack Electrofishing	796 s	Catch	#	1	0
			CPUE	Fish/min	0.075	0
	Baited Gee Minnow Trapping	28.6 days	Catch	#	18	0
			CPUE	Fish/day	0.63	0
2009*	Baited Gee Minnow Trapping	28.6 days	Catch	#	136	142
			CPUE	Fish/day	4.76	4.97
2010	Baited Gee Minnow Trapping	145.9 days	Catch	#	2293	2307
			CPUE	Fish/day	15.72	15.81
2011	Baited Gee Minnow Trapping	71 days	Catch	#	12	29
			CPUE	Fish/day	0.17	0.41
2012	Backpack Electrofishing	1051 s	Catch	#	0	4
			CPUE	Fish/min	0	0.23
	Baited Gee Minnow Trapping	43.0 days	Catch	#	3	6
			CPUE	Fish/day	0.07	0.14
2013	Backpack Electrofishing	3402 s	Catch	#	0	4
			CPUE	Fish/min	0	0.07
	Baited Gee Minnow Trapping	62.5 days	Catch	#	121	7
			CPUE	Fish/day	1.94	0.11

**Does not include the fish relocation program*

A total of 33 fish were caught during the 2012 Big Creek fisheries investigations, most of which were captured by electrofishing in July. In 2013, a total of 48 fish were captured in Big Creek, 19 of which were JCS. The most abundant species was slimy sculpins (28) and they were mostly captured by electrofishing in June. Table 2-2 summarizes fish captures in Big Creek.

Table 2-2 Summary of Fish captures in Big Creek in 2012 and 2013.

Year	Method	Effort	Summary Statistics	Units	Juvenile Chinook Salmon	All Other Species
2012	Backpack Electrofishing	273 s	Catch	#	1	23
			CPUE	Fish/min	0.22	5.05
	Baited Gee Minnow Trapping	11.8 days	Catch	#	7	2
			CPUE	Fish/day	0.59	0.17
2013	Backpack Electrofishing	911 s	Catch	#	0	27
			CPUE	Fish/min	0	1.78
	Baited Gee Minnow Trapping	14.8 days	Catch	#	19	2
			CPUE	Fish/day	1.28	0.14

3 OBJECTIVES

The objectives of the 2014 Fisheries Monitoring Program were to monitor, assess and characterize fish usage in Minto Creek during open water season, and to provide data allowing interpretation of the potential role and influence of the Minto Mine on the fish community. The 2014 fisheries program was a continuation of the previous year's components, and targeted on all species that have previously been encountered as well as any new species. As part of the 2014 monitoring program, assessments at Big Creek were made concurrently with sampling in Minto Creek, to compare fish use in a neighbouring system relative to Minto Creek. Fish monitoring studies were conducted in support of the requirements of Water Use License QZ096-006.

Past observations have indicated that the area at the confluence of Minto Creek and the Yukon River is not used by spawning salmon or other species. The annual fisheries program however, continues to involve monitoring of the confluence zone for spawning salmon and other species.

4 METHODOLOGY

4.1 FISH MONITORING

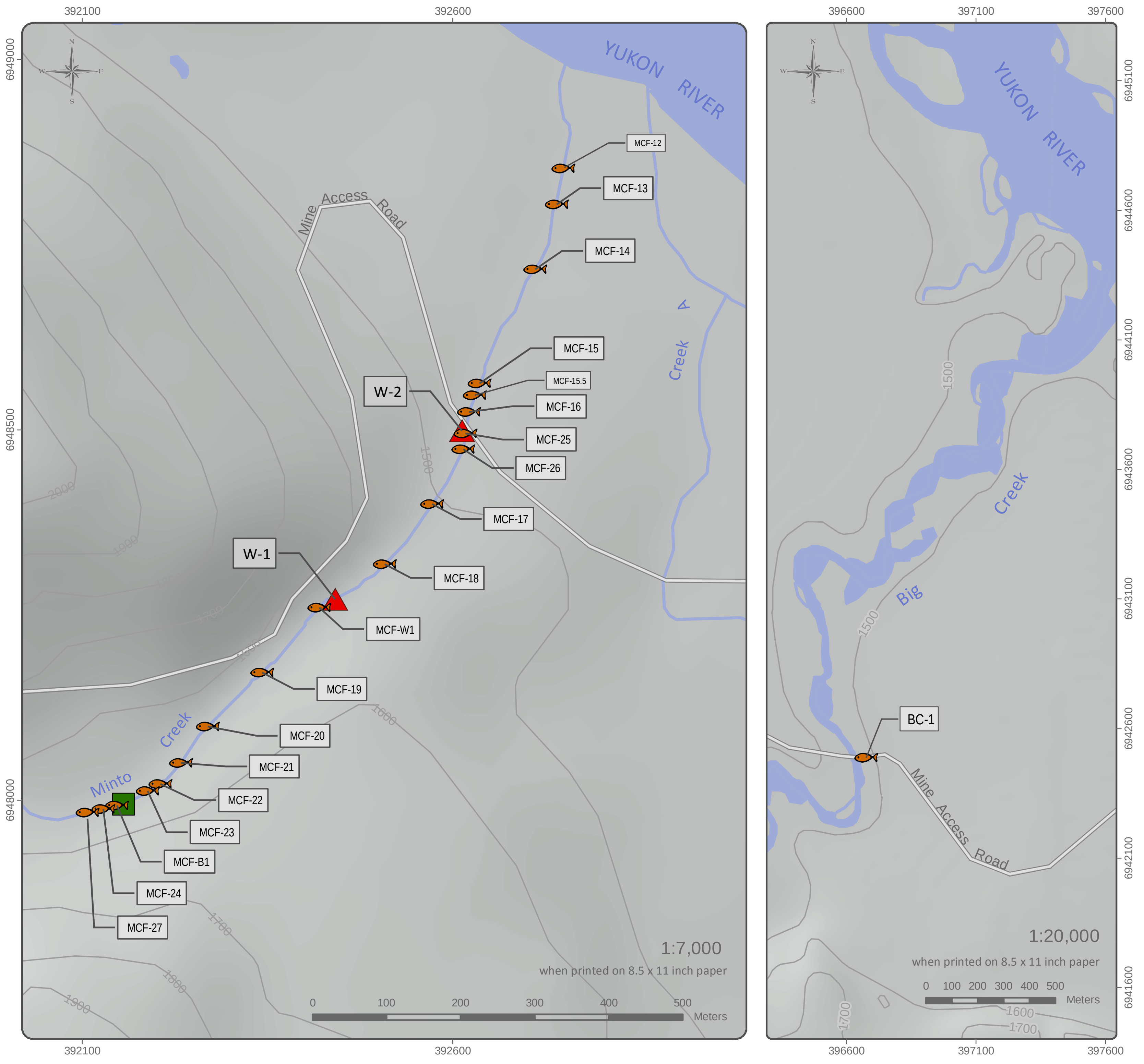
Fish monitoring of Minto Creek and Big Creek was conducted monthly during open water season, from June to October 2014, at trapping sites consistent with the 2010 mark-recapture study and the 2011 to 2013 fish monitoring programs (Figure 4-1). Capture effort included the use of Gee-type Minnow traps with 0.635 cm wire mesh size baited with Yukon River origin Chinook salmon roe. A total of 17 or 18 minnow traps were set each time in Minto Creek, depending on water levels and availability of pools and backwater areas. Four traps were set each time in Big Creek, in the vicinity of the Minto road bridge.

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

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

Aerial reconnaissance survey for potential fish spawning activity was conducted by ACG/Minnow on September 10th, 2014 for approximately 10 minutes. The survey was completed from a helicopter which flew over the mouth of McGinty Creek, Minto Creek, and the Yukon River between the barge landing and McGinty Creek, including the Ingersoll Islands located downstream of the mine area.

Selected photographs documenting field activities and site conditions are presented in Appendix A.



MINTO MINE

FISHERIES MONITORING PROGRAM
2014 SUMMARY REPORT

FIGURE 4-1
MINTO CREEK AND BIG CREEK FISHERIES MONITORING STATIONS

🟩 Observed Fish Barrier
Fish Monitoring Station
🔺 Water Quality Monitoring Station
Mine Access Road
Contours (ft)
Watercourse
Waterbody

National Topographic Data Base (NTDB) compiled
by Natural Resources Canada at a scale of 1:50,000.
Cadastral datacompiled by Natural Resources Canada.

NAD 83 UTM Zone 8N

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capstone
MINTO MINE

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5 RESULTS

The following sections present the fisheries statistics and effort in Minto Creek and Big Creek between June and October 2014.

5.1 MINTO CREEK

Minto Creek was assessed monthly between June and October 2014. A total of 154 fish were captured in Minto Creek, including 151 juvenile Chinook salmon (JCS), which were all were captured in August, September and October. In addition, two slimy sculpins and one burbot were also captured. The average catch per unit effort (CPUE) for JCS was 2.153 fish/trap-day throughout the open water season, but was as high as 5.047 fish/trap-day in September. In comparison, the average JCS CPUE for the same period (June to October) in 2013 was 2.104 fish/trap-day (1.936 fish/trap-day when including the May 2013 sampling event) and a maximum of 5.005 fish/trap-day was reached in October. The following table (Table 5-1) presents the effort applied and the summary of fish capture in Minto Creek in 2014.

Table 5-1 Summary statistics of Minnow Trapping in Minto Creek in 2014.

Month	Effort	Juvenile Chinook Salmon (*Onchoryhnchus tshawytscha*)		Slimy Sculpin (*Cottus cognatus*)		Burbot (*Lota lota*)	
		Results	CPUE*	Results	CPUE*	Results	CPUE*
June	288 trap-hours (12 trap-days)	0	0.000	0	0.000	0	0.000
July	337.8 trap-hours (14.1 trap-days)	0	0.000	0	0.000	0	0.000
August	320.8 trap-hours (13.4 trap-days)	58	4.339	2	0.149	1	0.075
September	423.2 trap-hours (17.6 trap-days)	89	5.047	0	0.000	0	0.000
October	313.8 trap-hours (13.1 trap-days)	4	0.306	0	0.000	0	0.000
TOTAL	**1683.6 trap-hours (70.2 trap-days)**	**151**	**2.153**	**2**	**0.029**	**1**	**0.014**

** CPUE = fish/trap-day*

5.2 BIG CREEK

Fisheries effort in Big Creek was initiated in June, and conducted monthly until October, resulting in the capture of 99 fish, 96 of which were juvenile Chinook salmon. As for Minto Creek, all the JCS were captured in August, September and October. In addition, one slimy sculpin, one burbot and one longnose sucker were also captured. The catch per unit effort for JCS in Big Creek was on average higher than in Minto Creek at 5.863 JCS/trap-day and was highest in September (23.010 fish/trap-day). In comparison, the average JCS CPUE for the same period (June to October) in 2013 was much lower at 1.284 JCS/trap-day (which was also lower than the average CPUE in Minto Creek) and the maximum was attained in August but was only 2.904 fish/trap-day. The following table (Table 5-2) presents the effort undertaken and the resulting fish capture in Big Creek in 2014.

Table 5-2 Summary statistics of Minnow Trapping in Big Creek in 2014.

Month	Effort	Juvenile Chinook Salmon (*Onchoryhnchus tshawytscha*)		Slimy Sculpin (*Cottus cognatus*)		Burbot (*Lota lota*)		Longnose Sucker *(Catostomus catostomus)*	
		Results	CPUE*	Results	CPUE*	Results	CPUE*	Results	CPUE*
June	77.1 trap-hours (3.2 trap-days)	0	0.000	0	0.000	0	0.000	0	0.000
July	77.0 trap-hours (3.2 trap-days)	0	0.000	0	0.000	0	0.000	0	0.000
August	70.4 trap-hours (2.9 trap-days)	4	1.364	0	0.000	0	0.000	1	0.341
September	89.7 trap-hours (3.7 trap-days)	86	23.010	1	0.268	1	0.268	0	0.000
October	78.8 trap-hours (3.3 trap-days)	6	1.827	0	0.000	0	0.000	0	0.000
TOTAL	**393 trap-hours (16.4 trap-days)**	**96**	**5.863**	**1**	**0.054**	**1**	**0.054**	**1**	**0.061**

**CPUE = fish/trap-day*

Figure 5-1 presents a comparison between monthly JCS capture and CPUE in Minto Creek and Big Creek for 2014.

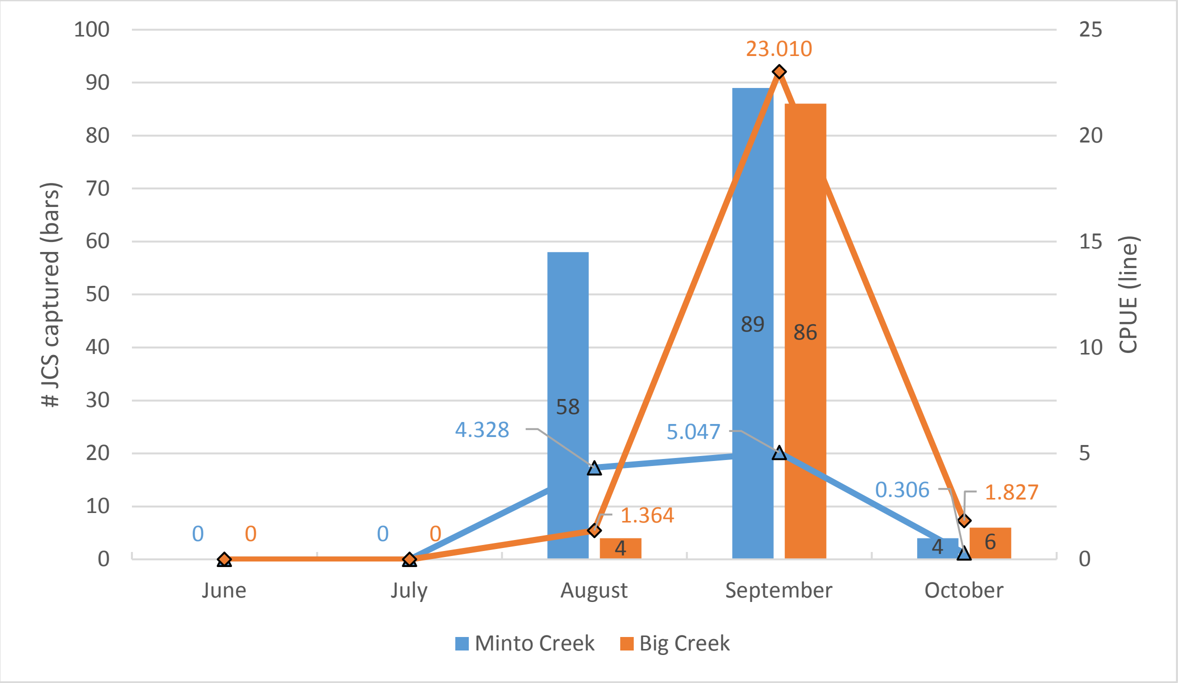

Figure 5-1 Monthly JCS capture in Minto Creek and Big Creek, 2014.

The average fork length of JCS captured in Minto Creek was 71.9 mm and the average weight was 4.36 g while the average fork length of JCS captured in Big Creek was 73.4 mm and the average weight was 4.62 g. Figure 5-2 presents the monthly averages for both Creeks. Individual results for all fish captured are presented in Appendix B.

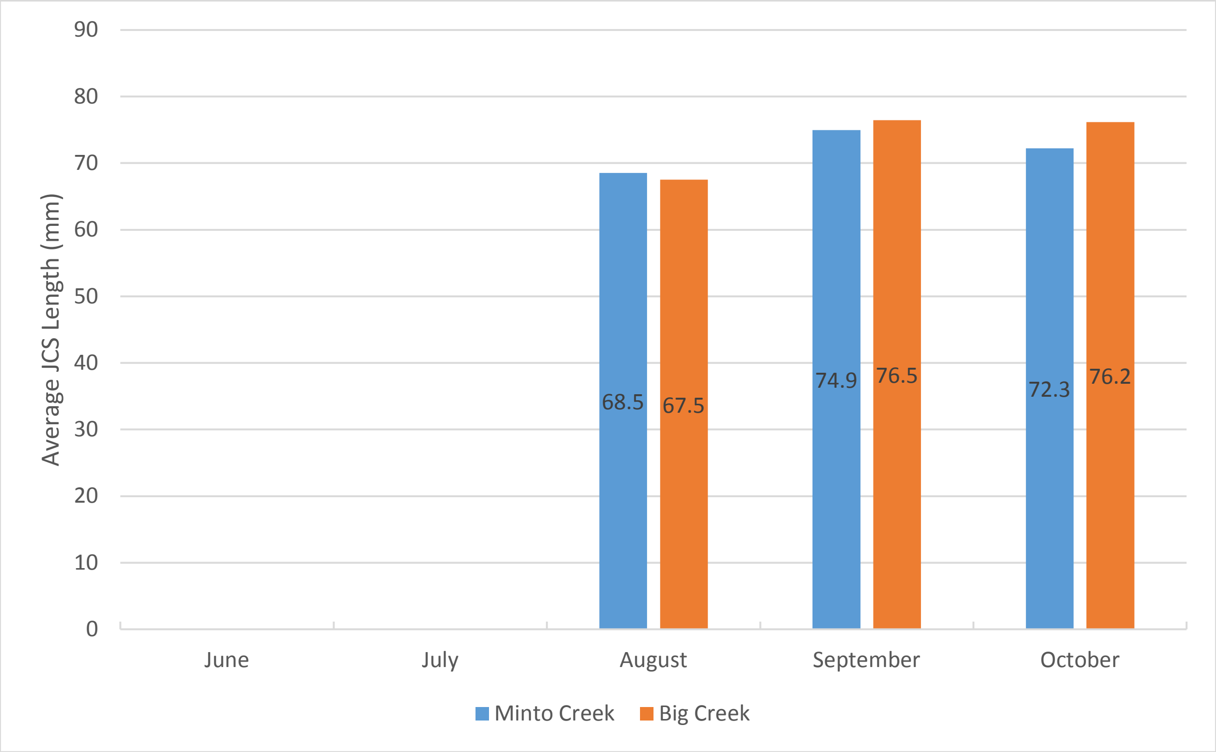

Figure 5-2 Average JCS length (fork) in Minto Creek and Big Creek, 2014.

5.3 WATER QUALITY PARAMETERS

In situ data was collected in Minto Creek (W2), Big Creek (bridge) and the Yukon River (W4) during each site visit and results are summarized in Table 5-3. In situ parameters were collected with a YSI Professional Plus multimeter (except in September when a YSI 559 MPS multimeter was used), which was calibrated prior to each trip.

Table 5-3 In situ and stream discharge data in Minto Creek, Big Creek and Yukon River, 2014.

Site	Date	Time	Temperature (°C)	Dissolved Oxygen (%)	Dissolved Oxygen (m/L)	Specific Conductance (µS/cm)	pH	Oxidation Reduction Potential (mV)*
Minto Creek	12/06/2014	17:00	8.2	93.3	11.00	282.6	8.30	133.1
	21/07/2014	16:50	8.3	95.4	11.17	493.6	8.22	-98.0
	13/08/2014	14:30	8.0	95.0	11.25	351.3	8.16	138.1
	15/09/2014	9:20	3.5	74.1	9.84	219	7.89	n/a
	9/10/2014	16:53	-0.1	91	12.5	265.1	7.81	241.3
Big Creek	12/06/2014	14:02	12.4	94.7	10.11	171.9	7.34	210.8
	21/07/2014	13:13	11.1	91.8	10.05	332.1	7.82	-17.9
	13/08/2014	15:02	12.3	105	10.5	244.1	8.06	218.6
	15/09/2014	8:15	5.1	72.0	9.19	123	7.67	n/a
	10/10/2014	10:27	0.7	97	12.8	158.8	7.77	262.6
Yukon River	12/06/2014	14:40	10.8	95.9	10.61	168.1	8.34	123.0
	22/07/2014	8:59	11.7	87.8	9.53	253.5	7.93	-24.6
	13/08/2014	14:40	14.5	90.6	9.22	178.9	8.14	131.1
	15/09/2014	9:10	8.8	66.8	7.79	101	7.99	n/a
	10/10/2014	10:09	4.2	98	11.7	117.7	7.67	211.6

**Negative ORP values are considered suspicious*

A TidbiT water temperature logger was deployed in the Yukon River at station W4 (between the barge landing and the mouth of Minto Creek) during the open water season, while a continuous logger located at W1 records the water temperature of lower Minto Creek. Figure 5-3 present the two temperature curves, together with manual measurements (shown by triangular markers) taken from Table 5-3 above. This figure indicates that the temperatures of Minto creek is generally colder than that of the Yukon River and that the diurnal cycle is greater in Minto Creek. It is possible that the water temperature of Minto Creek and of the Yukon River equilibrated for a short period in June, as was the case in previous years, however the 2014 record does not allow for confirmation of this.

Even though no logger was deployed in Big Creek, manual measurements (yellow markers in Figure 5-3) indicate that water temperature in Big Creek was generally between that of Minto Creek and the Yukon River.

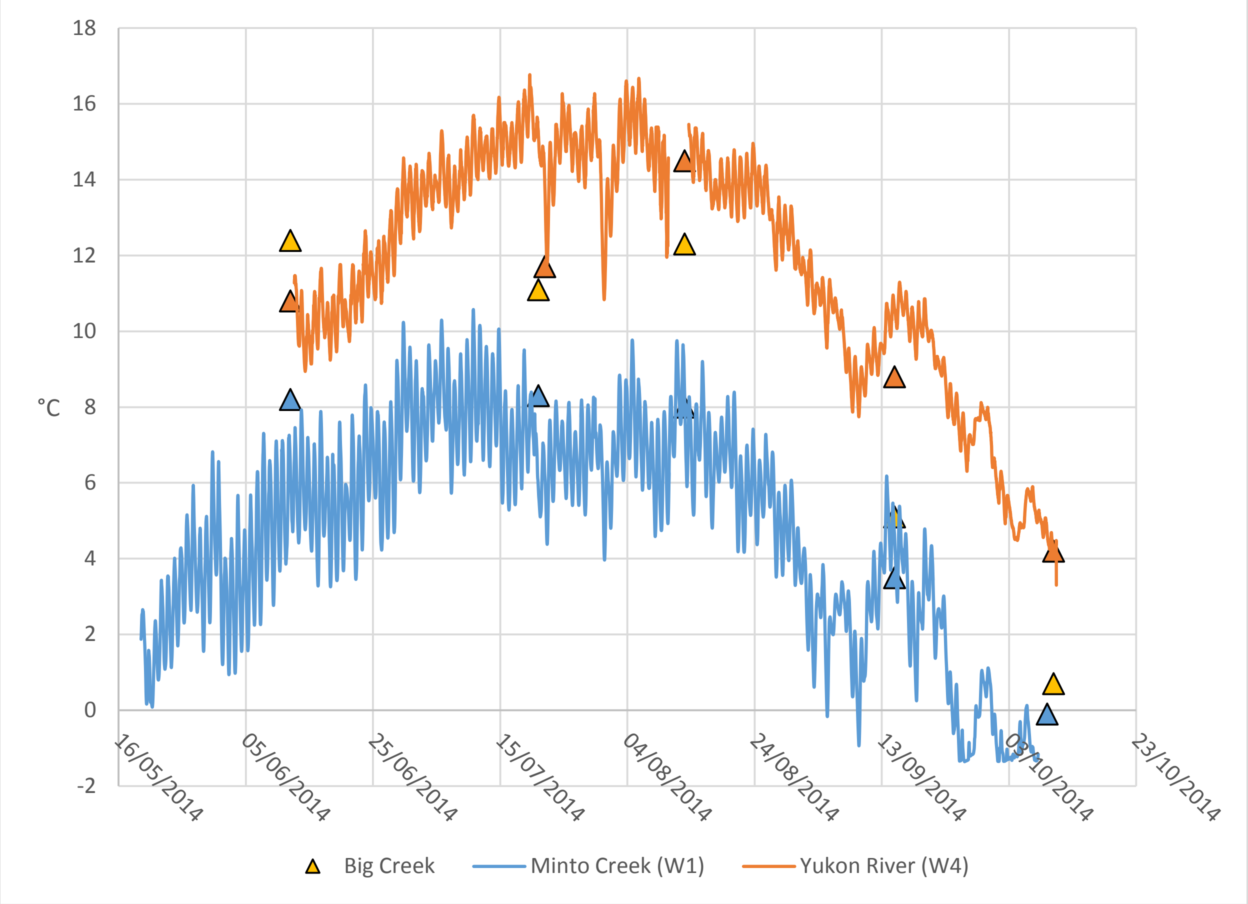

Figure 5-3 Water Temperature, Minto Creek and Yukon River, 2014

Turbidity in Minto Creek was noted to be higher in June and July (the July sampling event followed a significant rain event) and much lower in August, September and October. Figure 5-4 presents Total Suspended Solids (TSS) values measured at W2 from May 1st to October 31st, 2014; the dotted line indicates the trend. W2 TSS records for the open water season from 2011 to 2014 are presented in Appendix C for comparison.

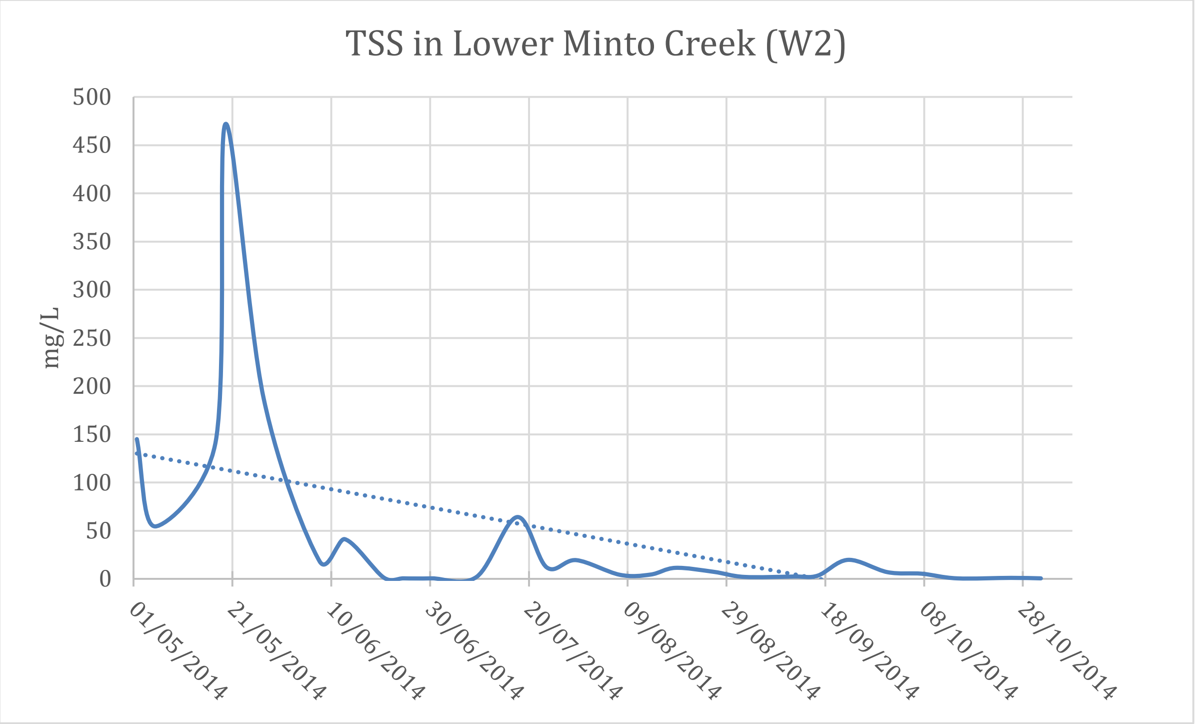

Figure 5-4 Total Suspended Solids (mg/L) measured at W2 in 2014

5.4 STAGE AND DISCHARGE

The staff gauge located at W1 in Minto Creek was read during each trip and discharge was measured at W1 with a Marsh McBirney Flo-Mate electromagnetic flow meter or a with a Hach FH950 electromagnetic flow meter. A continuously logging water level recorder is also located at W1 where Minto staff regularly measure discharge to construct a continuous discharge record. Water levels and discharge for Minto Creek and Big Creek are presented in Table 5-4 below for occasions when fisheries surveys occurred. Big Creek values were obtained through the Water Survey of Canada on-line database (Water Survey Canada, 2014) and are subject to change as they have not yet be validated by WSC.

Table 5-4 Stage and Discharge in Minto Creek and Big Creek, 2014.

Date	Time (PDT)	Minto Creek		Big Creek	
		Stage (m)	Discharge (m^3/s)	Stage (m)	Discharge (m^3/s)
12/06/2014	15:51	0.134	n/a	6.106	5.998
12/06/2014	16:49	0.134	0.036	6.106	5.998
13/06/2014	9:00	0.135	n/a	6.128	6.724
21/07/2014	14:27	0.200	0.094	6.541	30.698
21/07/2014	15:43	0.190	n/a	6.552	31.556
22/07/2014	10:44	0.155	0.124	6.631	37.873
13/08/2014	14:15	0.118	0.013	6.077	5.229
13/08/2014	16:04	0.118	n/a	6.077	5.228
14/08/2014	10:39	0.115	n/a	6.072	5.101
15/09/2014	11:25	0.125	n/a	6.254	12.131
16/09/2014	10:47	0.128	0.015	6.235	11.195
9/10/2014	16:41	0.147	0.015	6.117	6.361
10/10/2014	9:50	0.138	n/a	6.132	6.856

Figure 5-5 shows the continuous record available from May to early October. ACG processes those data gathered by Minto Staff.

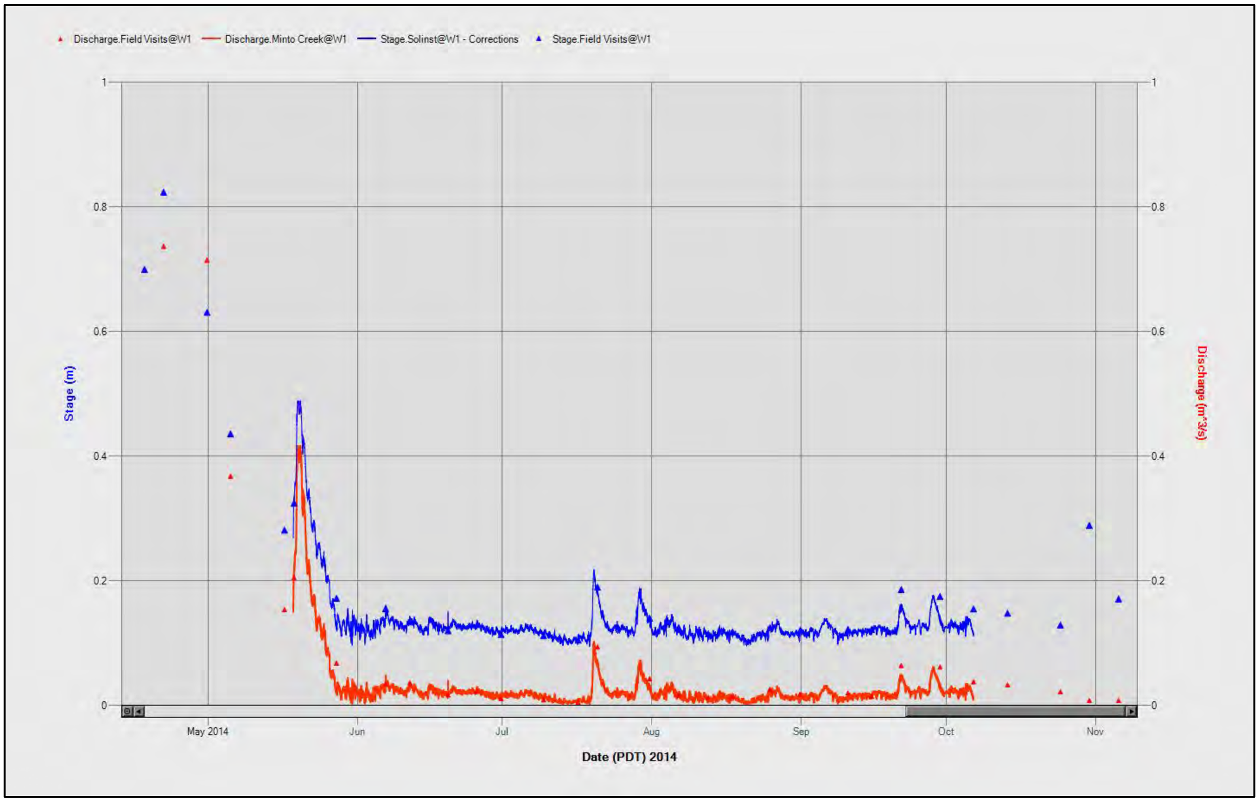

Figure 5-5 Stage and discharge in Minto Creek at monitoring station W1, 2014

The Big Creek hydrometric station (Water Survey of Canada station ID # 09AH003) is located downstream of the Minto road bridge, near its confluence with the Yukon River, at the following coordinates: 62° 34' 07'' N;

137° 00' 58'' W. It records continuous water level and discharge. Figure 5-6 presents data from June to October 2014.

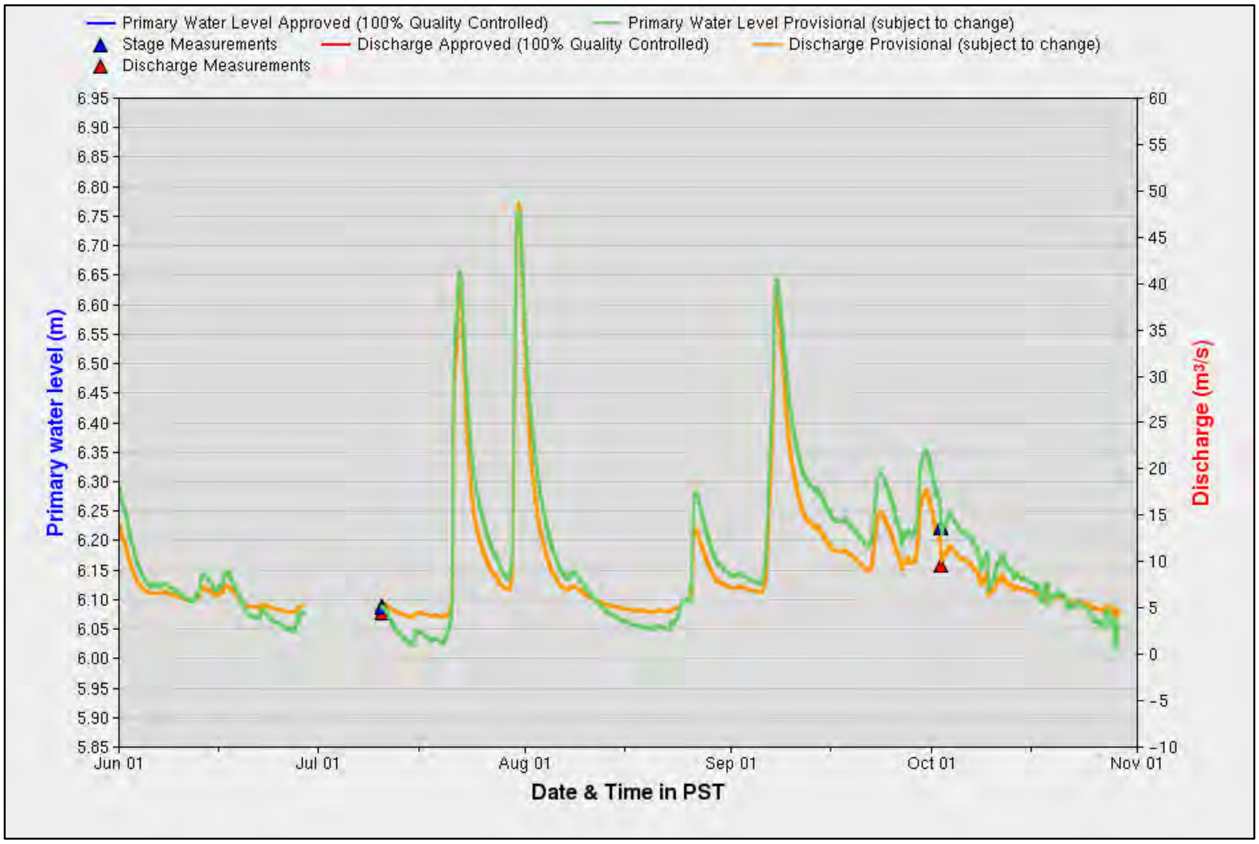

Figure 5-6 Water Level and Discharge in Big Creek 2014 *(Source: Water Survey of Canada, 2014).*

5.5 FISH BARRIER

The fish barrier located approximately 1.2 km upstream of the Yukon River (MCF-B1 on Figure 4-1), which was documented in previous years, was re-confirmed in 2014. Fish use upstream of the barrier, which consists of a log jam (Figure 5-7), was assessed by setting traps upstream of it during each sampling event. No fish were captured upstream of the barrier during 2014. Another log jam is located just upstream of station MCF-21 (see Figure 4-1 and Figure 5-8) and is thought to act as a temporary fish barrier during low flow conditions. No fish were captured upstream of it in August or in October 2014, but a large number of fish (20) were captured immediately downstream of the log jam in August. Two fish were captured upstream of it in September.

Figure 5-7 Fish Barrier at MCF-B1 (September 2014)

Figure 5-8 Log jam upstream of MCF-21, potentially acting as temporary fish barrier (August 2014)

5.6 AERIAL SURVEY

An aerial survey was conducted on September 10th, 2014 between approximately 5:45 PM and 5:55 PM, over the mouths of McGinty and Minto Creeks for any signs of salmon using the area for spawning such as redds and carcasses. Water was relatively clear in McGinty and Minto Creeks and moderately turbid in the Yukon River. The height of the helicopter was maintained between 10m and 20m. Two bald eagles were observed in the Ingersholl Islands and one near the mouth of Minto Creek, however no fish carcasses were present. No signs of salmon using Minto Creek of McGinty Creek for spawning were observed.

6 DISCUSSION

In 2014, no JCS were captured in Minto Creek or Big Creek before August. In general this is consistent with previous findings that JCS do not tend to enter Minto Creek until the water temperature has equilibrated with that of the Yukon River or reached a minimum threshold temperature, however in some years JCS had entered the creeks by mid-July. The 2014 July sampling results may have been influenced by the concurrent high precipitation event causing high flows and turbidity.

Contrary to 2013 however, the average CPUE for JCS was found to be higher in Big Creek than in Minto Creek, and much higher in September than any other month. The CPUE for JCS showed a decreasing trend in Big Creek from August to October, while the trend was increasing in Minto Creek over the same period. The CPUE in both Minto Creek and Big Creek was on average higher than in 2012 and 2013, and was also higher than in 2011 in the case of Minto Creek. In 2010 however, the average CPUE in Minto Creek was 15.7 fish/trap-day and some trapping events returned over 400 JCS. Figure 6-1 shows the CPUE trends since 2008 for JCS (Minnow trapping only) in Minto Creek and since 2012 in Big Creek.

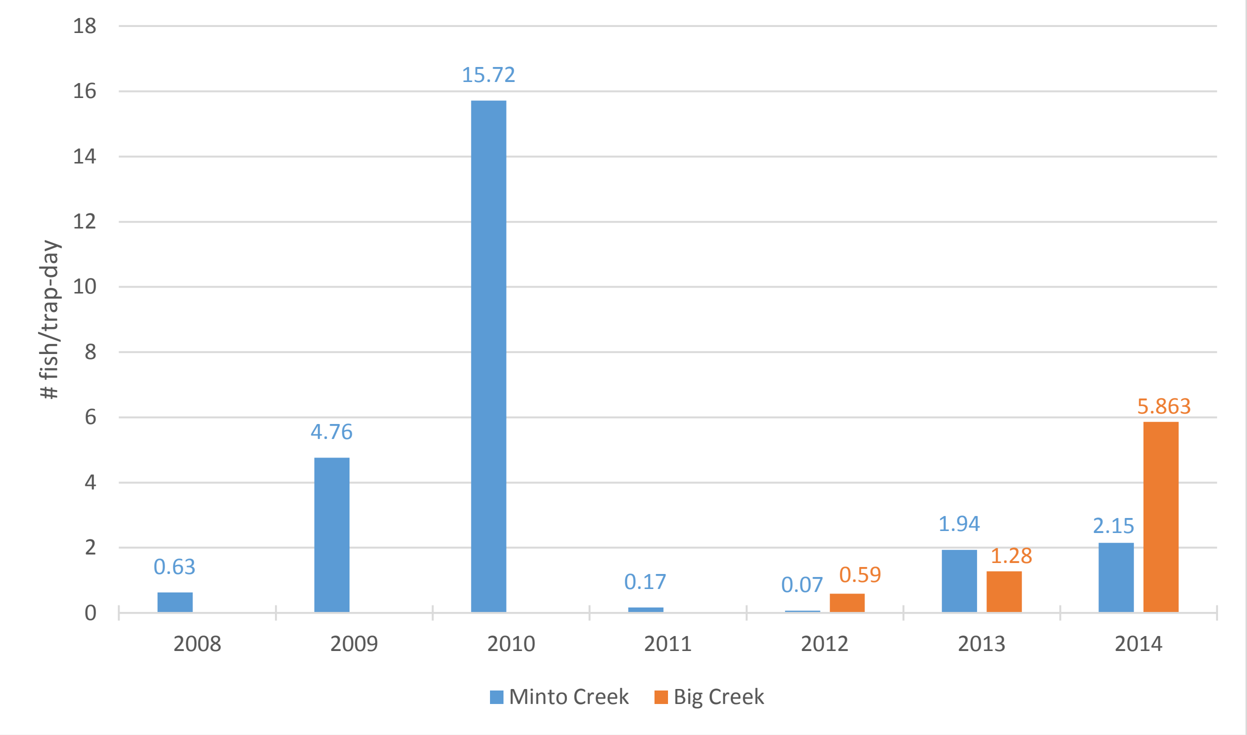

Figure 6-1 JCS average CPUE, Minnow Trapping, 2008-2014

In 2009 and 2010, the mine was discharging water in Minto Creek, causing higher and more consistent flow and temperature regimes in lower Minto Creek, conditions which may have been more attractive to JCS. Mine water discharge only occurred during spring freshet from 2012 to 2014 and no discharge occurred in 2011.

Also, following a forest fire in 2010, more sediment entered Minto Creek through runoff in 2011 and 2012 increasing water turbidity. A small landslide was also documented by Minto personnel in an upstream tributary in May 2012, likely contributing to high TSS levels observed downstream. The elevated turbidity may have deterred fish from entering Minto Creek. Average TSS values at W2 in 2014 were the lowest since 2011, and the highest were observed in 2012 (see Appendix C for details). A decreasing trend in turbidity was observed throughout the 2014 season, as confirmed by the TSS results presented in section 5.3; this may have created more favourable conditions for JCS towards the end of 2014 the season.

No adult fish were observed spawning in the vicinity of the Minto Creek/Yukon River confluence or in the area downstream and upstream of Minto Creek during 2014. Bottom substrate in the confluence area consists primarily of silt and mud which is not suitable substrate for salmon spawning. The natural barrier identified in previous years was confirmed in 2014. Therefore the area of usable fish habitat in Minto Creek is limited to the lower 1.2 km of the creek.

7 REFERENCES

Access Consulting Group, 2014. Fisheries Monitoring Program – Minto Creek, 2013 Summary Report.

Access Consulting Group, 2013. Fisheries Monitoring Program – Minto Creek, 2012 Summary Report.

Access Consulting Group, 2011. Fisheries Monitoring Program – Minto Creek, 2011 Summary Report.

Access Consulting Group. 2010. Juvenile Chinook Salmon Mark/Recapture Study Minto Creek, 2010,– Draft Report.

Access Consulting Group (Access). 2009. Minto Creek Fish Relocation Project. September 29 – October 2, 2009; October 12 – 14, 2009. Letter Report.

B.C. Fisheries Information Service Branch for the Resource Inventory Committee. 2001. Fish and Fish Habitat Inventory: Standards and Procedures. Version 2.0. April 2001.

Hallam Knight Piesold Ltd. 1994. Minto Project, Initial Environmental Evaluation, Supporting Volume II, Environmental Setting. Prepared for Minto Explorations Ltd. May 1994.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2009. Environmental Effects Monitoring First Interpretive Report, Minto Project, Yukon Territory. Prepared for Minto Explorations Ltd. January 2009.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2012. Minto Mine Cycle 2 Environmental Effects Monitoring. Prepared for Minto Explorations Ltd. January 2012

R&D Environmental. 2006. Fisheries Assessment of Minto Creek, September 2006. Prepared for the Access Consulting Group.

R&D Environmental. 2007. Fisheries Assessment of Minto Creek, May, June and August 2007. Prepared for the Access Consulting Group.

Water Survey of Canada. 2014. BIG CREEK NEAR THE MOUTH [YT] (09AH003). Real-time data - subject to change. Copyright Environment Canada (2014). http://wateroffice.ec.gc.ca/report/report_e.html?type=realTime&stn=09AH003

APPENDIX A

2014 PHOTO LOG

Photo 1: Trap being set in Big Creek – June

Photo 2: Low and turbid water in Minto Creek – June

Photo 3: High and turbid water in Big Creek – July

Photo 4: Trap set in Minto Creek (MCF-W1), turbid water – July

Photo 5: Low and clear water in Big Creek - August

Photo 6: Trap set in Minto Creek (MCF-W1), clear water - August

Photo 7: Longnose Sucker captured in Big Creek - August

Photo 8: Burbot captured in Minto Creek (MCF-13) - August

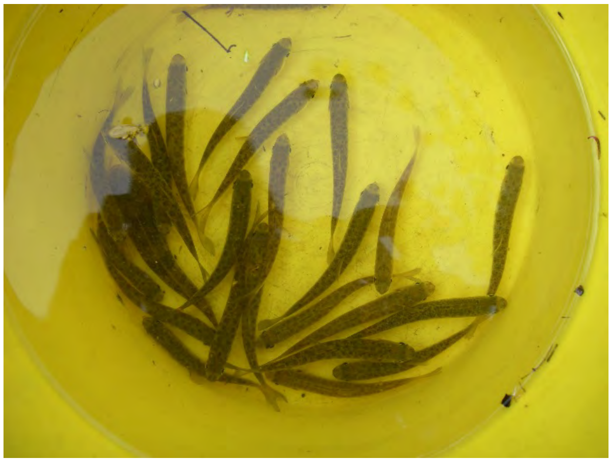

Photo 9: JCS captured in Minto Creek - August

Photo 10: JCS close-up, Minto Creek - August

Photo 11: Big Creek looking upstream - September

Photo 12: Trap set in Minto Creek (MCF-13) - September


09/15/2014 08:10

Photo 13: Burbot captured in Big Creek - September


09/15/2014 10:38

Photo 14: JCS with abnormality, Minto Creek - September


09/11/2014 09:36

Photo 15: Mouth of Big Creek - September


09/11/2014 09:38

Photo 16: Mouth of Minto Creek - September


09/11/2014 09:40

Photo 17: Mouth of McGinty Creek - September

Photo 18: Trap set in Big Creek - October

Photo 19: Trap set in Minto Creek (MCF-13) - October

Photo 20: Location of JCS capture (MCF-19), Minto Creek - October

Photo 21: Trap and log jam, Minto Creek (MCF-21) - October

Photo 22: Yukon River at W4, looking downstream - October

Photo 24: Fish Barrier in Minto Creek (MCF-B1) - October

APPENDIX B

FISH DATA, MINTO CREEK AND BIG CREEK, 2014

MINTO CREEK

Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments
14/08/2014	MT	MCF-13	BB	163	n/a	Released (good)	
14/08/2014	MT	MCF-13	SS	65	n/a	Released (good)	
14/08/2014	MT	MCF-26	JCS	67	3.34	Released (good)	
14/08/2014	MT	MCF-26	JCS	65	3.02	Released (good)	
14/08/2014	MT	MCF-26	JCS	68	3.49	Released (good)	
14/08/2014	MT	MCF-26	JCS	66	3	Released (good)	
14/08/2014	MT	MCF-17	JCS	76	4.83	Released (good)	
14/08/2014	MT	MCF-17	JCS	74	4.26	Released (good)	
14/08/2014	MT	MCF-17	JCS	69	3.87	Released (good)	
14/08/2014	MT	MCF-17	JCS	70	4.11	Released (good)	
14/08/2014	MT	MCF-17	JCS	69	4.1	Released (good)	
14/08/2014	MT	MCF-17	JCS	67	4.81	Released (good)	
14/08/2014	MT	MCF-W1	JCS	72	4.46	Released (good)	
14/08/2014	MT	MCF-W1	JCS	63	2.97	Released (good)	
14/08/2014	MT	MCF-W1	JCS	64	3.03	Released (good)	
14/08/2014	MT	MCF-W1	JCS	71	3.91	Released (good)	
14/08/2014	MT	MCF-19	SS	91	n/a	Released (good)	
14/08/2014	MT	MCF-19	JCS	65	3.19	Released (good)	
14/08/2014	MT	MCF-19	JCS	67	3.91	Released (good)	
14/08/2014	MT	MCF-19	JCS	73	3.6	Released (good)	
14/08/2014	MT	MCF-19	JCS	64	2.8	Released (good)	
14/08/2014	MT	MCF-19	JCS	67	3.22	Released (good)	
14/08/2014	MT	MCF-19	JCS	76	4.92	Released (good)	
14/08/2014	MT	MCF-19	JCS	62	2.8	Released (good)	
14/08/2014	MT	MCF-19	JCS	70	3.44	Released (good)	
14/08/2014	MT	MCF-19	JCS	74	5.91	Released (good)	
14/08/2014	MT	MCF-19	JCS	68	3.44	Released (good)	
14/08/2014	MT	MCF-19	JCS	73	4.63	Released (good)	
14/08/2014	MT	MCF-19	JCS	61	3.99	Released (good)	
14/08/2014	MT	MCF-19	JCS	66	3.64	Released (good)	
14/08/2014	MT	MCF-19	JCS	67	3.1	Released (good)	
14/08/2014	MT	MCF-19	JCS	67	3.09	Released (good)	
14/08/2014	MT	MCF-19	JCS	72	4.08	Released (good)	
14/08/2014	MT	MCF-19	JCS	70	3.48	Released (good)	
14/08/2014	MT	MCF-19	JCS	71	4.29	Released (good)	
14/08/2014	MT	MCF-19	JCS	61	3.21	Released (good)	
14/08/2014	MT	MCF-19	JCS	71	5.62	Released (good)	
14/08/2014	MT	MCF-19	JCS	69	4.96	Released (good)	
14/08/2014	MT	MCF-19	JCS	68	3.99	Released (good)	
14/08/2014	MT	MCF-19	JCS	74	4.2	Released (good)	
14/08/2014	MT	MCF-19	JCS	71	4.34	Released (good)	
14/08/2014	MT	MCF-21	JCS	65	3.05	Released (good)	
14/08/2014	MT	MCF-21	JCS	73	3.98	Released (good)	
14/08/2014	MT	MCF-21	JCS	68	3.21	Released (good)	
14/08/2014	MT	MCF-21	JCS	72	3.76	Released (good)	
14/08/2014	MT	MCF-21	JCS	71	3.52	Released (good)	
14/08/2014	MT	MCF-21	JCS	73	3.75	Released (good)	
14/08/2014	MT	MCF-21	JCS	64	2.83	Released (good)	
14/08/2014	MT	MCF-21	JCS	73	4.11	Released (good)	
14/08/2014	MT	MCF-21	JCS	72	4.06	Released (good)	

Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments
14/08/2014	MT	MCF-21	JCS	66	3.1	Released (good)	
14/08/2014	MT	MCF-21	JCS	64	3.01	Released (good)	
14/08/2014	MT	MCF-21	JCS	67	3.31	Released (good)	
14/08/2014	MT	MCF-21	JCS	68	3.35	Released (good)	
14/08/2014	MT	MCF-21	JCS	70	3.36	Released (good)	
14/08/2014	MT	MCF-21	JCS	70	3.49	Released (good)	
14/08/2014	MT	MCF-21	JCS	64	2.69	Released (good)	
14/08/2014	MT	MCF-21	JCS	63	3.17	Released (good)	
14/08/2014	MT	MCF-21	JCS	69	3.74	Released (good)	
14/08/2014	MT	MCF-21	JCS	63	2.75	Released (good)	
14/08/2014	MT	MCF-21	JCS	72	4.07	Released (good)	
15/09/2014	MT	MCF-12	JCS	83	5.55	Released (good)	
15/09/2014	MT	MCF-12	JCS	71	3.53	Released (good)	
15/09/2014	MT	MCF-25/26	JCS	80	6.2	Released (good)	
15/09/2014	MT	MCF-25/26	JCS	74	3.82	Released (good)	
15/09/2014	MT	MCF-25/26	JCS	74	4.28	Released (good)	
15/09/2014	MT	MCF-22	JCS	71	4.16	Released (good)	
15/09/2014	MT	MCF-22	JCS	85	6.19	Released (good)	
15/09/2014	MT	MCF-21	JCS	77	4.86	Released (good)	
15/09/2014	MT	MCF-21	JCS	78	5.21	Released (good)	
15/09/2014	MT	MCF-21	JCS	74	4.65	Released (good)	
15/09/2014	MT	MCF-21	JCS	89	8.15	Released (good)	
15/09/2014	MT	MCF-21	JCS	72	4.13	Released (good)	
15/09/2014	MT	MCF-21	JCS	71	3.73	Released (good)	
15/09/2014	MT	MCF-21	JCS	75	4.8	Released (good)	
15/09/2014	MT	MCF-21	JCS	73	3.92	Released (good)	
15/09/2014	MT	MCF-21	JCS	77	4.95	Released (good)	
15/09/2014	MT	MCF-21	JCS	73	4.39	Released (good)	
15/09/2014	MT	MCF-21	JCS	71	3.85	Released (good)	lump on side
15/09/2014	MT	MCF-21	JCS	78	4.75	Released (good)	
15/09/2014	MT	MCF-21	JCS	81	6.09	Released (good)	
15/09/2014	MT	MCF-21	JCS	68	3.34	Released (good)	
15/09/2014	MT	MCF-21	JCS	76	4.97	Released (good)	
15/09/2014	MT	MCF-21	JCS	69	3.32	Released (good)	
15/09/2014	MT	MCF-21	JCS	76	4.76	Released (good)	
15/09/2014	MT	MCF-21	JCS	67	3.36	Released (good)	
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15/09/2014	MT	MCF-21	JCS	81	5.62	Released (good)	
15/09/2014	MT	MCF-20	JCS	73	5.02	Released (good)	
15/09/2014	MT	MCF-20	JCS	80	5.39	Released (good)	
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15/09/2014	MT	MCF-20	JCS	70	3.78	Released (good)	
15/09/2014	MT	MCF-20	JCS	80	5.76	Released (good)	
15/09/2014	MT	MCF-20	JCS	69	3.32	Released (good)	
15/09/2014	MT	MCF-20	JCS	72	3.8	Released (good)	
15/09/2014	MT	MCF-20	JCS	71	3.9	Released (good)	
15/09/2014	MT	MCF-20	JCS	78	5.22	Released (good)	
15/09/2014	MT	MCF-20	JCS	69	3.51	Released (good)	
15/09/2014	MT	MCF-20	JCS	77	5.18	Released (good)	

Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments
15/09/2014	MT	MCF-20	JCS	75	4.42	Released (good)	
15/09/2014	MT	MCF-20	JCS	76	4.38	Released (good)	
15/09/2014	MT	MCF-20	JCS	75	5.02	Released (good)	
15/09/2014	MT	MCF-20	JCS	74	3.83	Released (good)	
15/09/2014	MT	MCF-19	JCS	70	4.09	Released (good)	
15/09/2014	MT	MCF-19	JCS	71	3.75	Released (good)	
15/09/2014	MT	MCF-19	JCS	79	5.83	Released (good)	
15/09/2014	MT	MCF-19	JCS	85	6.56	Released (good)	
15/09/2014	MT	MCF-19	JCS	74	3.92	Released (good)	
15/09/2014	MT	MCF-19	JCS	71	3.56	Released (good)	
15/09/2014	MT	MCF-19	JCS	78	4.65	Released (good)	
15/09/2014	MT	MCF-19	JCS	73	4.11	Released (good)	
15/09/2014	MT	MCF-19	JCS	75	4.32	Released (good)	
15/09/2014	MT	MCF-19	JCS	74	3.65	Released (good)	
15/09/2014	MT	MCF-19	JCS	70	3.51	Released (good)	
15/09/2014	MT	MCF-19	JCS	75	4.45	Released (good)	
15/09/2014	MT	MCF-19	JCS	74	4.09	Released (good)	
15/09/2014	MT	MCF-19	JCS	73	3.69	Released (good)	
15/09/2014	MT	MCF-W1	JCS	80	5.45	Released (good)	
15/09/2014	MT	MCF-W1	JCS	75	4.42	Released (good)	
15/09/2014	MT	MCF-W1	JCS	72	3.81	Released (good)	
15/09/2014	MT	MCF-W1	JCS	81	5.7	Released (good)	
15/09/2014	MT	MCF-W1	JCS	74	4.14	Released (good)	
15/09/2014	MT	MCF-W1	JCS	70	4.26	Released (good)	
15/09/2014	MT	MCF-W1	JCS	76	4.95	Released (good)	
15/09/2014	MT	MCF-W1	JCS	72	3.67	Released (good)	
15/09/2014	MT	MCF-W1	JCS	73	3.81	Released (good)	
15/09/2014	MT	MCF-W1	JCS	69	3.62	Released (good)	
15/09/2014	MT	MCF-W1	JCS	73	4.12	Released (good)	
15/09/2014	MT	MCF-W1	JCS	79	5.38	Released (good)	
15/09/2014	MT	MCF-W1	JCS	68	3.48	Released (good)	
15/09/2014	MT	MCF-W1	JCS	76	4.16	Released (good)	
15/09/2014	MT	MCF-W1	JCS	75	4.94	Released (good)	
15/09/2014	MT	MCF-W1	JCS	78	5.31	Released (good)	
15/09/2014	MT	MCF-W1	JCS	68	3.33	Released (good)	
15/09/2014	MT	MCF-W1	JCS	80	5.01	Released (good)	
15/09/2014	MT	MCF-W1	JCS	69	4.14	Released (good)	
15/09/2014	MT	MCF-W1	JCS	77	4.49	Released (good)	
15/09/2014	MT	MCF-W1	JCS	73	3.79	Released (good)	
15/09/2014	MT	MCF-W1	JCS	75	4.65	Released (good)	
15/09/2014	MT	MCF-W1	JCS	84	6.61	Released (good)	
15/09/2014	MT	MCF-17	JCS	77	5.04	Released (good)	
15/09/2014	MT	MCF-17	JCS	69	3.19	Released (good)	
15/09/2014	MT	MCF-15	JCS	74	4.78	Released (good)	
15/09/2014	MT	MCF-15	JCS	68	3.47	Released (good)	
15/09/2014	MT	MCF-15	JCS	85	5.6	Released (good)	
15/09/2014	MT	MCF-15	JCS	72	3.73	Released (good)	
15/09/2014	MT	MCF-15	JCS	77	4.63	Released (good)	
10/10/2014	MT	MCF-19	JCS	74	4.4	Released (good)	
10/10/2014	MT	MCF-19	JCS	72	4.96	Released (good)	
10/10/2014	MT	MCF-19	JCS	70	5.41	Released (good)	
10/10/2014	MT	MCF-19	JCS	73	4.51	Released (good)	

Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments

BIG CREEK

Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments
14/08/2014	MT	US of Bridge LB	LS	144	n/a	Released (good)	
14/08/2014	MT	US of Bridge LB	JCS	80	5.99	Released (good)	
14/08/2014	MT	US of Bridge LB	JCS	53	2.91	Released (good)	
14/08/2014	MT	US of Bridge LB	JCS	68	3.94	Released (good)	
14/08/2014	MT	US of Bridge LB	JCS	69	4.03	Released (good)	
15/09/2014	MT	Near Bridge	BB	282	n/a	Released (good)	Likely preyed on JCS in same trap
15/09/2014	MT	Near Bridge	SS	86	n/a	Released (good)	
15/09/2014	MT	Near Bridge	JCS	85	6.54	Released (good)	
15/09/2014	MT	Near Bridge	JCS	90	8.43	Released (good)	
15/09/2014	MT	Near Bridge	JCS	71	7.43	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	5.38	Released (good)	
15/09/2014	MT	Near Bridge	JCS	76	5.61	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	3.79	Released (good)	
15/09/2014	MT	Near Bridge	JCS	85	6.85	Released (good)	
15/09/2014	MT	Near Bridge	JCS	84	4.25	Released (good)	
15/09/2014	MT	Near Bridge	JCS	85	6.13	Released (good)	
15/09/2014	MT	Near Bridge	JCS	78	6.09	Released (good)	
15/09/2014	MT	Near Bridge	JCS	68	4.57	Released (good)	
15/09/2014	MT	Near Bridge	JCS	84	6.19	Released (good)	
15/09/2014	MT	Near Bridge	JCS	80	5.76	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	3.97	Released (good)	
15/09/2014	MT	Near Bridge	JCS	81	5.92	Released (good)	
15/09/2014	MT	Near Bridge	JCS	83	6.37	Released (good)	
15/09/2014	MT	Near Bridge	JCS	81	6.04	Released (good)	
15/09/2014	MT	Near Bridge	JCS	65	4.55	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	6.12	Released (good)	
15/09/2014	MT	Near Bridge	JCS	78	5.04	Released (good)	
15/09/2014	MT	Near Bridge	JCS	85	8.72	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	4.84	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	4.7	Released (good)	
15/09/2014	MT	Near Bridge	JCS	85	6.41	Released (good)	
15/09/2014	MT	Near Bridge	JCS	67	3.72	Released (good)	
15/09/2014	MT	Near Bridge	JCS	79	5.21	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	4.45	Released (good)	
15/09/2014	MT	Near Bridge	JCS	69	4.52	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	4.57	Released (good)	
15/09/2014	MT	Near Bridge	JCS	68	4.2	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	3.9	Released (good)	
15/09/2014	MT	Near Bridge	JCS	69	3.45	Released (good)	
15/09/2014	MT	Near Bridge	JCS	77	4.63	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	5.48	Released (good)	
15/09/2014	MT	Near Bridge	JCS	72	4.52	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	4.56	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	4.78	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	4.87	Released (good)	
15/09/2014	MT	Near Bridge	JCS	72	4.75	Released (good)	
15/09/2014	MT	Near Bridge	JCS	83	6.36	Released (good)	
15/09/2014	MT	Near Bridge	JCS	90	8.06	Released (good)	

Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments
15/09/2014	MT	Near Bridge	JCS	78	4.82	Released (good)	
15/09/2014	MT	Near Bridge	JCS	69	4.23	Released (good)	
15/09/2014	MT	Near Bridge	JCS	81	5.66	Released (good)	
15/09/2014	MT	Near Bridge	JCS	71	4.01	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	4.55	Released (good)	
15/09/2014	MT	Near Bridge	JCS	66	3.73	Released (good)	
15/09/2014	MT	Near Bridge	JCS	78	5.32	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	4.36	Released (good)	
15/09/2014	MT	Near Bridge	JCS	77	5.65	Released (good)	
15/09/2014	MT	Near Bridge	JCS	72	4.2	Released (good)	
15/09/2014	MT	Near Bridge	JCS	72	4.6	Released (good)	
15/09/2014	MT	Near Bridge	JCS	83	6.43	Released (good)	
15/09/2014	MT	Near Bridge	JCS	69	4.02	Released (good)	
15/09/2014	MT	Near Bridge	JCS	76	5.35	Released (good)	
15/09/2014	MT	Near Bridge	JCS	84	6.16	Released (good)	
15/09/2014	MT	Near Bridge	JCS	72	4.29	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	4.44	Released (good)	
15/09/2014	MT	Near Bridge	JCS	76	5.54	Released (good)	
15/09/2014	MT	Near Bridge	JCS	85	6.96	Released (good)	
15/09/2014	MT	Near Bridge	JCS	77	5.17	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	4.64	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	5.95	Released (good)	
15/09/2014	MT	Near Bridge	JCS	69	3.41	Released (good)	
15/09/2014	MT	Near Bridge	JCS	90	5.8	Released (good)	
15/09/2014	MT	Near Bridge	JCS	79	4.71	Released (good)	
15/09/2014	MT	Near Bridge	JCS	87	6.45	Released (good)	
15/09/2014	MT	Near Bridge	JCS	70	3.66	Released (good)	
15/09/2014	MT	Near Bridge	JCS	78	5.01	Released (good)	
15/09/2014	MT	Near Bridge	JCS	83	6.56	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	4.09	Released (good)	
15/09/2014	MT	Near Bridge	JCS	81	6.21	Released (good)	
15/09/2014	MT	Near Bridge	JCS	72	4.76	Released (good)	
15/09/2014	MT	Near Bridge	JCS	66	4.13	Released (good)	
15/09/2014	MT	Near Bridge	JCS	82	5.48	Released (good)	
15/09/2014	MT	Near Bridge	JCS	79	4.88	Released (good)	
15/09/2014	MT	Near Bridge	JCS	83	5.99	Released (good)	
15/09/2014	MT	Near Bridge	JCS	65	3.19	Released (good)	
15/09/2014	MT	Near Bridge	JCS	75	4.85	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	3.86	Released (good)	
15/09/2014	MT	Near Bridge	JCS	65	2.8	Released (good)	
15/09/2014	MT	Near Bridge	JCS	73	4.16	Released (good)	
15/09/2014	MT	Near Bridge	JCS	68	3.52	Released (good)	
15/09/2014	MT	Near Bridge	JCS	74	4.59	Released (good)	
15/09/2014	MT	Near Bridge	JCS	89	7.46	Released (good)	
15/09/2014	MT	Near Bridge	JCS	91	9.28	Killed (retreived dead)	
10/10/2014	MT	Near Bridge	JCS	87	6.51	Released (good)	
10/10/2014	MT	Near Bridge	JCS	75	4.57	Released (good)	
10/10/2014	MT	Near Bridge	JCS	74	3.79	Released (good)	
10/10/2014	MT	Near Bridge	JCS	77	4.65	Released (good)	
10/10/2014	MT	Near Bridge	JCS	65	3.18	Released (good)	
10/10/2014	MT	Near Bridge	JCS	79	4.08	Released (good)	

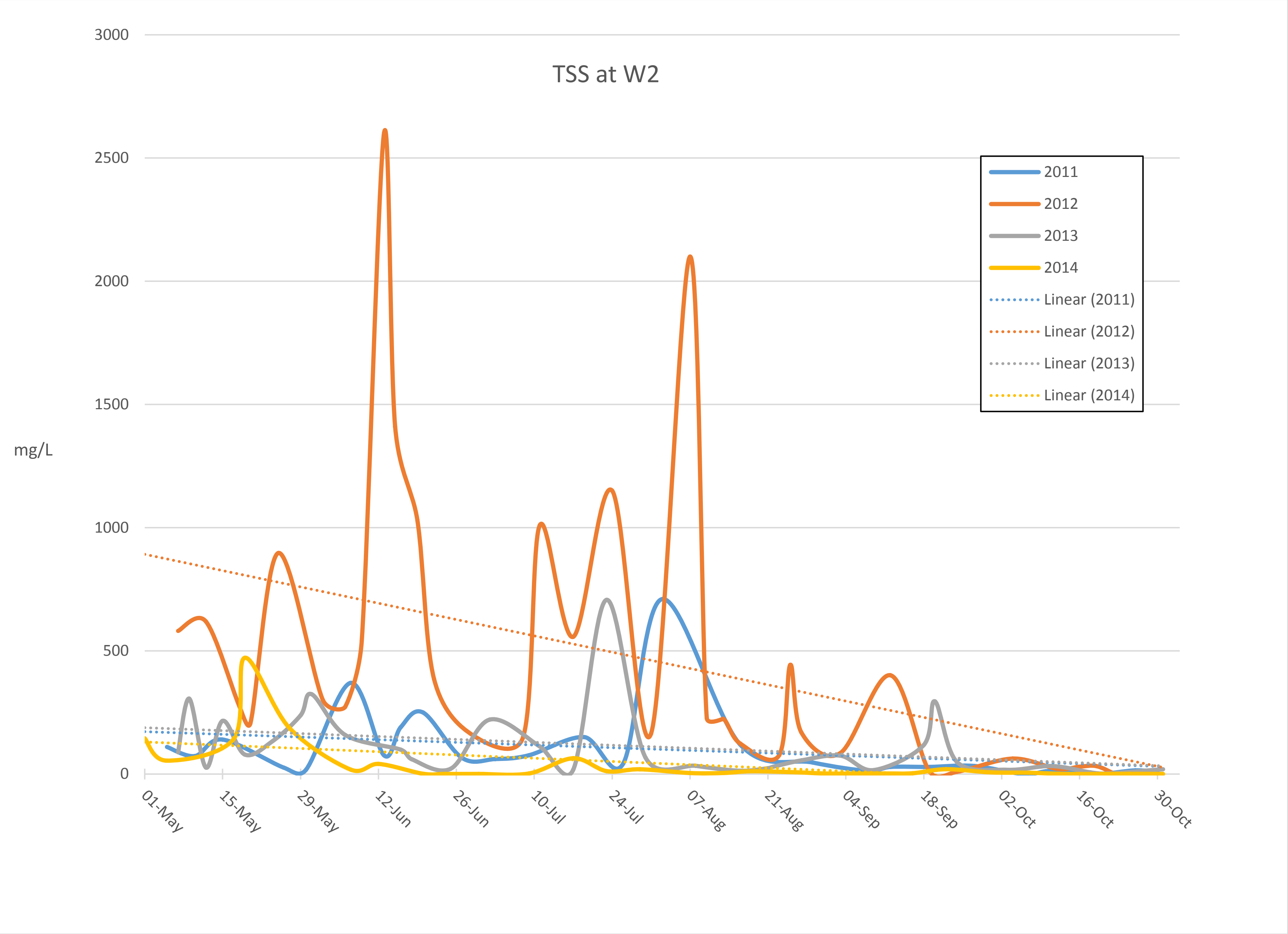
Date	Method	Location of capture	Species*	Length (mm)**	Weight (g)	Fate	Comments

* SS=Slimy Sculpin, JCS=Juvenile Chinook Salmon, BB=Burbot, LS=Longnose Sucker

**Fish length refers to fork length for JCS and LS and to total length for other species

APPENDIX C

TSS RESULTS AT W2, 2011-2014


TSS at W2
mg/L
3000
2500
2000
1500
1000
500
0
01-May
15-May
29-May
12-Jun
26-Jun
10-Jul
24-Jul
07-Aug
21-Aug
04-Sep
18-Sep
02-Oct
16-Oct
30-Oct
2011
2012
2013
2014
Linear (2011)
Linear (2012)
Linear (2013)
Linear (2014)

TSS @ W2 (mg/L)				
Date	**2011**	**2012**	**2013**	**2014**
01-May				145
02-May				
03-May				
04-May				
05-May	110			54.4
06-May				
07-May		581	88.3	
08-May				
09-May			306	
10-May	73			
11-May				
12-May		619	26.5	
13-May				
14-May				
15-May	140		216	
16-May				
17-May				143
18-May		276		
19-May			79	472
20-May		207		
21-May				
22-May				
23-May				
24-May			134	
25-May		897		
26-May	26			
27-May				187
28-May				
29-May			238	
30-May	18			
31-May			324	
01-Jun				
02-Jun		301		
03-Jun				
04-Jun				
05-Jun				
06-Jun		272	159	
07-Jun	370			18.2
08-Jun				
09-Jun		540		
10-Jun				
11-Jun				
12-Jun				41.2
13-Jun	76	2600		
14-Jun				

TSS @ W2 (mg/L)				
Date	**2011**	**2012**	**2013**	**2014**
15-Jun		1410		
16-Jun	190		99	
17-Jun				
18-Jun			60	
19-Jun		1030		
20-Jun	250			1.3
21-Jun				
22-Jun		385		
23-Jun				
24-Jun				<1.0
25-Jun			21.8	
26-Jun				
27-Jun	66			
28-Jun				
29-Jun		157		
30-Jun				<1.0
01-Jul				
02-Jul			221	
03-Jul	61			
04-Jul				
05-Jul				
06-Jul				
07-Jul				
08-Jul		150		
09-Jul	76			2.1
10-Jul				
11-Jul		1010	112	
12-Jul				
13-Jul				
14-Jul				
15-Jul				
16-Jul				
17-Jul		557	17.4	64.1
18-Jul				
19-Jul	150			
20-Jul				
21-Jul				
22-Jul				
23-Jul			707	11.9
24-Jul		1150		
25-Jul				
26-Jul	43			
27-Jul				
28-Jul				
29-Jul				19.4

TSS @ W2 (mg/L)				
Date	**2011**	**2012**	**2013**	**2014**
30-Jul			66.7	
31-Jul		165		
01-Aug				
02-Aug	710			
03-Aug				
04-Aug				
05-Aug				
06-Aug				
07-Aug		2100		4.2
08-Aug			33.5	
09-Aug				
10-Aug		228		
11-Aug				
12-Aug				
13-Aug		224		4.4
14-Aug				
15-Aug				
16-Aug	120	124	13.4	
17-Aug				
18-Aug				11.4
19-Aug				
20-Aug				
21-Aug			23.9	
22-Aug			30	
23-Aug		75.8		
24-Aug				
25-Aug		443		
26-Aug				7.3
27-Aug		169	55.5	
28-Aug				
29-Aug	47			
30-Aug				
31-Aug				
01-Sep				2
02-Sep				
03-Sep		85.1	74.7	
04-Sep				
05-Sep				
06-Sep				
07-Sep				
08-Sep	13			
09-Sep			16.1	
10-Sep				
11-Sep				2.4
12-Sep	29	401		

TSS @ W2 (mg/L)				
Date	**2011**	**2012**	**2013**	**2014**
13-Sep				
14-Sep				
15-Sep				
16-Sep				3.3
17-Sep				
18-Sep			118	
19-Sep	29	11.7		
20-Sep			295	
21-Sep				
22-Sep				19.7
23-Sep				
24-Sep		9.3	48.2	
25-Sep				
26-Sep				
27-Sep	33			
28-Sep				
29-Sep				
30-Sep				6.9
01-Oct				
02-Oct				
03-Oct			17.3	
04-Oct		62.8		
05-Oct				
06-Oct	<4			
07-Oct				5.3
08-Oct				
09-Oct				
10-Oct				
11-Oct	13		32.6	
12-Oct		21		
13-Oct				
14-Oct				<1.0
15-Oct				
16-Oct		30		
17-Oct				
18-Oct			6.5	
19-Oct	<4	32.4		
20-Oct				
21-Oct			2.3	
22-Oct		4.1		
23-Oct				
24-Oct				
25-Oct				1
26-Oct	15			
27-Oct				

TSS @ W2 (mg/L)				
Date	**2011**	**2012**	**2013**	**2014**
28-Oct				
29-Oct				
30-Oct	7			
31-Oct			19.5	<1.0
Average	**103**	**480.2**	**114.4**	**45.5**
Count	**26**	**34**	**32**	**27**
Minimum	**2**	**4.1**	**2.3**	**<1.0**
Maximum	**710**	**2600**	**707**	**472**
Geometric Mean	**45**	**205.6**	**58.3**	**8.1**
Count <DL	**2**	**0**	**0**	**4**
Standard Deviation	**151**	**599.9**	**143.4**	**98.8**
1st Quartile	**20**	**94.8**	**23.4**	**2.1**
Median	**54**	**250**	**63.4**	**6.9**
3rd Quartile	**118**	**575**	**140.2**	**30.5**

Appendix J – Minto Mine Phase 3 EEM – Investigation of Cause Interpretive Report

Minto Mine
Phase 3 EEM -
Investigation of Cause
Interpretive Report

Report Prepared For:
Capstone Mining Corp. – Minto Mine
13- 151 Industrial Road
Whitehorse, Yukon
Y1A 2V3

Prepared By:
Minnow Environmental Inc.
101 – 1025 Hillside Avenue
Victoria, B.C.
V8T 2A2

January 2015

Minto Mine Phase 3 EEM - Investigation of Cause Interpretive Report

Report Prepared for:

Capstone Mining Corp. - Minto Mine

Report Prepared by:

Minnow Environmental Inc.

Pierre Stecko, M.Sc., EP, RPBio
Project Manager

for

Cynthia Russel, B.Sc.
Project Principal

EXECUTIVE SUMMARY

The Minto Mine, operated by the Capstone Mining Corporation is an open pit copper/gold/silver mine located approximately 240 km northwest of Whitehorse in the Yukon Territory. The mine is located in the upper reaches of the Minto Creek watershed approximately 10 km west of the Minto Creek confluence with the Yukon River. Commercial production at the Minto Mine commenced in October 2007 and the mine is projected to run to 2022. Milling (concentrating) is done on site and tailings are dried and stacked at a storage facility located adjacent to the open pit and mill. Site water is ultimately managed in a Water Storage Pond located approximately 1.5 kilometers to the east (down-gradient) of the mill. The Minto Mine has one effluent discharge to Minto Creek from the Water Storage Pond, and discharge is intermittent as needed. The Minto Mine is required to undertake Environmental Effects Monitoring (EEM) under the federal Metal Mining Effluent Regulations (MMER). The current phase of EEM (Phase 3) is an investigation of cause (IOC) study into the previously-observed differences in benthic invertebrate community structure in upper Minto Creek relative to reference as detected using the Bray-Curtis index of dissimilarity.

Effluent sublethal toxicity tests conducted by the mine from 2012 to 2014 showed no effect to rainbow trout embryos, the alga *P. subcapitata*, or the plant *L. minor*. However, testing of the invertebrate *C. dubia* indicated that, although survival was not affected, one instance of reproductive impairment occurred (at 38.6% effluent in 2013). Coupled with in-creek effluent concentrations approaching 100%, this suggests a potential for occasional effluent-related impairment of invertebrate reproduction.

Routine water quality monitoring indicated an influence of the Minto Mine on Minto Creek evident in conductivity, hardness, nitrate, arsenic and copper that were greater than reference. Of these, concentrations of nitrate were most strongly associated with release of water from the water storage pond (WSP), but remained below the Canadian water quality guideline for the protection of aquatic life (CWQG). Copper was the only one of these analytes with a mean concentration greater the CWQG, and dissolved copper (which represents bioavailable copper better than total) was typically elevated during freshet/WSP discharge. Water quality of upper Minto Creek during the IOC study (in September 2014) did not represent WSP discharge (discharge was not active at the time of IOC implementation), but did have elevated conductivity relative to most, but not all, reference sites. During the IOC study, all analytes except strontium and tin were within the range of reference and no analytes were present at concentrations greater than CWQGs.

The benthic invertebrate community of Minto Creek was evaluated using two approaches: the community of upper Minto Creek (where the investigation of cause was triggered based on results of previous EEM studies) was evaluated using a reference condition approach (RCA), and the community of lower Minto Creek was evaluated using a control-impact (CI) approach. The RCA evaluation of upper Minto Creek indicated that two of three upper Minto Creek replicates (UMC-1 and UMC-2) did not differ from the reference condition on the basis of any of the four primary EEM-effect metrics (abundance, taxon richness, Simpson's evenness or Bray-Curtis index of dissimilarity [hereafter referred to as Bray-Curtis distance]). Replicate UMC-3 was within reference condition for taxon richness and Simpson's evenness, had organism abundance significantly greater than the reference condition, and had a Bray-Curtis distance that could not be conclusively categorized as within the reference condition nor significantly different from the reference condition. The lack of consistent differences from reference across replicates suggests that effluent exposure has had minimal influence on benthic invertebrate communities of upper Minto Creek. It is notable that Bray-Curtis distance, which triggered the IOC based on significant differences in the two previous EEM studies, was within the reference condition in two of three replicates in upper Minto Creek and uncertain with respect to one of the three replicates. This metric has been previously identified as being pre-disposed towards producing significant differences even in the absence of a real effect. However, some supporting benthic invertebrate community metrics continue to suggest subtle differences in community structure relative to reference (including lower percent mayflies and stoneflies, higher percent caddisflies, and higher percent chironomidae) that are similar to those previously observed. Despite the fact that an effect on Bray-Curtis distance was not supported in the RCA evaluation, correlation analysis was conducted to explore potential relationships between benthic invertebrate community structure and measured variables (i.e., to identify potential cause) and did not identify any clear mine-related influences on the benthic invertebrate community. Several benthic invertebrate community endpoints (abundance, richness and Bray-Curtis distance) were negatively associated with total Kjeldahl nitrogen (TKN) concentrations, but TKN concentrations at the exposed sites were low and the benthic endpoints of exposed sites were similar to those of reference sites with similar TKN concentrations. It is unclear whether the minor community structure dissimilarities between upper Minto Creek and reference as detected by supporting benthic invertebrate community metrics (but not by EEM-effect metrics) were due to naturally occurring conditions or mine related activities.

The CI evaluation of lower Minto Creek indicated statistically significant benthic invertebrate community differences relative to the lower Wolverine Creek reference area (greater density, greater Bray-Curtis distance, and some taxon proportions). Conversely, the greatest relative abundance of pollution sensitive EPT taxa (Ephemeroptera, Plecoptera and Trichoptera; commonly named mayflies, stoneflies and caddisflies) occurred at effluent-exposed lower Minto Creek (primarily due to high abundance of Nemoura stoneflies). The high abundance of stoneflies in lower Minto Creek is opposite of what was observed in upper Minto Creek relative to the reference condition. The observed differences between lower Minto Creek and lower Wolverine Creek may be largely attributable to the narrow comparison (to only one reference area) rather than any mine-related effect, but an influence of effluent exposure cannot be ruled out as there is evidence of an association with elevated conductivity observed at exposure area stations. Similar associations with water depth and dissolved oxygen indicate that habitat differences are also important.

Overall, the investigation of cause indicated that the differences in benthic invertebrate community structure of upper Minto Creek detected using Bray-Curtis distance in previous EEM studies were likely due to comparison to too few reference areas (resulting in inadequate characterization of the range of reference condition). The investigation did not support a mine-related water quality influence on Bray-Curtis distance in upper Minto Creek. Some minor differences in benthic invertebrate community structure of upper Minto Creek detected by supporting metrics (but not by the EEM-effect metrics of abundance, taxon richness, Simpson's evenness or Bray-Curtis distance) were no more strongly associated with mine-related physical and chemical variables than to natural physical and chemical variables.

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1.0 INTRODUCTION

1.1 Site Description

The Minto Mine is a high-grade copper mine located within Selkirk First Nation (SFN) Category A Settlement Land Parcel R-6A approximately 240 km northwest of Whitehorse, Yukon Territory (62°37'N latitude and 137°15'W longitude; Figure 1.1). It is owned and operated by Capstone Mining Corporation. Development of the mine was initiated in 1997, commercial operations started in October 2007 and the anticipated operating life is to 2022. The facility is permitted to conduct open pit and underground mining with milling at a rate of 4,200 tonnes of copper/gold/silver ore per day, and produced 37.2 million pounds of copper in 2013. Copper reserves are approximately 440 millions pounds. Mine-impacted seepage from the Tailings Storage Facility and the Mill Valley Fill (MVF) is collected at the Minto Creek Detention Structure at the toe of the MVF and pumped to the main pit (Figure 1.2). Non-impacted water and treated mine-impacted water are collected in a Water Storage Pond (WSP; Figure 1.2). Effluent from the WSP is periodically discharged to Minto Creek under conditions specified in Water Use Licence (WUL) QZ96-006 (Amendment 7, April 2011 and Amendment 8, September 2012). Minto Creek flows into the Yukon River approximately 12 km south-east of the mine site (Figure 1.2).

1.2 Regulatory Context

Federal effluent regulations for the metal mining industry (Metal Mining Effluent Regulations; MMER) were most recently amended in March 2012 (Government of Canada 2014). These regulations, administered under the federal *Fisheries Act*, apply to mining and milling operations that have discharged effluent at a rate greater than 50 m^3/day and therefore apply to the Minto Mine. The MMER outline requirements for routine effluent monitoring, acute lethality testing, and Environmental Effects Monitoring (EEM). The objective of EEM is to determine whether mine effluent discharge is causing an effect on fish, benthic invertebrate communities and/or the use of fisheries resources. The Minto Mine triggered the MMER on July 10th, 2006.

In accordance with the MMER, the Minto Mine has completed two phases of EEM (Minnow/Access 2007, 2009, 2010, 2012) and is presently in phase three. The Phase 3 EEM biological study is an Investigation of Cause (IOC) study, triggered by a finding of consistent differences in the structure of the benthic invertebrate community of Minto Creek compared to reference (as indicated by the Bray-Curtis Index of Dissimilarity) through the first two phases of EEM.

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MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
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Map of Canada

Figure 1.1: Location of the Minto Mine

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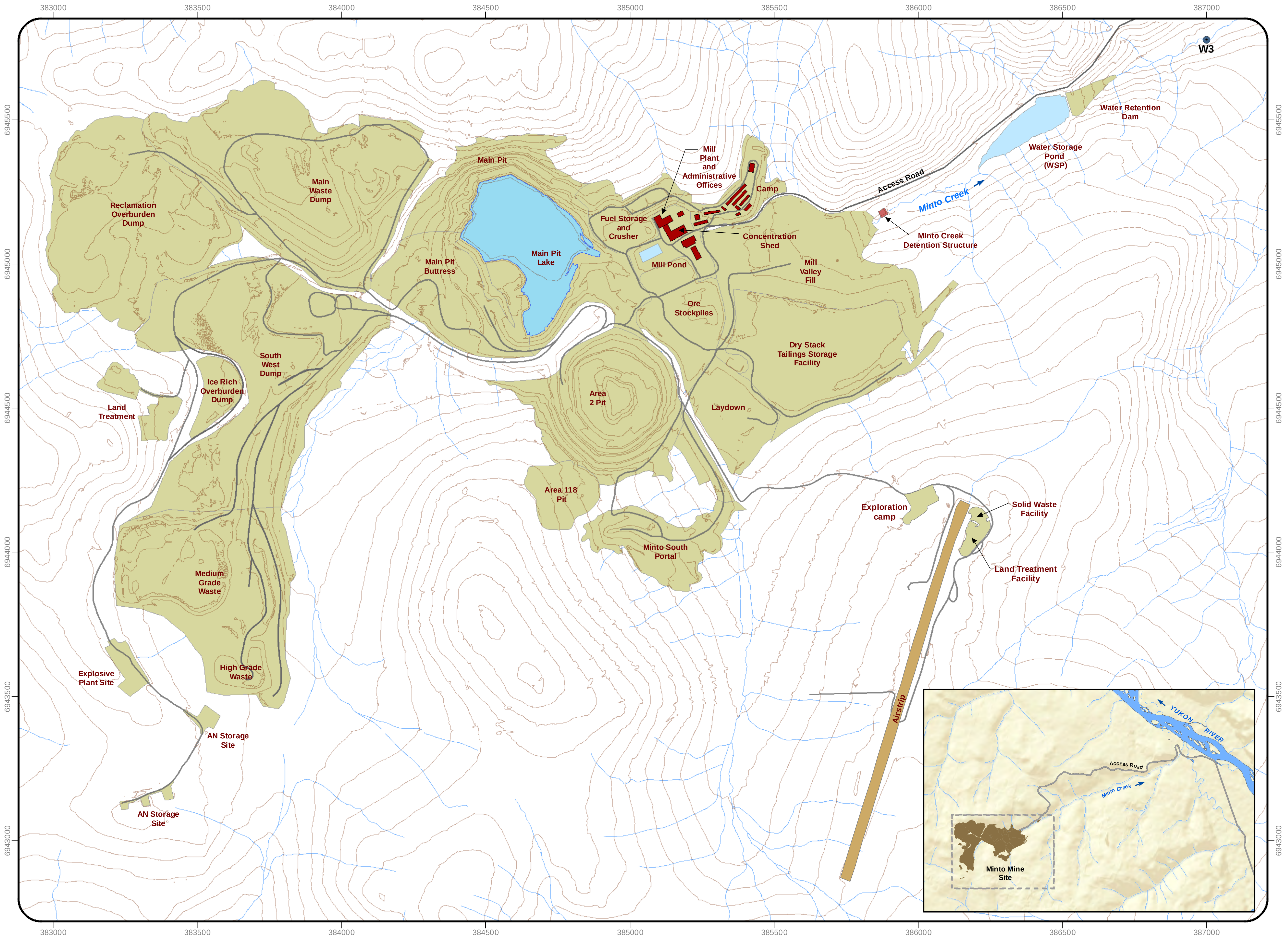

Features

- ● Final Effluent Discharge Point
- → Direction of Flow
- Mine Road
- Contour
- Watercourse
- Waterbody
- Mine Feature Footprint
- Main Pit Lake
- Minto Creek Detention Structure
- Building

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MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
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Mine site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.

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Figure 1.2: Minto Mine Site Layout and Receiving Environment

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minnow
environmental inc.

A study design for the IOC was prepared and submitted to Environment Canada in March 2014 (Minnow 2014). Comments were received on July 24th, 2014 (File MM4011) and written responses were submitted August 13th, 2014 (Appendix A). Biological monitoring was implemented from September 9th to 14th, 2014 and the study results are provided in this report.

1.3 Study Objective and Overview

The objective of this Phase 3 EEM / IOC study is to determine the cause of the differences in benthic invertebrate community structure in Minto Creek compared to reference observed in the first two phases of EEM (Minnow/Access 2009, 2012). Specific hypotheses of cause are: 1) the observed difference was due to comparison to a small number of reference areas (two) that did not completely match upper Minto Creek nor capture the range in reference area variability; and 2) the observed difference was due to a mine-related water quality effect (nutrient concentrations, temperature and/or specific conductance; Minnow 2014).

Briefly, the hypotheses of cause were addressed through a focussed assessment of the benthic invertebrate community of upper Minto Creek using a Reference Condition Approach (RCA) that included a total of 12 reference sites. A control-impact design was also applied to an assessment of the benthic invertebrate community of lower Minto Creek. All benthic invertebrate community sampling was supported by a full suite of physical and chemical measurements including nutrient chemistry to assist in the evaluation of potential cause. This IOC study also includes an evaluation of effluent sublethal toxicity test results and water quality.

1.4 Effluent Discharge and Quality

Minto Mine final effluent is discharged to Minto Creek via a control structure located at monitoring Station W3 (Figure 1.2). This location captures effluent discharged from the WSP as well as surface and groundwater inputs to the section of Minto Creek between the toe of the WSP and Station W3 (Figure 1.2). A total of 1,074,282 m^3 of effluent was discharged to Minto Creek at Station W3 over the period from 2012 to 2014 (the Phase 3 EEM period; 164,669 m^3 in 2012, 426,594 m^3 in 2013, and 487,641 m^3 in 2014). Most of the discharge in all three years was in April and May associated with the release of water from the WSP during spring freshet (Figure 1.3). During spring freshet, the Minto Mine has different effluent quality standards under WUL QZ96-006 and limits for lower Minto Creek are not in effect. Average daily discharge rate during the spring WSP water releases (2012-2014) was approximately 8,000 m^3/d (maximum 14,760 m^3/d). Minto Mine effluent quality met the effluent limits specified under the MMER, with the exception of one total suspended solids

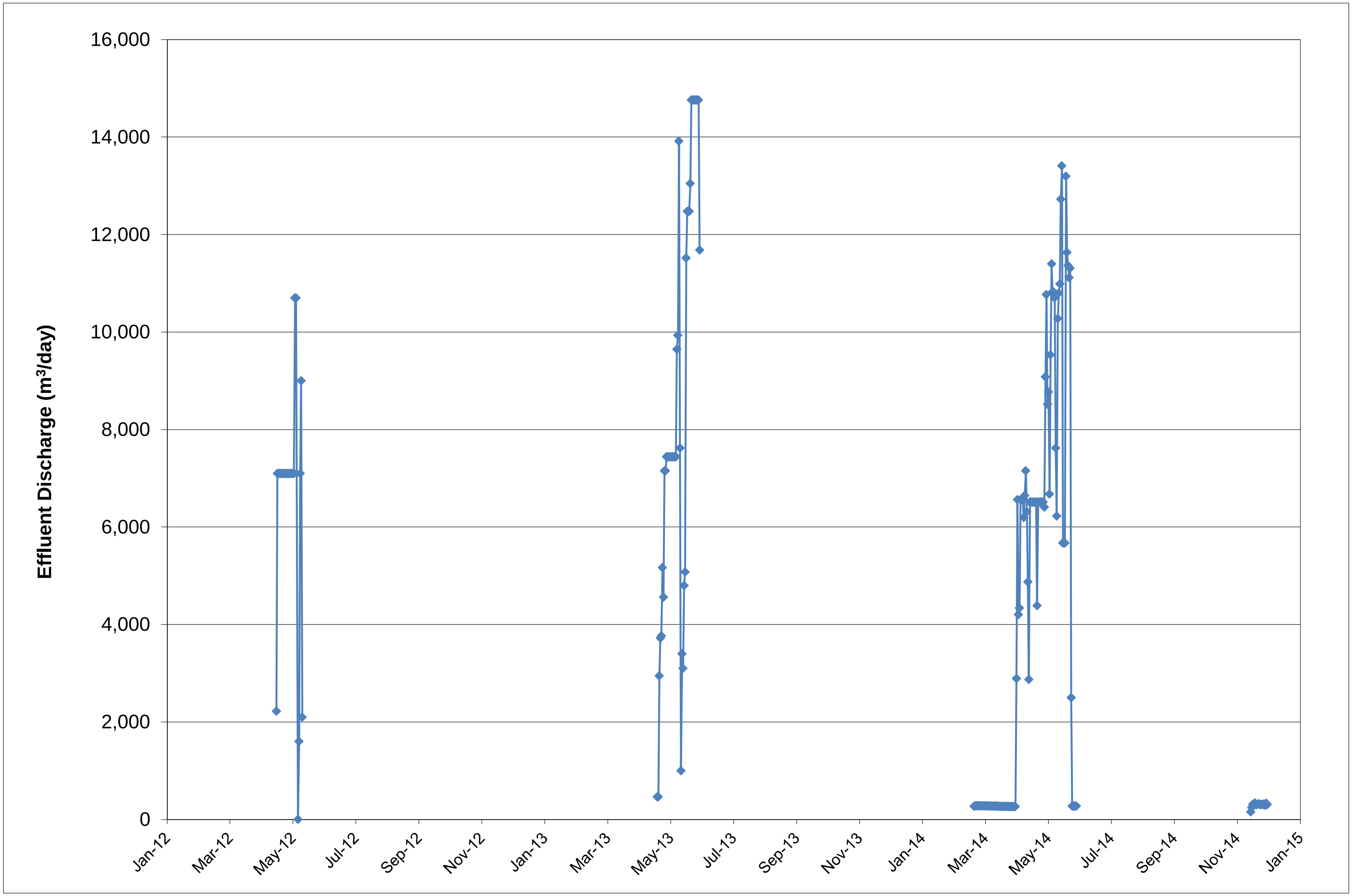


Figure 1.3: Daily effluent discharge volume (Station W3), 2012 - 2014 (year-to-date)

result in 2013 and another in 2014 (out of 42 and 55 observations, respectively; Appendix Table B.1). No acute toxicity to rainbow trout was observed and there was only one occurrence of toxicity to *Daphnia magna* (in August 2012; Appendix Table B.2). Routine effluent monitoring (Appendix Table B.1) and effluent characterization (conducted four times per year; Appendix Table B.3) indicate that effluent quality has been consistent through the Phase 3 EEM period.

1.5 Report Organization

Methods employed during the IOC study are outlined in detail in Section 2.0. Section 3.0 presents a summary of the effluent sub-lethal toxicity test data collected between 2012 and 2014 and interpretation of potential in-situ influence. Water quality data and other supporting measures are presented and interpreted in Section 4.0. The benthic invertebrate community evaluations are presented and interpreted in Section 5.0. Conclusions and recommendations of the IOC study are presented in Section 6.0. References cited throughout the document are listed in Section 7.0.

2.0 METHODS

2.1 Overview

The Phase 3 EEM (IOC) study for the Minto Mine consisted of the following components: 1) effluent sublethal toxicity testing; 2) receiving water quality monitoring; and 3) a benthic invertebrate community investigation. A fish survey was not required as the IOC was triggered by previous benthic invertebrate community results only, and a fish tissue (mercury) assessment was not required because mercury concentrations in final effluent have not exceeded 0.0001 mg/L (Environment Canada 2012).

The benthic invertebrate community survey, supported by physical measures and water quality, was conducted from September 9th to 14th, 2014. The benthic survey included an evaluation of upper Minto Creek using a Reference Condition Approach (RCA) that included 12 reference sites, 10 of which were new sites (Table 2.1; Figure 2.1). The benthic survey also included a supporting evaluation of lower Minto Creek using a Control-Impact (CI) design, with lower Wolverine Creek serving as the reference area (Figure 2.1).

2.2 Effluent Sublethal Toxicity

Under the MMER, the Minto Mine implements sublethal toxicity testing of final effluent on an annual frequency. Sublethal toxicity samples were collected into 20 litre plastic containers. Following collection, samples were placed on ice inside coolers and shipped to Maxxam Analytics Inc. (Burnaby, BC) where they arrived within 48 hours. Sample appearance, odour, temperature and hardness were recorded upon arrival at the laboratory. Tests were conducted using rainbow trout (*Oncorhynchus mykiss*) embryos, the invertebrate *Ceriodaphnia dubia*, the algae *Pseudokerchneriella subcapitata* and the plant *Lemna minor* using Environment Canada test methods (1998, 2007a,b,c). Sublethal toxicity data were subsequently reported to Environment Canada as part of Minto Mine annual reports and are synthesized in this report.

2.3 Water Quality

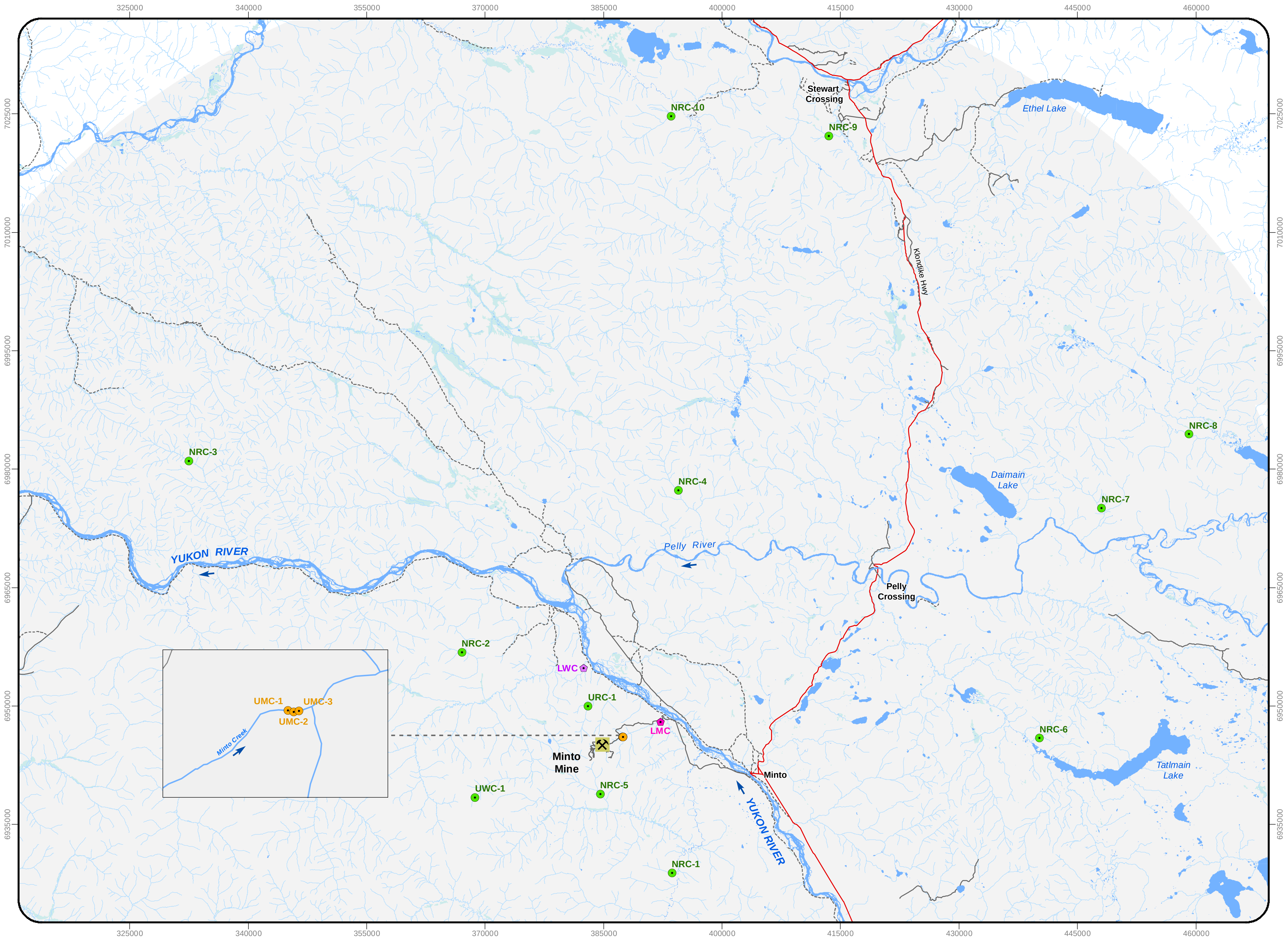
Under the MMER, the Minto Mine monitors receiving water quality at a frequency of four times per year. Monitoring is conducted at lower Minto Creek (Station W2) and a north-flowing tributary to Minto Creek (Station W7), representing mine-exposed and reference conditions, respectively (Figure 2.2). In addition to routine water quality monitoring, water samples were collected once at each benthic invertebrate sampling site during the IOC. Results from both the routine monitoring and the EEM water quality monitoring are incorporated into the overall assessment of receiving water quality.

Table 2.1: Overview of the Minto Mine Cycle 3 EEM (IOC) study

Area	Benthic Invertebrate Community Survey		Index of Primary Productivity	Supporting Water Quality	
	Overview	**Supporting Data**		**Field-Based Measures[a]**	**Analytical Samples[b]**
"Upper" Effluent-Exposed Area (RCA Design)					
Upper Minto Creek	Quantitative survey conducted in erosional cobble habitat. Three stations to provide replication at the near-field exposure site. One sample per station with each a 3-grab composite using a Hess sampler equipped with 500 μm mesh	Substrate characterization, water velocity and depth, field-based water quality (meter measures), habitat notes, and GPS coordinates at each station	One sample of periphyton for chlorophyll a determination (per unit stream area [m^2]) at each station	Collected at each benthic invertebrate station	One water sample at each station collected during benthic invertebrate survey. Parameter suite includes all MMER compliance monitoring analytes and additional nutrients
"Upper" Reference Areas (RCA Design)					
Upper McGinty Creek	Quantitative survey conducted August or September 2014 in erosional habitat, one station per creek. One sample per station, each a 3-grab composite using a Hess sampler equipped with 500 μm mesh	Substrate characterization, water velocity and depth, field-based water quality (meter measures), habitat notes, and GPS coordinates at each station	One sample of periphyton for chlorophyll a determination (per unit stream area [m^2]) at each station	Collected at all benthic invertebrate stations	One water sample at each station collected during benthic invertebrate survey. Parameter suite includes all MMER compliance monitoring analytes and additional nutrients
Upper Wolverine Creek					
Ten new RCA Reference Creeks					
"Lower" Effluent-Exposed Area (CI Design)					
Lower Minto Creek	Quantitative survey conducted in erosional cobble habitat. Five stations to provide replication at the near-field exposure site. One sample per station with each a 3-grab composite using a Hess sampler equipped with 500 μm mesh	Substrate characterization, water velocity and depth, field-based water quality (meter measures), habitat notes, and GPS coordinates at each station	One sample of periphyton for chlorophyll a determination (per unit stream area [m^2]) at each station	Collected at all benthic invertebrate stations	One water sample at each station collected during benthic invertebrate survey. Parameter suite includes all MMER compliance monitoring analytes and additional nutrients
"Lower" Reference Area (CI Design)					
Lower Wolverine Creek	Quantitative survey conducted in erosional cobble habitat. Five stations to provide replication at the near-field exposure site. One sample per station with each a 3-grab composite using a Hess sampler equipped with 500 μm mesh	Substrate characterization, water velocity and depth, field-based water quality (meter measures), habitat notes, and GPS coordinates at each station	One sample of periphyton for chlorophyll a determination (per unit stream area [m^2]) at each station	Collected at all benthic invertebrate stations	One water sample at each station collected during benthic invertebrate survey. Parameter suite includes all MMER compliance monitoring analytes and additional nutrients

[a] Field-based water quality parameter suite includes water temperature, dissolved oxygen, pH and conductivity

[b] Analytical water quality parameter suite includes hardness, alkalinity, pH, TSS, ammonia, nitrate, ICP total metal scan (including aluminum, arsenic, cadmium, copper, iron, lead, molybdenum, nickel, selenium, zinc), mercury, total nitrogen, total Kjeldahl nitrogen, nitrite, total phosphorus, and phosphate



Features

- ● Exposure Site
- ● Reference Site
- ⬟ Exposure Area
- ⬟ Reference Area
- ⚒ Minto Mine Site
- Road
- Limited-use road
- Trail
- Watercourse
- 🟦 Waterbody
- Wetland
- Search Area (100 kilometers)
- → Direction_of_Flow2

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MAP INFORMATION:
Datum: NAD 83 Map Projection: UTM Zone 7N & Zone 8N

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Figure 2.1: Minto Mine IOC Sampling Sites / Areas

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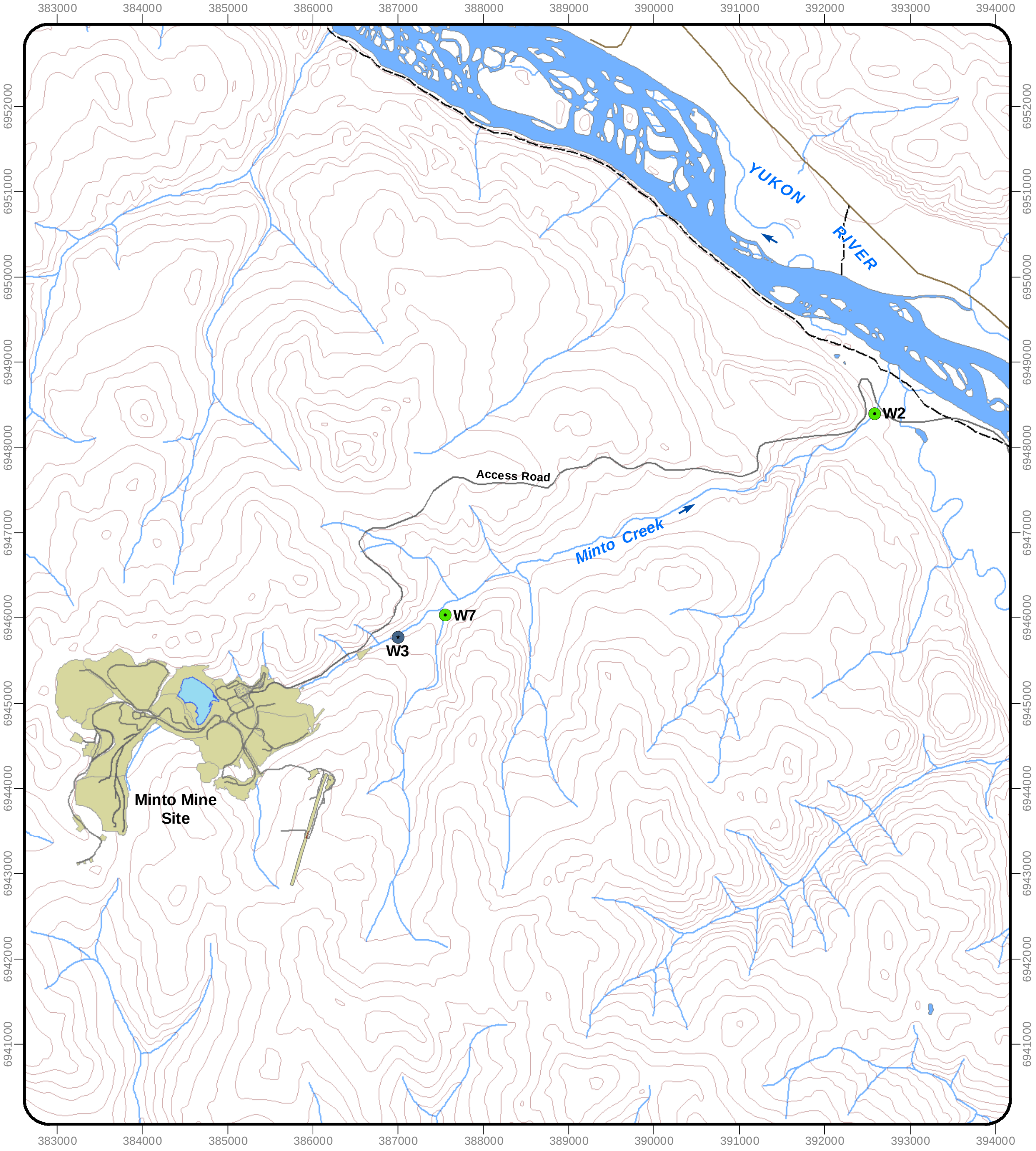

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MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
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Mine site contours derived from 2012 aerial imagery obtained from Challenger Geomatics.
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Features

- ● Water Quality Stations
- ● Final Effluent Discharge Point
- ▨ Mine Feature Footprint
- ▨ Main Pit Lake
- ▨ Waterbody
- — Watercourse
- — Contour
- → Direction of Flow

Figure 2.2: Minto Mine Routine Water Quality Monitoring Stations

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2.3.1 Sample Collection

During the EEM field survey, *in-situ* measures of water temperature, dissolved oxygen (DO) concentration and saturation, pH, and specific conductance were collected at each benthic invertebrate community sampling site. *In-situ* measurements were taken using a YSI 650MDS hand held meter equipped with a YSI 600XLM sonde (Yellow Springs, OH) portable field meter that was checked against standards or calibrated daily as required. One water sample was collected at each benthic site during the benthic invertebrate community survey. Samples were collected into pre-labelled sample bottles that were rinsed with site water. All samples were maintained in coolers with ice packs during transportation or at 4°C in an on-site refrigerator until submitted to ALS Environmental (ALS; Whitehorse, Yukon).

2.3.2 Laboratory Analyses

At ALS, water samples were analysed for analytes required under EEM (hardness, alkalinity, aluminum, arsenic, cadmium, copper, iron, lead, mercury, molybdenum, nickel, selenium, zinc, total suspended solids, ammonia, and nitrate; Environment Canada 2012) and for a number of additional analytes identified as beneficial to the IOC (total organic carbon, total Kjeldahl nitrogen, total phosphorus and total dissolved phosphorus). Briefly, alkalinity was determined by potentiometric titration, anions by ion chromatography, carbon by combustion, metals by collision reaction cell ICPMS (inductively coupled plasma - mass spectrometry) or ICPOES (inductively coupled plasma - optical emission spectrophotometry), mercury by CVAFS (cold vapour atomic fluorescence spectrophotometry), ammonia and total Kjeldahl nitrogen by fluorescence, and phosphorus by colour. Hardness was calculated from calcium and magnesium concentrations.

2.3.3 Data Analysis

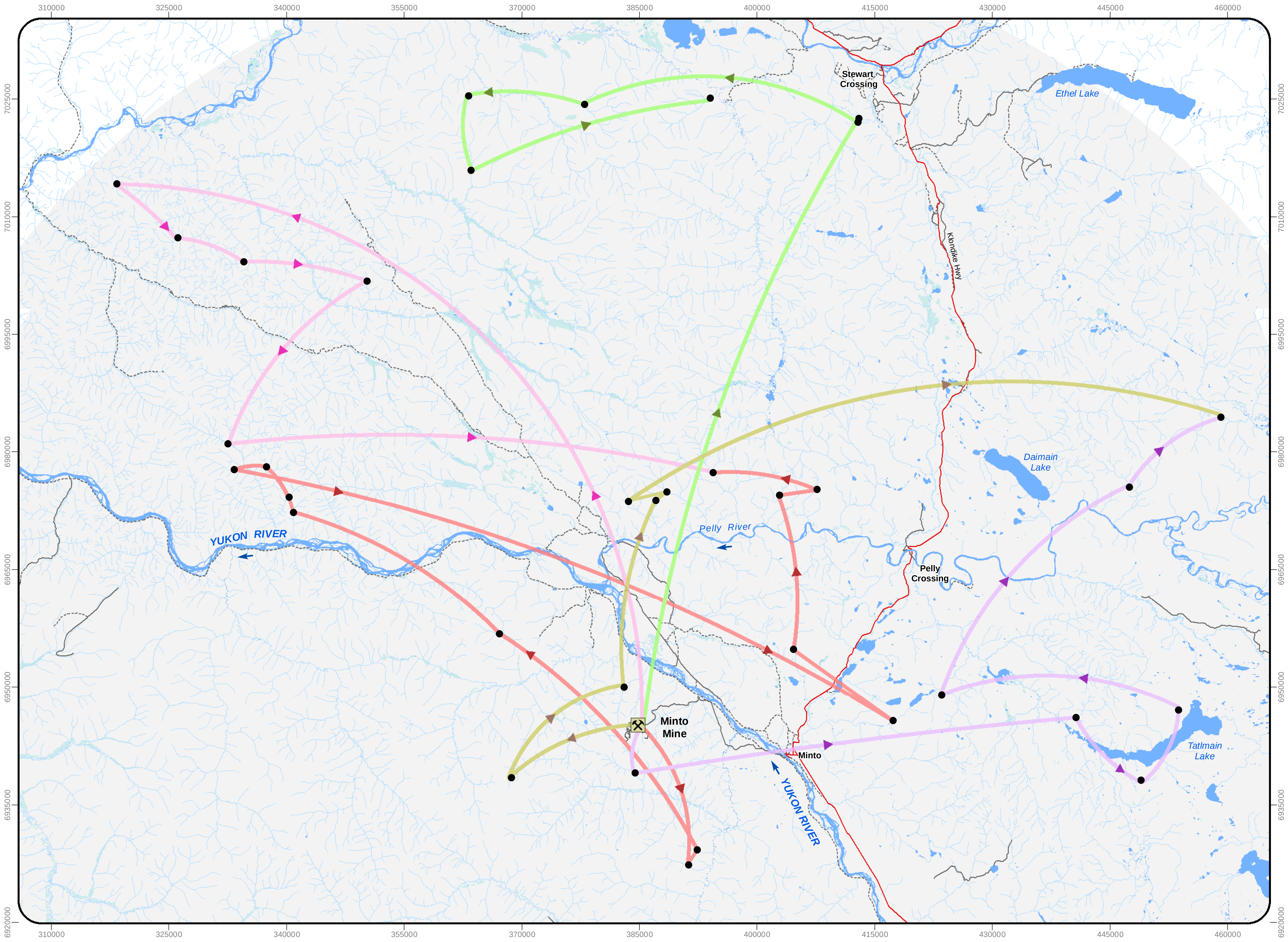
Water quality data were subject to a Data Quality Assessment (DQA), including the evaluation of laboratory blank results, laboratory spikes and laboratory duplicates (Appendix C). Water quality data were evaluated relative to Canadian Water Quality Guidelines for the protection of aquatic life (CWQG; CCME 2014). Water quality of Minto Creek was also evaluated relative to reference areas. As part of the benthic invertebrate community data interpretation, Principal Components Analysis (PCA) was used to reduce the water quality dataset for correlation analysis against benthic metrics. Analytes for which more than 90% of the available data were below laboratory method detection limits (MDL) were excluded from the data matrix (this procedure resulted in the exclusion of beryllium, bismuth, mercury, phosphorus, silver, thallium and zinc which were less than MDL in all samples). Principal component axes were then generated from the remaining data matrix.

For analytes that exceeded water quality guidelines in Minto Creek and were also greater than reference, data analysis was enhanced by examining additional water quality data collected by the Minto Mine under their Water Use Licence (WUL). Specifically, data from the Phase 3 EEM period (2012-2014) were plotted with periods of discharged highlighted in order to further identify and interpret the influence of the Minto Mine on the water quality of Minto Creek.

2.4 Benthic Invertebrate Community

The benthic invertebrate community survey included an evaluation of upper Minto Creek using a Reference Condition Approach (RCA) that included 12 reference sites, 10 of which were new sites (Figure 2.1). The benthic survey also included a supporting evaluation of lower Minto Creek using a Control-Impact (CI) design, with lower Wolverine Creek serving as the reference area (Figure 2.1).

Prior to implementation of the benthic invertebrate community survey, a total of 60 potential RCA reference sites were identified, all of which required helicopter access (Appendix A). These 60 potential RCA reference sites were selected from a pool of 396 potential streams/watersheds that were identified on the basis of elevation (660 m), stream order (second or third order) and distance from upper Minto Creek (within a 100 km radius). The 396 potential sites were reduced to those that had aspects similar to Minto (east to south facing watersheds). This reduction resulted in a total of 135 potential RCA sites, which were further reduced based on cloud cover plus shadow (12 removals), and finally, to better match the fire history of the Minto Creek watershed, 50% of watershed needed to have been burned since 1950. This resulted in 60 potential reference stations, which were then ranked using Principal Components Analysis (PCA) and three dimensional space. Landcover variables that composed less than 5% of the upper Minto Creek watershed were not used in PCA. Environmental variables used in PCA were: watershed area, watershed perimeter, stream length, stream density, low shrubs, herbs, sparse conifers, plutonic geology, volcanic geology, granodiorite / diorite / monzodiorite bedrock, basalt / breccia / andesite / porphyry dacite / trachyte bedrock, percent of watershed not burned since 1950, basin slope and stream order). Ultimately, the 10 new reference sites were selected and sampled after evaluating a total of 35 of the top ranked potential sites, with a total helicopter flight distance of 949 kilometers (Figure 2.3). Reference sites were selected on the basis of habitat similarity to the upper Minto Creek effluent-exposed sites, particularly substrate size, water velocity and water depth. The sites that were visited but not sampled, were rejected primarily due to the absence of an appropriate helicopter landing spot, unsuitable substrate (typically sand or mud), or dry conditions. At the ten selected reference sites, habitat conditions were



Features

⚒ Minto Mine

● Potential Sites

Search Path

▶ Day 1 (Sept. 10, 2014)

▶ Day 2 (Sept. 11, 2014)

▶ Day 3 (Sept. 12, 2014)

▶ Day 4 (Sept. 13, 2014)

▶ Day 5 (Sept. 14, 2014)

— Road

— Limited-use road

--- Trail

— Watercourse

🟦 Waterbody

▨ Wetland

▨ Search Area (100 kilometers)

→ Direction of Flow

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MAP INFORMATION:
Datum: NAD 83 Map Projection: UTM Zone 7N & Zone 8N

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Figure 2.3: Daily Search Path for Minto Mine IOC Reference Sites, September 2014.

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carefully controlled when placing sampling stations to maintain consistency in habitat condition and thereby minimize the natural influences on data variability.

2.4.1 Sample Collection

Benthic invertebrate samples were collected from each of the study sites using a 0.1 m^2 Hess sampler equipped with a 500-μm mesh collection net. For the RCA sampling (three sites on upper Minto Creek and 12 reference sites), one sample was collected at each site, with each sample representing a composite of three-grabs to ensure that the sample was representative of the station (0.3 m^2 in total). For the CI sampling (lower Minto Creek and lower Wolverine Creek), one sample was collected from each of five stations (separated by a minimum distance of three bankfull widths), with each sample representing a composite of three-grabs to ensure that the sample was representative of the station (0.3 m^2 in total). Each sub-sample was collected by carefully placing the base of the Hess sampler onto the substrate and pushing the sampler into the substrate to a depth of approximately 5 to 10 cm after which gravel and cobble contained within the sampler were carefully washed using a scrub brush while allowing the current to carry dislodged organisms into the mesh collection net. After the area within the sampler was completely washed, any organisms adhering to the mesh were rinsed into the collection net using creek water. At that point, the sampler was moved to the next sub-sampling location and the procedure repeated. After collection of the third sub-sample, all organisms were carefully rinsed to the end of the mesh collection net and carefully transferred into a one-litre, wide-mouth plastic jar labelled with the project number, sample location and collection date. Internal labels were also used to ensure correct identification should the external labelling become illegible due to wear. Benthic samples were preserved with buffered formalin to a nominal concentration of 10%. Preservation occurred within six hours of collection to eliminate the potential effects of within-sample predation that could affect abundance estimates. All samples were maintained in coolers or totes at the Minto Mine until submitted to Cordillera Consulting (Summerland, British Columbia).

2.4.2 Laboratory Processing

At Cordillera, samples were analyzed whole (no sub-sampling was required) to the “lowest practical level”, which in most cases was genus or species. Following identification and enumeration of benthic organisms, representative specimens of each taxon were preserved in 75% ethanol (with 3% glycerol) in separately-labelled vials and stored as part of the Minto Mine benthic invertebrate voucher collection. As required by Environment Canada, 10% of samples were re-sorted to verify that fewer than 10% of total organisms were missed (Environment Canada 2012, Glozier et al. 2002).

2.4.3 Data Analysis - Upper Minto Creek (RCA)

Benthic invertebrate community data were subject to a Data Quality Assessment (DQA), which included an evaluation of sorting efficiency (Appendix C). The RCA was initiated by evaluating the appropriateness of the reference stations for defining the reference condition. Indirect correlation of environmental variables with station scores derived from a reference station Correspondence Analysis (CA) was used to identify the strongest (Pearson correlation with $p < 0.10$) environmental predictors of reference benthic invertebrate community structure. Principal components analysis (PCA) of all reference stations and the exposed station was then conducted using the significant environmental variable predictors of reference community structure to ensure that the range of 'natural' environmental conditions found at the mine-exposed stations was encompassed by the reference stations. Any stations identified as outliers were carefully considered to determine whether they should be used to define the reference condition.

Benthic invertebrate communities were evaluated using EEM primary metrics of mean invertebrate density (organisms per m^2), mean taxonomic richness, Simpson's Evenness Index (calculated as in Smith and Wilson 1996; Environment Canada 2012) and the Bray-Curtis Index of Dissimilarity (calculated as in Bray and Curtis 1957). These endpoints were calculated following the exclusion of Collembola, Ostracods, Copepods, Nemata, and Turbellaria from the analysis as these taxa are either non-benthic or are generally smaller than 500 µm in size. These primary indices were calculated at the family level of taxonomy in accordance with EEM requirements. Simpson's Index of Diversity (calculated as in Smith and Wilson 1996; Environment Canada 2012) was also used to describe benthic invertebrate communities. The relative proportions of the most abundant taxa were also computed (calculated as the abundance of each respective dominant/indicator taxon relative to the total number of organisms in the sample). Dominant/indicator taxon groups were defined as those groups representing more than 5% of total organism abundance or any groups considered to be important indicators of environmental stress. All required and selected endpoints were summarized by reporting mean, median, minimum, maximum, standard deviation, standard error and sample size for each sampling site.

Correspondence analysis (CA) was then used to assess benthic invertebrate community structure of mine-exposed and reference stations. CA is a multivariate technique, which is used to create synthetic species prevalence axes extracted in a sequential manner. Each score (number) on a CA axis is the sum of a weighted vector of species proportion. Species with correlated proportions vary together and will have similar weights and scores on a CA axis. When depicted in two-dimensional plots, taxa that tend to co-occur plot together, while those that rarely co-occur plot farther apart. Similarly, stations sharing many taxa plot closest to one another, while those with little in common plot farthest apart. The greatest variation among either taxa or stations is explained by the first axis, with other axes accounting for progressively less variation. This type of multivariate analysis describes not only which stations have distinct benthic communities but also how these benthic communities differ among stations (i.e., which particular taxa differ). Prior to CA, the data were screened for rare taxa, as these can distort results. Taxa occurring at 5% or fewer of the stations were removed. After screening and data reduction, a proportional data matrix was used to conduct a CA using the program PC-ORD$^{©}$ version 6 (McCune and Mefford 2011). Scores for both taxa and stations were calculated to evaluate the associations of organisms and stations.

The RCA experimental design evaluates individual mine-exposed sites against a reference condition, which is comprised of multiple reference sites. Therefore, a traditional ANOVA evaluation cannot be used in an RCA design. When testing for statistical differences between multiple reference areas and a single exposed area two non-central tests were employed; a one-sample, non-central, equivalence test; and a one-sample, non-central, interval test (Kilgour et al. 1998). Determination that a test site is different from the reference condition (i.e. outside the range of reference values) is assessed using a critical effect size of 1.96 reference standard deviations and tested using two null hypotheses: H_{01} – the absolute value of the reference mean subtract the test site value is ≥ 1.96 reference standard deviations (equivalence test), and H_{02} – the absolute value of the reference mean subtract the test site value is ≤ 1.96 reference standard deviations (interval test). This testing results in three possible outcomes: a non-central p-value (ncP) < 0.1 (interval test) that indicates a community endpoint is outside of the reference condition; a ncP > 0.9 (equivalence test) that indicates a community endpoint is within the reference condition; and a ncP-value between 0.1 and 0.9 that is inconclusive with respect to potential difference from the reference condition (Kilgour et al. 1998). Any exposed stations found to be statistically outside the range of reference conditions (ncP < 0.1) were further evaluated through inspection of the raw data and taxonomic proportions.

The ecological and habitat requirements of the dominant taxa were assessed using standard references (Clarke 1981, Edmunds et al. 1976, Weiderholm 1983, Wiggins 1996, Merritt et al. 2008) in order to consider the statistical results of benthic invertebrate community survey in the context of ecological and habitat requirements.

2.4.4 Data Analysis - Lower Minto Creek (CI)

Benthic invertebrate community data associated with the CI design (lower Minto Creek and the lower Wolverine Creek reference) were summarized on the basis of the same metrics as used for the RCA design, also calculated at the family level of taxonomy. All metrics were calculated using the same exclusion rules and formulae as presented above (Section 2.4.3). Benthic metrics were then plotted to explore spatial patterns in the benthic community data. Multivariate analysis of variance (MANOVA), followed by analysis of variance (ANOVA) were used to test for differences in benthic metrics between areas (effluent-exposed and reference). Data were transformed as necessary to satisfy assumptions of normality and homogeneity of variance. In instances where variances could not be homogenized by transformation, contrast tests not requiring this assumption were used. Statistical tests and plots were generated using SPSS version 22 software (SPSS 2013). Interpretation of benthic community metrics was enhanced by inspection of raw data and taxonomic proportions to detect patterns of ecologically relevant differences between reference and exposure areas. Ecological and habitat requirements of benthic invertebrates, as outlined in standard references (Clarke 1981; Edmunds *et al*. 1976; Weiderholm 1983; Wiggins 1996; Merritt et al. 2008), were used in data interpretation.

In instances when a significant difference between effluent-exposed and reference area means was detected using ANOVA, the magnitude of the difference was calculated for that metric. The Technical Guidance Document (Environment Canada 2012) states that the benthic invertebrate community survey should minimally have sufficient power to detect a difference (effect size) of ± two standard deviations (SDs). Therefore, the magnitude of the difference was calculated to reflect the number of reference mean SDs as follows:

(exposure mean – reference mean) / SD of the reference mean

If a significant difference between areas was not detected for a benthic metric, then the minimum effect size that could be detected was calculated using the mean square error generated from the ANOVA as an estimate of variability, with alpha and beta equal to 0.10. The minimum detectable effect size was based on the minimum number of reference area standard deviations, according to the following equation:

$\delta = [(t_\alpha+t_\beta)(\sqrt{}MSE)(\sqrt{}2/n)]/SD_{ref}$, where

δ = minimum detectable effect size,

MSE = mean square error

n = sample size per area (in this case = 5), and

SD_{ref} = standard deviation of the reference mean.

2.5 Supporting Measures

In addition to *in-situ* water quality measurements and the water chemistry data collected as described above, supporting information collected at each station included global positioning system (GPS) coordinates recorded in latitude and longitude using WGS 1984 map datum, water velocity, sampling depth, stream gradient, stream wetted width, stream bankfull width, percent cobble/gravel/sand, median intermediate pebble axis length, median embeddedness, and periphyton chlorophyll a mass per unit area. Additional data collected to characterize each benthic invertebrate sampling station included: water appearance, creek morphology, bank condition, instream cover, residual pool depth, instream features, overhead canopy, aquatic vegetation, riparian vegetation, surrounding land use and anthropogenic disturbance, and photographs.

GPS coordinates were recorded using a Garmin Oregon 300 handheld GPS. Water velocity was measured using a Marsh-McBirney Flo-Mate 2000 portable flow meter and depth was measured using a meter stick. Stream gradient was measured using a Suunto clinometer. Wetted and bankfull widths were measured at each sampling station using a tape measure. Percent cobble/gravel/sand was estimated visually. The intermediate axis length of 100 rocks that were washed in the Hess sampler at each station were measured and recorded. In addition, the percent embeddedness of ten rocks was also evaluated and recorded. This type of substrate characterization is similar to the Canadian Aquatic Biomonitoring Network (CABIN) protocol (CABIN 2012) for characterizing benthic invertebrate habitat and provided additional information to assess and standardize habitat conditions between sampling stations. Summary statistics of intermediate axis lengths and embeddedness were calculated for each station per CABIN protocol. Periphyton chlorophyll a mass per unit area was measured as an index of primary productivity as chlorophyll a is the primary photosynthetic pigment of all oxygen-evolving photosynthetic organisms (Wetzel 2001). Periphyton samples were collected using a stainless steel razor blade to scrape periphyton from rocks and transfer it to filters that were then folded and placed into opaque (black) centrifuge tubes labelled with the project number, sample location and collection date. The surface area scraped to form each sample was carefully recorded. All periphyton samples were maintained in coolers with ice packs during transportation and then at 4°C in a refrigerator on site until submission to the ALS Environmental (ALS; Whitehorse, Yukon). Upon receipt, the chlorophyll a data, reported as µg per sample, were divided by the surface area sampled and expressed as mg/m^2.

2.6 Correlation Analysis

Potential relationships between benthic invertebrate community metrics and physical/chemical conditions of the study areas were explored using correlation analysis as part of causal assessment (Suter et al. 2015). In order to reduce the number of comparisons made, benthic invertebrate community metrics were compared to physical variables and to a reduced set of chemical variables (e.g., meter measures, water chemistry PCA axes, and key water chemistry analytes identified in the water quality data evaluation). Following derivation of correlation coefficients, a Bonferroni-type correction (i.e., p-value [0.05] divided by the total number of correlations examined for independent variables only) was applied to minimize the risk of declaring false positive correlations since at least 5% of derived correlations would be expected to occur by chance alone at an uncorrected p-value of 0.05. Any significant correlations found at the Bonferroni-adjusted p-value or at a p-value of 0.01 were further investigated using scatter plots to determine if a continuous distribution of data was realized (possible causal relationships) or if these relationships were "leveraged" by outlying points (or groups of points). The effects of leverage were carefully considered because any difference in benthic community attributes of the effluent-exposed areas relative to reference might be correlated with mine-related differences in water or sediment quality regardless of cause. Significant correlations, coupled with careful examination of scatterplots, were used to identify the factors that most contribute to variability in benthic invertebrate community endpoints. The causative merit of these factors were then considered in light of known physical and chemical influences on benthic invertebrate communities (e.g., stimulation by nutrient enrichment, toxicity by exposure to high metal concentrations).

3.0 EFFLUENT SUBLETHAL TOXICITY

Effluent sublethal toxicity tests conducted by the mine from 2012 to 2014 showed no effects to the survival of rainbow trout embryos, the survival of *Ceriodaphnia dubia* (a cladoceran invertebrate often referred to as a water flea), nor to the growth of *Pseudokirchneriella subcapitata* (an algae) and *Lemna minor* (a plant; Table 3.1). However, testing of *C. dubia* in 2013 indicated reproductive impairment at an effluent concentration of 38.6% (Table 3.1). This impairment was not corroborated by tests conducted in 2012 or 2014.

Overall, sublethal toxicity test results conducted over the 2012 to 2014 period are consistent with those of previous cycles, and indicate a low incidence of reproductive impairment to *C. dubia* (Table 3.1). Effluent concentrations in Minto Creek represent a substantial portion of total flow in April and May (34%, on average, with short term maxima approaching 100%; Appendix Figure B.1 and Appendix Table B.4). Coupled with the observation of reproductive impairment to *C. dubia* at geometric mean effluent concentration of 73% in Cycle 3, this suggests that reproductive effects to benthic invertebrates could occur in Minto Creek. However, it is notable that all effluent grab samples for sub-lethal toxicity testing were collected outside of periods when water was released from the WSP, suggesting potential impairment associated with water other than WSP effluent (i.e., surface runoff and groundwater reporting to station Minto Creek between the foot of the water retention dam and Station W3 (Figure 1.2).

Table 3.1: Minto mine effluent sublethal toxicity test results collected at W3 (as % effluent), 2007-2014.

EEM Cycle	Date	Rainbow trout embryo	*Ceriodaphnia dubia*		*Pseudokirchneriella subcapitata*	*Lemna minor*	
		EC25 Survival	LC50 Survival	IC25 Reproduction	IC25 Growth[a]	IC25 Dry Weight[a]	IC25 Frond Increase[a]
Cycle 1	5 & 7-Jun-07	> 100%[b]	> 100%	> 100%	> 90.0%	> 97%	> 97%
	29-Oct-07	> 100%	> 100%	> 100%	> 90.0%	> 97%	> 97%
	3-June-08	88%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	28-Oct-08	> 100%	> 100%	0.33%	> 90.9%	> 97%	> 97%
Geometric Mean		**97%**	**> 100%**	**24%**	**> 90.9%**	**> 97%**	**> 97%**
Cycle 2	26-May-09	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	15-Sep-09	-	> 100%	> 100%	-	-	-
	16-Nov-09	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	11-May-10	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	22-Nov-11	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
Geometric Mean		**> 100%**	**> 100%**	**> 100%**	**> 90.9%**	**> 97%**	**> 97%**
Cycle 3	16-Oct-12	> 100%	> 100%	> 100%	> 90.9%	> 97%	> 97%
	5-Nov-13	> 100%	> 100%	38.6%	> 90.9%	> 97%	> 97%
	27-Oct-14	> 100%	> 100%	>100%	> 90.9%	> 97%	> 97%
Geometric Mean		**> 100%**	**> 100%**	**73%**	**> 90.9%**	**> 97%**	**> 97%**

[a] highest concentration tested

[b] 2007 June Test invalid due to non-viable eggs - the quality control criteria for viability in controls were not met

4.0 WATER QUALITY AND SUPPORTING MEASURES

Water quality has been routinely monitored by the Minto Mine at lower Minto Creek (Station W2) and a reference tributary (Station W7; Figure 2.2). Water quality was also characterized during the IOC benthic invertebrate community survey in September 2014, when *in-situ* measurements of water quality, water samples for laboratory chemical analysis, and supporting physical and biological measures were collected at all benthic invertebrate community sampling sites (Figure 2.1).

4.1 Routine Water Quality Monitoring

Water quality at effluent-exposed lower Minto Creek differed from reference (Station W7; Figure 2.2) primarily on the basis of water temperature, electrical conductivity, hardness, nitrate, arsenic, and copper, which were the only analytes with concentrations greater than the upper 95% confidence limit of the reference mean (Table 4.1). Plots of these analytes indicate that concentrations of nitrate, arsenic and copper all increase in the spring in association with freshet and/or discharge (Figure 4.1; Appendix Figures D.1 and D.2). The relative influence of freshet and discharge is difficult to distinguish because effluent is only discharged during freshet, but elevated nitrate concentrations appear to most strongly co-occur with discharge (Figure 4.1). Electrical conductivity and hardness both decrease during discharge, and water temperature reflects seasonal air temperatures (Appendix Figure D.1).

Of the analytes elevated in lower Minto Creek relative to reference, only copper occurred at a mean concentration greater than a Canadian Water Quality Guideline (CWQG; in 2014 only; Table 4.1). Concentrations of total copper were strongly related to concentrations of TSS (Appendix Figure D.3), and concentrations of dissolved copper (which better represents bioavailable copper) were typically elevated relative to the CWQG only during freshet/effluent discharge (Appendix Figure D.2).

4.2 *In-situ* Measures during the IOC Study

During the IOC study, the temperature of upper Minto Creek (-0.28 ºC) was lower than the reference creeks (mean 0.35 ºC; Figure 4.2) and was related to coldest air temperatures immediately preceding sampling there. *In-situ* dissolved oxygen concentrations measured at Minto Creek during the benthic invertebrate community survey were high (mean 12.3 mg/L) and comparable to reference areas (Figure 4.2 and Appendix Table D.2). Dissolved oxygen concentrations at all study areas were also well above the water quality guideline minimum of 6.5 mg/L. Specific conductance of upper Minto Creek (mean 305 µS/cm) was greater than at most reference sites (Figure 4.2), but below the highest specific conductance reported at a

Table 4.1: Summary of routine water quality monitoring under MMER, Minto Mine, 2012-2014

Analyte	Guideline [a]	Station W7 (Reference)						
		2012 mean	2013 mean	2014 mean	Reference [b]	2012 mean [c]	2013 mean	2014 mean
Physical								
Water Temperature, °C	-	2.3	1.1	0.80	- 0.06 - 2.7	2.4	3.9	3.5
Electrical Conductivity, µS/cm	-	200	256	234	299	248	315	297
Dissolved Oxygen, mg/L	> 9.50	14.0	12.4	13.1	12.1 - 14.4	14.05	12.8	13.3
pH	6.50 - 9.00	8.04	7.94	7.76	7.72 - 8.11	8.08	8.06	8.02
Ions, Nutrients and Solids								
Hardness, mg/L	-	109	126	120	152	122	209	151
Alkalinity, mg/L	-	101	124	113	147	118	140	137
Ammonia, mg/L	0.63 [d]	0.066	0.043	0.022	0.073	0.024	0.031	0.028
Nitrate, mg/L	2.9	0.11	0.12	0.15	0.17	0.19	0.57	0.10
Total Suspended Solids, mg/L	narrative [e]	47	18	6.2	53	**49**	**27**	**17**
Metals								
Aluminum, mg/L	0.100	**1.58**	**0.395**	**0.120**	1.7	**0.548**	**0.686**	**0.363**
Arsenic, mg/L	0.0050	0.0012	0.00056	0.00043	0.0011	0.0010	0.0013	0.00065
Cadmium, mg/L	0.00016 [f]	0.000042	0.000014	0.000015	0.000043	0.000024	0.000016	0.000020
Copper, mg/L	0.0024 [f]	**0.0048**	**0.0033**	**0.0040**	0.0065	0.0044	**0.0054**	**0.0071**
Iron, mg/L	0.30	**2.8**	**0.87**	0.28	2.7	1.4	**2.7**	**0.64**
Lead, mg/L	0.0032 [f]	0.00062	0.00027	< 0.00020	0.0006	0.0004	0.00042	0.00030
Mercury, mg/L	0.00003	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00000	< 0.00001	< 0.00001
Molybdenum, mg/L	1.0	0.0013	0.0013	0.0014	0.0015	0.0010	0.0016	0.0013
Nickel, mg/L	0.095 [f]	0.0041	0.0017	0.0012	0.0040	0.0025	0.0027	0.0017
Selenium, mg/L	0.0010	0.00017	0.00022	0.00019	0.00025	0.0001	0.00018	0.00010
Zinc, mg/L	0.32 [f]	0.0075	0.0052	0.0060	0.0081	0.0051	0.0060	0.0064

🟧 out of reference range

bold font = concentration greater than guideline

[a] water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2014); blue text are BC Water Quality Guidelines (BCMOE 2014)

[b] reference values - 95% confidence limits of the 2012-2014 mean

[c] data for 2012 without the leverage sample with 1,030 mg/L total suspended solids

[d] at temperature 5°C and pH 8.4 (slightly conservative conditions)

[e] maximum increase of 25 mg/L from background for short-term exposures (e.g., 24-h period) and maximum increase of 5 mg/L from background for longer term exposures

[f] at hardness of 100 mg/L (conservative conditions for Minto Creek)

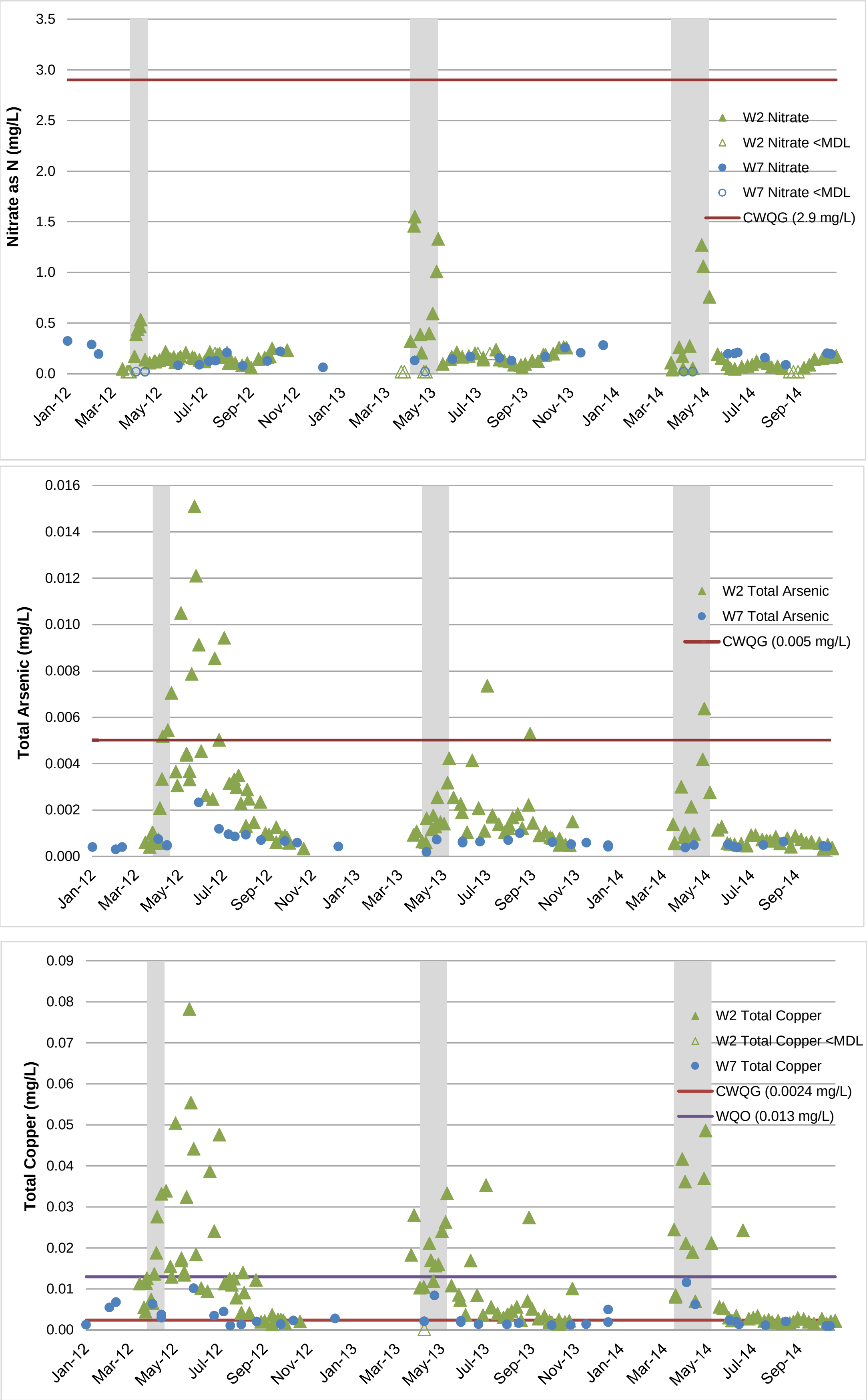

Figure 4.1: Concentrations of nitrate, total arsenic and total copper at lower Minto Creek (Station W2) and the reference tributary (Station W7), 2012-2014. Grey shading indicates periods of Water Storage Pond discharge

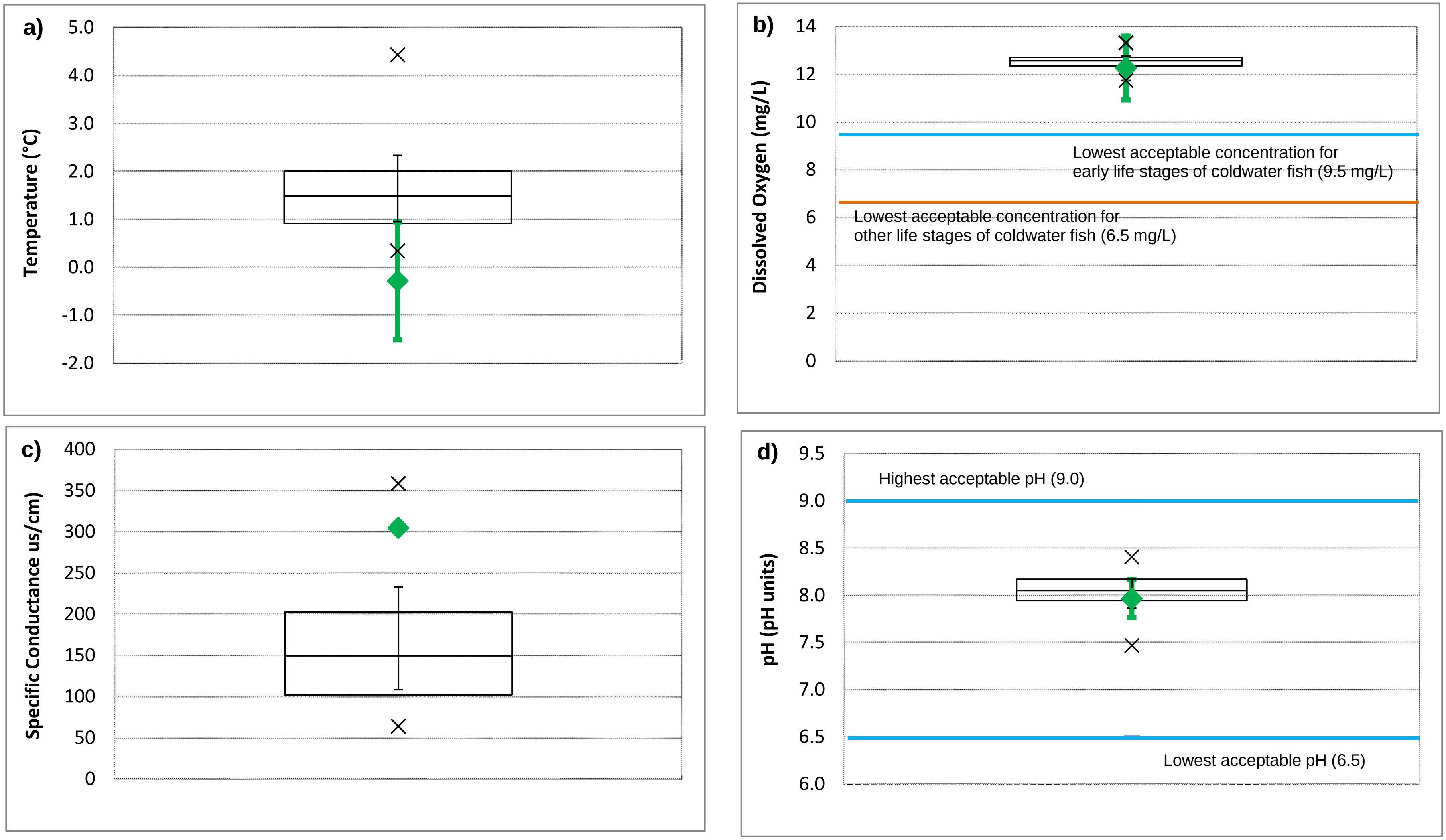

Figure 4.2: Supporting in-situ water quality measures collected at upper creek sites during the Minto IOC RCA study, September 2014 [a]

a - box-and-whisker plot of reference site data (n=12; quartiles, 95% confidence limits of the mean, minimum, maximum) in black and mean and 95% confidence limits of effluent exposed sites in green reference site (359 µS/cm; Figure 4.2 and Appendix Table D.2). Lastly, pH of Minto Creek was slightly alkaline (mean 7.97), but was similar to pH observed at the reference sites and within the acceptable range specified in the CWQG (6.5 to 9.0; Figure 4.2).

During the IOC study, temperature and dissolved oxygen concentrations of lower Minto Creek were similar to those of the lower Wolverine reference area, and dissolved oxygen concentrations were well above the water quality guideline minimum of 6.5 mg/L (Figure 4.3). Specific conductance of lower Minto Creek (mean 282 µS/cm) was significantly greater than that of lower Wolverine Creek (mean 167 µS/cm; Figure 4.3; Appendix Table D.3). Aqueous pH of lower Minto Creek was slightly alkaline (mean 8.12), was significantly greater than pH of lower Wolverine Creek (mean 7.77), but was within the acceptable range specified in the CWQG (Figure 4.3).

4.3 Laboratory Measures during the IOC Study

A Data Quality Assessment (DQA) was performed and indicated that the laboratory analytical data collected as part of the IOC were of good quality and suitable for addressing the objectives of this study (Appendix C). During the IOC study, only two analytes in upper Minto Creek were present at concentrations outside the range of reference (strontium and tin; both only slightly) and no analytes were present at concentrations greater than guidelines (Table 4.2). This result is consistent with the fact that the Minto Mine was not discharging WSP effluent at the time of sampling. Similarly, during the IOC, no analytes were present in lower Minto Creek at concentrations outside the range of reference and no analytes were present at concentrations greater than guidelines (Table 4.2).

4.4 Other Supporting Measures during the IOC Study

Mean water velocity at effluent-exposed upper Minto Creek (0.14 m/s) was lower than the reference mean (0.23 m/s), but was within the range of reference (Figure 4.4; Appendix Table D.2). Mean sampling depth at effluent-exposed upper Minto Creek (11.8 cm) was lower than at the reference sites and similar to the lowest depth recorded at a reference site (12 cm; Figure 4.4; Appendix Table D.2). However, both water velocity and sampling depth spanned narrow ranges, from 0.12 to 0.28 m/s and 11 to 22 cm, respectively (Appendix Table D.1). Median intermediate axis length of pebbles cleaned for benthic invertebrate community sampling in upper Minto Creek (3.9 cm) was similar to reference (4.2 cm), as was the overall distribution of pebble size (Figure 4.4). Mean chlorophyll a concentration (chlorophyll a per unit surface area of creek bottom) in upper Minto Creek (19.1 mg/m^2) was greater than the reference mean (7.2 mg/m^2), but within the range of reference (Figure 4.5).

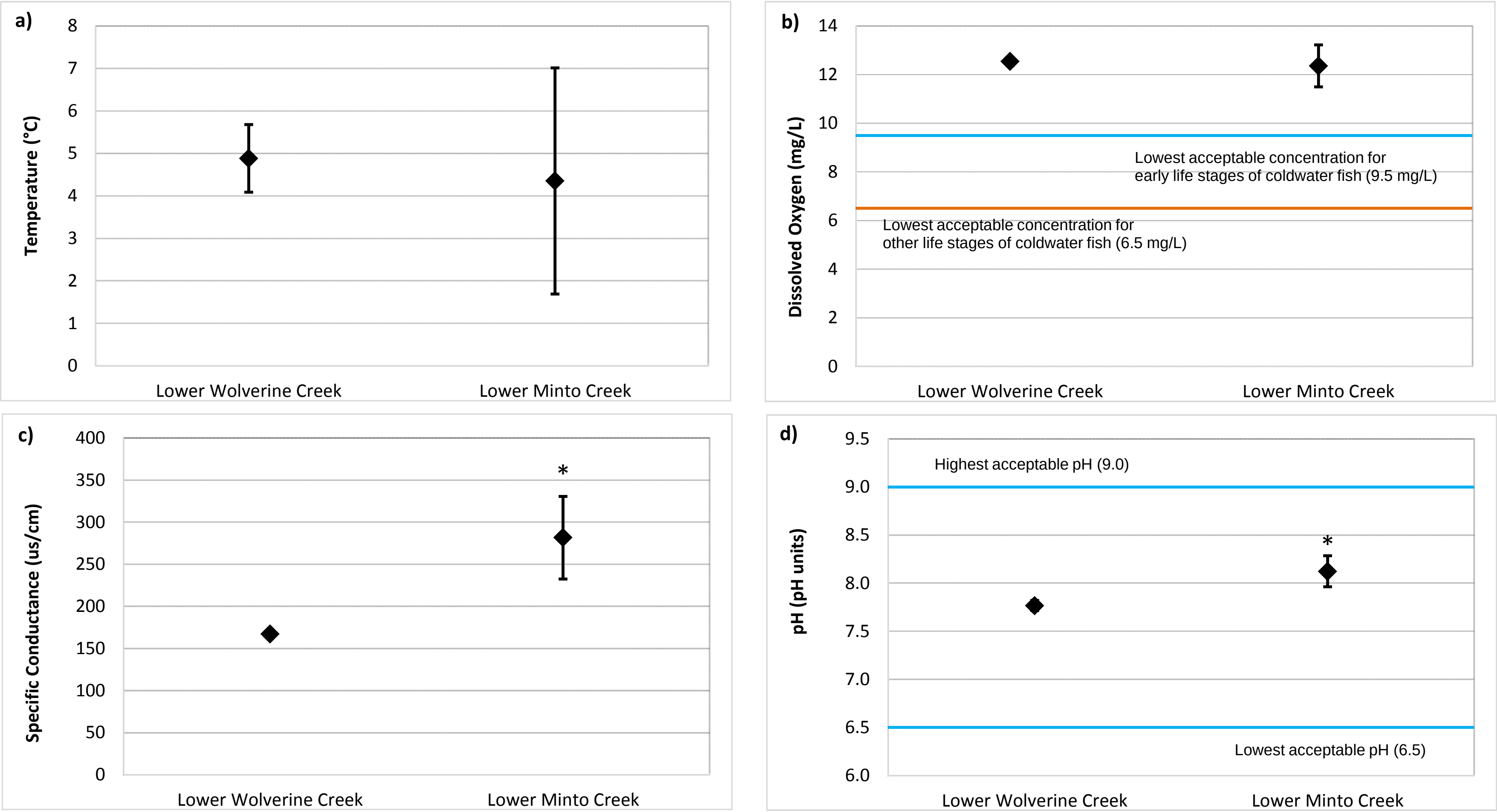

Figure 4.3: Supporting in-situ water quality measures collected at lower creek areas during the Minto IOC CI study, September 2014 [a]

a - mean and 95% confidence limits; star (*) denotes a lower Minto Creek mean that differs significantly from reference ($p<0.05$)

Table 4.2: Water quality data collected during the Minto Mine IOC study, September 2014.

Analyte	Guidelines [a]	Upper Creeks																		Lower Creeks	
		Reference															Effluent-Exposed			Reference	Exposed
		UWC-1	URC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	Reference Minimum	Reference Mean [f]	Reference Maximum	UMC-1	UMC-2	UMC-3	LWC	LMC
Physical Tests																					
Hardness (as CaCO3)	-	54.2	78.9	97.0	40.0	90.7	131	146	297	137	173	316	43.6	40.0	134	316	233	236	233	91.1	164
pH	6.5 - 9.0	7.87	8.00	7.99	7.65	7.91	8.05	8.36	8.38	8.32	8.30	8.38	7.87	7.65	8.09	8.38	8.21	8.29	8.28	7.97	8.33
Total Suspended Solids	14 [b]	<3.0	<3.0	7.3	8.7	<3.0	4.0	<3.0	3.4	<3.0	<3.0	<3.0	<3.0	<3.0	4.0	8.7	<3.0	<3.0	<3.0	3.3	<3.0
Anions and Nutrients																					
Alkalinity, Total (as CaCO3)	-	62.8	72.6	94.7	32.8	61.3	83.9	176	187	133	144	270	45.2	32.8	114	270	221	223	225	84.6	176
Ammonia, Total (as N)	0.63 [c]	0.0092	0.0062	0.0061	0.0188	<0.0050	0.0084	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.006	0.007	0.019	<0.0050	<0.0050	<0.0050	0.0075	<0.0050
Nitrate (as N)	2.9	0.014	0.057	0.072	0.104	0.335	0.069	0.121	<0.050	0.075	0.152	0.049	0.016	0.014	0.093	0.34	0.288	0.294	0.295	0.017	0.046
Total Kjeldahl Nitrogen	-	0.486	0.348	0.467	0.477	0.283	0.184	0.251	0.259	0.116	0.147	0.096	0.109	0.096	0.27	0.49	0.187	0.161	0.158	-	0.328
Phosphorus (P)-Total Dissolved	-	<0.0010	0.0095	0.0024	0.0130	<0.0010	0.0026	0.0201	0.0030	<0.0020	<0.0010	0.0036	<0.0010	<0.0010	0.005	0.020	0.0036	0.0039	0.0042	0.0072	0.0070
Phosphorus (P)-Total	-	0.0047	0.0113	0.0197	0.0373	0.0074	0.0115	0.0180	0.0028	<0.0020	<0.0020	0.0029	<0.0020	<0.0020	0.010	0.037	0.0059	0.0061	0.0076	0.0068	0.014
Organic / Inorganic Carbon																					
Total Organic Carbon	-	18.6	12.4	13.2	14.0	8.3	4.2	7.3	9.8	3.3	3.9	2.1	3.1	2.1	8.3	18.6	5.0	4.4	4.2	16.0	9.82
Total Metals																					
Aluminum (Al)-Total	0.1	0.096	0.026	**0.159**	**0.395**	0.075	0.074	0.015	0.027	0.013	0.023	0.007	0.018	0.007	0.077	0.395	0.010	0.013	0.018	0.118	0.047
Antimony (Sb)-Total	0.02	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00025	0.00019	<0.00010	<0.00010	<0.00010	0.00012	0.00025	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Arsenic (As)-Total	0.005	0.00026	0.00056	0.00057	0.00067	0.00020	0.00038	0.00069	0.00029	0.00063	0.00079	0.00048	0.00019	0.00019	0.00048	0.00079	0.00030	0.00031	0.00030	0.00050	0.00061
Barium (Ba)-Total	1	0.009	0.033	0.063	0.045	0.065	0.053	0.043	0.050	0.046	0.066	0.088	0.030	0.009	0.049	0.088	0.080	0.081	0.079	0.038	0.056
Beryllium (Be)-Total	0.0053	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Bismuth (Bi)-Total	-	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)-Total	1.5	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.028	<0.010	0.011	<0.010	0.023	<0.010	<0.010	0.013	0.028	0.017	0.020	0.019	0.014	<0.010
Cadmium (Cd)-Total	0.00016 [d]	<0.000010	<0.000010	<0.000010	0.000012	<0.000010	0.000011	0.000040	0.000016	<0.000010	<0.000010	0.000012	<0.000010	<0.000010	0.000013	0.000040	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Calcium (Ca)-Total	-	11.7	21.7	28.9	10.2	25.9	33.8	34.6	71.1	29.6	42.0	84.4	12.7	10.2	33.9	84.4	53.9	54.4	53.8	19.9	42.2
Chromium (Cr)-Total	0.001 / 0.009 [e]	0.00073	0.00042	0.00061	**0.0012**	0.00031	0.00029	0.00043	0.00018	0.00033	0.00017	0.00012	0.00017	0.00012	0.00041	0.0012	0.00014	0.00014	0.00017	0.00084	0.00039
Cobalt (Co)-Total	0.004	0.00018	0.00011	0.00021	0.00070	<0.00010	0.00011	0.00013	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00017	0.00070	<0.00010	<0.00010	<0.00010	0.00013	0.00011
Copper (Cu)-Total	0.0024 [d]	0.0015	0.0012	0.0016	**0.0034**	0.0018	0.0008	0.0007	0.0013	0.0008	0.0006	<0.0005	<0.0005	<0.0005	0.0012	0.0034	0.0019	0.0018	0.0017	0.0026	0.0016
Iron (Fe)-Total	0.3	**0.384**	**0.538**	**0.437**	**1.27**	0.098	0.173	0.216	0.056	0.026	0.114	<0.010	0.022	0.022	0.279	1.3	0.036	0.036	0.051	0.287	0.315
Lead (Pb)-Total	0.0032 [d]	<0.000050	<0.000050	0.000070	0.000154	<0.000050	0.000080	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000063	0.00015	0.000065	0.000072	<0.000050	<0.000050	<0.000050
Lithium (Li)-Total	0.014	<0.00050	<0.00050	0.0009	0.0007	0.0006	0.0056	0.0017	0.0025	0.0080	0.0017	0.0114	0.0012	<0.00050	0.0029	0.011	0.0023	0.0024	0.0023	0.0014	0.0013
Magnesium (Mg)-Total	-	6.10	6.00	6.04	3.54	6.33	11.4	14.4	28.9	15.4	16.5	25.6	2.90	2.90	11.9	28.9	23.9	24.2	23.9	10.5	14.1
Manganese (Mn)-Total	1.5	0.019	0.033	0.037	0.101	0.008	0.024	0.034	0.003	0.007	0.023	<0.0004	0.001	<0.0004	0.024	0.10	0.023	0.024	0.025	0.012	0.009
Mercury (Hg)-Total	0.000026	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.00010	<0.00010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Molybdenum (Mo)-Total	1	0.0008	0.0011	0.0003	0.0008	0.0004	0.0008	0.0017	0.0025	0.0019	0.0003	0.0061	0.0011	0.0003	0.0015	0.0061	0.0033	0.0032	0.0032	0.0005	0.0014
Nickel (Ni)-Total	0.095 [d]	0.00089	0.00105	0.00121	0.00142	<0.00050	0.00057	0.00112	0.00298	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.0010	0.0030	0.00054	0.00052	0.00056	0.0019	0.0012
Phosphorus (P)-Total	-	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0	<0.050	<0.050	<0.050	<0.30	<0.050
Potassium (K)-Total	-	0.14	0.58	1.40	0.56	1.01	1.52	0.49	4.00	0.82	0.66	1.61	0.39	0.14	1.10	4.00	2.11	2.14	2.06	0.62	1.30
Selenium (Se)-Total	0.001	<0.00010	0.00031	<0.00010	0.00010	<0.00010	0.00056	0.00052	0.00016	0.00028	0.00024	**0.0028**	<0.00010	<0.00010	0.00045	0.0028	0.00025	0.00026	0.00024	0.00011	0.00011
Silicon (Si)-Total	-	6.47	6.28	7.61	6.86	4.31	6.93	6.35	6.29	7.08	2.88	6.33	6.98	2.88	6.20	7.61	5.58	5.65	5.62	5.44	6.04
Silver (Ag)-Total	0.0001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Sodium (Na)-Total	-	7.82	4.04	4.90	3.18	2.79	4.76	19.3	5.64	5.87	1.28	7.12	2.75	1.28	5.79	19.3	15.4	15.8	15.5	6.38	8.43
Strontium (Sr)-Total	-	0.142	0.146	0.163	0.060	0.225	0.173	0.598	0.508	0.266	0.193	0.563	0.042	0.04	0.26	0.60	0.724	0.736	0.726	0.175	0.415
Sulfur (S)-Total	-	1.00	3.91	2.67	1.96	4.62	16.1	2.72	40.0	6.72	10.4	20.5	1.86	1.00	9.37	40.0	15.0	15.2	14.8	-	4.94
Thallium (Tl)-Total	0.0008	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000012	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Tin (Sn)-Total	-	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00015	0.00016	<0.00010	<0.00010	<0.00010
Titanium (Ti)-Total	2	<0.010	<0.010	<0.010	0.017	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.011	0.017	<0.010	<0.010	<0.010	<0.010	<0.010
Uranium (U)-Total	0.015	0.000265	0.000462	0.000268	0.000075	0.000439	0.00101	0.00129	0.00102	0.00255	0.000913	**0.0264**	0.000447	0.00008	0.0029	0.026	0.0027	0.0027	0.0027	0.0006	0.0015
Vanadium (V)-Total	0.006	0.0021	<0.0010	0.0013	0.0023	<0.0010	<0.0010	0.0013	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0013	0.0023	<0.0010	<0.0010	<0.0010	0.0015	<0.0010
Zinc (Zn)-Total	0.32 [d]	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

bold text denotes value greater than guideline

🟨	greater than the upper creek reference mean, but within the reference range
🟧	out of upper creek reference range

[a] water quality guidelines for the protection of aquatic life. Black text are Canadian Environmental Quality Guidelines (CCME 2014); blue text are BC Water Quality Guidelines (BCMOE 2014)

[b] maximum increase of 5 mg/L from background for longer term exposures

[c] at temperature 5°C and pH 8.4 (slightly conservative conditions)

[d] at hardness of 100 mg/L (conservative conditions for Minto Creek)

[e] 0.001 for hexavalent chromium (CrVI); 0.009 for trivalent chromium (CrIII)

[f] reference mean calculated following substitution of <MDL results with the MDL

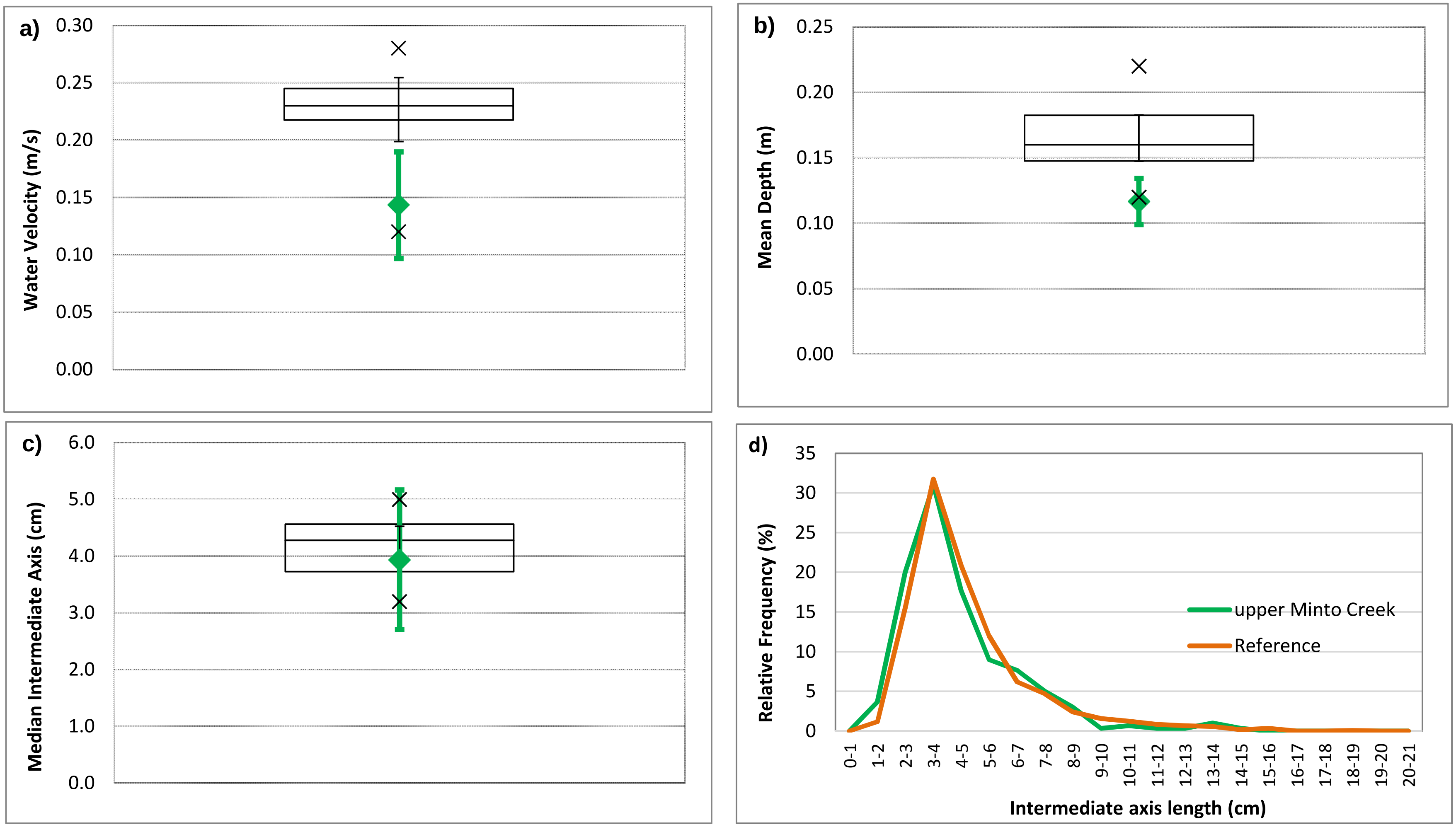

Figure 4.4: Additional supporting measures collected at upper creek areas during the Minto IOC RCA study, September 2014 [a]

[a] - box-and-whisker plot of reference data (n=12; quartiles, 95% confidence limits of the mean, minimum, maximum) in black and mean and 95% confidence limits of effluent exposed area in green

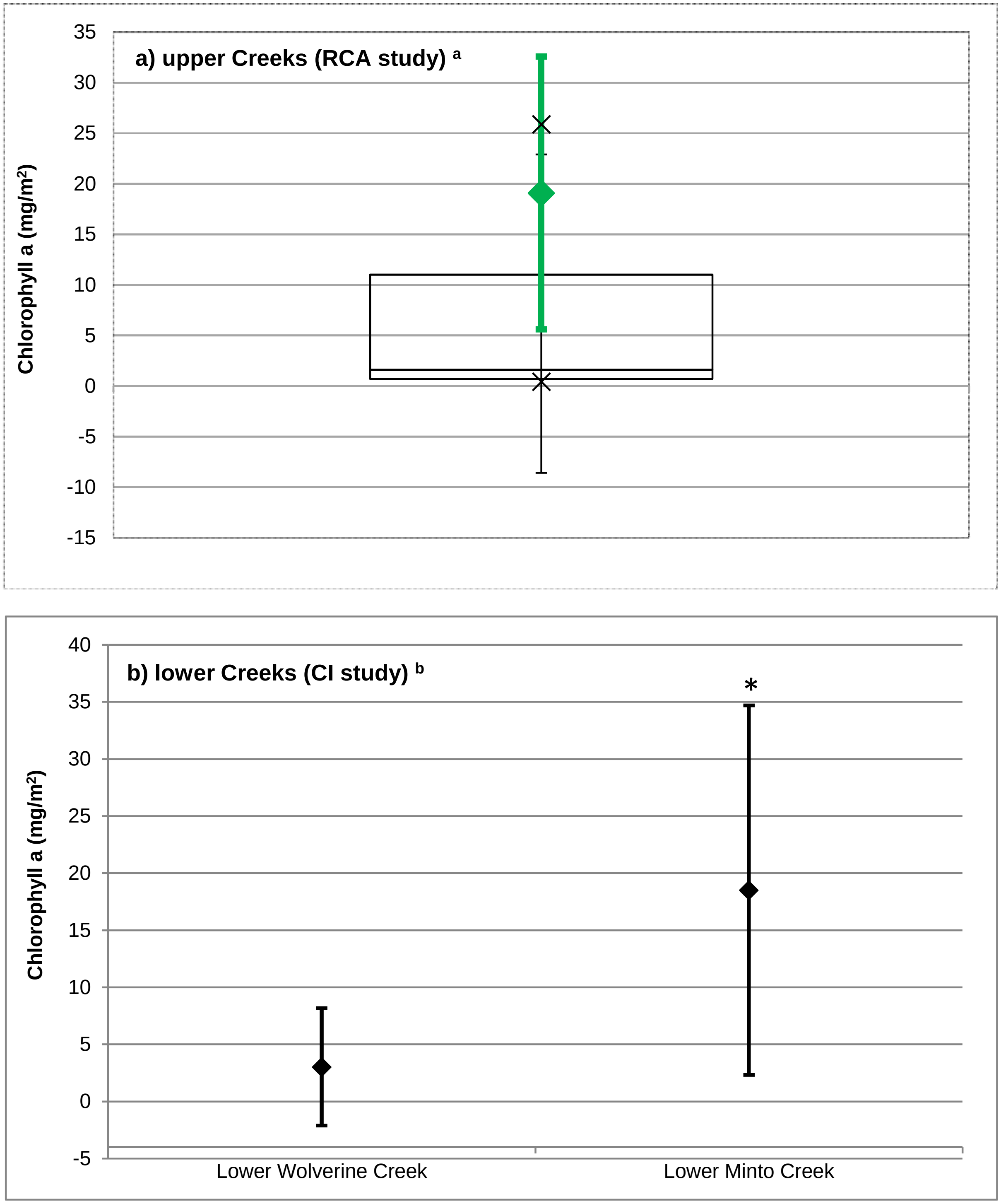

Figure 4.5: Periphyton chlorophyll a per creek surface area (mg/m^2) during the Minto IOC RCA and CI studies, September 2014

a - box-and-whisker plot of reference data (n=12; quartiles, 95% confidence limits of the mean, minimum, maximum) in black and mean and 95% confidence limits of effluent exposed area in green

b - mean and 95% confidence limits; star (*) denotes a lower Minto Creek mean that differs significantly from reference ($p<0.05$)

All chlorophyll a concentrations were below the British Columbia water quality guidelines of 50 mg/m^2 for recreation and 100 mg/m^2 for the protection of aquatic life (BCMOE 1985).

Mean water velocity at effluent-exposed lower Minto Creek was similar to that of the lower Wolverine Creek reference area, but mean depth (10 cm) was slightly, but significantly, lower (13 cm; Figure 4.6; Appendix Table D.3). As with the upper creeks, both the median intermediate axis length and the overall length distribution of pebbles cleaned for benthic invertebrate community sampling were similar in lower Minto Creek and the lower Wolverine Creek reference (Figure 4.5). Mean chlorophyll a concentration in lower Minto Creek (18.5 mg/m^2) was significantly greater than in lower Wolverine Creek (3.0 mg/m^2), was similar to that of upper Minto Creek, and was below the British Columbia water quality guidelines of 50 mg/m^2 for recreation and 100 mg/m^2 for the protection of aquatic life (Figure 4.5).

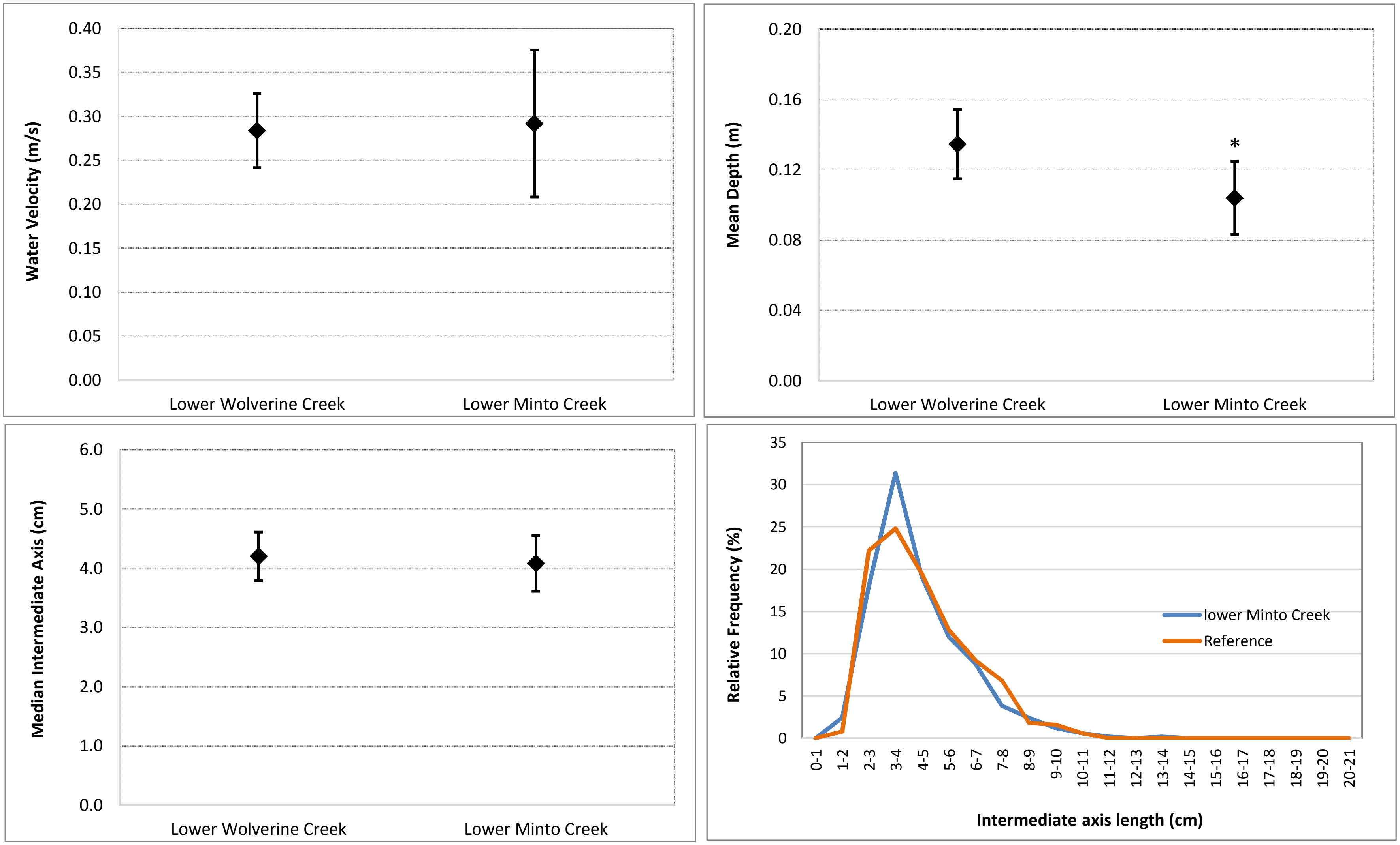

Figure 4.6: Additional supporting measures collected at lower creek areas during the Minto IOC CI study, September 2014 [a]

a - mean and 95% confidence limits; star (*) denotes a lower Minto Creel mean that differs significantly from reference (p<0.05)

5.0 BENTHIC INVERTEBRATE COMMUNITY

Benthic invertebrate community samples were collected at three upper Minto Creek effluent-exposed sites and 12 reference sites (two historical reference sites located on upper Wolverine and McGinty Creek and ten unnamed helicopter access creeks; Figure 2.1). The upper Minto Creek sites were evaluated relative to reference using a Reference Condition Approach (RCA). Benthic invertebrate community samples were also collected at the lower Minto Creek effluent-exposed area and the lower Wolverine Creek reference area (Figure 2.1) and compared using a Control-Impact (CI) approach. All benthic invertebrate samples were collected using a Hess sampler outfitted with a 500-μm mesh net. In the laboratory, samples were identified and enumerated to the lowest practical level (Appendix Tables E.3 and E.20); however, this evaluation is based on family level taxonomic results. Benthic invertebrate community data were subject to Data Quality Assessment and were of good quality (Appendix C).

5.1 RCA Evaluation of Upper Minto Creek

5.1.1 Evaluation of Reference Areas

Correlation of reference area benthic invertebrate community correspondence analysis (CA) axis 1 and 2 scores with sixty-five environmental variables resulted in ten having significant ($p < 0.10$) Spearman correlation (Figure 5.1; Appendix Table E.8). Of the ten environmental predictors of reference community structure, only one - distance to upper Minto Creek was not carried forward in the principal components analysis (PCA) of potential outliers because all reference areas were chosen to be within a 100 km radius of upper Minto Creek. The PCA of environmental variables demonstrated that the significant environmental predictors of natural benthic invertebrate community structure represent those that occur at effluent-exposed upper Minto Creek (Figure 5.2). Box and whisker plots of PCA axes 1 and 2 were examined to ensure that the range of environmental variables was within the outlier threshold of 1.5 times the inter-quartile range from either quartile (Appendix Figure E.1; Quinn and Keough 2013).

5.1.2 EEM Metrics

The benthic invertebrate community of the mine-exposed sites on upper Minto Creek was compared to the reference condition (defined by 12 reference areas) for four primary EEM metrics: density, taxon richness, Simpson's evenness and Bray-Curtis (BC) distance. Summary statistics of all calculated benthic invertebrate endpoints and exact ncP-values are found in Appendix Tables E.11 to E.14. Replicates UMC-1 and UMC-2 were within reference

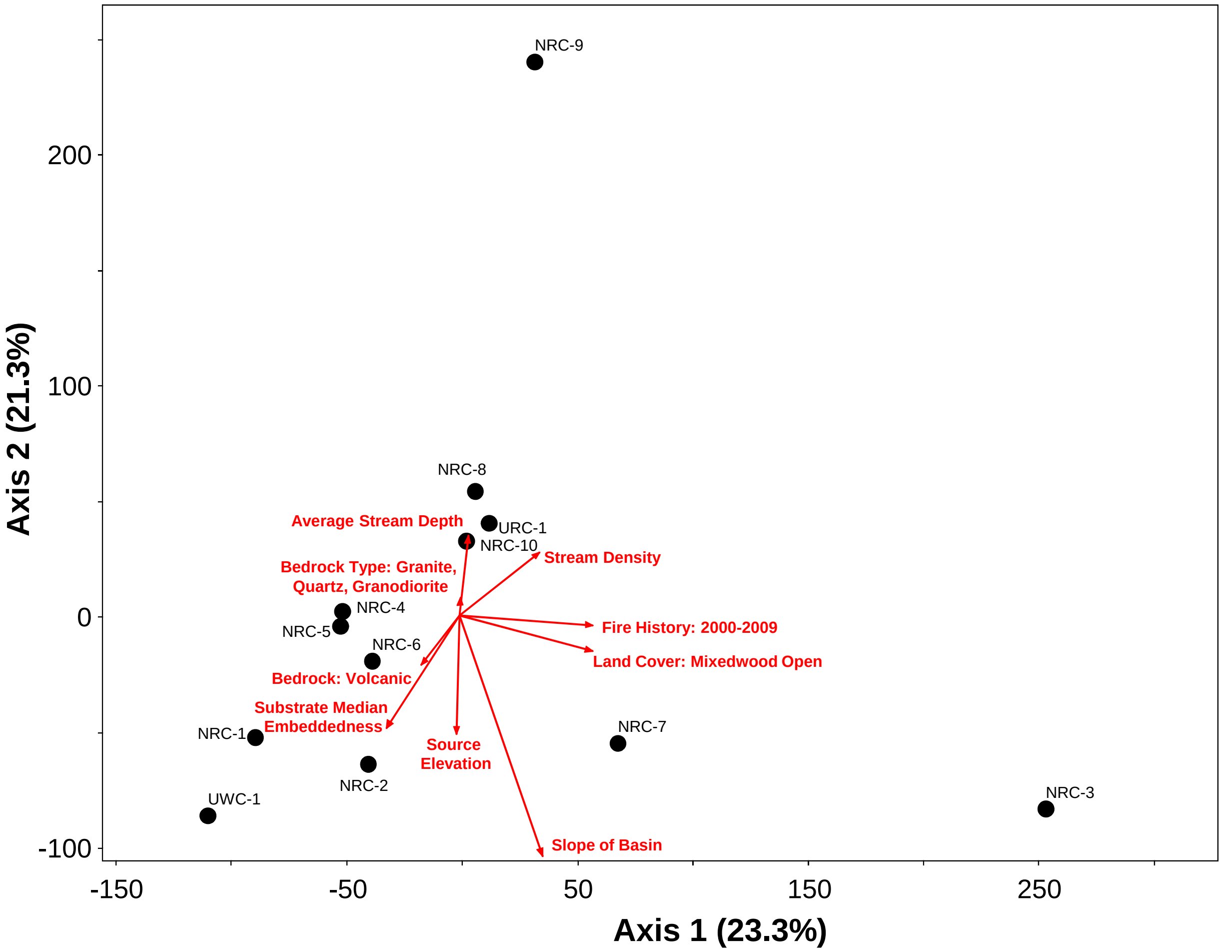

Figure 5.1: **Biplot of correspondence analyses of reference RCA study areas, Minto Mine September 2014. Vector length is proportional to the magnitude of family proportion correlation with each axis. Analyses conducted at the family level of taxonomy and processed at 500 µm. Vector length is proportional to the magnitude of taxon correlation with each axis. Only environmental variables with Spearman correlation P-values < 0.10 are displayed.**

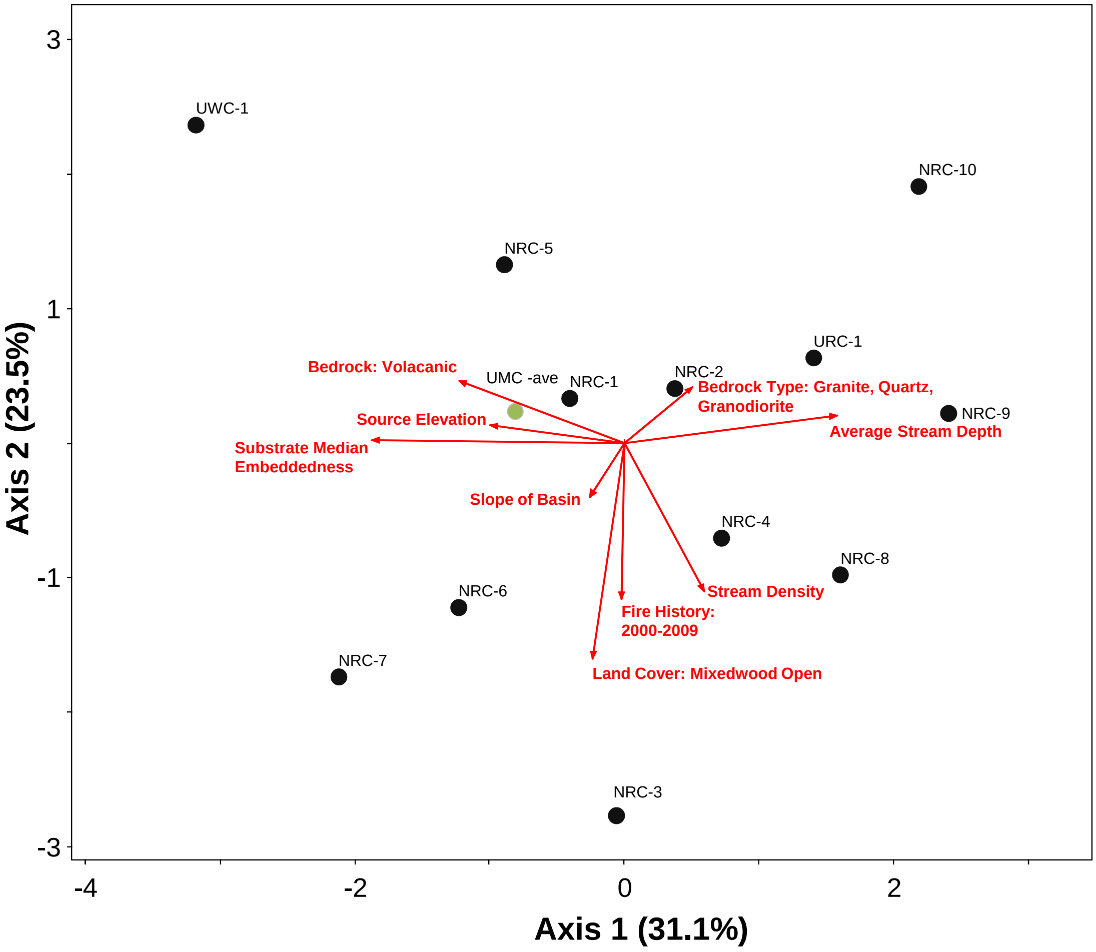

Figure 5.2: Biplot of principal components analyses of RCA study areas, Minto Mine, September 2014. The green circle represents the average of UMC mine-exposed stations and a black circle represents reference stations. Vector length is proportional to the magnitude of environmental variable correlation with each axis. Only variables with Spearman correlation P-values < 0.01 are displayed. PCA only includes the 9 environmental predictors of reference area community structure (Appendix Table E.9).

condition (ncP > 0.9) for all four primary metrics (Table 5.1). Replicate UMC-3 had significantly higher abundance (ncP < 0.1) than the reference condition and was possibly outside the range of reference (0.1 < ncP < 0.9) relative to BC distance (Figure 5.3: Table 5.1). Replicate UMC-3 was within reference condition for richness and Simpson's evenness. Abundance/density of organisms in benthic communities often declines in response to a stressor, but can also vary widely or increase (e.g., if effluent has a stimulating effect on aquatic productivity). Accordingly, the greater abundance at UMC-3 is not necessarily indicative of an adverse effect.

5.1.3 Community Composition

The average reference community was composed of approximately 40% EPT taxa (Ephemeroptera, Plecoptera and Trichoptera or mayflies, stoneflies and caddisflies) and approximately 45% Diptera (true flies; Figure 5.4). The replicate upper Minto Creek samples had 10-20% EPT taxa and 60-70% Diptera. No statistically significant differences were evident for any mine-exposed replicate (relative to reference) for the following supporting endpoints: Simpson's diversity, % Ephemeroptera, % Plecoptera, % Chironomidae, % Arachnida, % Oligocheata, or CA axes 1 and 2 (Figure 5.5 and Table 5.1). Replicate UMC-1 had significantly higher proportions of Trichoptera (caddisflies) relative to the reference condition. Inspection of the raw data indicated that the Trichopteran *Eccilsomyia sp*. was by far the dominant trichopteran at UMC. The dominance of *Eccilsomyia sp*. is not indicative of an effluent effect as it has a tolerance value of 2, with 0 being most sensitive and 10 being most tolerant of adverse conditions (Barbour 1999). Replicate UMC-2 had significantly higher proportions of Diptera (excluding chironomidae) and uncertainty regarding % EPT taxa and % Trichoptera relative to the reference condition. Lastly, replicate UMC-3 had significantly higher proportions of Diptera (excluding chironomidae) relative to the reference condition and uncertainty regarding % EPT relative to the reference condition. The majority of these differences were attributable to the families Limnephilidae (caddisflies), Psychodidae (drain flies) and Tipulidae (crane flies; Figure 5.6); specifically, the Limnephilidae *Ecclisomyia sp*., the Psychodidae *Telmatoscopus sp.*, and the Tipulidae *Dicranota sp*. (Appendix Tables E.3 - E.5). Most benthic invertebrates can feed at multiple functional groups (Merritt et al. 2008) and the three genera listed above are of no exception; however, the Psychodidae can thrive and feed in harsh conditions (Merritt et al. 2008). Psychodidae prevalence at UMC could be due to an effluent-related effect or due to the fact that riffle areas are sparse in UMC, as the predominant stream substrate is sand.

Table 5.1: Statistical comparisons of benthic community metrics for mine-exposed stations UMC-1, UMC-2, and UMC-3, relative to the reference condition, Minto Mine September 2014.

Type	Endpoint	Reference Mean (n = 12) (URC-1, UWC-1, NRC-1, NRC-2, NRC-3, NRC-4, NRC-5, NRC-6, NRC-7, NRC-8, NRC-9, NRC-10)	Upper Minto Creek		
			UMC-1	UMC-2	UMC-3
Primary Metrics	Density/Abundance	177	136	309	652
	Richness	11	11	11	10
	Evenness (Simpson's)	0.40	0.32	0.39	0.33
	B-C Distance	0.58	0.71	0.84	0.90
Supporting Metrics	Diversity (Simpson's)	0.7	0.71	0.77	0.70
	%EPT	40.7	22.8	10.4	8.3
	%Ephemeroptera	13.1	0.7	0.6	0.3
	%Plecoptera	24.8	2.9	1.9	2.8
	%Trichoptera	2.8	19.1	7.8	5.2
	%Diptera(excluding Chironomidae)	14.2	21.3	40.1	39.3
	%Chironomidae	29.9	47.1	36.9	44.5
	%Arachnida	3.5	0.0	5.2	1.8
	%Oligocheata	11.27818906	8.1	7.4	6.1
	CA1	4.37 / 5.84 / 5.32 *	-69.68	-78.69	-74.37
	CA2	-3.88 / -5.92 / -3.76 *	49.87	60.16	41.37

* CA is conducted seperately for each exposure site, therefore reference CA values are calculated for each exposure analysis. Reference means are presented for UMC-1, UMC-,2 and UMC-3, respectively.

[a] Monte Carlo P-value was below 0.10, therefore statistical inference not appropriate.

Note. Family level taxonomic resolution was used to calculate richness, diversity, evenness, and CA values.

ncP - probability that metric value at exposure area is inside the range of reference values.

🟩 Within reference range (ncP>0.9)
🟨 Possibly outside of reference range (0.1<ncP<0.9)
🟧 Outside of reference range (ncP<0.1)

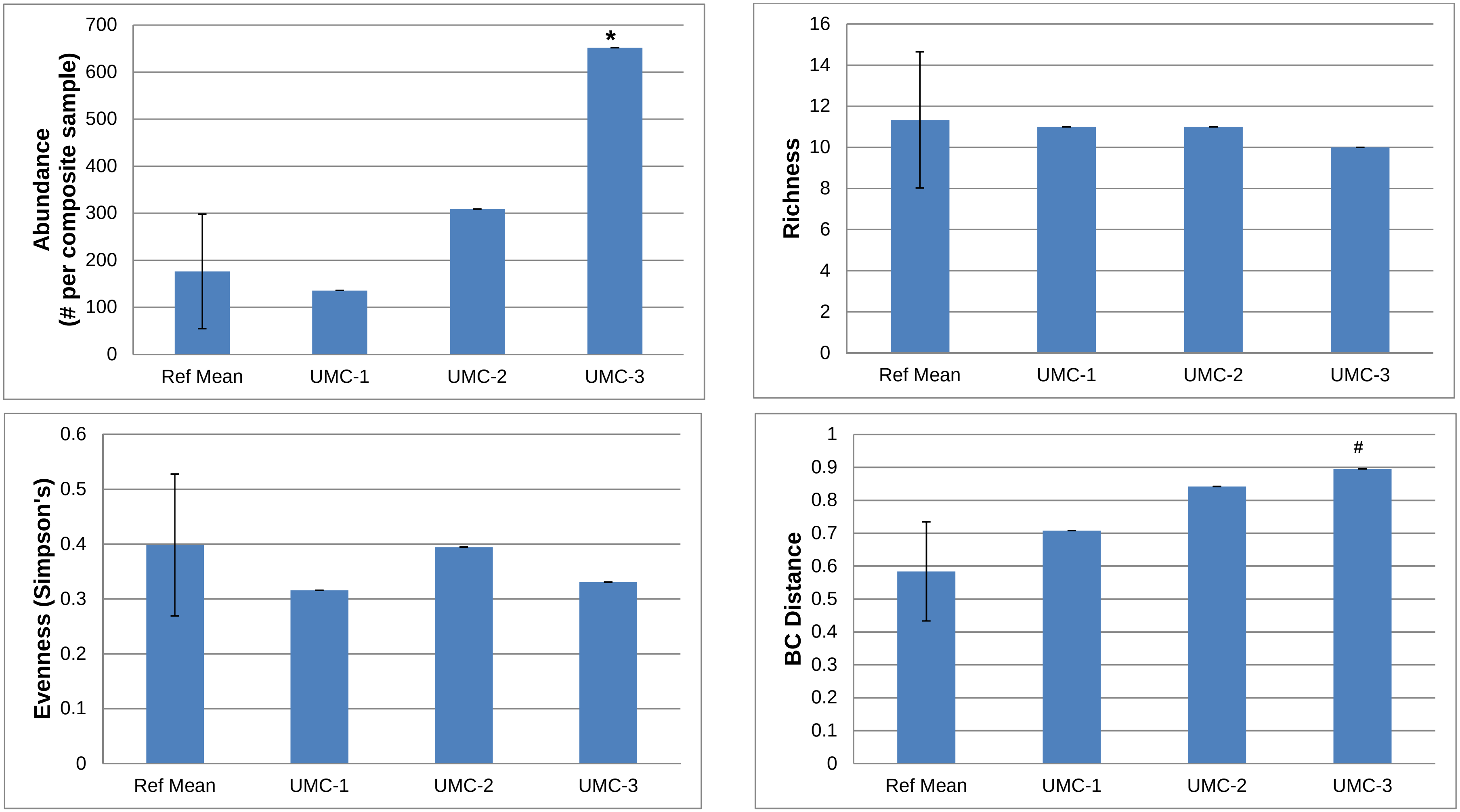

Figure 5.3: **Primary benthic invertebrate metrics of reference group mean (Ref Mean; n = 12; ± 1SD) and mine-exposed upper Minto Creek stations, Minto Mine, September 2014. Exposed stations that are significantly different ncP < 0.1) and possibly different (0.1 < ncP < 0.9) from the grouped reference stations are identified using "*" and "#", respectively. Analyses conducted at the family level of taxonomy and processed at 500 µm.**

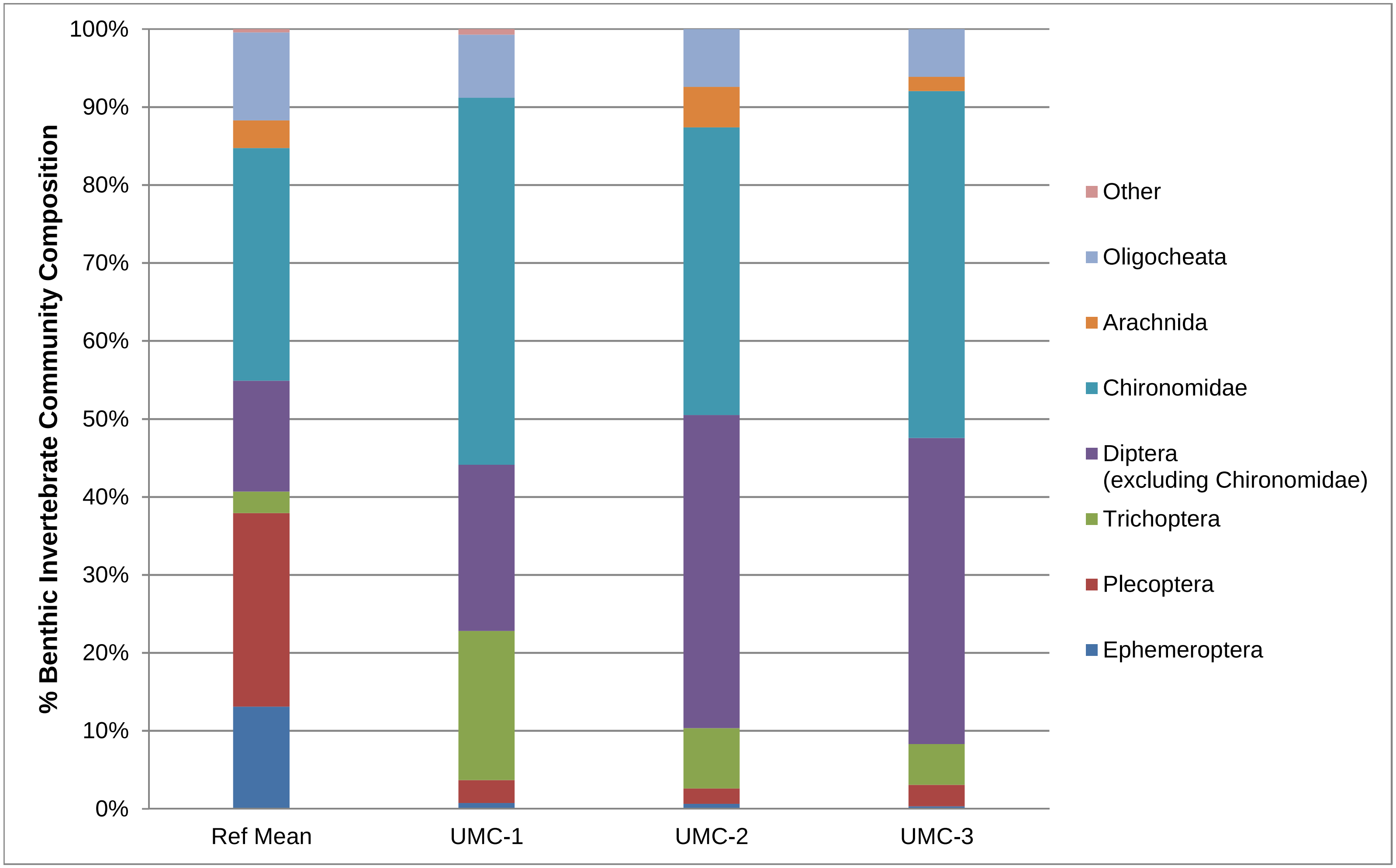

Figure 5.4: Benthic invertebrate community composition of the most dominant taxa at the RCA stations. The 'REF mean' value is the mean of 12 reference stations; URC-1, UWC-1, and NRC-(1 to 10).

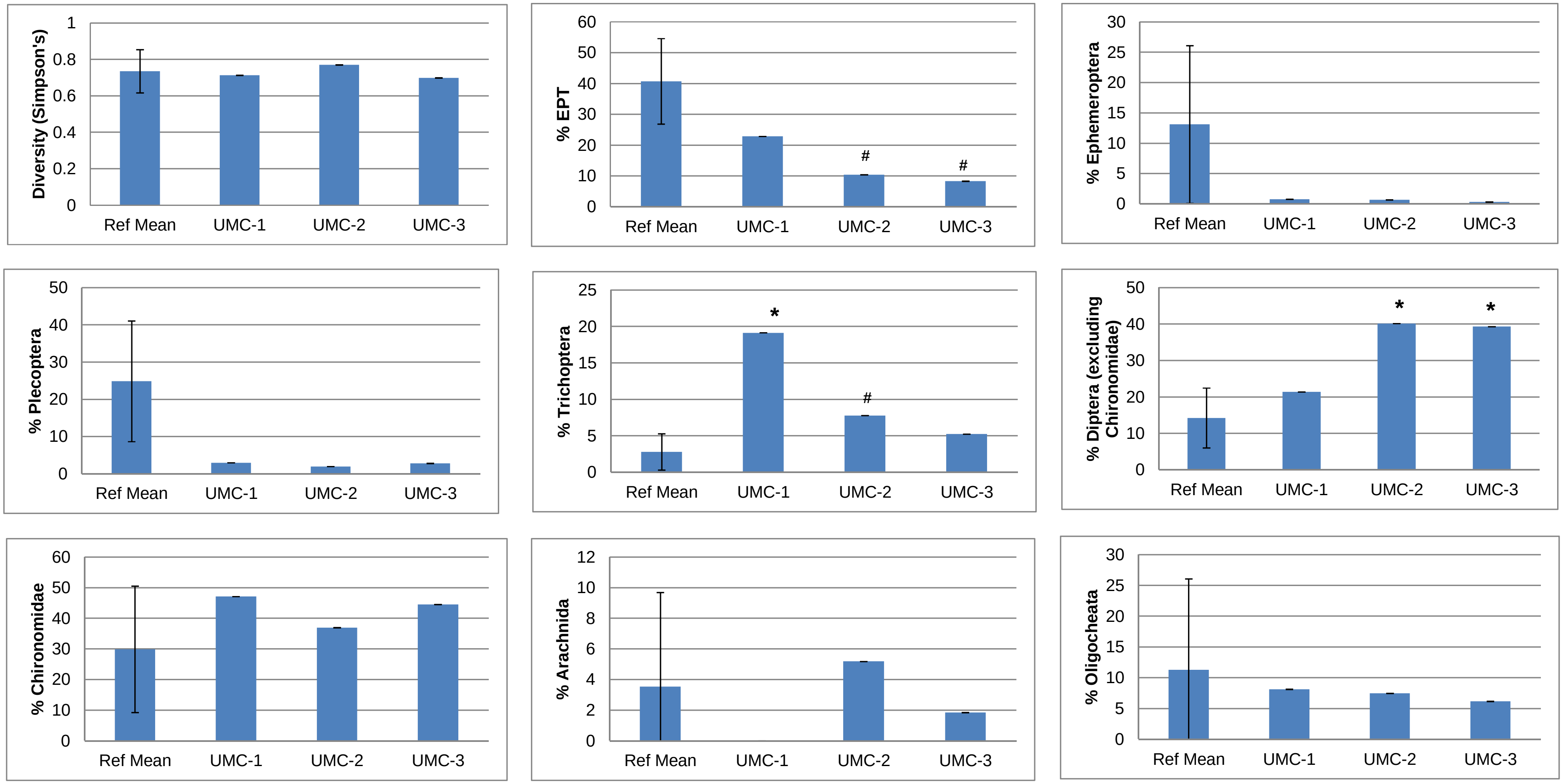

Figure 5.5: Dominant taxa of reference group mean (Ref Mean; n = 12; ± 1SD) and mine-exposed upper Minto Creek stations, Minto Mine IOC, September 2014. Exposed stations that are significantly different (ncP <0.1) and possibly different (0.1 < ncP < 0.9) from the grouped reference stations are identified using "*" and "#", respectively. Analyses conducted at the family level of taxonomy and processed at 500 µm.

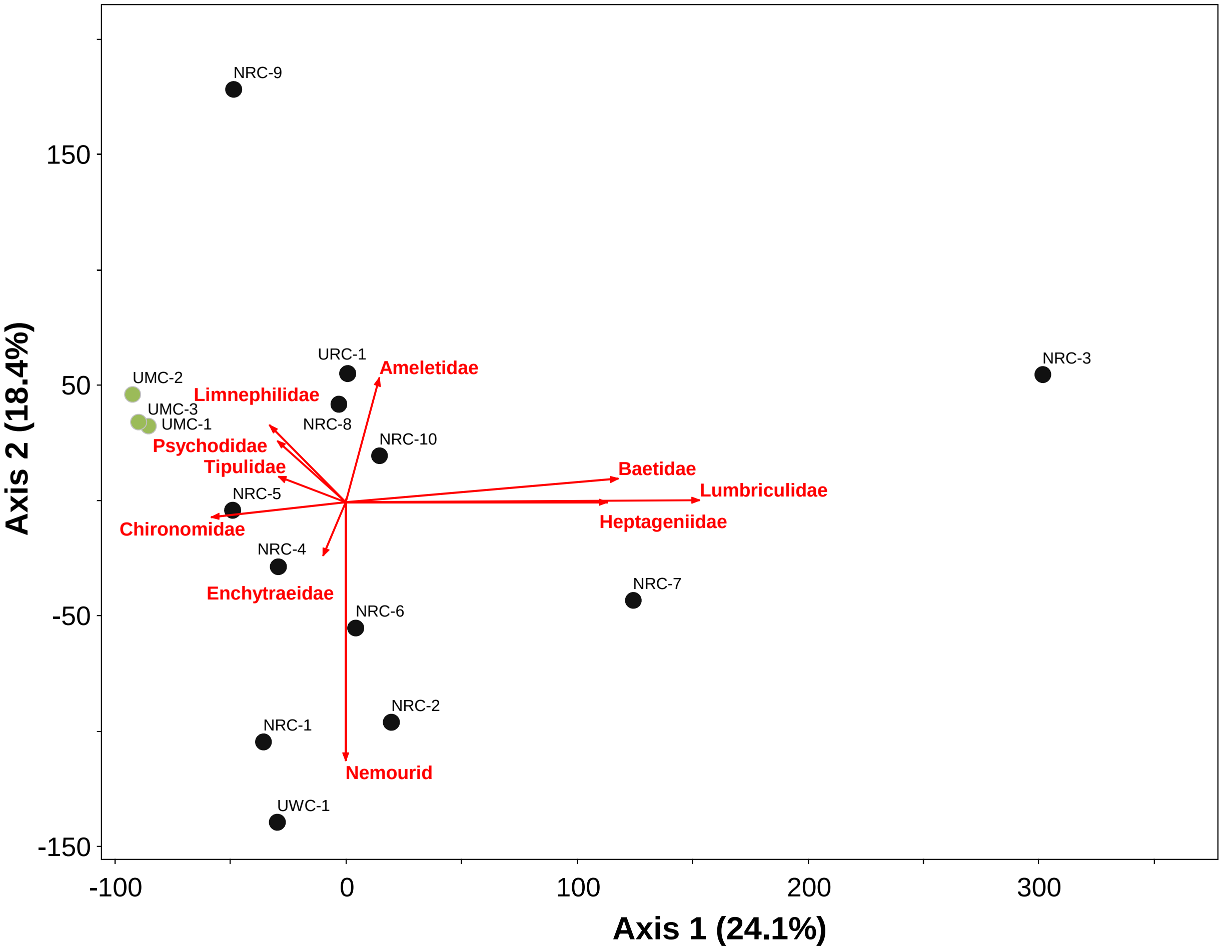

Figure 5.6: Biplot of correspondence analyses of RCA study areas, Minto Mine September 2014. A green circle represents mine-exposed stations and black circle represents reference stations. Vector length is proportional to the magnitude of family proportion correlation with each axis. Analyses conducted at the family level of taxonomy and processed at 500 µm. Vector length is proportional to the magnitude of taxon correlation with each axis. Only families with Spearman correlation P-values < 0.10 are displayed.

5.2 CI Evaluation of Lower Minto Creek

Benthic invertebrate community samples of the lower creeks (CI design) were collected by Hess sampler at five stations in effluent-exposed lower Minto Creek, with five stations in lower Wolverine Creek serving as reference (Figure 2.1).

5.2.1 EEM Metrics

Mean benthic organism density (individuals/m^2) was significantly greater at the lower Minto Creek effluent-exposed area (LMC) than at the lower Wolverine Creek reference area (LWC) (Figure 5.7; Table 5.2; Appendix Table E.22 and E.23). Mean taxon richness (number of benthic invertebrate families per station) did not differ between areas (Figure 5.7; Table 5.2; Appendix Tables E.22 and E.23). The observation of similar taxon richness does not support a hypothesis of a degraded benthic community associated with effluent exposure - in a degraded environment, the number of taxa typically declines relative to the number of taxa found in a reference benthic community (Pielou 1974; Begon et. al. 1996). Simpson's Diversity (D), and Evenness (E) also did not differ significantly between areas (Figure 5.7; Table 5.2; Appendix Tables E.22 and E.23). Reference stations defined the extreme low and high values of Simpson's D and E (LWC-5 and LWC-1, respectively), and therefore the range of values for both areas broadly overlapped.

The Bray-Curtis dissimilarity metric (BC distance) was computed for a hypothetical reference station by using the median benthic abundances from all taxa at the 5 reference stations. BC distance indicated that LMC was dissimilar from LWC (Figure 5.7; Table 5.2; Appendix Table E.22 and E.23). Community differences detected by B-C dissimilarity are non-directional and not necessarily related to effluent exposure. That is, communities may be significantly dissimilar due to effluent effects, or to natural variation, and an effluent exposure difference can be significant even if the exposure effect results in a richer or more diverse community.

5.2.2 Community Composition

Dominant invertebrate groups at EEM study areas included EPT taxa (Ephemeroptera, Plecoptera, Trichoptera), non-biting midges (Chironomidae) and oligochaete worms (Appendix Tables E.21 and E.22). The percent of organisms from the pollution sensitive EPT orders was significantly greater at the LMC effluent-exposed than at the LWC reference area, mostly on the basis of greater proportions of Plecoptera (principally stoneflies in the genus Nemoura), whereas Ephemeroptera (caddisflies) were proportionally less abundant at LMC (Figure 5.8; Table 5.2; Appendix Tables E.22 and E.23). Trichoptera (mayflies) were found at similar proportions in the two areas (Table 5.2; Appendix Tables E.22 and E.23). Greater relative abundance of EPT taxa (in this case, largely attributable to a single genus of

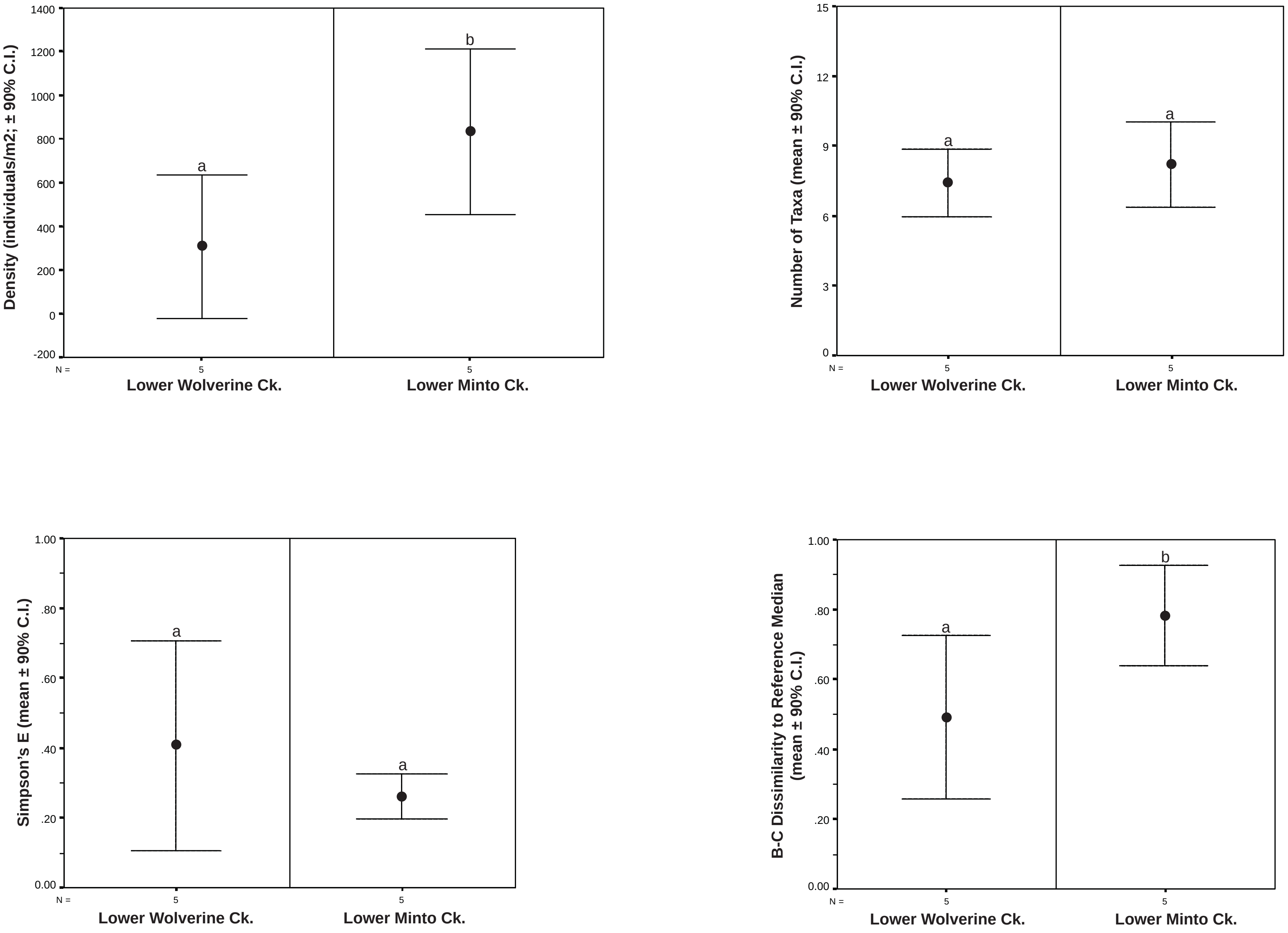

Figure 5.7: Comparison of benthic invertebrate community indices (family level), Minto Mine IOC, 2014. The same letter next to data points indicate no significant difference between areas.

Table 5.2: Statistical comparisons of benthic invertebrate community endpoints between lower creek areas, lower Minto Creek versus lower Wolverine Creek, Minto Mine IOC Study, September 2014.

	2-group ANOVA; Magnitude of Difference; Estimation of Effect Size				
Metric	**Significant Difference Among Areas? (p-value)**[a]		**Power**	**Magnitude of Difference (# of SDs)**[b]	**Minimum Detectable Effect Size (# of SDs)**[c]
Density (individuals /m^2)	YES	0.055	0.657	1.5	~
Number of Taxa	NO	0.486	0.175	~	2.5
Simpson's Diversity	NO	0.672	0.127	~	1.8
Simpson's Evenness	NO	0.341	0.241	~	1.6
Bray-Curtis Dissimilarity	YES	0.054	0.661	1.2	~
EPT (%)	YES	0.024	0.814	1.6	~
Ephemeroptera (%)	YES	0.033	0.758	-1.2	~
Plecoptera (%)	YES	0.001	0.999	6.2	~
Trichoptera (%)	NO	0.398	0.211	~	1.5
Chironomids (%)	NO	0.565	0.151	~	1.7
Oligochaetes (%)	YES	0.086	0.557	-0.9	~
CA Axis 1 (47.8%)	YES	0.000	1.000	5.7	~
CA Axis 2 (18.4%)	NO	0.968	0.100	~	1.5
CA Axis 3 (11.4%)	NO	0.901	0.102	~	1.8

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[a] p-value obtained from 1-way ANOVA

[b] Magnitude calculated by comparing the difference between the reference and exposure area means to the reference area standard deviation (SD) [(exposure mean - reference mean) / standard deviation of the reference mean]

[c] Minimum effect size detectable calculated based on variance as square root of MSE from ANOVA and alpha = beta = 0.10. Minimum effect size reported as the minimum number of standard deviations detectable based on reference area standard deviation.

plecopterans) is not supportive of a deleterious effect of effluent exposure, as these organisms, particularly plecopterans, are widely considered to be intolerant of contaminants and of eutrophication (Merritt et al. 2008). The proportion of chironomid (non-biting) midge larvae did not differ between the two areas (Table 5.2; Figure 5.8; Appendix Tables E.22 and E.23). Lastly, oligochaete worms, encompassing some pollution tolerant taxa, and which are most common in soft organic substrates, were significantly less abundant at the LMC effluent-exposed stations than at the LWC reference stations, suggesting some habitat differences between areas.

Correspondence Analysis (CA) was also used to examine community composition. In the present study, CA explained 77.6% of the total community variance in the first three axes (Appendix Table E.24). Effluent-exposed LMC differed from the reference LWC on the first CA axis (47.8% of variance), based upon high relative abundance of Simuliidae (black flies) and nemourid stoneflies and low relative abundance of perlodid stoneflies, and three families of mayflies (Heptageniidae, Ephemerellidae, Baetidae) at LMC relative to LWC (Table 5.2; Figure 5.9; Appendix Table E.24). Subsequent CA axes did not differ in contrasts of LMC and LWC (Table 5.2; Appendix Tables E.23 and E.24).

5.3 Correlation Analysis / Assessment of Cause

Correlation analysis was used as a key tool in the assessment of potential causes of observed differences in effluent-exposed and reference benthic invertebrate communities. Correlation analysis of benthic invertebrate community endpoints and water quality/habitat variables was conducted to determine if mine associated water quality parameters were the strongest predictors of benthic invertebrate communities.

5.3.1 RCA Upper Minto Creek

Water quality data were reduced by PCA to extract the main gradients of area separation due to metal concentrations. Only PCA axis 1 and 2 explained more variation than by chance alone (Table E.18). The three replicate effluent exposed samples (UMC) ordinated to the negative quadrants of axis 1 and 2 but they were encompassed by the ordination space of the reference areas (Appendix Figure E.5). Spearman correlation of the four primary benthic invertebrate community metrics and potential mine impacted water quality variables resulted in six significant relationships at $p < 0.01$ (Table 5.3). Density and richness decreased with increasing total Kjeldahl nitrogen (TKN), and BC distance decreased with increased total suspended solids (TSS), ammonia, TKN, and total organic carbon (TOC; Figure 5.10). Concentrations of TSS and ammonia were below detection limits at all three upper Minto Creek replicates indicating that these endpoints likely have little or no

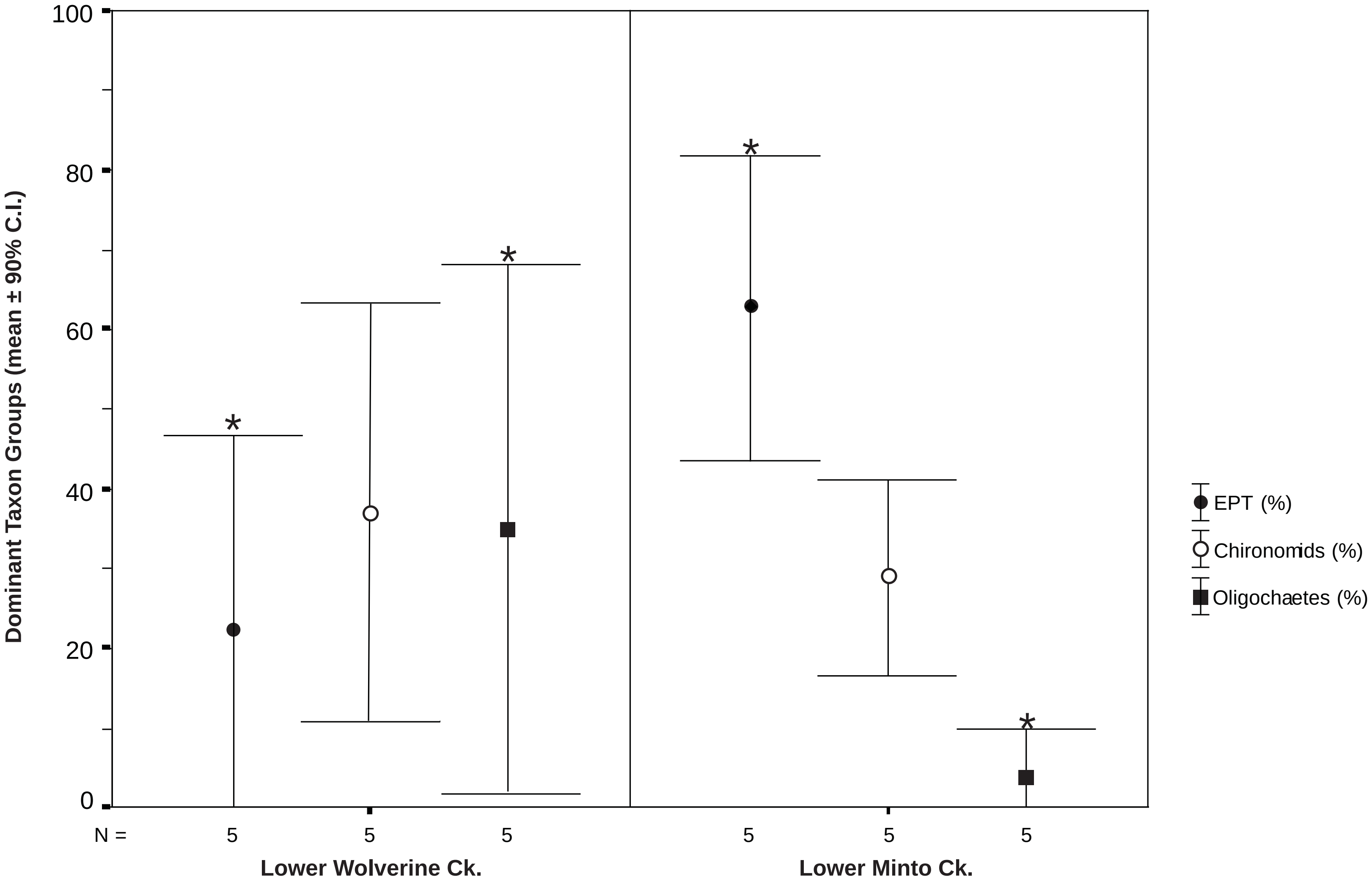


Figure 5.8: Dominant taxon groups (% abundance, family level), Minto Mine IOC, 2014.
* indicates a significant difference between areas.

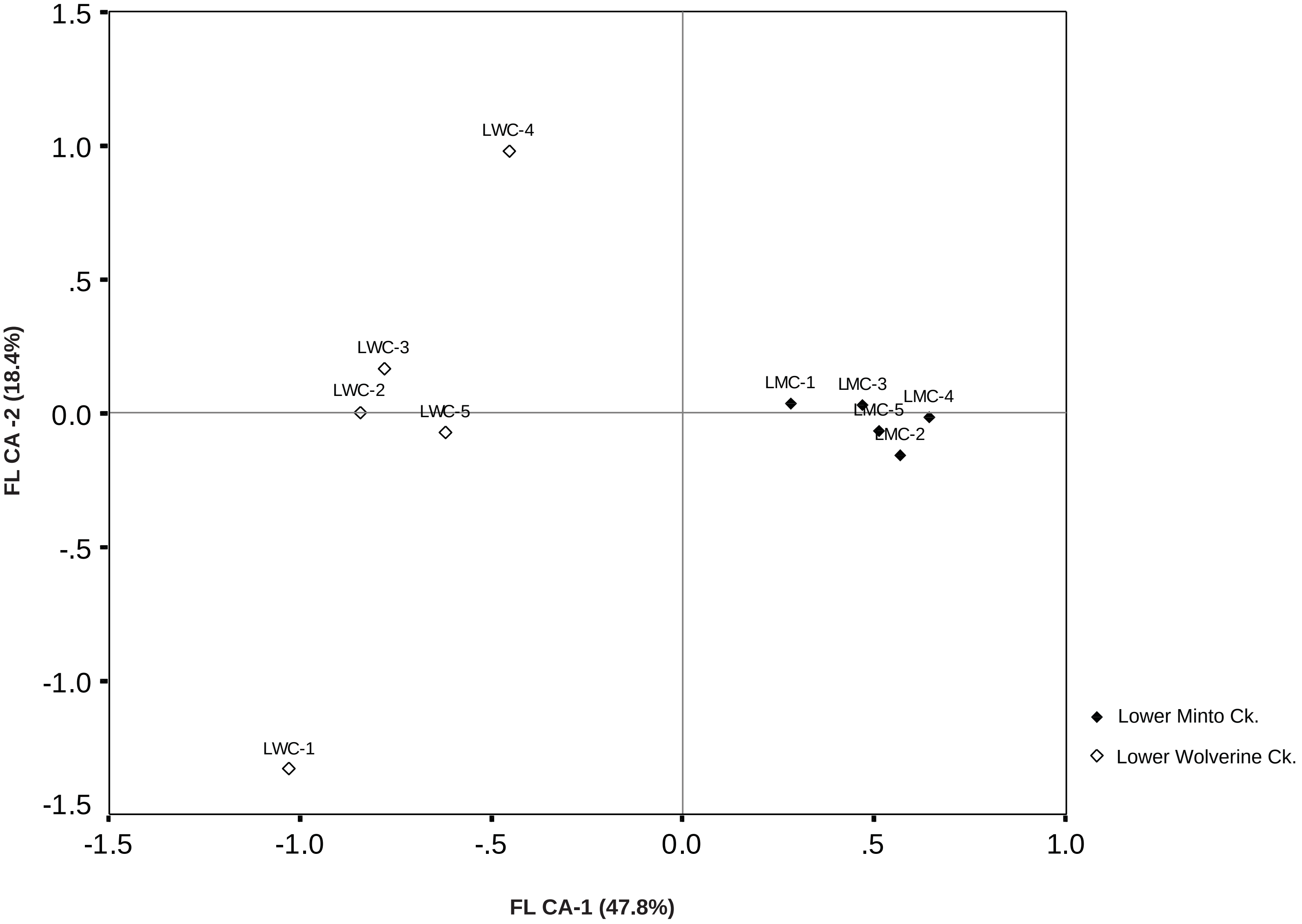


Figure 5.9: Biplot of benthic community correspondence axes 1 and 2 (CI), Minto Mine IOC, 2014.

Table 5.3: Correlations between benthic metrics and environmental supporting measurements at Minto Mine upper creek areas (RCA study), Minto Mine IOC, September 2014.

		Density/ Abundance		Richness		Evenness (Simpson's)		B-C Distance	
Analyte or Measure	**Units**	r	p	r	p	r	p	r	p
Metals PCA Axis 1	-	-0.38	0.1606	-0.28	0.3176	0.00	0.9939	-0.54	0.0376
Metals PCA Axis 2	-	-0.01	0.9668	0.43	0.1071	-0.19	0.5072	-0.08	0.7698
Temperature	°C	-0.25	0.3643	0.55	0.0340	0.06	0.8451	-0.19	0.4937
Specific Conductivity	µS/cm	0.29	0.2999	0.03	0.9039	0.08	0.7899	0.44	0.1040
Dissolved Oxygen (mg/L)	mg/L	0.08	0.7697	0.08	0.7814	0.05	0.8482	-0.13	0.6352
Dissolved Oxygen (%)	%	-0.18	0.5173	0.50	0.0563	0.10	0.7360	-0.28	0.3086
pH	pH units	0.13	0.6390	-0.07	0.8048	0.10	0.7284	0.22	0.4311
Hardness	mg/L	0.30	0.2709	0.12	0.6689	-0.03	0.9295	0.36	0.1885
Total Suspended Solids	mg/L	-0.50	0.0553	-0.30	0.2702	0.26	0.3469	-0.66	0.0080
Alkalinity	mg/L	0.41	0.1320	0.07	0.8162	-0.04	0.8894	0.42	0.1212
Ammonia	mg/L	-0.46	0.0818	-0.29	0.2985	0.28	0.3109	-0.66	0.0075
Nitrate	mg/L	0.16	0.5585	-0.23	0.4062	-0.44	0.1045	0.44	0.1014
Total Kjehldahl Nitrogen	mg/L	-0.83	0.0001	-0.67	0.0068	0.26	0.3549	-0.64	0.0097
Total Dissolved Solids	mg/L	0.08	0.7639	-0.15	0.5842	0.03	0.9035	-0.02	0.9491
Total Phosphorus	mg/L	-0.29	0.3027	-0.50	0.0574	0.02	0.9521	-0.40	0.1365
Total Organic Carbon	mg/L	-0.58	0.0227	-0.61	0.0148	0.25	0.3606	-0.66	0.0074
Chlorophyll *a*	mg/m^2	0.15	0.5942	0.27	0.3379	0.11	0.6835	0.17	0.5484

🟨 correlation scatterplot inspected; $p < 0.01$

🟩 significant correlation at $p < 0.0007$ ($p = 0.05$ adjusted for 68 comparisons)

Note: n = 15 for all correlations

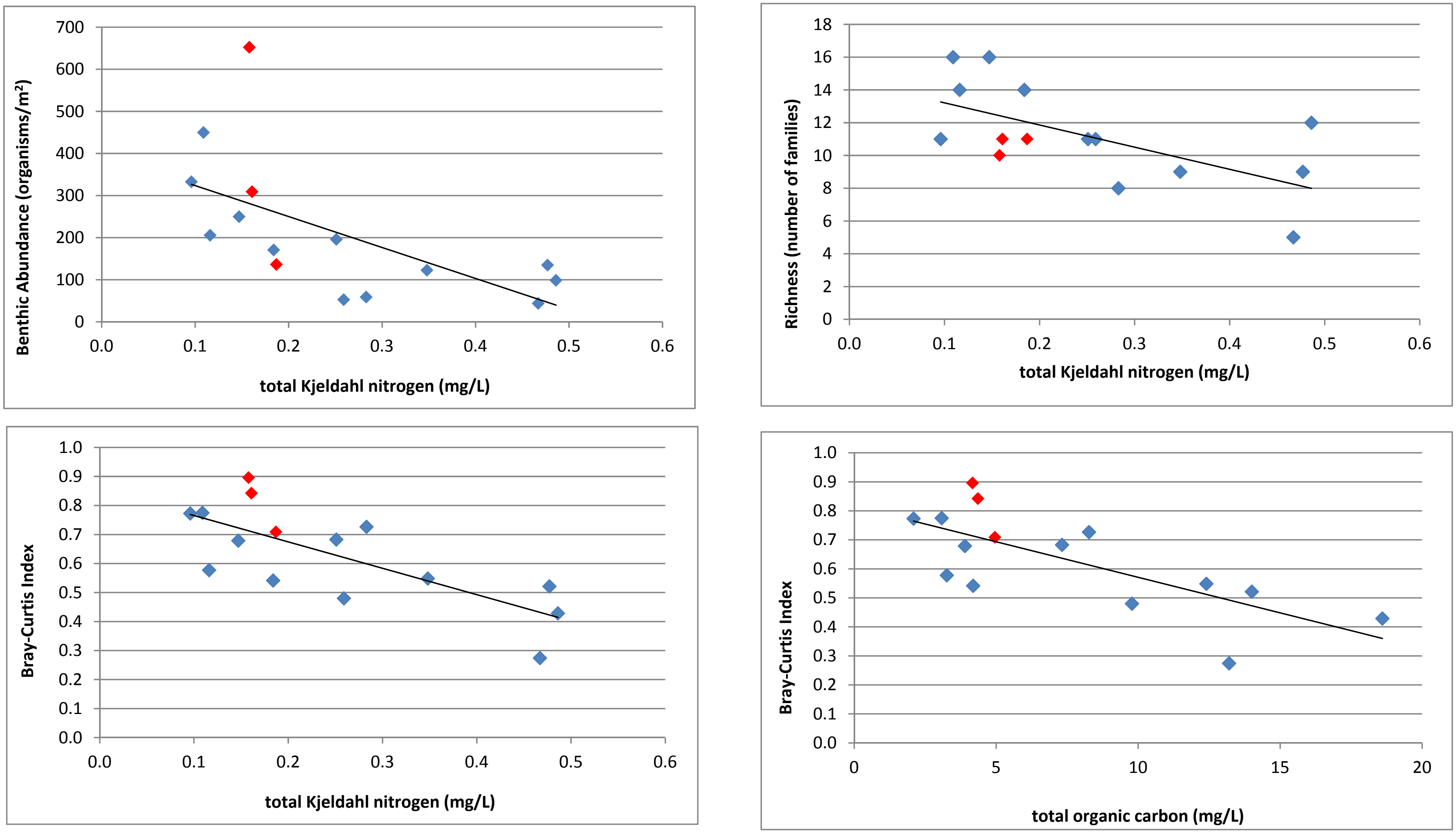


Figure 5.10: Biplots of significant relationships between primary benthic invertebrate community metrics and water quality in upper creeks (RCA study), Minto Mine IOC, September 2014. Effluent-exposed sites (upper Minto Creek) are red; reference are blue.

impact on the benthic communities of UMC. Overall, differences in the primary metrics correlate most strongly with TKN. At the time of the IOC study (September 2014), TKN was on the low side of the range of reference and the benthic metrics were either on the high side of reference (abundance and BC distance) or similar to reference (richness). Thus, no mine-related effect is suggested by this relationship. It is notable that there were no statistically significant relationships between mine-related analytes (such as specific conductivity, metals PCA axes and nitrate) and benthic metrics (Table 5.3), although this is presumably due to the absence of discharge during the IOC study. Furthermore, examination of relationships between all benthic metrics and environmental variables that are not influenced by mine activity indicated relationships with large-scale habitat descriptors such as land cover (a higher proportion of oligochaetes and higher CA Axis 1 scores with increasing proportion of exposed land and recent fire; and fewer EPT taxa with increasing proportion of herbaceous plants; Appendix Table E.27).

5.3.2 CI Lower Minto Creek

Correlation analysis between benthic indices and the water chemistry and physical supporting variables was limited to those that differed among areas in order to constrain the number of correlations. Correlations between seven benthic metrics and five supporting measurements resulted in eight significant correlations at a p-level of 0.01, of which two were significant at the Bonferroni-corrected p-level of 0.001 (Table 5.4). Due to the low number of stations (10) used in these correlations, the tests have limited power and therefore correlations significant at the more liberal p-value of 0.01 were plotted to examine associations of possible biological interest at Minto stations. It is also important to consider that illustration of a significant or suggestive degree of correlation between two variables does not necessarily imply a cause-and-effect relationship, though it is cause to investigate further and to consider known biological responses to environmental change.

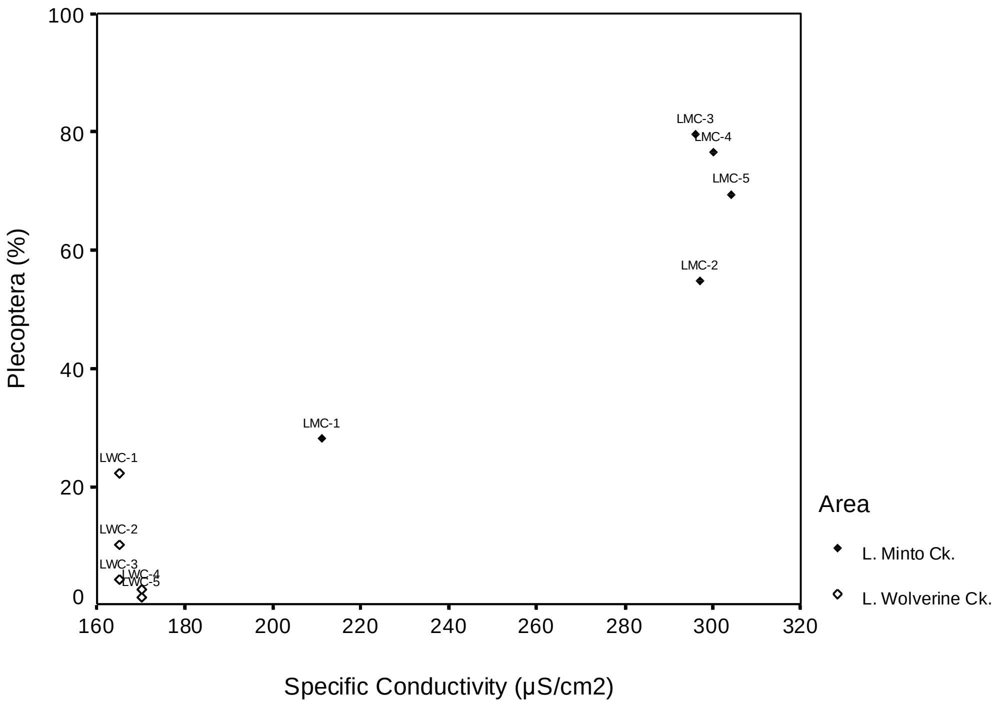
The only two correlations significant at the Bonferroni-corrected p-level were the positive correlation between the percent abundance of Plecoptera and specific conductivity and the CA Axis 1 scores and specific conductivity (Table 5.4; Figure 5.11). High stonefly abundance at Minto exposure stations 2 to 5; due almost entirely to stoneflies in the genus *Nemoura* - was responsible for these relationships (and are supported by a positive relationship between proportion EPT taxa and specific conductivity that is significant at a p-level of 0.01 but not the Bonferroni-corrected p-level). Plecopteran taxa generally are intolerant of effluent or enrichment effects, so it is likely that the higher abundance of *Nemoura* at LMC is attributable to habitat conditions. There is also a suggestive (non-significant after Bonferroni adjustment) negative correlation between sampling water depth

Table 5.4: Correlations between benthic metrics and environmental supporting measurements at Minto Mine lower creek stations (CI study), Minto Mine IOC, September 2014.

Benthic Invertebrate Community Metric		Depth (m)	Average Depth (cm) (Sampler pushed into substrate)	DO (%)	Specific Conductivity (µS/cm2)	pH
Density (individuals/m^2)	Pearson Correlation	-0.3945	0.0168	-0.4921	0.7400	0.5229
	Sig. (2-tailed)	0.2593	0.9632	0.1485	0.0144	0.1210
BC Dissimilarity	Pearson Correlation	-0.5333	0.0408	-0.5557	0.7322	0.4237
	Sig. (2-tailed)	0.1124	0.9110	0.0953	0.0160	0.2224
EPT (%)	Pearson Correlation	-0.8510	0.0877	-0.4212	0.7897	0.4795
	Sig. (2-tailed)	0.0018	0.8096	0.2255	0.0066	0.1608
Ephemeroptera (%)	Pearson Correlation	0.1150	-0.3545	0.5203	-0.6419	-0.6679
	Sig. (2-tailed)	0.7517	0.3148	0.1231	0.0454	0.0348
Plecoptera (%)	Pearson Correlation	-0.7998	0.1896	-0.5672	0.9596	0.6803
	Sig. (2-tailed)	0.0055	0.5999	0.0873	0.0000	0.0304
Oligochaetes (%)	Pearson Correlation	0.7704	-0.2091	0.3956	-0.5717	-0.3797
	Sig. (2-tailed)	0.0091	0.5621	0.2578	0.0842	0.2792
CA Axis 1 (47.8%)	Pearson Correlation	-0.5925	0.4612	-0.7806	0.9388	0.8315
	Sig. (2-tailed)	0.0711	0.1797	0.0077	0.0001	0.0029

🟨	correlation scatterplot inspected ; $p < 0.01$
🟩	significant correlation; $p < 0.001$ ($p = 0.05$ adjusted for 35 comparisons)

Note: n = 10 for all correlations



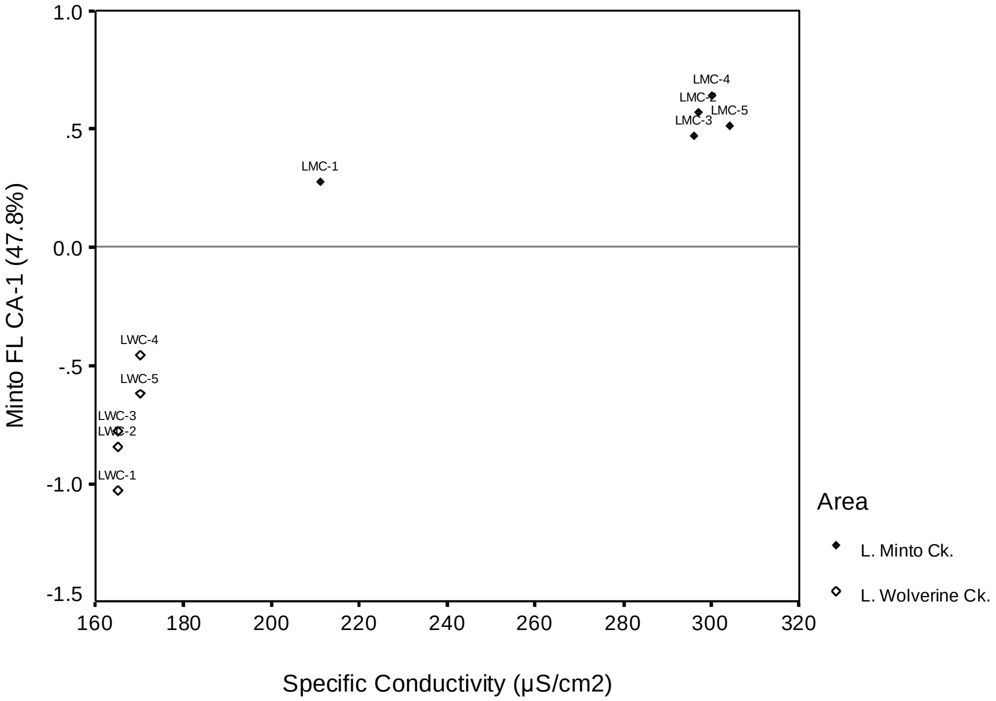


Figure 5.11: Biplot of percent Plecoptera and CA axis-1 versus specific conductivity (CI)

and percent EPT (and Plecoptera alone) in benthic samples and a positive correlation between sampling water depth and percent oligochaetes (Table 5.4). Shallow-water stations appear to have higher percent EPT abundance and lower oligochaete abundance (Appendix Figures E.8 and E.13). This may reflect the preference for shallow, more turbulent riffle habitat for rheophilic taxa such as Heptageniidae and *E. dorothea* mayflies, and for many taxa of stoneflies. This association neither supports nor discounts an effluent exposure effect, but rather points out the strong effects of some habitat variables on benthic communities. Lastly, CA Axis 1 was also negatively correlated with dissolved oxygen (Appendix Figure E.12). Lower Minto Creek stations had slightly lower percent oxygen saturation than the reference stations (95% versus 98%) and CA-1 scores were uniformly lower at the reference stations. Lower Minto Creek stations were characterized by low relative abundance of these taxa, and higher relative abundance of black fly larvae (Simuliidae), *Diamesa* and *Eukiefferiella* chironomids, and stoneflies in the genus *Nemoura*. The taxa most strongly contributing to reference CA scores were *Pseudosmittia* and *Orthocladius* chironomids, stoneflies in the family Perlodidae, and mayflies (Heptageniidae, *Ephemerella dorothea*/*excrucians*, Baetidae) (Appendix Table E.24), most of which have low tolerance scores (Barbour et al. 1999) indicating sensitivity to degraded water quality.

5.4 Summary

In summary, mine-exposed benthic communities associated with two of three upper Minto Creek replicates (UMC-1 and UMC-2) did not differ from the reference condition on the basis of any of the four primary EEM metrics. Replicate UMC-3 was within reference condition for taxon richness and Simpson’s evenness, was possibly outside the reference range for BC distance, and had organism abundance significantly greater than the reference condition. The lack of consistent differences from reference across replicates indicates that effluent exposure has not had a clear adverse influence on benthic invertebrate communities of upper Minto Creek. However, some supporting benthic invertebrate community metrics continue to suggest subtle differences in community structure relative to reference (including lower percent mayflies and stoneflies, higher percent caddisflies, and higher percent chironomidae). Although the significant difference in BC distance observed in previous EEM studies is not supported when compared to a reference condition defined by more reference sites and BC distance has been previously identified as being pre-disposed towards producing significant differences even in the absence of a real effect (Huebert et al. 2011), the subtle differences observed in the supporting metrics in this study are similar to those previously observed (i.e., lower proportions of EPT taxa and higher proportions of chironomid taxa; Minnow 2014). Despite the fact that an effect on BC distance was not supported in the

RCA evaluation, correlation analysis was conducted to explore potential relationships between benthic invertebrate community structure and measured variable (i.e., potential cause). This evaluation did not identify any clear mine-related influences on the benthic invertebrate community. Relationships between several benthic invertebrate community endpoints (abundance, richness and BC distance) were all negatively associated with TKN concentrations, but TKN concentrations at the exposed sites were low and the exposed sites generally fell within the relationships defined by reference sites. It is unclear whether the minor community structure dissimilarities occurring in supporting benthic invertebrate community metrics of upper Minto Creek were due to naturally occurring conditions or mine related activities.

The evaluation of lower Minto Creek indicated statistically significant community differences relative to the lower Wolverine Creek reference area (greater density, greater BC distance, and some differences in taxon proportions). Conversely, the greatest relative abundance of pollution sensitive EPT taxa occurred in effluent-exposed lower Minto Creek (primarily due to high abundance of Nemoura stoneflies). The high abundance of stoneflies in lower Minto Creek is opposite of what was observed in upper Minto Creek relative to the reference condition. The observed differences may be largely attributable to the comparison to only one reference area, but an influence of effluent exposure cannot be ruled out as there is evidence of an association with elevated conductivity observed at exposure area stations. Similar associations with water depth and dissolved oxygen indicate that habitat differences are also important. Evaluation of associations between benthic invertebrate community condition and chemical/physical variables in a comparison of two areas is problematic due to highly leveraged data points (i.e., any difference in benthic invertebrate community condition will likely appear to be associated with any parameter that differs between areas regardless of causality) and highlights the superior interpretability of the RCA evaluation (with 12 reference areas rather than one).

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The Minto Mine Cycle 3 EEM (IOC) conducted in September 2014 provided an integrated assessment of the influence of the Minto Mine on the water chemistry and benthic invertebrate community condition of Minto Creek relative to reference areas/conditions. Conclusions of this EEM, by monitoring component, are provided below.

Effluent sublethal toxicity tests conducted by the mine from 2012 to 2014 showed no effect to rainbow trout embryos, the alga *P. subcapitata*, or the plant *L. minor*. However, testing of the invertebrate *C. dubia* indicated that, although survival was not affected, one instance of reproductive impairment occurred (at 38.6% effluent in 2013). Coupled with in-creek effluent concentrations approaching 100%, this suggests a potential for occasional effluent-related impairment of invertebrate reproduction.

Routine water quality monitoring indicated an influence of the Minto Mine on Minto Creek evident in conductivity, hardness, nitrate, arsenic and copper that were greater than reference. Of these, concentrations of nitrate were most strongly associated with release of water from the water storage pond (WSP), but remained below the Canadian water quality guideline for the protection of aquatic life (CWQG). Copper was the only one of these analytes with a mean concentration greater the CWQG and dissolved copper (which represents bioavailable copper better than total) was typically elevated during freshet/WSP discharge. Water quality of upper Minto Creek during the IOC study (in September 2014) did not represent WSP discharge, but did have elevated conductivity relative to most reference sites. During the IOC study, all analytes except strontium and tin were within the range of reference and no analytes were present at concentrations greater than CWQGs.

The benthic invertebrate community of Minto Creek was evaluated using two approaches: the community of upper Minto Creek (where the investigation of cause was triggered based on results of previous EEM studies) was evaluated using a reference condition approach (RCA), and the community of lower Minto Creek was evaluated using a control-impact (CI) approach. The RCA evaluation of upper Minto Creek indicated that two of three upper Minto Creek replicates (UMC-1 and UMC-2) did not differ from the reference condition on the basis of any of the four primary EEM-effect metrics (abundance, taxon richness, Simpson's evenness or Bray-Curtis dissimilarity). Replicate UMC-3 was within reference condition for taxon richness and Simpson's evenness, had organism abundance significantly greater than the reference condition, and had a BC distance that could not be conclusively categorized as within the reference condition nor significantly different from the reference condition. The lack of consistent differences from reference across replicates suggests that effluent exposure has had minimal influence on benthic invertebrate communities of upper Minto Creek. It is notable that BC distance, which triggered the IOC based on significant differences in the two previous EEM studies, was within the reference condition in two of three replicates in upper Minto Creek and uncertain with respect to one of the three replicates. This metric has been previously identified as being pre-disposed towards producing significant differences even in the absence of a real effect (Huebert et al. 2011). However, some supporting benthic invertebrate community metrics continue to suggest subtle differences in community structure relative to reference (including lower percent mayflies and stoneflies, higher percent caddisflies, and higher percent chironomidae) that are similar to those previously observed. Despite the fact that an effect on BC distance was not supported in the RCA evaluation, correlation analysis was conducted to explore potential relationships between benthic invertebrate community structure and measured variables (i.e., to identify potential cause) and did not identify any clear mine-related influences on the benthic invertebrate community. Several benthic invertebrate community endpoints (abundance, richness and BC distance) were negatively associated with TKN concentrations, but TKN concentrations at the exposed sites were low and the exposed sites generally fell within the reference relationships to TKN. It is unclear whether the minor community structure dissimilarities between upper Minto Creek and reference as detected by supporting benthic invertebrate community metrics (but not by EEM-effect metrics) were due to naturally occurring conditions or mine related activities.

The CI evaluation of lower Minto Creek indicated statistically significant benthic invertebrate community differences relative to the lower Wolverine Creek reference area (greater density, greater BC distance, and some taxon proportions). Conversely, the greatest relative abundance of pollution sensitive EPT taxa occurred at effluent-exposed lower Minto Creek (primarily due to high abundance of Nemoura stoneflies). The high abundance of stoneflies in lower Minto Creek is opposite of what was observed in upper Minto Creek relative to the reference condition. The observed differences between lower Minto Creek and lower Wolverine Creek may be largely attributable to the narrow comparison (to only one reference area) rather than any mine-related effect, but an influence of effluent exposure cannot be ruled out as there is evidence of an association with elevated conductivity observed at exposure area stations. Similar associations with water depth and dissolved oxygen indicate that habitat differences are also important. Evaluation of associations between benthic invertebrate community condition and chemical/physical variables in a comparison of two areas is problematic due to highly leveraged data points (i.e., any difference in benthic invertebrate community condition will appear to be associated with any parameter that differs between areas regardless of causality) and highlights the superior interpretability associated with the RCA evaluation (with 12 reference areas rather than one).

Overall, the investigation of cause indicated that the differences in benthic invertebrate community structure of upper Minto Creek detected using Bray-Curtis distance in previous EEM studies were likely due to comparison to too few reference areas (resulting in inadequate characterization of the range of reference condition). The investigation did not support a mine-related water quality influence on Bray-Curtis distance in upper Minto Creek. Some minor differences in benthic invertebrate community structure of upper Minto Creek detected by supporting metrics (but not by the EEM-effect metrics of abundance, taxon richness, Simpson's evenness or Bray-Curtis distance) were no more strongly associated with mine-related physical and chemical variables than to natural physical and chemical variables.

6.2 Recommendations

Based on the findings of the Phase 3 EEM Investigation of Cause study, the Minto Mine will be required to submit a fourth interpretive report in three years (January 10th 2018). Specific recommendations for the Phase 4 EEM are as follow.

1. Implement the study in 2016 to allow more time to complete the Interpretive Report due on January 10th 2018;
2. Conduct effluent sampling for sublethal toxicity testing when water is being released from the Water Storage Pond; and
3. Implement the Phase 4 EEM benthic invertebrate community survey using an RCA approach.

7.0 REFERENCES

Barbour, M.T., J. Gerristen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish - Second Edition. EPA 841-B-99-002

BCMOE (British Columbia Ministry of Environment). 1985. Water Quality Criteria for Nutrients and Algae. Technical Appendix. Prepared by R. Nordin, Water Quality Unit. October 1985.

Begon, M, J.L. Harper, and C.R. Townsend. 1996. Ecology: individuals, populations, and communities. Blackwell Science, Oxford. 1068 pp.

Bray, J.T., and J.T. Curtis. 1957. An ordination of upland forest communities of southern Wisconsin. Ecological Monographs 27: 325-349.

CABIN (Canadian Aquatic Biomonitoring Network). Field Manual: Wadeable Streams. Environment Canada. March 2012.

CCME (Canadian Council of Ministers of the Environment). 2014. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Accessed at http://st-ts.ccme.ca/, February 2014.

Clarke, A.H. 1981. The freshwater molluscs of Canada. National Museums of Canada, Ottawa 446 pp.

Edmunds, G.F. Jr., S.L. Jensen and L. Berner. 1976. The Mayflies of North and Central America. Univ. Minnesota Press, Minneapolis. 330 pp.

Environment Canada. 1998. Toxicity Tests Using Early Life Stages of Salmonid Fish (Rainbow Trout). Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/28. July 1998.

Environment Canada. 2007a. Biological Test Method: Test of Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia*. Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report EPS 1/RM/21. Second Edition. February 2007.

Environment Canada. 2007b. Biological Test Method: Growth Inhibition Test Using a Freshwater Alga. Environmental Technology Centre, Ottawa, Ontario. Report EPS 1/RM/25. Second Edition. March 2007.

Environment Canada. 2007c. Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte *Lemna minor*. Environmental Technology Centre, Ottawa, Ontario. Environmental Protection Series. Report 1/RM/37. Second Edition. January 2007.

Environment Canada. 2012. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada Report EEM/2002/1. June, 2012.

Glozier, N.E., J.M. Culp, and D. Halliwell. 2002. Revised Guidance for Sample Sorting and Subsampling Protocols for EEM Benthic Invertebrate Community Surveys.

Government of Canada. 2014. Metal Mining Effluent Regulations, Consolidation. SOR/2002-222. Current to October 27th, 2014.

Huebert, D.B., M. McKernan and C. Paquette. 2011. Canada's Environmental Effects Monitoring Program: Areas for Improvement. Integr. Environ. Assess. Manag. 7: 143-144.

Kilgour, B.W., K.M. Somers and D.E. Mathews. 1998. Using the normal range as a criterion for ecological significance in environmental monitoring and assessment. Ecoscience 5: 542 – 550.

McCune, B., and M.J. Mefford. 2011. PC_ORD. Multivariate Analysis of Ecological Data Version 6.08. MjM Software, Gleneden Beach, Oregon, U.S.A.

Merritt, R.L., K.M. Cummins, and M.B. Berg, Editors. 2008. An Introduction to the Aquatic Insects of North America. 4th Ed. Kendall/Hunt Publishing, Dubuque. 1158 pp.

Minnow (Minnow Environmental Inc.). 2014. Capstone Mining Corp. Minto Mine Phase 3 EEM Study Design - Investigation of Cause. Prepared for Capstone Mining Corp. March 2014.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2007. Environmental Effect Monitoring. First Study Design. Prepared for Minto Explorations Ltd. July 2007.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2009. Environmental Effects Monitoring First Interpretive Report, Minto Project, Yukon Territory. Prepared for Minto Explorations Ltd. January 2009.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2010. Environmental Effects Monitoring Study Design - Cycle 2. Prepared for Minto Explorations Ltd. July 2010.

Minnow/Access (Minnow Environmental Inc./Access Consulting Group). 2012. Minto Mine Cycle 2 Environmental Effects Monitoring (EEM). Prepared for Minto Explorations Ltd. January 2012.

Pielou, E.C. 1974. Population and Community Ecology: principles and methods. Gordon and Breach, New York. 424 pp.

Quinn, G.P., and M.J. Keough. 2013. Experimental Design and Data Analysis for Biologists. Cambridge University Press.

Smith, B. and J.B. Wilson. 1996. A consumer's guide to evenness indices. Oikos 76: 70-82.

SPSS (PASW) version 22 (2013). IBM-SPSS Inc. 233 S. Wacker Drive, 11th floor. Chicago, Illinois, U.S.A.

Suter, G.W.II., S.M. Cormier and S.B. Norton. 2015. Forming Causal Conclusions. In: S.B. Norton S.M. Cormier and G.W. Suter II (Eds.) - Ecological Causal Assessment. CRC Press, Boca Raton pp. 251-270.

Weiderholm, T. (ed.) 1983. Chironomidae of the Holartic region. Keys and diagnoses, Part 1. - Larvae ent. Scand. Suppl. 19. 457 pp.

Wetzel, R.G. 2001. Limnology: Lake and River Ecosystems. Third Edition. Academic Press. San Diego, CA, USA. 1006 p.

Wiggins, G.B. 1996. Larvae of the North American caddisfly genera (Trichoptera), 2^{nd} Ed.

Appendix A

STUDY DESIGN CORRESPONDENCE

Environment Environnement
Canada Canada

Environmental Protection Operations Directorate
Pacific and Yukon Region
Environment Canada
91782 Alaska Highway, 2nd Floor
Whitehorse, Yukon
Y1A 5X7

July 24, 2014 File: MM4011

Jennie Gjertsen, Environmental Manager
Capstone Mining Corp.
Minto Mine
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(604) 759-4634 (mine site)
jennieg@mintomine.com

Dear Ms. Gjersten,

Subject: Review of the Minto Mine Phase 3 EEM Study Design - Investigation of Cause

This letter is to advise you that we have reviewed your Environmental Effects Monitoring (EEM) biological study design report entitled *Minto Mine Phase 3 EEM Study Design - Investigation of Cause*, which was received on March 31, 2014. The review of the study design report takes into account information requirements in the *Metal Mining Effluent Regulations* (MMER) of the *Fisheries Act*, and also offers comments on the design based on the EEM Technical Guidance Document and other scientifically valid methods.

As per ongoing discussions with our Regional EEM Coordinator, and in accordance with subsection 19(1)(b) of Schedule 5 of the MMER, you are required to provide me, as Authorization Officer, information identifying and describing the supplementary reference sites to be utilized for the Reference Condition Approach you intend to adopt. Details may be provided in a letter which supports the information already provided in the Study Design. We consider the Study Design to be incomplete until this information is provided.

Given the date we received the subject report, and your intention to conduct the biological survey in early September 2014, I am obliged to inform you that it does not appear you will meet the requirements of subsection 19(1) of Schedule 5 of the MMER:

> ***"Subsequent Study Designs***
>
> *19.(1) Subject to subsection (2), the study design for a second and any subsequent biological monitoring study shall be submitted to the*

> *authorization officer at least six months before a second or subsequent biological monitoring study is conducted ..."*

Please provide to me a final schedule relating to the biological monitoring at least two weeks prior to the commencement of field activities.

We look forward to receiving your interpretive report no later than January 6, 2015. Should you have any questions or concerns regarding the EEM program or wish to discuss any major changes or decisions to the study design, please do not hesitate to contact Denis Lacroix at 867-667-3401, or at denis.lacroix@ec.gc.ca.

Sincerely,

Barry D Smith

Barry Smith
A/ Regional Director
Environmental Protection Operations Directorate, Pacific/Yukon Region

Barry.smith@ec.gc.ca

(604) 666-2399

cc:

Paul Ross, Head, Compliance Promotion & Environmental Effects Monitoring Unit, Environment Canada, Vancouver, BC
Janice Boyd, Program Scientist, Environment Canada, Vancouver, BC
Travis Teel, Enforcement Officer, Environment Canada, Whitehorse, YT

minnow
environmental inc.

August 13, 2014

Ms. Jennie Gjertsen
Environmental Manager
Capstone Mining Corporation - Minto Mine
13-151 Industrial Road
Whitehorse, Yukon, Y1A 2V3

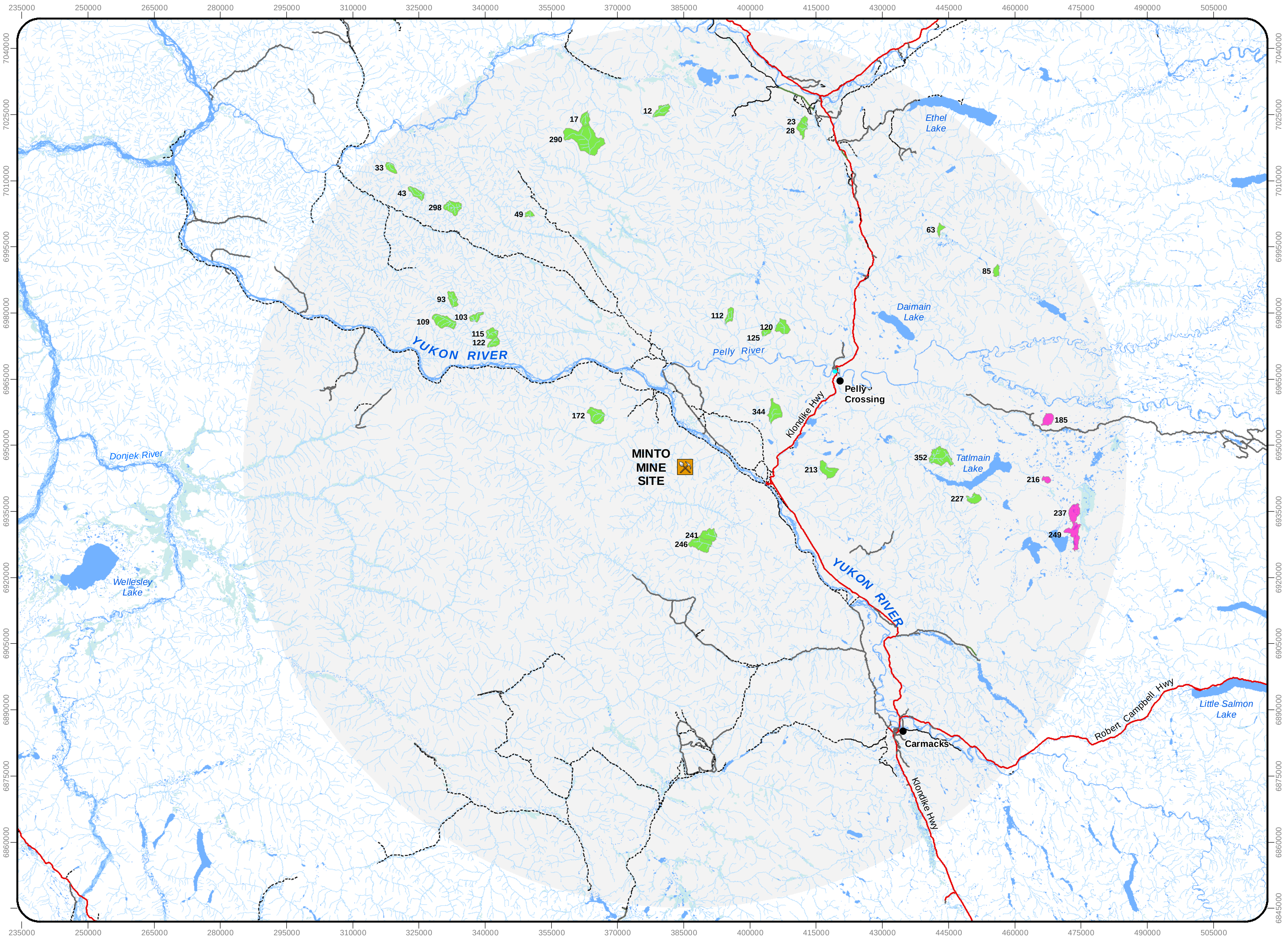
Dear Ms. Gjertsen,

Re: Response to Environment Canada Review of the Minto Mine Phase 3 EEM Study Design (IOC)

Minnow Environmental has reviewed comments on the proposed Cycle 3 EEM Investigation of Cause (IOC) Study Design provided to Capstone Mining Corp. - Minto Mine by Environment Canada Pacific and Yukon Region (dated July 24, 2014). Our response to the comments is provided herein.

> ***Comment:*** *Environment Canada requires that the mine provide information identifying and describing the supplementary reference sites to be used for the Reference Condition Approach that was proposed.*

Response: Selection of potential reference areas using Geographic Information System (GIS) data has now been completed as outlined in the study design report. This work was undertaken by qualified GIS Technicians and CABIN (Canadian Aquatic Biomonitoring Network) Project Managers. The exercise included GIS data layers of geology, land classification, stream network, and a Digital Elevation Model (DEM). A DEM was used to identify suitable reference areas for upper Minto Creek. This was accomplished through identification of all areas where 2nd or 3rd order streams were found at 660 m elevation above sea level with the constraint that they be within 100 km of Minto Mine. This list was then further condensed based on similarity of key natural watershed features indicative of upper Minto Creek (i.e., watershed size, watershed geology, watershed land use/cover types, percent forest burned, etc.). The potential reference areas were then ranked using principal components analysis based on their similarity to upper Minto Creek relative to the key natural watershed features. The top 30 reference areas and associated watersheds are shown in Figure 1 along with their rank. Upon visual evaluation of the final 30 watersheds, four were eliminated due to



Features

- Minto Mine Site
- Road
- Limited-use road
- Trail
- Cut line
- WATERCOURSE
- 🟩 Potential Reference Watershed
- 🟪 Potential Reference Watershed Removed
- 🟦 WATERBODY
- WETLAND
- Search Area (100 kilometers)

Top 30 Reference Watersheds

Rank	Watershed
1	246
2	241
3	172
4	23
5	249
6	28
7	213
8	237
9	185
10	216
11	120
12	112
13	125
14	344
15	122
16	49
17	93
18	12
19	298
20	115
21	43
22	352
23	33
24	103
25	109
26	63
27	85
28	290
29	17
30	227

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MAP INFORMATION
Datum: NAD 83 Map Projection: UTM Zone 8N
Data Source: National Topographic Data Base (NTDB)
compiled by Department of Natural Resources Canada
at a scale of 1:50,000. All rights reserved.
Created By: M.LaPalme
Creation Date: August 2014
Project No. 2535

Figure 1: Location of the Top 30 Watershed Reference Sites for the Minto Cycle 3 Benthic Survey.

Created by:
minnow
environmental inc.

suspected inappropriate stream and watershed delineation and/or the presence small water bodies making them dissimilar to upper Minto Creek (see Figure 1, Rank 5, 8, 9 and 10). Therefore, 26 potential reference watersheds were identified. The final selection of the 10 supplementary reference sites will be undertaken during study implementation beginning with a flyover and followed by field reconnaissance as outlined in the study design report. Field reconnaissance will be undertaken starting with the highest ranked reference site. Field crews will then place particular emphasis on specific habitat features known to be important to benthic invertebrate community composition of shallow riffle/run habitats including water depth, water velocity, substrate characteristics (particle size, organic content, woody debris, plants or algae), general physical and biological characteristics (field observations), and in situ water quality measurements (temperature, dissolved oxygen, conductivity and pH).

I trust that this response meets your requirements and expectations. If you have any further questions or concerns regarding the study design, please to not hesitate to contact me.

Sincerely,
Minnow Environmental Inc.

Pierre Stecko, M.Sc., EP, RPBio
Aquatic Scientist & Principal

Appendix B

MINTO MINE EFFLUENT DATA

Appendix Table B.1: Minto Mine weekly MMER effluent quality data, 2012-2014

Date		Effluent Volume	pH	Total Suspended Solids	Arsenic	Copper	Lead	Nickel	Zinc	Radium-226
		m^3	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L
	MMER limit (grab)		6.0 - 9.5	30	1.0	0.60	0.4	1	1	1.11
2012-01-02	Grab	303	8.22	< 4.0	0.00020	0.0018	< 0.0002	< 0.0010	< 0.0050	
2012-01-08	Grab	324	8.01	< 1.0	0.00020	0.0018	< 0.0002	0.0010	< 0.0050	
2012-01-22	Grab	324	8.13	6.0	0.00030	0.0051	< 0.0002	0.0010	< 0.0050	
2012-01-31	Grab	304	8.12	< 4.0	0.00020	0.0036	0.0006	0.0010	< 0.0050	
2012-02-07	Grab	346	8.44	< 4.0	0.00020	0.0017	0.0002	< 0.0010	< 0.0050	
2012-02-14	Grab	302	8.34	< 4.0	0.00030	0.0023	< 0.0002	< 0.0010	< 0.0050	
2012-02-20	Grab	345	7.99	< 4.0	0.00020	0.0019	< 0.0002	< 0.0010	< 0.0050	
2012-02-25	Grab	346	8.12	< 4.0	0.00020	0.0065	< 0.0002	< 0.0010	< 0.0050	
2012-03-05	Grab	259	8.32	3.9	0.00020	0.0018	< 0.0002	< 0.0010	< 0.0050	
2012-03-12	Grab	259	8.11	5.1	0.00200	0.0019	< 0.0002	< 0.0010	< 0.0050	
2012-03-19	Grab	216	8.16	4.2	0.00030	0.0028	< 0.0002	< 0.0010	< 0.0050	
2012-03-27	Grab	346	8.26	2.3	0.00030	0.0032	< 0.0002	< 0.0010	< 0.0050	
2012-04-02	Grab	259	8.32	9.6	0.00030	0.0027	< 0.0002	< 0.0010	< 0.0050	
2012-04-09	Grab	259	8.15	13	0.00060	0.0095	0.0003	0.0010	< 0.0050	
2012-04-14	Grab	6,048	8.24	17	0.00050	0.0066	< 0.0005	0.0015	< 0.0050	
2012-04-24	Grab	6,739	8.23	4.7	0.00042	0.0255	0.0007	0.0012	< 0.0050	< 0.01
2012-05-07	Grab	605	8.10	6.2	0.00040	0.0080	< 0.0002	0.0012	< 0.0050	
2012-05-16	Grab	346	8.35	4.4	0.00041	0.0086	< 0.0002	0.0016	< 0.0050	
2012-05-24	Grab	251	8.25	< 1.0	0.00021	0.0053	< 0.0002	0.0012	< 0.0050	
2012-06-02	Grab	251	8.17	< 1.0	0.00024	0.0024	< 0.0002	< 0.0010	< 0.0050	
2012-06-08	Grab	259	8.31	< 1.0	0.00025	0.0031	< 0.0002	0.0011	0.0050	
2012-06-19	Grab	346	8.36	< 1.0	0.00027	0.0037	< 0.0002	0.0012	< 0.0050	< 0.01
2012-06-28	Grab	337	8.19	< 1.0	0.00027	0.0026	< 0.0002	< 0.0010	< 0.0050	
2012-07-05	Grab	350	8.39	< 1.0	0.00029	0.0031	< 0.0002	0.0011	< 0.0050	
2012-07-09	Grab	276	8.47	< 1.0	0.00026	0.0025	< 0.0002	< 0.0010	< 0.0050	
2012-07-18	Grab	281	8.32	1.8	0.00026	0.0022	< 0.0002	< 0.0010	< 0.0050	
2012-07-24	Grab	285	7.96	1.0	0.00026	0.0024	0.0002	0.0010	0.0050	
2012-07-30	Grab	320	8.28	< 1.0	0.00028	0.0021	< 0.0002	< 0.0010	< 0.0050	
2012-08-07	Grab	328	8.33	< 1.0	0.00025	0.0021	< 0.0002	0.0010	< 0.0050	
2012-08-16	Grab	328	8.42	< 1.0	0.00025	0.0019	< 0.0002	< 0.0010	< 0.0050	
2012-08-23	Grab	302	8.25	< 1.0	0.00026	0.0024	< 0.0002	< 0.0010	< 0.0050	< 0.01
2012-08-30	Grab	285	8.33	< 1.0	0.00023	0.0030	< 0.0002	< 0.0010	< 0.0050	
2012-09-03	Grab	302	8.25	< 1.0	0.00027	0.0027	< 0.0002	0.0013	< 0.0050	
2012-09-05	Grab	302	8.30	< 1.0	0.00024	0.0023	< 0.0002	< 0.0010	< 0.0050	
2012-09-09	Grab	605	8.22	2.1	0.00032	0.0046	< 0.0002	0.0018	< 0.0050	
2012-09-19	Grab	328	8.18	< 1.0	0.00024	0.0037	< 0.0002	0.0012	< 0.0050	
2012-09-24	Grab	302	8.33	< 1.0	0.00025	0.0022	< 0.0002	< 0.0010	< 0.0050	
2012-10-03	Grab	337	8.33	< 1.0	0.00023	0.0022	< 0.0002	0.0011	< 0.0050	
2012-10-12	Grab	346	8.03	< 1.0	0.00028	0.0027	< 0.0002	0.0014	< 0.0050	
2012-10-16	Grab	337	8.23	< 1.0	0.00025	0.0023	< 0.0002	0.0012	< 0.0050	< 0.01
2012-10-19	Grab	337	8.09	< 1.0	0.00022	0.0020	< 0.0002	0.0010	< 0.0050	
2012-10-25	Grab	328	8.04	3.4	0.00032	0.0031	< 0.0002	0.0014	< 0.0050	
2012-11-02	Grab	294	7.98	< 1.0	0.00043	0.0020	< 0.0002	0.0013	< 0.0050	
2012-11-09	Grab	337	8.10	< 1.0	0.00024	0.0017	< 0.0000	0.0008	0.0004	
2012-11-18	Grab	259	8.15	< 1.0	0.00028	0.0016	< 0.0002	< 0.0010	< 0.0050	
2012-11-24	Grab	285	8.16	< 1.0	0.00021	0.0023	< 0.0002	0.0012	< 0.0050	
2012-12-04	Grab	173	8.30	< 1.0	0.00025	0.0027	0.0002	0.0012	0.0055	
2012-12-11	Grab	259	8.26	< 1.0	0.00024	0.0021	< 0.0002	0.0011	< 0.0050	
2012-12-18	Grab	251	8.04	< 1.0	0.00028	0.0024	< 0.0002	< 0.0010	< 0.0050	< 0.01
2012-12-27	Grab	251	8.18	< 1.0	0.00023	0.0023	< 0.0002	< 0.0010	< 0.0050	
2012 Summary Statistics	**Count**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**50**	**5**
	Count < MDL	**0**	**0**	**35**	**0**	**0**	**44**	**23**	**46**	**5**
	Count > MDL	**50**	**50**	**15**	**50**	**50**	**6**	**27**	**4**	**0**
	Mean [1]	**555**	**8.22**	**2.8**	**0.00031**	**0.0036**	**<0.00020**	**<0.0010**	**<0.0050**	**<0.01**
	Median [1]	**304**	**8.23**	**1.0**	**0.00026**	**0.0024**	**<0.00020**	**<0.0010**	**<0.0050**	**<0.01**
	Maximum	**6,739**	**8.47**	**17**	**0.00200**	**0.0255**	**0.0007**	**0.0018**	**0.0055**	**<0.01**

Appendix Table B.1: Minto Mine weekly MMER effluent quality data, 2012-2014

Date		Effluent Volume	pH	Total Suspended Solids	Arsenic	Copper	Lead	Nickel	Zinc	Radium-226
		m^3	pH units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	Bq/L
2013-01-04	Grab	267	7.92	< 1.0	0.00019	0.0019	< 0.0002	< 0.0010	< 0.0050	
2013-01-09	Grab	302	7.96	< 4.0	0.00012	0.0020	< 0.0002	< 0.0010	< 0.0050	
2013-01-17	Grab	259	7.94	< 1.0	0.00019	0.0022	< 0.0002	< 0.0010	0.0076	
2013-01-22	Grab	259	8.33	< 1.0	0.00026	0.0016	< 0.0002	< 0.0010	< 0.005	
2013-01-28	Grab	242	8.06	< 1.0	0.00020	0.0019	< 0.0004	< 0.0020	< 0.0100	
2013-02-07	Grab	251	8.02	< 1.0	0.00027	0.0023	< 0.0002	< 0.0010	< 0.0050	
2013-02-12	Grab	251	7.92	< 1.0	0.00023	0.0016	< 0.0002	< 0.0010	< 0.0050	
2013-02-19	Grab	251	8.06	< 1.0	0.00022	0.0015	< 0.0002	< 0.0010	< 0.0050	
2013-02-26	Grab	251	8.07	< 1.0	0.00024	0.0019	< 0.0002	< 0.0010	< 0.0050	
2013-03-04	Grab	190	8.28	< 1.0	0.00019	0.0015	0.0002	< 0.0010	< 0.0050	
2013-03-11	Grab	251	8.31	< 1.0	0.00023	0.0018	< 0.0002	< 0.0010	< 0.0050	
2013-03-18	Grab	242	8.20	< 1.0	0.00021	0.0017	< 0.0002	< 0.0010	< 0.0050	
2013-03-31	Grab	225	8.16	2.3	0.00029	0.0034	< 0.0002	0.0011	< 0.0050	
2013-04-06	Grab	216	8.19	< 1.0	0.00029	0.0017	< 0.0002	< 0.0010	< 0.0050	
2013-04-12	Grab	216	8.32	< 1.0	0.00027	0.0031	< 0.0002	< 0.0010	< 0.0050	
2013-04-15	Grab	259	8.24	< 1.0	0.00023	0.0025	< 0.0002	< 0.0010	< 0.0050	
2013-04-30	Grab	4,622	8.28	5.3	0.00035	0.0197	< 0.0002	< 0.0010	< 0.0050	0.02
2013-05-02	Grab	9,677	8.27	< 4.0	0.00033	0.0205	< 0.0002	< 0.0010	< 0.0050	
2013-05-09	Grab	10,282	8.09	8.3	0.00038	0.0265	< 0.0002	0.0012	< 0.0050	
2013-05-14	Grab	7,474	7.74	21	0.00112	0.0822	0.0009	0.0032	0.0104	
2013-05-21	Grab	10,800	7.71	30	0.00077	0.0533	0.0008	0.0022	0.0068	
2013-05-28	Grab	11,232	7.97	8.6	0.00050	0.0350	0.0002	0.0015	< 0.0050	
2013-06-06	Grab	333	8.38	37	0.00034	0.0087	< 0.0002	0.0015	< 0.0050	
2013-06-14	Grab	333	8.23	15	0.00032	0.0062	< 0.0002	0.0017	0.0052	
2013-06-17	Grab	333	8.30	< 1.0	0.00039	0.0049	< 0.0002	0.0015	< 0.0050	
2013-06-19	Grab	333	8.29	1.1	0.00032	0.0043	0.0003	< 0.0010	< 0.0050	
2013-06-24	Grab	333	8.34	4.8	0.00026	0.0028	< 0.0002	< 0.0010	< 0.0050	
2013-07-01	Grab	242	8.37	< 1.0	0.00032	0.0028	< 0.0002	0.0011	< 0.0050	
2013-07-10	Grab	242	8.21	< 1.0	0.00031	0.0032	< 0.0002	0.0014	< 0.0050	
2013-07-11	Grab	242	8.20	< 1.0	0.00027	0.0030	< 0.0002	0.0010	< 0.0050	
2013-07-19	Grab	242	8.35	< 1.0	0.00037	0.0030	< 0.0002	0.0013	< 0.0050	
2013-07-23	Grab	242	8.28	< 1.0	0.00047	0.0061	< 0.0002	0.0019	< 0.0050	
2013-07-30	Grab	242	8.35	< 1.0	0.00032	0.0031	< 0.0002	0.0012	< 0.0050	
2013-08-08	Grab	242	8.27	< 1.0	0.00032	0.0028	< 0.0002	0.0011	< 0.0050	
2013-08-14	Grab	238	8.31	< 1.0	0.00030	0.0026	< 0.0002	0.0014	< 0.0050	
2013-08-19	Grab	259	8.23	< 1.0	0.00032	0.0024	< 0.0002	0.0011	< 0.0050	
2013-08-21	Grab	259	8.35	< 1.0	0.00031	0.0023	< 0.0002	< 0.0010	< 0.0050	< 0.01
2013-08-26	Grab	249	8.28	< 1.0	0.00025	0.0022	< 0.0002	< 0.0010	< 0.0050	
2013-09-02	Grab	259	8.04	< 1.0	0.00029	0.0025	< 0.0002	0.0011	< 0.0050	
2013-09-12	Grab	302	8.14	< 1.0	0.00028	0.0026	< 0.0002	0.0011	< 0.0050	
2013-09-17	Grab	302	8.13	< 1.0	0.00034	0.0026	< 0.0002	0.0012	< 0.0050	
2013-09-28	Grab	337	8.16	< 1.0	0.00033	0.0036	< 0.0002	0.0016	< 0.0050	
2013-10-03	Grab	276	8.18	< 1.0	0.00028	0.0027	< 0.0002	0.0012	< 0.0050	
2013-10-08	Grab	302	8.25	< 1.0	0.00027	0.0026	< 0.0002	0.0013	< 0.0050	
2013-10-16	Grab	294	8.44	< 1.0	0.00018	0.0027	< 0.0002	0.0012	< 0.0050	
2013-10-21	Grab	287	8.25	< 1.0	0.00025	0.0023	< 0.0002	0.0010	< 0.0050	< 0.01
2013-10-28	Grab	276	8.27	1.0	0.00034	0.0023	< 0.0002	0.0011	< 0.0050	
2013-11-05	Grab	363	8.23	< 1.0	0.00025	0.0022	< 0.0002	0.0010	< 0.0050	
2013-11-14	Grab	354	8.33	< 1.0	0.00023	0.0021	< 0.0002	< 0.0010	< 0.0050	
2013-11-18	Grab	691	8.28	< 1.0	0.00023	0.0019	< 0.0002	< 0.0010	< 0.0050	
2013-11-30	Grab	778	8.04	< 1.0	0.00025	0.0022	< 0.0002	< 0.0010	< 0.0050	
2013-12-05	Grab	259	7.98	< 1.0	0.00025	0.0018	< 0.0002	< 0.0010	< 0.0050	
2013-12-09	Grab	259	8.24	< 1.0	0.00023	0.0022	< 0.0002	< 0.0010	< 0.0050	
2013-12-16	Grab	259	8.21	< 1.0	0.00023	0.0016	< 0.0002	< 0.0010	< 0.0050	
2013-12-23	Grab	346	8.21	< 1.0	0.00028	0.0023	< 0.0002	0.0011	< 0.0050	
2013 Summary Statistics	**Count**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**55**	**3**
	Count < MDL	**0**	**0**	**44**	**0**	**0**	**50**	**27**	**51**	**2**
	Count > MDL	**55**	**55**	**11**	**55**	**55**	**5**	**28**	**4**	**1**
	Mean [1]	**1,242**	**8.18**	**3**	**0.00031**	**0.0067**	**0.00023**	**<0.0010**	**<0.0050**	**<0.01**
	Median [1]	**259**	**8.23**	**<1**	**0.00028**	**0.0025**	**<0.00020**	**<0.0010**	**<0.0050**	**<0.01**
	Maximum	**11,232**	**8.44**	**36.6**	**0.00112**	**0.0822**	**0.00087**	**0.0032**	**0.0104**	**0.02**

Appendix Table B.1: Minto Mine weekly MMER effluent quality data, 2012-2014

Date		Effluent Volume	pH		Total Suspended Solids	Arsenic	Copper		Lead		Nickel		Zinc		Radium-226
		m^3	pH units		mg/L	mg/L	mg/L		mg/L		mg/L		mg/L		Bq/L
2014-01-02	Grab	276	8.12	<	1.0	0.00034	0.0018	<	0.0002	<	0.0010	<	0.0050		
2014-01-07	Grab	302	8.24	<	1.0	0.00033	0.0023	<	0.0002	<	0.0010	<	0.0050		
2014-01-16	Grab	259	7.97	<	1.0	0.00023	0.0020	<	0.0002	<	0.0010	<	0.0050		
2014-01-22	Grab	242	8.28		3.9	0.00020	0.0019	<	0.0002	<	0.0010	<	0.0050		
2014-01-27	Grab	346	8.09	<	1.0	0.00042	0.0065	<	0.0002	<	0.0010	<	0.0050		
2014-02-03	Grab	283	8.20	<	1.0	0.00022	0.0016	<	0.0002	<	0.0010	<	0.0050		
2014-02-13	Grab	283	8.16	<	1.0	0.00024	0.0020	<	0.0002	<	0.0010	<	0.0050		
2014-02-18	Grab	283	8.09	<	1.0	0.00027	0.0019	<	0.0002	<	0.0010	<	0.0050		
2014-02-20	Grab	283	8.25	<	1.0	0.00026	0.0016	<	0.0002	<	0.0010	<	0.0050		
2014-02-25	Grab	565	8.18	<	1.0	0.00032	0.0049	<	0.0002	<	0.0010	<	0.0050		
2014-03-08	Grab	563	8.24		1.8	0.00038	0.0046	<	0.0002		0.0012	<	0.0050		
2014-03-10	Grab	558	8.20	<	1.4	0.00035	0.0052	<	0.0002		0.0011	<	0.0050		0.013
2014-03-17	Grab	555	8.31		11	0.00046	0.0058	<	0.0002		0.0015	<	0.0050		
2014-03-27	Grab	549	8.30		4.3	0.00026	0.0045	<	0.0002		0.0013	<	0.0050		
2014-04-02	Grab	5,289	8.29		5.8	0.00040	0.0051	<	0.0002		0.0012	<	0.0050		
2014-04-07	Grab	5,289	7.94		14	0.00045	0.0176	<	0.0002		0.0016		0.0058		
2014-04-17	Grab	5,289	8.21		13	0.00045	0.0445		0.0445		0.0013		0.0059		
2014-04-21	Grab	5,289	8.21		13	0.00045	0.0481		0.0002		0.0014		0.0055		
2014-04-28	Grab	5,289	8.15		13	0.00062	0.0476		0.0003		0.0018		0.0063		
2014-05-05	Grab	8,286	8.13		6.5	0.00040	0.0184	<	0.0002		0.0016	<	0.0050	<	0.01
2014-05-11	Grab	8,286	8.05		5.9	0.00046	0.0408	<	0.0002		0.0016		0.0108		
2014-05-14	Grab	8,286	7.96		16	0.00067	0.0401		0.0003		0.0019		0.0069		
2014-05-17	Grab	8,286	7.98		9.3	0.00045	0.0335	<	0.0002		0.0016	<	0.0050		
2014-05-22	Grab	8,826	7.82		14	0.00086	0.0699		0.0005		0.0024		0.0117		
2014-05-26	Grab	8,826	7.96		15	0.00080	0.0539		0.0004		0.0018		0.0074		
2014-06-04	Grab	259	8.41	<	1.0	0.00032	0.0046	<	0.0002		0.0013	<	0.0050		
2014-06-11	Grab	259	8.28	<	1.0	0.00026	0.0032	<	0.0002		0.0012	<	0.0050		
2014-06-17	Grab	259	8.30	<	1.0	0.00024	0.0029	<	0.0002	<	0.0010	<	0.0050		
2014-06-24	Grab	259	8.37	<	1.0	0.00026	0.0026	<	0.0002	<	0.0010	<	0.0050		
2014-06-30	Grab	259	8.29	<	1.0	0.00024	0.0026	<	0.0002	<	0.0010	<	0.0050		
2014-07-09	Grab	246	8.54	<	1.0	0.00028	0.0027	<	0.0002	<	0.0010	<	0.0050		
2014-07-15	Grab	246	8.19	<	1.0	0.00024	0.0024	<	0.0002	<	0.0010	<	0.0050		
2014-07-21	Grab	246	8.40	<	1.0	0.00028	0.0048	<	0.0002	<	0.0010	<	0.0050		
2014-07-31	Grab	246	8.25	<	1.0	0.00026	0.0027	<	0.0002	<	0.0010	<	0.0050		
2014-08-04	Grab	259	8.20	<	1.0	0.00026	0.0025	<	0.0002	<	0.0010	<	0.0050	<	0.01
2014-08-14	Grab	259	8.31		1.1	0.00023	0.0077	<	0.0002	<	0.0010	<	0.0050		
2014-08-18	Grab	259	8.31	<	1.0	0.00023	0.0025	<	0.0002	<	0.0010	<	0.0050		
2014-08-26	Grab	259	8.22	<	1.0	0.00027	0.0026	<	0.0002	<	0.0010	<	0.0050		
2014-09-04	Grab	276	8.22		283	0.00023	0.0023	<	0.0002		0.0012	<	0.0050		
2014-09-12	Grab	276	8.28		1.5	0.00051	0.0029	<	0.0002	<	0.0010	<	0.0050		
2014-09-15	Grab	276	8.26		1.0	0.00020	0.0024	<	0.0002	<	0.0010	<	0.0050		
2014-09-22	Grab	276	8.36		4.1	0.00027	0.0027	<	0.0002	<	0.0010	<	0.0050		
2014 Summary Statistics (to Sep 22 only)	**Count**	**42**	**42**		**42**	**42**	**42**		**42**		**42**		**42**		**3**
	Count < MDL	**0**	**0**		**22**	**0**	**0**		**36**		**24**		**34**		**2**
	Count > MDL	**42**	**42**		**20**	**42**	**42**		**6**		**18**		**8**		**1**
	Mean [1]	**2,072**	**8.20**		**11**	**0.00035**	**0.0124**		**0.0013**		**<0.0010**		**<0.0050**		**<0.01**
	Median [1]	**283**	**8.22**		**1.0**	**0.00028**	**0.0031**		**<0.00020**		**<0.0010**		**<0.0050**		**<0.01**
	Maximum	**8,826**	**8.54**		**283**	**0.00086**	**0.0699**		**0.0445**		**0.0024**		**0.0117**		**0.013**

🟧 highlight indicates a result greater than the applicable MMER limit

[1] mean and median values calculated following substitution of < method detection limit values with the method detection limit (1xMDL)

Appendix Table B.2: Acute toxicity test results for Minto Mine effluent (Station W3), 2012-2014

Year	**Sample Date**	**Discharge** [a]	**Rainbow Trout**		***Daphnia magna***
			Survival at 100% effluent	**Pass/Fail**	**Survival at 100% effluent**
2012	22-Jan	ND	100	pass	100
	14-Feb	ND	100	pass	100
	5-Mar	ND	100	pass	100
	24-Apr	D	100	pass	100
	19-Jun	ND	100	pass	100
	23-Aug	ND	100	pass	37
	5-Sep	ND	100	pass	100
	19-Sep	ND	100	pass	87
	18-Dec	ND	100	pass	100
2013	30-Apr	D	100	pass	100
	21-May	D	100	pass	100
	21-Aug	ND	100	pass	100
	21-Oct	ND	100	pass	100
2014 year-to-date	10-Mar	D	100	pass	100
	30-Jun	ND	100	pass	100
	4-Aug	ND	100	pass	100

[a] D = discharge; ND = non-discharge

🟨 indicates a test failure

Appendix Table B.3: Minto Mine MMER effluent characterization data, 2012-2014

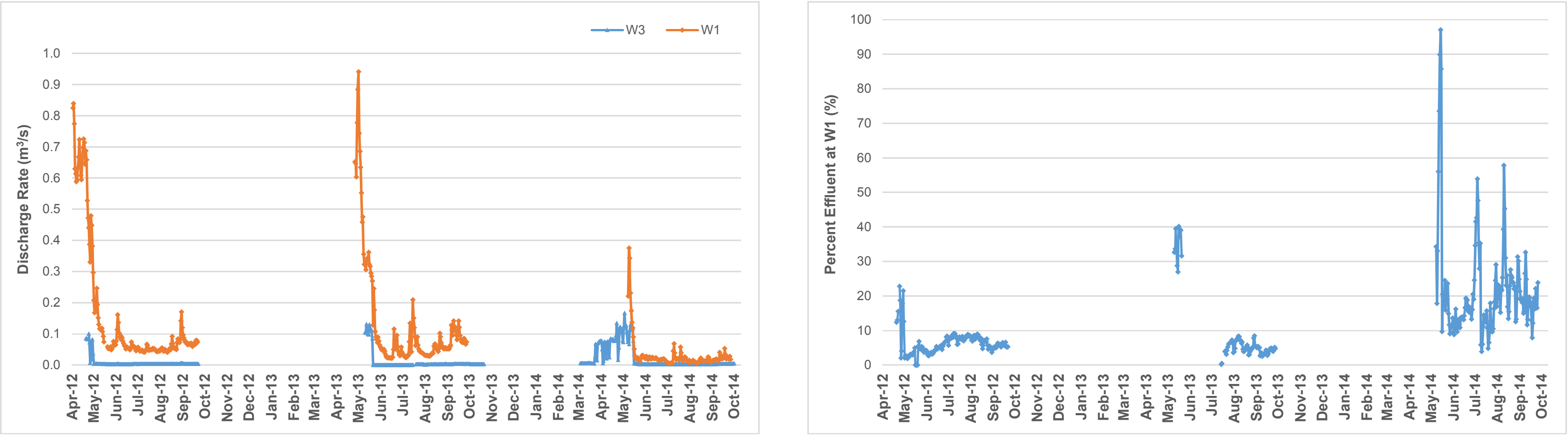
Date		Temperature	Electrical Conductivity	Hardness	Alkalinity	Ammonia	Nitrate	Aluminum	Cadmium	Iron	Mercury	Molybdenum	Selenium
		°C	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
2012-04-24	Grab	1.7	484	206	182	0.025	4.23	0.15	0.000065	0.218	< 0.00001	0.0052	0.0015
2012-06-19	Grab	3.2	488	241	213	0.094	0.623	0.016	0.000017	0.0437	< 0.00001	0.0042	0.00034
2012-08-23	Grab	2.8	513	241	224	0.012	0.510	0.0049	< 0.000010	0.0203	< 0.00001	0.0048	0.00040
2012-10-16	Grab	0.7	490	288	214	0.012	0.530	0.0068	< 0.000010	0.0268	< 0.00001	0.0046	0.00039
2012 Summary Statistics	**Count**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Count < MDL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**4**	**0**	**0**
	Count > MDL	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**2**	**4**	**0**	**4**	**4**
	Mean [1]	**2.1**	**494**	**244**	**208**	**0.036**	**1.47**	**0.045**	**0.000026**	**0.0772**	**<0.00001**	**0.0047**	**0.00065**
	Median [1]	**2.3**	**489**	**241**	**214**	**0.019**	**0.577**	**0.012**	**0.000014**	**0.0353**	**<0.00001**	**0.0047**	**0.00040**
	Maximum	**3.2**	**513**	**288**	**224**	**0.094**	**4.23**	**0.15**	**0.000065**	**0.218**	**<0.00001**	**0.0052**	**0.0015**
2013-04-30	Grab	1.2	450	213	182	0.020	2.61	0.17	< 0.000010	0.284	< 0.00001	0.0041	0.00069
2013-05-21	Grab	2.1	128	62.3	45.9	0.034	0.808	1.2	0.000031	1.92	< 0.00001	0.0015	0.00015
2013-08-21	Grab	3.9	497	251	218	0.014	0.290	0.029	< 0.000010	0.0268	< 0.00001	0.0055	0.00046
2013-10-21	Grab	0	496	236	210	0.022	0.313	0.015	< 0.000010	0.0353	< 0.00001	0.0052	0.00039
2013 Summary Statistics	**Count**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Count < MDL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**0**	**0**
	Count > MDL	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**1**	**4**	**0**	**4**	**4**
	Mean [1]	**1.8**	**393**	**191**	**164**	**0.023**	**1.01**	**0.36**	**0.000015**	**0.567**	**<0.00001**	**0.0041**	**0.00042**
	Median [1]	**1.7**	**473**	**225**	**196**	**0.021**	**0.561**	**0.10**	**<0.00001**	**0.160**	**<0.00001**	**0.0047**	**0.00043**
	Maximum	**3.9**	**497**	**251**	**218**	**0.034**	**2.610**	**1.2**	**0.000031**	**1.92**	**<0.00001**	**0.0055**	**0.00069**
2014-04-21	Grab	2	439	190	176	0.110	0.977	0.51	0.000015	0.790	< 0.00001	0.0043	0.00076
2014-06-30	Grab	3.1	512	243	218	0.021	0.202	0.0043	< 0.000010	0.0140	< 0.00001	0.0052	0.00038
2014-08-14	Grab	1.6	526	247	229	0.018	0.196	0.011	< 0.000010	0.0300	< 0.00001	0.0052	0.00035
2014-10-27	Grab	-1.5	539	269	220	0.043	0.283	0.030	< 0.000010	0.0610	< 0.00001	0.0048	0.00043
2014 Summary Statistics	**Count**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
	Count < MDL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**4**	**0**	**0**
	Count > MDL	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**1**	**4**	**0**	**4**	**4**
	Mean [1]	**1.3**	**504**	**237**	**211**	**0.048**	**0.415**	**0.14**	**0.000011**	**0.224**	**<0.00001**	**0.0049**	**0.00048**
	Median [1]	**1.8**	**519**	**245**	**219**	**0.032**	**0.243**	**0.021**	**<0.00001**	**0.0455**	**<0.00001**	**0.0050**	**0.00041**
	Maximum	**3.1**	**539**	**269**	**229**	**0.11**	**0.977**	**0.51**	**0.000015**	**0.790**	**<0.00001**	**0.0052**	**0.00076**

[1] mean and median values calculated following substitution of < method detection limit values with the method detection limit (1xMDL)

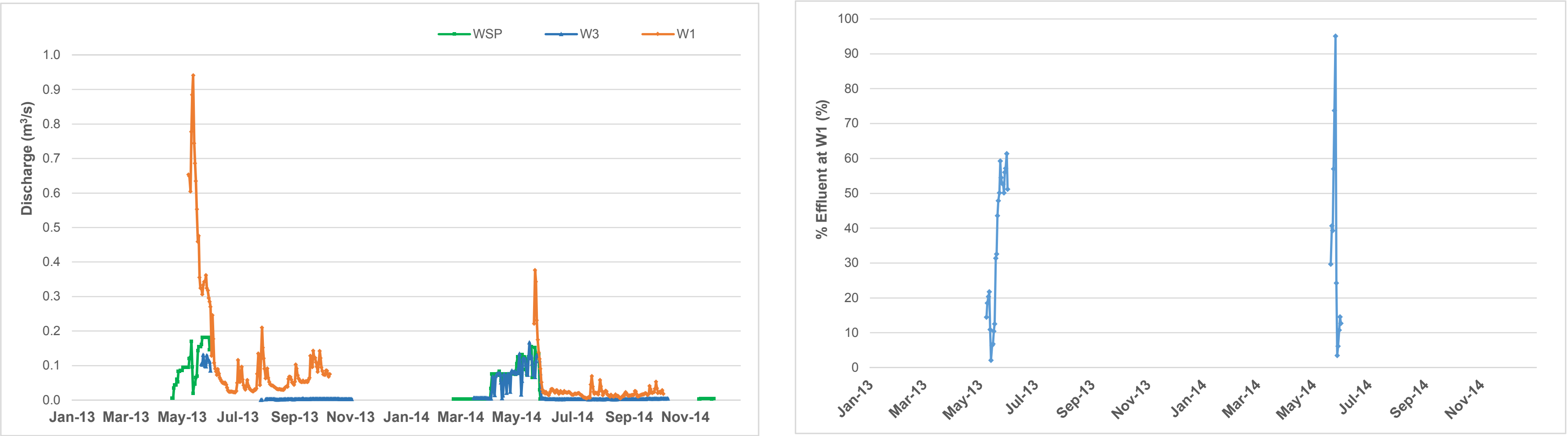
Appendix Table B.4: Summary of Minto Mine Effluent Concentrations in lower Minto Creek (Station W1), 2013 and 2014

Year	Condition	% WSP/WTP at W1		% W3 at W1	
		Mean	Range	Mean	Range
2013	no WSP/WTP Discharge	0	-	5%	0.16 - 32%
	WSP/WTP discharge	34%	2 - 61%	35%	30 - 40%
2014	no WSP/WTP Discharge	0	-	19%	4 - 58%
	WSP/WTP discharge	34%	4 - 95%	46%	10 - 97%

Appendix Figure B.1: Effluent discharge rates, water discharge rates and associated effluent concentrations in lower Minto Creek



A) Effluent discharge rate at Station W3 (final effluent), water discharge rate at lower Minto Creek and associated percent effluent in lower Minto Creek, 2012-2014



B) Effluent discharge rate from the water storage pond (WSP), water discharge rate at lower Minto Creek and associated percent WSP effluent in lower Minto Creek, 2013 and 2014

Appendix C

DATA QUALITY ASSESSMENT

APPENDIX C: DATA QUALITY ASSESSMENT

LIST OF TABLES

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C1.0 INTRODUCTION

Data Quality Assessment (DQA) was conducted on data collected as part of the Minto Mine Phase 3 Environmental Effects Monitoring (EEM) study. This EEM study was an Investigation of Cause (IOC) of differences in benthic invertebrate community structure (as defined by the Bray-Curtis Index of Dissimilarity) of upper Minto Creek versus reference creeks. The objective of DQA is to define the overall quality of the data presented in the Interpretive Report, and, by extension, the confidence with which the data can be used to derive conclusions.

C1.1 Background

A variety of factors can influence the chemical and biological measurements made in an environmental study and thus affect the accuracy and/or precision of the data. Inconsistencies in sampling or laboratory methods, use of instruments that are inadequately calibrated or which cannot measure to the desired level of accuracy or precision, and contamination of samples in the field or laboratory are just some of the factors that can lead to the reporting of data that do not accurately reflect actual environmental conditions. Depending on the magnitude of the problem, inaccuracy or imprecision have the potential to affect the reliability of any conclusions made from the data. Therefore, it is important to ensure that monitoring programs incorporate appropriate steps to control the non-natural sources of data variability (i.e., minimize the variability that does not reflect natural spatial and temporal variability in the environment) and thus assure the quality of the data.

Data quality as a concept is meaningful only when it relates to the intended use of the data. That is, one must know the context in which the data will be interpreted in order to establish a relevant basis for judging whether or not the data set is adequate. DQA involves comparison of actual field and laboratory measurement performance to data quality objectives (DQOs) established for a particular study, such as evaluation of method detection limits, blank sample data, data precision (based on field and laboratory duplicate samples), and data accuracy (based on matrix spike recoveries and/or analysis of standards or certified reference materials).

DQOs were established either at the outset of the field program or by the laboratory (ALS Environmental) and reflect reasonable and achievable performance expectations (Table C.1). Programs involving a large amount of samples and analytes usually result in some results that exceed the DQOs. This is particularly so for multi-element scans (e.g., ICP scans for metals) since the analytical conditions are not necessarily optimal

Table C.1: Data quality objectives for environmental samples.

Quality Control Measure	Quality Control Sample Type	Study Component		
		Water Quality	Chlorophyll a	Benthic Invertebrate Community
Method Detection Limits (MDL)	Comparison actual MDL versus target MDL	MDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline value [a]	MDL for each variable should be at least as low as applicable guidelines, ideally ≤1/10th guideline value [a]	-
Blank Analysis	Field or Laboratory Blank	≤two-times the laboratory MDL	n/a	-
Laboratory Precision	Field Duplicates	as specified by analytical laboratory	as specified by analytical laboratory	>95% organism recovery <20% subsampling error
Field Precision	Field Duplicates	≤25% RPD [b]	≤50% RPD [b]	-

[a] or below predictions, if applicable and no guideline exists for the substance.

[b] RPD - Relative Percent Difference

n/a - not applicable

for every element included in the scan. Generally, scan results may be considered acceptable if no more than 20% of the parameters fail to meet the DQOs. Overall, the intent of comparing data to DQOs was not to reject any measurement that did not meet the DQO, but to ensure that any questionable data received more scrutiny to determine what effect, if any, this had on interpretation of results within the context of this project.

C1.2 Types of Quality Control Samples

Several types of quality control (QC) samples were assessed based on samples collected (or prepared) in the field and laboratory. These samples, and a description of each, include the following:

- **Blanks** are samples of de-ionized water and/or appropriate reagent(s) that are handled and analyzed the same way as regular samples. These samples will reflect any contamination of samples occurring in the field (in the case of field or travel blanks) or the laboratory (in the case of laboratory or method blanks). Analyte concentrations should be non-detectable although a data quality objective of twice the method detection limit allows for slight “noise” around the detection limit.

- **Field Duplicates** are replicate samples collected from a randomly selected field station using identical collection and handling methods that are then analyzed separately in the laboratory. The duplicate samples are handled and analyzed in an identical manner in the laboratory. The data from field replicate samples reflect natural variability, as well as the variability associated with sample collection methods, and therefore provide a measure of field precision.

- **Laboratory Duplicates** are replicate sub-samples created in the laboratory from randomly selected field samples which are sub-sampled and then analyzed independently using identical analytical methods. The laboratory duplicate sample results reflect any variability introduced during laboratory sample handling and analysis and thus provide a measure of laboratory precision.

- **Spike Recovery Samples** are created in the laboratory by adding a known amount/concentration of a given analyte (or mixture of analytes) to a randomly selected test sample previously divided to create two sub-samples. The spiked and regular sub-samples are then analyzed in an identical manner. The spike recovery represents the difference between the measured spike amount (total amount in spiked sample minus amount in original sample) relative to the known spike amount (as a percentage). Two types of spike recovery samples are commonly analyzed. Spiked blanks (or blank spikes) are created using laboratory control materials whereas matrix spikes are created using field-collected samples. The analysis of spiked samples provides an indication of the accuracy of analytical results.

- **Certified Reference Materials** are samples containing known chemical concentrations that are processed and analyzed along with batches of environmental samples. The sample results are then compared to target results to provide a measure of analytical accuracy. The results are reported as the percent of the known amount that was recovered in the analysis.

The following QC was applied to benthic invertebrate community samples as follows:

- **Organism Recovery Checks** for benthic invertebrate community samples involve the re-processing of previously sorted material from a randomly selected sample to determine the number of invertebrates that were not recovered during the original sample processing. The reprocessing is conducted by an analyst not involved during the original processing to reduce any bias. This check allows the determination of accuracy through assessment of recovery efficiency.

C2.0 WATER SAMPLES

C2.1 Method Detection Limits

Most reported MDLs were at or below the target concentrations with the exception of those for five analytes: total suspended solids (TSS), total Kjeldahl nitrogen (TKN), cadmium, copper and mercury (Table C.2). Even though these MDLs were higher than targeted concentrations, they were all lower than guideline levels. In addition, TKN was detectable in all samples and copper was detectable in the majority of samples. Therefore, data for this project can be reliably interpreted relative to guidelines.

C2.2 Laboratory Blank Sample Analysis

All blank samples contained non-detectable analyte concentrations, except for one sample of which contained a low, but detectable, concentration of manganese (see analytical reports in Appendix D). This indicates that there was little inadvertent contamination of samples within the laboratory during analysis.

C2.3 Data Precision

The field duplicate samples all met the DQO of ≤25%, with the exception of total suspended solids, ammonia, arsenic, cadmium and chromium each in one of two field duplicate sets (Table C.3). Close agreement was achieved for most analytes in the laboratory duplicate samples (see analytical reports in Appendix D). The relative percent difference for mercury was not available as the results were below method detection limits (see analytical reports in Appendix D). Overall, these results indicate good analytical precision.

C2.4 Data Accuracy

C2.4.1 Blank Spike Recovery Samples

Analyte recoveries for spiked blanks all met the data quality objectives indicating excellent analytical accuracy for the water sample analyses (see analytical reports in Appendix D).

C2.4.1 Matrix Spike Recovery Samples

Recoveries of some analytes could not be calculated by the analytical laboratory due to high analyte background in the samples (see analytical reports in Appendix D). Results for the following analytes could not be calculated: nitrate, dissolved

Table C.2: Laboratory method detection limits (MDLs) relative to targets and water quality guidelines, Minto Mine, IOC, 2014.

Analyte		Units	Method Detection Limit		CCME Water Quality [a]	
			Target	Achieved	30 Day	Max
Physical Tests	Hardness (as CaCO3)	mg/L	-	0.5	-	-
	pH	pH units	-	0.1	-	-
	Total Suspended Solids	mg/L	0.885	3.0	8.85 [b]	-
Non Metals	Alkalinity, Total	mg/L	-	1.0 - 2.0	-	-
	Ammonia, Total (as N)	mg/L	0.03	0.005	0.63 [c]	
	Nitrate (as N)	mg/L	0.29	0.005	13	550
	Total Kjeldahl Nitrogen	mg/L	0.006	0.05	0.197	-
	Orthophosphate-Dissolved (as P)	mg/L	-	0.001	-	-
	Phosphorus (P)-Total	mg/L	-	0.002	-	-
	Phosphorus (P)-Total dissolved	mg/L	-	0.002	-	-
	Total Organic Carbon	mg/L	-	0.5 - 1.0	-	-
Total Metals	Total Aluminum (Al)	mg/L	0.01	0.003	0.1 [d]	-
	Total Antimony (Sb)	mg/L	-	0.0001	-	-
	Total Arsenic (As)	mg/L	0.0005	0.0001	0.005	-
	Total Barium (Ba)	mg/L	-	0.00005	-	-
	Total Beryllium (Be)	mg/L	-	0.0001	-	-
	Total Bismuth (Bi)	mg/L	-	0.0005	-	-
	Total Boron (B)	mg/L	0.15	0.01	1.5	2.9
	Total Cadmium (Cd)	mg/L	0.000007	0.00001	0.00007 [e]	0.00083 [e]
	Total Calcium (Ca)	mg/L	-	0.05	-	-
	Total Chromium (Cr)	mg/L	0.0001	0.0001	0.001 Cr(VI)	-
	Total Cobalt (Co)	mg/L	-	0.0001	-	-
	Total Copper (Cu)	mg/L	0.0002	0.0005	0.002 [e]	-
	Total Iron (Fe)	mg/L	0.03	0.01	0.3	-
	Total Lead (Pb)	mg/L	0.0001	0.00005	0.001 [e]	-
	Total Lithium (Li)	mg/L	-	0.0005	-	-
	Total Magnesium (Mg)	mg/L	-	0.1	-	-
	Total Manganese (Mn)	mg/L	-	0.00005 - 0.00035	-	-
	Total Mercury (Hg)	mg/L	0.000003	0.00001	0.00003	-
	Total Molybdenum (Mo)	mg/L	0.007	0.00005	0.073	-
	Total Nickel (Ni)	mg/L	0.0025	0.0005	0.025 [e]	-
	Total Phosphorus (P)	mg/L	-	0.05	-	-
	Total Potassium (K)	mg/L		0.1	-	-
	Total Selenium (Se)	mg/L	0.0001	0.0001	0.001	-
	Total Silicon (Si)	mg/L	-	0.05	-	-
	Total Silver (Ag)	mg/L	0.00001	0.00001	0.0001	
	Total Sodium (Na)	mg/L	-	0.05	-	-
	Total Strontium (Sr)	mg/L	-	0.0002	-	-
	Total Sulfur (S)	mg/L		0.5		
	Total Thallium (Tl)	mg/L	0.00008	0.00001	0.0008	-
	Total Tin (Sn)	mg/L	-	0.0001	-	-
	Total Titanium (Ti)	mg/L	-	0.01	-	-
	Total Uranium (U)	mg/L	0.0015	0.00001	0.015	0.033
	Total Vanadium (V)	mg/L	-	0.001	-	-
	Total Zinc (Zn)	mg/L	0.003	0.003	0.03	-

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

[b] Based on the median of background levels plus 5 mg/L

[c] Based on lowest guideline using highest temperature and pH

[d] Based on lowest guideline using highest pH

[e] Based on lowest guideline using lowest hardness

▨ value greater than DQO

Table C.3: Field duplicate results for analysis of water samples. Highlighted values did not meet the data quality objective of ≤25% relative percent difference (RPD).

Analyte		Units	Duplicate 1			Duplicate 4		
			NRC-4	NRC-4Z	RPD (%)	NRC-8	NRC-8Z	RPD (%)
Physical Tests	Hardness (as CaCO3)	mg/L	131	129	1.54%	173	174	0.576%
	pH	pH units	8.1	8.1	0.25%	8.3	8.3	0.24%
	Total Suspended Solids	mg/L	4.00	9.30	79.7%	3	3	0%
Non Metals	Alkalinity, Total	mg/L	84	81	3.5%	144	146	1.38%
	Ammonia, Total (as N)	mg/L	0.008	0.011	28%	<0.005	<0.005	0%
	Nitrate (as N)	mg/L	0.069	0.070	0.86%	0.2	0.2	0%
	Total Kjeldahl Nitrogen	mg/L	0.184	0.175	5.01%	0.15	0.14	7.0%
	Orthophosphate-Dissolved (as P)	mg/L	0.003	0.003	4%	<0.001	<0.001	0%
	Phosphorus (P)-Total	mg/L	0.012	0.012	1.7%	<0.002	<0.002	0%
	Total Organic Carbon	mg/L	4.2	3.9	7.9%	3.9	3.8	2.6%
Total Metals	Total Aluminum (Al)	mg/L	0.074	0.077	5.0%	0.023	0.025	9.2%
	Total Antimony (Sb)	mg/L	<0.0001	<0.0001	0%	0.00019	0.00017	11%
	Total Arsenic (As)	mg/L	0.00038	0.00027	34%	0.00079	0.00078	1.3%
	Total Barium (Ba)	mg/L	0.053	0.052	2.1%	0.066	0.067	1.1%
	Total Beryllium (Be)	mg/L	<0.0001	<0.0001	0%	<0.0001	<0.0001	0%
	Total Bismuth (Bi)	mg/L	<0.0005	<0.0005	0%	<0.0005	<0.0005	0%
	Total Boron (B)	mg/L	<0.01	<0.01	0%	<0.01	<0.01	0%
	Total Cadmium (Cd)	mg/L	0.00001	0.00003	100%	<0.00001	<0.00001	0%
	Total Calcium (Ca)	mg/L	34	33	1.2%	42.0	42.4	0.948%
	Total Chromium (Cr)	mg/L	0.0003	0.0003	0%	0.00017	0.00010	52%
	Total Cobalt (Co)	mg/L	0.0001	<0.0001	10%	<0.0001	<0.0001	0%
	Total Copper (Cu)	mg/L	0.00081	0.00071	13%	0.00062	0.00063	1.6%
	Total Iron (Fe)	mg/L	0.17	0.18	2.3%	0.11	0.12	0.9%
	Total Lead (Pb)	mg/L	0.000080	0.000078	2.5%	<0.00005	<0.00005	0%
	Total Lithium (Li)	mg/L	0.006	0.005	1%	0.0017	0.0018	1.7%
	Total Magnesium (Mg)	mg/L	11.4	11.2	1.77%	16.5	16.6	0.604%
	Total Manganese (Mn)	mg/L	0.024	0.021	15%	0.0230	0.0231	0.434%
	Total Mercury (Hg)	mg/L	<0.00001	<0.00001	0%	<0.00001	<0.00001	0%
	Total Molybdenum (Mo)	mg/L	0.00079	0.00077	2.6%	0.00029	0.00031	5.6%
	Total Nickel (Ni)	mg/L	0.00057	0.00056	1.8%	<0.0005	<0.0005	0%
	Total Phosphorus (P)	mg/L	<0.05	<0.05	0%	<0.05	<0.05	0%
	Total Potassium (K)	mg/L	1.52	1.46	4.03%	0.66	0.65	1.5%
	Total Selenium (Se)	mg/L	0.00056	0.00058	3.5%	0.00024	0.00026	8.0%
	Total Silicon (Si)	mg/L	6.9	6.8	1.5%	2.88	2.90	0.692%
	Total Silver (Ag)	mg/L	<0.00001	<0.00001	0%	<0.00001	<0.00001	0%
	Total Sodium (Na)	mg/L	4.8	4.6	3.0%	1	1	0%
	Total Strontium (Sr)	mg/L	0.173	0.172	0.580%	0.193	0.191	1.04%
	Total Sulfur (S)	mg/L	16.1	16.0	0.623%	10.4	10.2	1.94%
	Total Thallium (Tl)	mg/L	<0.00001	<0.00001	0%	<0.00001	<0.00001	0%
	Total Tin (Sn)	mg/L	<0.0001	<0.0001	0%	<0.0001	<0.0001	0%
	Total Titanium (Ti)	mg/L	<0.01	<0.01	0%	<0.01	<0.01	0%
	Total Uranium (U)	mg/L	0.001	0.001	0%	0.00091	0.00093	2.1%
	Total Vanadium (V)	mg/L	<0.001	<0.001	0%	<0.001	<0.001	0%
	Total Zinc (Zn)	mg/L	<0.003	<0.003	0%	<0.003	<0.003	0%

orthophosphate, total phosphorus, total organic carbon (TOC), barium, calcium, manganese, silicon, sodium and strontium (see analytical reports in Appendix D). All recoveries that could be calculated met the DQO for matrix spike recovery, indicating good spike recovery.

C2.4.3 Certified Reference Materials

Analyte recoveries from certified reference materials all met the data quality objective indicating excellent analytical accuracy (see analytical reports in Appendix D).

C3.0 CHLOROPHYLL A IN PERIPHYTON

C3.1 Data Precision

Of two field duplicate samples for chlorophyll a in periphyton, one met the DQO of ≤50% RPD and one did not (Table C.4). The duplicate sample collected at station NRC-8 had an RPD of 91%, possibly due to high spatial variability in periphyton coverage. High variability in periphyton should be considered in data interpretation.

Table C.4: Field duplicate results for analysis of chlorophyll a samples in periphyton. Highlighted values did not meet the data quality objective of ≤50% relative percent difference (RPD).

Analyte	Units	Duplicate 1			Duplicate 4		
		NRC-8	NRC-8Z	RPD (%)	NRC-10	NRC-10Z	RPD (%)
Chlorophyll a	mg/m^2	12.6	4.7	91%	0.8	1.1	31%

C4.0 BENTHIC INVERTEBRATE COMMUNITY

In all but one sample, the benthic invertebrate community laboratory sorted, counted and identified the entire benthic invertebrate sample (Table C.5). Therefore, evaluation of sub-sampling error was not required. Percent organism recovery (sorting efficiency) was met for the two re-sorted samples, with a percent recovery of approximately 96% for each sample (Table C.6). This indicated that the data can be reliably interpreted.

Table C.5: Fraction of each benthic invertebrate community sample analyzed.

Area	Station									
	1	2	3	4	5	6	7	8	9	10
URC	100%	-	-	-	-	-	-	-	-	-
UWC	100%	-	-	-	-	-	-	-	-	-
NRC	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
UMC	100%	100%	50%	-	-	-	-	-	-	-

Table C.6: Percent recovery of benthic invertebrates, Minto Mine, 2013.

Site	Initial Sort	Re-sort	Percent sorting efficiency[a]
NRC-1	44	2	96%
NRC-6	53	2	96%

[a] percent sorting efficiency = (1-(# in QA/AC re-sort / (# sorted originally + # in QA/QC resort)))* 100

▨ value less than 90%

C5.0 DATA QUALITY STATEMENT

The overall quality of data for this project was suitable to serve the project objectives. The only poor result was for field precision associated with periphyton samples collected for chlorophyll a. Although it is likely that the high variability reflects true spatial variability, this should be considered in comparing results among sites.

Appendix D

WATER QUALITY DATA

Table D.1: Minto Mine routine EEM water quality monitoring data, 2012-2014

		Station W7 (Reference)														
		24-Apr-12	19-Jun-12	23-Aug-12	16-Oct-12	30-Apr-13	14-May-13	21-Aug-13	21-Oct-13	23-Apr-14	30-Jun-14	9-Aug-14	31-Oct-14	**MEAN**	**L95%CL**	**U95%CL**
Water Temperature	C	0	4.1	4.6	0.40	0	0	4.2	0	0	2.5	2.3	-1.6	1.4	0.06	2.7
Electrical Conductivity	µS/cm	75	178	285	261	387	61	286	288	64	278	291	304	230	161	299
Dissolved Oxygen	mg/L	15.55	12.45	10.94	17.10		13.46	12.06	11.57	13.79	12.14	12.92	13.39	13.22	12.08	14.35
pH	pH units	7.63	8.12	8.25	8.17	8.18	8.20	7.81	7.58	7.72	8.11	7.92	7.29	7.92	7.72	8.11
Hardness, mg/L	mg/L	37.0	105	151	143	198	36.4	144	126	36.6	135	143	164	118	84.0	152
Alkalinity, mg/L	mg/L	36.2	87.4	147	132	187	29.4	143	138	30.6	130	142	150	113	78.8	147
Ammonia, mg/L	mg/L	< 0.0050	0.18	0.049	0.028	0.0082	0.066	0.051	0.048	0.014	0.025	0.025	0.022	0.043	0.014	0.073
Nitrate, mg/L	mg/L	< 0.020	0.083	0.21	0.13	0.13	0.020	0.16	0.17	< 0.020	0.20	0.16	0.20	0.12	0.079	0.17
TSS, mg/L	mg/L	11.2	165	1.50	9.90	5.80	55.3	3.80	7.40	14.7	4.50	2.90	2.60	23.7	-6.03	53.5
Aluminum, mg/L	mg/L	0.766	5.38	0.0342	0.127	0.0111	1.34	0.137	0.0931	0.336	0.103	0.0320	0.0103	0.697	-0.273	1.67
Arsenic, mg/L	mg/L	0.00074	0.0023	0.00093	0.00065	0.00019	0.00072	0.00070	0.00061	0.00037	0.00040	0.00049	0.00044	0.00071	0.00037	0.0011
Cadmium, mg/L	mg/L	0.00003	0.0001	< 0.00001	< 0.00001	< 0.00001	0.00003	< 0.00001	< 0.00001	0.00003	0.00001	< 0.00001	< 0.00001	0.00002	0.000004	0.00004
Copper, mg/L	mg/L	0.00635	0.0102	0.00134	0.00144	0.00210	0.00840	0.00138	0.00119	0.0116	0.00205	0.00119	0.000980	0.00402	0.00149	0.00654
Iron, mg/L	mg/L	1.32	7.88	1.12	0.995	0.0288	2.20	0.619	0.638	0.595	0.183	0.179	0.145	1.33	-0.0439	2.69
Lead, mg/L	mg/L	0.00029	0.00178	< 0.0002	< 0.0002	< 0.0002	0.00046	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	0.0004	0.0001	0.0006
Mercury, mg/L	mg/L	< 0.00001	< 0.000001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	<0.0001	<0.0001	<0.0001
Molybdenum, mg/L	mg/L	< 0.0010	0.0012	0.0016	0.0012	0.0013	< 0.0010	0.0016	0.0011	< 0.0010	0.0015	0.0016	0.0015	0.0013	0.0011	0.0015
Nickel, mg/L	mg/L	0.0019	0.011	0.0016	0.0023	< 0.0010	0.0029	0.0014	0.0016	0.0016	< 0.0010	< 0.0010	< 0.0010	0.0023	0.00062	0.0040
Selenium, mg/L	mg/L	< 0.00010	0.00020	0.00017	0.00020	0.00042	0.00011	0.00014	0.00021	0.00010	0.00018	0.00030	0.00016	0.00019	0.00013	0.00025
Zinc, mg/L	mg/L	< 0.0050	0.015	< 0.0050	0.0050	< 0.0050	0.0059	< 0.0050	< 0.0050	0.0088	< 0.0050	< 0.0050	< 0.0050	0.0062	0.0043	0.0081

		Station W2 (Effluent-Exposed)												
		24-Apr-12	19-Jun-12	23-Aug-12	16-Oct-12	30-Apr-13	19-May-13	21-Aug-13	21-Oct-13	22-Apr-14	30-Jun-14	7-Aug-14	31-Oct-14	**MEAN**
Water Temperature	C	0	5.6	7.0	0.20	0	0.60	7.0	8.15	-0.10	8.7	6.6	-1.4	3.5
Electrical Conductivity	µS/cm	125	234	318	302	446	177	317	319	144	333	333	377	285
Dissolved Oxygen	mg/L	16.25	12.24	10.87	15.03		13.3	11.13	13.99	13.98	10.96	13.72	14.34	13.26
pH	pH units	7.80	8.15	8.22	8.23	8.30	8.17	7.71		8.00	8.30	8.08	7.69	8.06
Hardness, mg/L	mg/L	57.3	193	156	153	412	91.4	168	163	80.9	167	180	176	166
Alkalinity, mg/L	mg/L	54.9	110	156	144	183	74.6	154	149	62.7	151	154	181	131
Ammonia, mg/L	mg/L	0.0051	0.20	0.049	0.017	0.022	0.044	0.025	0.032	0.050	0.040	0.014	0.0091	0.042
Nitrate, mg/L	mg/L	0.39	0.15	0.021	0.16	1.6	0.40	0.14	0.19	0.051	0.049	0.12	0.18	0.28
TSS, mg/L	mg/L	32.3	1,030	83.5	30.000000	< 1.00	79.000000	23.9	2.30	62.000000	< 1.00	4.20	< 1.00	113
Aluminum, mg/L	mg/L	0.681	20.2	0.716	0.246	0.0304	1.95	0.713	0.0514	1.23	0.0509	0.156	0.0142	2.17
Arsenic, mg/L	mg/L	0.00073	0.0091	0.0013	0.00089	0.0016	0.0015	0.0012	0.00077	0.0010	0.00052	0.00072	0.00032	0.0016
Cadmium, mg/L	mg/L	0.00004	0.0005	0.00002	< 0.00001	< 0.00001	0.00003	0.00001	< 0.00001	0.00004	0.00002	< 0.00001	< 0.00001	0.00006
Copper, mg/L	mg/L	0.00654	0.0442	0.00404	0.00256	< 0.000200	0.0160	0.00364	0.00185	0.0211	0.00341	0.00219	0.00163	0.00895
Iron, mg/L	mg/L	1.22	30.5	2.06	1.06	4.96	3.57	1.60	0.644	1.87	0.119	0.492	0.083	4.01
Lead, mg/L	mg/L	0.00031	0.00856	0.0006	0.00021	< 0.0002	0.00096	0.0003	< 0.0002	0.00061	< 0.0002	< 0.0002	< 0.0002	0.0010
Mercury, mg/L	mg/L	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	< 0.00001	<0.0001
Molybdenum, mg/L	mg/L	< 0.0010	0.0020	< 0.0010	0.0010	0.0018	0.0013	0.0017	0.0014	< 0.0010	0.0016	0.0015	0.0012	0.0014
Nickel, mg/L	mg/L	0.0021	0.0345	0.0033	0.0022	0.0014	0.0045	0.0028	0.0021	0.0031	0.0011	0.0013	0.0011	0.0050
Selenium, mg/L	mg/L	0.00017	0.00056	< 0.00010	0.00013	< 0.00010	0.00029	0.00019	0.00014	0.00029	0.00013	0.00010	< 0.00010	0.00019
Zinc, mg/L	mg/L	< 0.0050	0.0718	0.0052	< 0.0050	< 0.0050	0.0091	< 0.0050	< 0.0050	0.0102	0.0053	< 0.0050	< 0.0050	0.0114

Table D.2: ***In-situ*** **water quality and physical measures at upper creek benthic invertebrate community survey sites, Minto Mine IOC, September 2014.**

Area		Station	Temperature (°C)	Specific Conductance (µs/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH (pH units)	Water Velocity (m/s)	Mean Depth (m)	Median Intermediate Axis (cm)
		Water Quality Guidelines	**-**	**-**	**6.5**	**-**	**6.5 - 9.0**	**-**	**-**	**-**
Reference	**McGinty Creek**	URC-1	1.51	109	12.8	91.4	7.47	0.21	0.19	4.35
	Wolverine Creek Tributary	UWC-1	0.98	82	13.3	93.4	8.41	0.22	0.14	4.20
	New Reference Creeks	NRC-1	0.55	128	12.3	85.2	7.98	0.23	0.15	4.55
		NRC-2	0.73	64	12.5	87.4	7.98	0.28	0.18	3.20
		NRC-3	1.94	130	11.7	85.1	8.20	0.23	0.16	4.45
		NRC-4	1.39	169	12.7	90.5	7.84	0.24	0.15	3.65
		NRC-5	0.35	214	12.8	88.1	7.79	0.26	0.16	3.55
		NRC-6	2.21	345	12.4	90.2	8.16	0.18	0.12	3.75
		NRC-7	2.23	185	12.4	90.4	8.06	0.28	0.14	4.20
		NRC-8	4.44	199	12.1	93.2	8.09	0.23	0.19	4.70
		NRC-9	1.48	359	12.7	90.3	8.04	0.12	0.18	4.60
		NRC-10	1.94	66	12.6	91.0	8.22	0.24	0.22	5.00
		n	10	10	10	10	10	10	10	10
		mean	1.73	186	12.4	89.1	8.04	0.23	0.17	4.17
		median	1.71	177	12.5	90.3	8.05	0.24	0.16	4.33
		minimum	0.35	64	11.7	85.1	7.79	0.12	0.12	3.20
		maximum	4.44	359	12.8	93.2	8.22	0.28	0.22	5.00
		standard deviation	1.17	101	0.32	2.6	0.14	0.05	0.03	0.59
		standard error	0.37	32	0.10	0.83	0.05	0.02	0.01	0.19
Exposure	**Upper Minto Creek**	UMC-1	0.25	303	11.7	80.8	7.92	0.13	0.12	4.00
		UMC-2	-0.35	305	12.8	86.7	7.92	0.16	0.11	4.30
		UMC-3	-0.73	307	12.3	81.5	8.06	0.14	0.12	3.50
		n	3	3	3	3	3	3	3	3
		mean	-0.28	305	12.3	83.0	7.97	0.14	0.12	3.93
		median	-0.35	305	12.3	81.5	7.92	0.14	0.12	4.00
		minimum	-0.73	303	11.7	80.8	7.92	0.13	0.11	3.50
		maximum	0.25	307	12.8	86.7	8.06	0.16	0.12	4.30
		standard deviation	0.49	2.00	0.54	3.2	0.08	0.02	0.01	0.40
		standard error	0.29	1.15	0.31	1.9	0.05	0.01	0.00	0.23

Table D.3: ***In-situ*** **water quality and physical measures at lower creek benthic invertebrate community stations, Minto Mine IOC, September 2014.**

Area		Station	Temperature (°C)	Specific Conductance (µs/cm)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (%)	pH (pH units)	Water Velocity (m/s)	Mean Depth (m)	Median Intermediate Axis (cm)
Water Quality Guidelines			**-**	**-**	**6.5**	**-**	**6.5 - 9.0**	**-**	**-**	**-**
Reference	**Lower Wolervine Creek**	LWC-1	4.55	165	12.7	98.1	7.71	0.25	0.11	4.00
		LWC-2	5.01	165	12.7	99.3	7.82	0.27	0.14	4.00
		LWC-3	5.88	165	12.4	99.3	7.76	0.35	0.13	3.75
		LWC-4	4.17	170	12.5	96.1	7.75	0.25	0.14	4.75
		LWC-5	4.80	170	12.4	97.0	7.80	0.30	0.16	4.50
		n	5	5	5	5	5	5	5	5
		mean	4.88	167	12.5	98.0	7.77	0.28	0.13	4.20
		median	4.80	165	12.5	98.1	7.76	0.27	0.14	4.00
		minimum	4.17	165	12.4	96.1	7.71	0.25	0.11	3.75
		maximum	5.88	170	12.7	99.3	7.82	0.35	0.16	4.75
		standard deviation	0.64	2.74	0.14	1.4	0.04	0.04	0.02	0.41
		standard error	0.29	1.22	0.06	0.63	0.02	0.02	0.01	0.18
Exposure	**Lower Minto Creek**	LMC-1	1.46	211	13.3	94.5	8.30	0.18	0.13	4.30
		LMC-2	3.37	297	12.7	95.4	8.06	0.27	0.09	4.65
		LMC-3	4.42	296	12.5	96.6	8.22	0.37	0.08	3.70
		LMC-4	7.22	300	11.6	95.9	8.05	0.38	0.10	3.50
		LMC-5	5.27	304	11.8	92.8	7.99	0.26	0.12	4.25
		n	5	5	5	5	5	5	5	5
		mean	4.35	282	12.4	95.0	8.12	0.29	0.10	4.08
		median	4.42	297	12.5	95.4	8.06	0.27	0.10	4.25
		minimum	1.46	211	11.6	92.8	7.99	0.18	0.08	3.50
		maximum	7.22	304	13.3	96.6	8.30	0.38	0.13	4.65
		standard deviation	2.14	40	0.69	1.5	0.13	0.08	0.02	0.47
		standard error	0.96	18	0.31	0.66	0.06	0.04	0.01	0.21

Table D.4: Intermediate axis length and embeddedness of 100 cobble washed at upper creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	UMC-1		UMC-2		UMC-3		UWC-1	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	14.0		3.1		7.0		3.1	
2	13.7		2.6		5.6		4.8	
3	8.7		3.5		4.4		3.5	
4	6.6		3.3		3.1		8.8	
5	5.5		4.6		7.5		4.4	
6	3.7		5.0		8.7		6.0	
7	4.4		5.2		5.0		3.6	
8	4.5		4.5		7.5		4.1	
9	3.5		6.4		4.8		3.9	
10	3.3	25	6.0	25	7.0	50	2.8	50
11	4.9		5.3		6.1		3.5	
12	2.8		9.0		4.5		2.3	
13	3.9		6.9		4.2		4.9	
14	2.8		10.2		5.7		4.8	
15	4.2		5.7		4.8		3.4	
16	2.8		6.4		4.2		2.7	
17	2.5		4.2		3.5		4.6	
18	3.0		3.7		4.6		5.9	
19	2.8		4.8		2.0		3.5	
20	2.6	50	4.5	50	2.3	25	3.8	50
21	2.7		5.1		4.0		3.8	
22	2.8		8.4		5.4		6.5	
23	4.9		7.3		3.4		4.9	
24	3.2		6.6		4.5		4.4	
25	2.2		4.4		3.1		3.2	
26	3.1		8.0		3.9		3.9	
27	7.5		5.6		3.4		3.5	
28	6.2		7.6		3.9		6.0	
29	4.7		9.7		4.7		4.2	
30	5.7	25	4.0	50	2.6	50	4.4	25
31	2.6		3.8		2.4		7.5	
32	4.0		6.5		7.9		3.5	
33	7.7		3.7		3.5		4.9	
34	4.3		2.5		4.0		4.2	
35	5.8		3.8		3.3		9.7	
36	4.9		3.1		3.0		8.7	
37	2.3		3.2		4.3		9.5	
38	2.4		3.5		4.2		5.3	
39	4.5		5.5		2.7		4.9	
40	4.1	25	2.4	50	3.2	25	3.9	50
41	8.4		6.5		3.5		4.4	
42	13.3		6.8		2.6		4.6	
43	4.6		3.7		4.7		7.2	
44	3.9		2.0		3.3		9.0	
45	5.6		2.1		3.8		5.7	
46	3.7		4.4		3.0		4.7	
47	3.5		3.8		3.5		3.5	
48	7.7		3.1		3.6		4.6	
49	10.5		3.4		5.5		4.3	
50	6.6	50	2.7	25	3.2	50	5.8	50
51	3.2		4.0		2.7		2.8	
52	3.5		2.9		2.5		2.5	
53	4.0		3.0		3.1		8.7	
54	8.5		3.7		3.7		9.2	
55	4.2		3.2		3.4		6.4	
56	4.5		5.4		2.5		4.5	
57	4.1		2.6		3.2		5.1	
58	2.5		2.6		2.4		3.7	
59	3.6		4.1		3.3		3.9	
60	3.8	50	2.5	50	3.2	75	3.5	25
61	7.2		5.4		4.1		4.6	
62	3.5		2.4		2.6		3.3	
63	2.6		3.2		3.0		2.0	
64	2.0		8.4		3.0		3.2	
65	1.9		3.3		3.4		3.6	
66	2.4		5.6		2.9		5.6	
67	3.1		4.4		4.8		4.5	
68	3.4		4.0		4.0		6.5	
69	2.7		2.2		3.2		4.3	
70	6.1	50	3.1	50	3.0	25	5.0	50
71	7.8		3.3		3.6		2.5	
72	3.7		7.2		2.9		3.8	
73	5.3		3.9		6.4		3.7	
74	3.5		5.6		3.5		3.6	
75	3.5		4.1		3.3		3.9	
76	4.8		4.5		4.7		5.7	
77	5.0		3.1		3.9		8.3	
78	6.0		3.8		5.1		3.6	
79	6.4		1.8		3.7		4.7	
80	15.0	25	2.2	25	4.4	50	4.0	25
81	7.0		2.1		5.0		4.1	
82	3.6		1.5		2.2		3.1	
83	12.0		5.1		3.2		5.2	
84	4.0		5.0		3.0		3.7	
85	2.9		5.6		2.4		5.1	
86	1.8		6.6		2.1		4.7	
87	6.4		7.6		2.8		3.9	
88	6.4		3.2		3.5		3.7	
89	9.0		7.3		2.5		2.8	
90	4.5	25	4.5	50	5.7	25	3.2	25
91	2.5		3.6		3.2		2.9	
92	12.5		6.5		6.7		8.5	
93	1.7		3.5		3.0		2.7	
94	1.7		8.1		2.4		5.0	
95	3.4		4.9		2.1		3.5	
96	4.5		5.5		1.7		3.4	
97	4.2		6.5		3.9		3.0	
98	3.6		7.5		4.0		3.8	
99	1.7		5.2		4.4		5.8	
100	3.0	50	3.6	25	3.1	50	3.5	50
Minimum	**1.7**		**1.5**		**1.7**		**2.0**	
Maximum	**15.0**		**10.2**		**8.7**		**9.7**	
Mean	**4.9**		**4.7**		**3.9**		**4.6**	
Geometric mean	**4.3**		**4.3**		**3.7**		**4.4**	
Median	**4.0**	**37.5**	**4.3**	**50.0**	**3.5**	**50.0**	**4.2**	**50.0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.4: Intermediate axis length and embeddedness of 100 cobble washed at upper creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	URC-1		NRC-1		NRC-2		NRC-3	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	13.4		3.2		4.9		4.4	
2	13.5		3.9		5.0		5.3	
3	15.5		7.0		5.1		8.5	
4	12.1		3.6		3.5		5.8	
5	7.4		6.2		3.2		6.6	
6	7.1		5.6		3.1		5.5	
7	6.2		15.0		5.1		5.6	
8	5.2		10.7		5.0		6.0	
9	4.0		18.4		4.6		3.5	
10	4.0	25	7.8	50	5.7	50	3.2	25
11	3.8		12.4		7.5		3.0	
12	4.5		3.7		3.2		5.2	
13	5.5		3.7		4.0		6.0	
14	4.3		3.9		4.9		4.5	
15	3.0		3.5		3.2		5.3	
16	4.2		5.2		5.3		3.7	
17	3.7		6.6		2.6		5.7	
18	2.6		3.4		4.6		5.5	
19	4.4		4.0		2.5		3.7	
20	4.3	25	8.6	25	4.5	25	6.6	50
21	8.0		5.1		4.3		4.3	
22	8.5		5.5		3.8		7.8	
23	2.9		4.1		3.6		4.2	
24	3.7		4.0		3.0		7.0	
25	3.7		3.8		4.5		4.1	
26	4.8		10.0		3.0		4.3	
27	4.5		5.6		3.5		3.9	
28	5.3		3.3		2.7		7.5	
29	3.1		14.2		4.2		5.9	
30	4.2	25	10.6	75	3.5	50	5.3	25
31	8.0		5.1		3.6		6.8	
32	7.0		3.6		4.5		6.3	
33	3.7		4.9		3.9		6.5	
34	5.1		4.3		3.5		3.8	
35	2.8		2.8		3.0		6.4	
36	3.8		3.5		2.6		3.4	
37	3.8		2.9		3.1		7.4	
38	3.9		5.0		3.2		3.3	
39	4.1		4.3		4.0		8.6	
40	5.0	50	4.8	50	2.2	25	4.3	25
41	4.9		5.1		3.0		6.5	
42	6.3		3.5		3.4		4.6	
43	3.0		6.9		3.3		5.0	
44	3.3		10.0		3.6		5.2	
45	4.1		9.7		2.1		3.5	
46	7.8		5.0		2.7		4.4	
47	4.6		3.3		2.0		7.0	
48	9.6		10.8		4.0		4.6	
49	4.1		4.2		3.4		4.4	
50	6.5	25	8.0	25	3.0	25	3.9	25
51	5.4		3.3		3.0		4.8	
52	2.8		3.5		2.7		2.7	
53	3.1		11.2		4.7		10.5	
54	4.0		4.1		5.3		3.7	
55	5.1		4.0		3.4		3.6	
56	3.8		4.1		3.8		5.0	
57	3.5		3.9		3.1		5.0	
58	4.3		4.5		3.0		5.8	
59	13.7		2.6		3.2		4.9	
60	4.5	25	4.5	50	5.1	50	2.0	25
61	6.0		2.6		2.1		4.5	
62	4.4		6.0		2.3		3.2	
63	3.5		4.0		3.1		2.7	
64	3.2		2.2		2.2		6.6	
65	4.4		4.0		3.2		5.8	
66	5.3		5.6		2.6		5.8	
67	4.4		1.8		2.5		3.1	
68	4.7		4.5		3.4		3.4	
69	6.4		3.0		4.0		3.9	
70	4.7	25	2.5	50	2.5	25	5.9	50
71	6.6		3.8		2.5		5.4	
72	3.3		3.0		2.2		3.1	
73	4.6		4.5		2.7		3.2	
74	4.6		5.5		2.7		2.8	
75	3.4		5.8		2.6		10.3	
76	3.6		12.2		2.6		3.4	
77	2.7		7.5		2.7		5.2	
78	4.2		4.0		4.2		4.1	
79	5.8		5.9		3.3		4.4	
80	3.5	50	3.5	75	3.3	25	2.9	25
81	3.1		4.6		3.0		4.1	
82	4.8		4.6		4.1		3.5	
83	5.5		6.9		2.7		8.3	
84	4.7		11.5		2.8		2.9	
85	4.0		10.5		1.9		4.0	
86	5.4		3.4		1.7		4.1	
87	3.0		3.6		2.2		2.2	
88	3.4		3.5		3.5		3.4	
89	4.8		3.0		2.6		6.2	
90	4.3	25	5.7	50	2.1	50	2.8	25
91	3.4		12.0		2.5		3.5	
92	4.6		5.0		1.8		3.9	
93	3.4		3.9		2.6		4.1	
94	3.5		7.3		2.9		4.1	
95	2.9		14.0		4.5		2.8	
96	4.8		8.0		2.2		8.3	
97	5.1		5.6		4.1		3.3	
98	4.0		7.3		3.1		5.4	
99	4.0		6.5		2.4		3.4	
100	3.8	25	3.5	50	3.5	50	5.1	25
Minimum	**2.6**		**1.8**		**1.7**		**2.0**	
Maximum	**15.5**		**18.4**		**7.5**		**10.5**	
Mean	**5.0**		**5.8**		**3.4**		**4.9**	
Geometric mean	**4.6**		**5.1**		**3.2**		**4.6**	
Median	**4.4**	**25.0**	**4.6**	**50.0**	**3.2**	**37.5**	**4.5**	**25.0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.4: Intermediate axis length and embeddedness of 100 cobble washed at upper creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	NRC-4		NRC-5		NRC-6		NRC-7	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	4.0		4.2		3.8		8.5	
2	3.9		3.1		3.1		6.0	
3	3.6		3.4		5.2		6.0	
4	3.2		3.0		4.5		4.0	
5	3.2		4.5		2.9		3.7	
6	2.5		3.9		3.4		3.8	
7	2.6		5.2		6.5		3.1	
8	3.3		4.7		8.0		3.1	
9	3.8		5.2		3.8		2.6	
10	4.6	50	2.6	25	5.0	50	3.2	50
11	6.9		2.9		3.2		4.2	
12	3.6		2.8		4.5		4.4	
13	3.6		3.2		4.9		4.5	
14	4.6		5.1		5.2		4.7	
15	4.2		2.1		3.3		4.5	
16	3.7		2.6		3.5		4.7	
17	3.2		6.6		3.5		3.6	
18	4.6		6.1		4.5		4.1	
19	3.3		3.4		3.4		3.0	
20	3.0	25	5.5	25	2.3	25	4.0	25
21	3.4		4.0		3.4		6.5	
22	4.7		3.1		4.5		4.2	
23	2.5		4.3		3.9		6.3	
24	2.6		3.2		4.0		4.2	
25	3.0		2.9		5.0		4.6	
26	3.7		9.4		3.7		2.7	
27	3.0		8.3		3.0		8.5	
28	1.6		5.0		3.5		6.5	
29	2.8		4.0		4.4		11.5	
30	2.6	50	3.6	50	7.5	50	10.4	50
31	3.5		3.1		4.8		7.4	
32	4.0		2.0		1.7		4.0	
33	3.4		4.8		3.7		6.0	
34	3.2		2.3		3.6		15.6	
35	4.1		3.7		2.6		5.7	
36	3.2		2.1		4.5		6.6	
37	2.3		5.7		4.3		4.4	
38	2.1		2.8		2.4		4.0	
39	6.0		3.0		4.0		5.0	
40	4.5	25	2.2	25	5.0	50	3.8	50
41	2.9		4.3		3.3		4.2	
42	3.0		4.0		3.7		2.7	
43	3.2		3.9		4.9		3.4	
44	4.5		3.6		3.2		3.1	
45	4.3		3.9		2.9		2.9	
46	6.4		8.7		2.7		3.0	
47	4.5		5.0		3.5		2.7	
48	4.4		2.1		2.5		2.9	
49	3.8		6.9		2.9		3.8	
50	3.5	25	2.0	50	6.8	25	3.7	50
51	2.4		3.1		2.8		3.0	
52	4.0		3.5		7.0		3.0	
53	3.4		2.5		4.1		2.6	
54	3.9		1.8		11.6		4.7	
55	4.1		3.0		6.5		5.0	
56	2.5		2.9		3.0		4.5	
57	5.5		3.5		6.0		5.5	
58	3.4		3.1		3.1		7.0	
59	2.5		2.8		2.6		3.3	
60	5.0	25	5.6	25	3.8	50	4.3	50
61	3.5		3.3		6.1		2.7	
62	3.3		7.0		7.5		2.6	
63	3.9		5.1		5.5		3.1	
64	2.6		3.5		3.8		3.4	
65	4.0		4.7		3.7		4.5	
66	2.9		3.7		3.2		2.8	
67	4.4		3.2		5.4		5.3	
68	4.9		2.6		2.8		5.9	
69	5.2		3.5		3.6		5.0	
70	2.9	50	3.5	50	4.2	50	4.5	25
71	3.9		3.7		2.6		7.2	
72	4.2		3.1		2.9		3.2	
73	3.2		4.2		2.6		4.7	
74	3.8		6.1		3.8		3.9	
75	5.0		4.0		5.9		4.0	
76	3.3		6.0		5.5		2.3	
77	3.6		3.5		3.7		3.8	
78	2.7		6.5		3.1		1.9	
79	4.4		8.1		3.1		8.0	
80	5.8	25	4.4	25	3.3	25	3.0	25
81	5.2		4.6		3.2		4.4	
82	3.5		5.5		2.9		9.5	
83	5.1		4.1		3.0		5.3	
84	4.2		13.2		6.5		3.9	
85	3.8		3.9		7.8		4.1	
86	3.6		3.7		7.0		3.4	
87	2.8		3.6		4.7		3.6	
88	4.0		3.9		5.2		3.2	
89	7.3		4.0		6.5		4.2	
90	6.0	25	3.2	50	3.5	50	3.9	50
91	3.4		3.0		2.2		10.3	
92	2.8		3.1		9.6		6.9	
93	5.5		3.4		9.5		10.8	
94	4.9		3.0		2.5		3.3	
95	4.5		2.5		3.7		7.6	
96	2.2		3.0		3.8		5.1	
97	5.8		3.0		3.4		2.7	
98	3.8		2.1		4.3		5.6	
99	3.7		3.3		3.5		7.8	
100	2.9	50	3.4	50	7.5	25	4.3	25
Minimum	**1.6**		**1.8**		**1.7**		**1.9**	
Maximum	**7.3**		**13.2**		**11.6**		**15.6**	
Mean	**3.8**		**4.1**		**4.3**		**4.8**	
Geometric mean	**3.7**		**3.8**		**4.0**		**4.4**	
Median	**3.7**	**25.0**	**3.6**	**37.5**	**3.8**	**50.0**	**4.2**	**50.0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.4: Intermediate axis length and embeddedness of 100 cobble washed at upper creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	NRC-8		NRC-9		NRC-10	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	10.4		11.8		15.3	
2	7.4		9.5		12.1	
3	5.3		11.4		13.0	
4	7.8		11.0		14.0	
5	12.9		9.1		9.5	
6	12.5		6.9		6.8	
7	9.1		4.0		7.9	
8	5.6		7.3		6.1	
9	5.7		5.4		4.9	
10	5.2	50	4.5	25	5.8	25
11	4.1		6.0		10.7	
12	3.8		7.2		4.6	
13	4.3		4.6		4.8	
14	7.5		3.8		3.5	
15	5.0		6.8		4.3	
16	3.6		5.6		3.4	
17	3.4		7.8		4.5	
18	3.5		4.2		3.7	
19	4.3		4.1		5.0	
20	3.0	50	3.1	25	4.6	25
21	5.1		4.5		6.9	
22	2.6		4.5		3.4	
23	5.4		4.5		4.0	
24	2.1		3.8		7.4	
25	6.8		2.7		5.9	
26	3.3		2.5		8.9	
27	2.7		3.0		8.0	
28	6.7		3.7		5.0	
29	3.1		4.4		6.5	
30	5.2	25	3.9	50	8.4	25
31	4.7		3.2		5.0	
32	6.3		5.7		12.0	
33	6.4		7.3		6.6	
34	4.7		6.3		6.9	
35	5.3		6.1		4.8	
36	9.3		8.7		5.2	
37	2.9		8.6		5.5	
38	3.5		3.5		5.2	
39	4.4		8.9		11.7	
40	3.5	25	3.6	25	4.9	50
41	3.2		6.7		3.9	
42	2.4		7.4		4.9	
43	8.8		4.7		3.4	
44	3.5		4.5		3.8	
45	8.1		5.5		2.7	
46	8.5		5.5		3.2	
47	4.5		3.2		7.3	
48	3.8		5.7		7.0	
49	4.7		3.4		3.4	
50	6.4	25	2.4	25	5.0	50
51	5.2		5.6		3.9	
52	5.5		7.8		4.7	
53	3.0		3.7		3.1	
54	3.0		4.6		3.7	
55	2.8		3.0		7.8	
56	5.4		3.9		4.9	
57	4.4		3.3		3.4	
58	5.3		5.4		4.2	
59	4.2		3.5		4.8	
60	5.0	25	5.2	25	6.6	25
61	4.7		3.1		2.5	
62	7.5		2.1		4.3	
63	4.4		3.7		4.5	
64	2.4		4.7		2.9	
65	7.7		4.0		2.8	
66	3.8		3.2		6.4	
67	3.3		11.0		10.9	
68	3.4		4.6		6.9	
69	14.0		5.3		9.0	
70	4.4	25	5.5	25	2.6	25
71	8.0		9.3		4.6	
72	3.9		9.7		3.5	
73	5.7		3.9		8.0	
74	5.1		5.2		5.0	
75	4.2		3.8		6.5	
76	9.2		6.1		7.5	
77	4.1		3.9		2.8	
78	7.3		11.4		3.5	
79	7.2		6.1		5.6	
80	5.2	25	3.5	50	7.8	25
81	6.5		5.7		10.9	
82	12.4		4.1		3.3	
83	8.0		2.5		7.2	
84	4.0		4.4		4.0	
85	5.5		5.7		8.1	
86	4.1		3.2		5.7	
87	5.0		3.5		3.5	
88	3.6		3.4		3.7	
89	5.5		4.0		3.8	
90	5.5	25	3.3	25	4.2	25
91	3.6		2.5		16.0	
92	3.4		1.9		5.7	
93	3.4		9.0		6.6	
94	3.8		7.1		4.7	
95	5.0		3.7		7.5	
96	2.6		6.0		8.8	
97	4.0		7.1		4.4	
98	4.0		6.3		4.5	
99	3.8		4.1		3.5	
100	3.8	25	5.4	25	8.0	25
Minimum	**2.1**		**1.9**		**2.5**	
Maximum	**14.0**		**11.8**		**16.0**	
Mean	**5.3**		**5.3**		**6.0**	
Geometric mean	**4.9**		**4.9**		**5.5**	
Median	**4.7**	**25.0**	**4.6**	**25.0**	**5.0**	**25.0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.5: Intermediate axis length and embededdness of 100 cobble washed at at lower creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	LWC-1		LWC-2		LWC-3		LWC-4	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	3.9		8.6		8.0		3.7	
2	5.2		6.2		5.4		6.9	
3	3.3		10.6		5.9		5.1	
4	10.6		6.4		7.6		7.2	
5	3.2		4.0		9.0		4.9	
6	4.4		5.3		4.6		4.9	
7	4.8		2.8		6.2		4.1	
8	4.5		2.2		3.7		8.3	
9	4.4		3.8		4.6		7.4	
10	4.3	0	6.4	0	3.9	0	7.2	25
11	3.3		4.1		4.0		6.3	
12	5.2		2.6		3.0		6.0	
13	5.1		5.0		3.2		4.3	
14	6.1		2.9		5.2		4.7	
15	4.3		4.4		4.8		4.0	
16	5.7		4.7		5.6		4.3	
17	4.7		7.1		2.2		3.5	
18	3.5		4.1		4.6		4.2	
19	6.4		3.9		2.5		5.7	
20	5.6	25	2.0	0	8.6	25	9.5	0
21	3.5		7.0		4.1		6.8	
22	5.2		5.0		3.6		7.7	
23	6.0		5.2		3.7		7.3	
24	9.3		3.9		3.0		6.8	
25	5.7		4.5		7.1		7.9	
26	7.1		4.5		3.1		5.8	
27	7.8		3.7		3.4		9.0	
28	3.2		2.5		6.8		5.3	
29	3.6		4.8		3.6		6.1	
30	3.9	25	5.1	50	3.2	0	6.4	0
31	4.3		4.1		3.5		6.6	
32	2.8		3.8		4.2		5.9	
33	7.0		2.9		4.8		6.3	
34	4.1		4.0		2.4		7.6	
35	2.6		3.5		3.2		5.8	
36	2.9		7.8		2.3		4.9	
37	4.0		5.2		6.6		6.8	
38	3.0		7.7		4.1		3.6	
39	6.0		5.6		7.8		4.3	
40	2.9	75	6.1	50	7.6	25	5.8	50
41	4.7		7.3		2.5		5.8	
42	2.6		6.2		4.7		7.4	
43	5.7		7.3		5.0		5.5	
44	3.2		5.0		4.8		5.8	
45	2.7		6.5		4.8		4.9	
46	2.8		4.9		4.9		5.7	
47	2.6		3.6		5.0		5.9	
48	3.0		4.7		3.2		5.5	
49	2.7		6.2		3.8		5.3	
50	2.5	0	6.5	0	6.1	25	4.9	0
51	2.5		4.2		3.1		5.0	
52	8.3		3.0		2.9		4.1	
53	6.4		3.4		3.0		3.6	
54	5.5		5.1		6.0		4.0	
55	3.7		5.0		2.9		4.2	
56	4.9		2.9		6.9		4.0	
57	8.5		4.0		4.9		4.3	
58	4.8		2.9		3.1		3.3	
59	3.1		2.9		2.9		3.0	
60	3.6	25	5.1	25	4.6	0	4.1	25
61	3.7		3.6		5.8		4.8	
62	3.2		5.0		3.2		4.2	
63	9.8		7.5		4.6		6.2	
64	5.5		3.3		2.7		4.5	
65	3.3		4.7		4.6		3.0	
66	3.2		2.6		2.5		4.0	
67	3.0		3.6		2.6		4.0	
68	4.7		6.6		6.7		3.3	
69	6.0		4.5		5.1		3.2	
70	5.3	25	2.6	0	3.4	50	3.4	0
71	3.9		2.5		2.9		3.5	
72	4.4		3.0		3.1		5.6	
73	3.7		3.5		2.7		3.1	
74	3.0		2.1		4.6		3.5	
75	5.2		2.3		7.4		4.0	
76	3.8		3.1		3.8		3.0	
77	4.6		3.0		3.5		2.5	
78	7.0		2.8		3.6		3.2	
79	2.9		2.7		4.5		4.0	
80	3.2	25	5.5	25	4.4	75	3.9	25
81	2.5		2.9		3.4		3.3	
82	3.1		3.2		3.8		2.8	
83	2.9		2.7		4.4		2.9	
84	3.2		2.9		3.7		3.8	
85	2.7		3.2		2.9		3.5	
86	2.3		2.6		3.1		2.9	
87	3.3		2.1		3.4		2.8	
88	3.5		3.0		3.9		2.2	
89	3.2		2.6		4.6		2.2	
90	2.3	25	3.0	25	3.4	50	2.5	0
91	10.8		5.1		2.7		2.9	
92	7.2		6.2		2.7		2.6	
93	4.0		6.6		3.0		2.5	
94	2.9		2.3		3.3		7.6	
95	6.5		1.9		2.3		6.1	
96	4.6		3.2		3.5		3.4	
97	5.5		2.5		2.8		5.4	
98	3.7		2.8		3.2		5.0	
99	8.6		4.1		2.6		5.3	
100	4.8	0	3.1	0	2.3	25	5.3	25
Minimum	**2.3**		**1.9**		**2.2**		**2.2**	
Maximum	**10.8**		**10.6**		**9.0**		**9.5**	
Mean	**4.5**		**4.3**		**4.2**		**4.9**	
Geometric mean	**4.2**		**4.0**		**4.0**		**4.6**	
Median	**4.0**	**25**	**4.0**	**13**	**3.8**	**25**	**4.8**	**13**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.5: Intermediate axis length and embededdness of 100 cobble washed at at lower creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	LWC-5		LMC-1		LMC-2		LMC-3	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	5.1		5.8		8.6		5.3	
2	8.0		7.4		5.7		4.0	
3	9.1		2.7		8.4		5.0	
4	3.8		3.3		6.3		2.9	
5	4.9		2.5		8.4		4.5	
6	9.6		4.3		6.1		5.9	
7	5.7		3.6		4.4		3.5	
8	6.0		4.4		2.6		3.6	
9	3.4		5.7		4.2		3.5	
10	5.4	0	10.0	25	6.8	0	3.7	0
11	7.1		7.0		5.5		8.0	
12	7.8		4.8		6.2		4.8	
13	5.6		5.5		3.7		4.8	
14	4.4		5.9		5.0		3.6	
15	6.3		7.9		9.9		3.8	
16	6.9		4.3		4.2		4.9	
17	5.1		8.0		3.2		5.5	
18	3.0		9.5		1.9		4.0	
19	4.6		6.4		7.0		6.7	
20	6.6	0	11.5	25	5.2	75	5.6	75
21	2.3		8.7		1.9		3.6	
22	4.1		5.4		8.4		5.8	
23	7.0		4.2		4.3		3.0	
24	7.2		5.0		3.9		3.2	
25	4.2		7.1		13.1		3.2	
26	3.0		4.7		4.5		3.4	
27	7.6		6.1		2.8		4.2	
28	5.9		6.8		5.0		2.9	
29	7.0		5.2		3.1		2.7	
30	4.7	25	7.0	25	2.4	75	2.8	
31	4.6		3.7		3.5		2.5	
32	2.6		3.7		10.1		3.5	
33	9.0		4.2		3.4		3.0	
34	3.0		3.4		2.4		3.5	
35	2.9		3.9		2.5		3.5	
36	2.7		3.1		2.7		9.9	
37	6.8		4.0		2.8		4.0	
38	3.7		4.3		2.9		2.5	
39	4.2		6.6		4.6		2.9	
40	2.2	50	5.0	25	7.2	0	3.6	0
41	3.0		3.6		2.8		4.9	
42	3.0		6.0		4.0		3.9	
43	2.5		3.5		9.9		3.8	
44	2.5		6.1		3.3		4.2	
45	3.5		7.0		3.3		3.0	
46	3.9		4.6		4.4		2.2	
47	5.1		3.5		3.6		4.6	
48	7.7		2.8		2.0		3.4	
49	3.9		5.7		4.0		6.0	
50	6.5	0	3.1	50	3.3	25	8.5	
51	4.3		5.6		8.7		4.1	
52	3.6		6.2		5.9		4.1	
53	3.1		5.5		5.0		3.2	
54	2.6		6.5		4.9		3.9	
55	4.7		7.2		4.8		4.3	
56	3.6		7.5		5.3		3.9	
57	2.7		3.1		3.5		3.7	
58	3.0		3.8		5.0		7.0	
59	5.0		6.0		4.1		6.5	
60	5.1	75	3.7	25	3.0	0	6.0	25
61	2.5		2.4		5.1		2.4	
62	4.2		3.5		4.8		3.2	
63	2.0		3.5		3.5		5.2	
64	3.4		3.0		3.6		2.9	
65	3.5		4.0		3.7		3.2	
66	3.6		3.4		5.4		8.4	
67	4.3		3.2		6.1		4.5	
68	2.5		2.9		3.3		3.2	
69	6.2		4.4		8.4		3.5	
70	3.0	75	6.1	50	4.6	75	3.8	0
71	3.7		2.5		4.3		2.3	
72	5.5		3.6		3.5		5.0	
73	2.0		3.9		6.0		2.3	
74	3.3		3.3		5.5		4.5	
75	3.2		3.0		4.9		3.7	
76	4.0		3.2		2.6		3.8	
77	2.7		3.1		2.2		3.2	
78	3.0		3.6		4.7		2.7	
79	4.0		4.8		5.0		3.5	
80	9.1	25	4.5	25	7.0	0	3.5	75
81	9.2		3.4		5.4		3.8	
82	3.2		2.5		5.8		3.4	
83	7.3		3.0		6.4		3.2	
84	4.2		4.0		2.8		2.9	
85	6.4		3.7		6.5		8.2	
86	8.0		4.9		3.6		8.0	
87	9.2		6.1		3.2		5.8	
88	5.1		8.2		6.7		4.0	
89	5.0		3.4		6.6		4.5	
90	2.6	0	2.6	25	2.8	75	4.9	25
91	6.5		3.1		5.4		4.0	
92	6.3		2.4		3.0		2.7	
93	4.7		8.2		2.3		3.5	
94	5.4		5.6		7.6		3.2	
95	5.2		5.5		5.8		3.0	
96	4.7		5.1		5.9		3.1	
97	7.2		3.6		5.8		2.4	
98	4.6		2.9		5.0		3.6	
99	8.0		3.2		4.2		3.0	
100	4.0	25	3.8	25	7.6	75	3.2	0
Minimum	**2.0**		**2.4**		**1.9**		**2.2**	
Maximum	**9.6**		**11.5**		**13.1**		**9.9**	
Mean	**4.8**		**4.8**		**4.9**		**4.1**	
Geometric mean	**4.5**		**4.5**		**4.5**		**3.9**	
Median	**4.5**	**25**	**4.3**	**25**	**4.7**	**50**	**3.7**	**13**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.5: Intermediate axis length and embededdness of 100 cobble washed at at lower creek benthic invertebrate stations, Minto Mine IOC, September 2014.

Cobble Number	LMC-4		LMC-5	
	Intermediate Axis Length (cm)	Embeddedness (%)	Intermediate Axis Length (cm)	Embeddedness (%)
1	2.2		6.0	
2	2.5		5.1	
3	4.1		6.2	
4	5.0		5.8	
5	2.0		5.6	
6	1.6		6.3	
7	2.1		5.8	
8	6.0		5.0	
9	2.5		4.7	
10	2.9	0	7.0	0
11	2.4		4.2	
12	3.8		6.9	
13	3.6		10.0	
14	2.3		6.8	
15	2.6		6.8	
16	3.5		5.3	
17	2.4		3.6	
18	1.8		3.5	
19	2.9		6.3	
20	2.3	0	6.8	25
21	2.3		4.3	
22	1.9		7.5	
23	2.6		4.3	
24	2.3		3.5	
25	2.5		8.0	
26	2.0		4.0	
27	1.9		6.0	
28	2.4		3.5	
29	3.8		5.2	
30	1.6	0	4.1	0
31	1.6		7.5	
32	3.6		7.5	
33	3.0		5.1	
34	3.5		3.4	
35	6.4		5.5	
36	3.2		3.1	
37	4.0		4.5	
38	3.4		4.5	
39	10.9		3.8	
40	6.2	25	4.0	25
41	4.4		4.1	
42	5.9		5.0	
43	3.9		4.6	
44	3.6		4.0	
45	5.9		4.2	
46	6.9		3.6	
47	6.7		4.4	
48	3.9		3.3	
49	5.2		4.5	
50	5.5	25	4.5	0
51	4.5		5.4	
52	4.1		3.8	
53	3.0		5.1	
54	3.5		3.2	
55	4.1		4.9	
56	4.5		2.5	
57	3.3		3.5	
58	3.4		3.5	
59	3.8		3.4	
60	3.3	25	4.0	0
61	5.9		3.5	
62	1.8		3.3	
63	3.5		4.1	
64	4.7		3.4	
65	6.5		3.0	
66	3.0		3.3	
67	3.8		3.0	
68	5.0		2.5	
69	3.4		3.2	
70	2.7	50	3.5	25
71	2.1		2.5	
72	7.2		3.8	
73	3.0		3.5	
74	2.2		3.7	
75	10.7		4.2	
76	2.1		3.9	
77	2.2		3.6	
78	3.5		3.3	
79	4.6		2.8	
80	3.0	0	3.4	50
81	3.1		2.6	
82	2.8		3.0	
83	5.0		3.1	
84	3.3		3.0	
85	3.0		2.8	
86	5.0		3.5	
87	2.4		6.5	
88	4.8		7.6	
89	4.3		6.6	
90	4.7	50	6.1	0
91	7.9		6.0	
92	4.9		5.5	
93	4.8		5.8	
94	5.0		7.6	
95	4.7		6.8	
96	3.0		6.5	
97	3.2		4.3	
98	4.8		5.0	
99	5.5		3.8	
100	3.6	0	4.5	0
Minimum	**1.6**		**2.5**	
Maximum	**10.9**		**10.0**	
Mean	**3.8**		**4.7**	
Geometric mean	**3.5**		**4.4**	
Median	**3.5**	**13**	**4.3**	**0**

Note: intermediate axis length is the second longest axis on a cobble. Embeddedness refers to how deeply the cobble is surrounded or buried by other substrate.

Table D.6: Periphyton chlorophyll a in upper and lower creeks, Minto Mine IOC, September 2014.

Site / Station		Area sampled	Total Chlorophyll a	Chlorophyll a / area	
		(cm^2)	(µg)	(µg / cm^2)	(mg / m^2)
Upper Creek Sites	UMC-1	10	25	2.5	25
	UMC-2	10	17	1.7	17
	UMC-3	10	15	1.5	15
	URC-1	8.0	19	2.4	24
	UWC-1	10	0.42	0.042	0.42
	NRC-1	20	4.1	0.20	2.0
	NRC-2	15	1.1	0.075	0.75
	NRC-3	10	1.2	0.12	1.2
	NRC-4	22	1.1	0.050	0.50
	NRC-5	12	0.76	0.064	0.64
	NRC-6	10	7.0	0.70	7.0
	NRC-7	8.0	21	2.6	26
	NRC-8	4.0	5.0	1.3	13
	NRC-9	10	11	1.1	11
	NRC-10	20	1.6	0.079	0.79
	NRC-8Z	4.0	1.9	0.47	4.7
	NRC-10Z	20	2.2	0.11	1.1
Lower Creek Stations	LMC-1	10	39	3.9	39
	LMC-2	25	19	0.77	7.7
	LMC-3	25	16	0.63	6.3
	LMC-4	14	25	1.8	18
	LMC-5	24	53	2.2	22
	LWC-1	67	4.0	0.060	0.60
	LWC-2	9.0	1.0	0.11	1.1
	LWC-3	5.0	5.1	1.0	10
	LWC-4	35	12	0.33	3.3
	LWC-5	46	0.11	0.0024	0.024

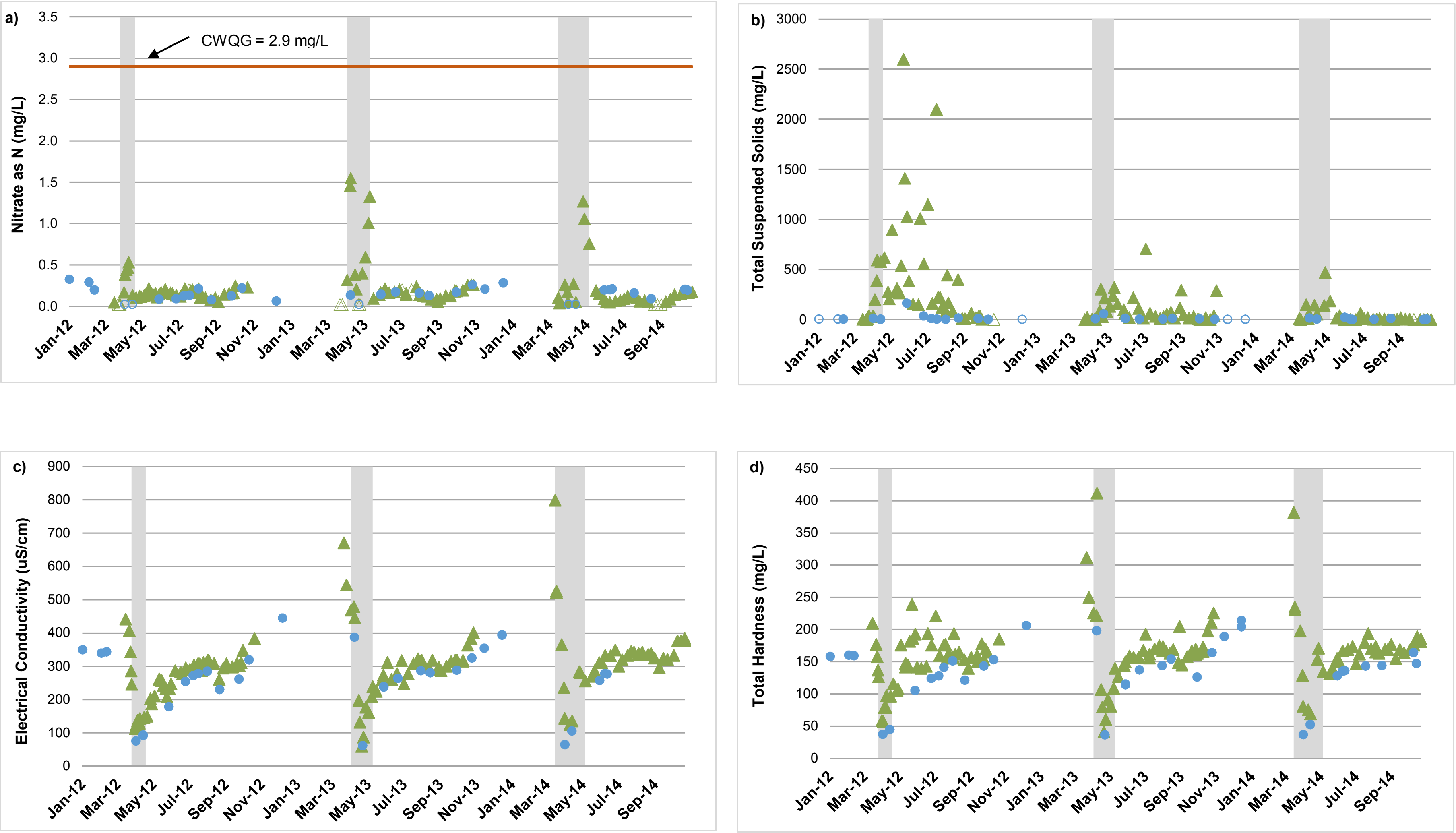


Figure D.1: Routine water quality monitoring from 2012 to 2014; a) nitrate; b) total suspended solids; c) electrical conductivity and d) total hardness. Shaded areas indicate when the mine is discharging effluent. Green triangles represent area W2 and blue squares represent area W7. Open symbols represent values that are < MDL.

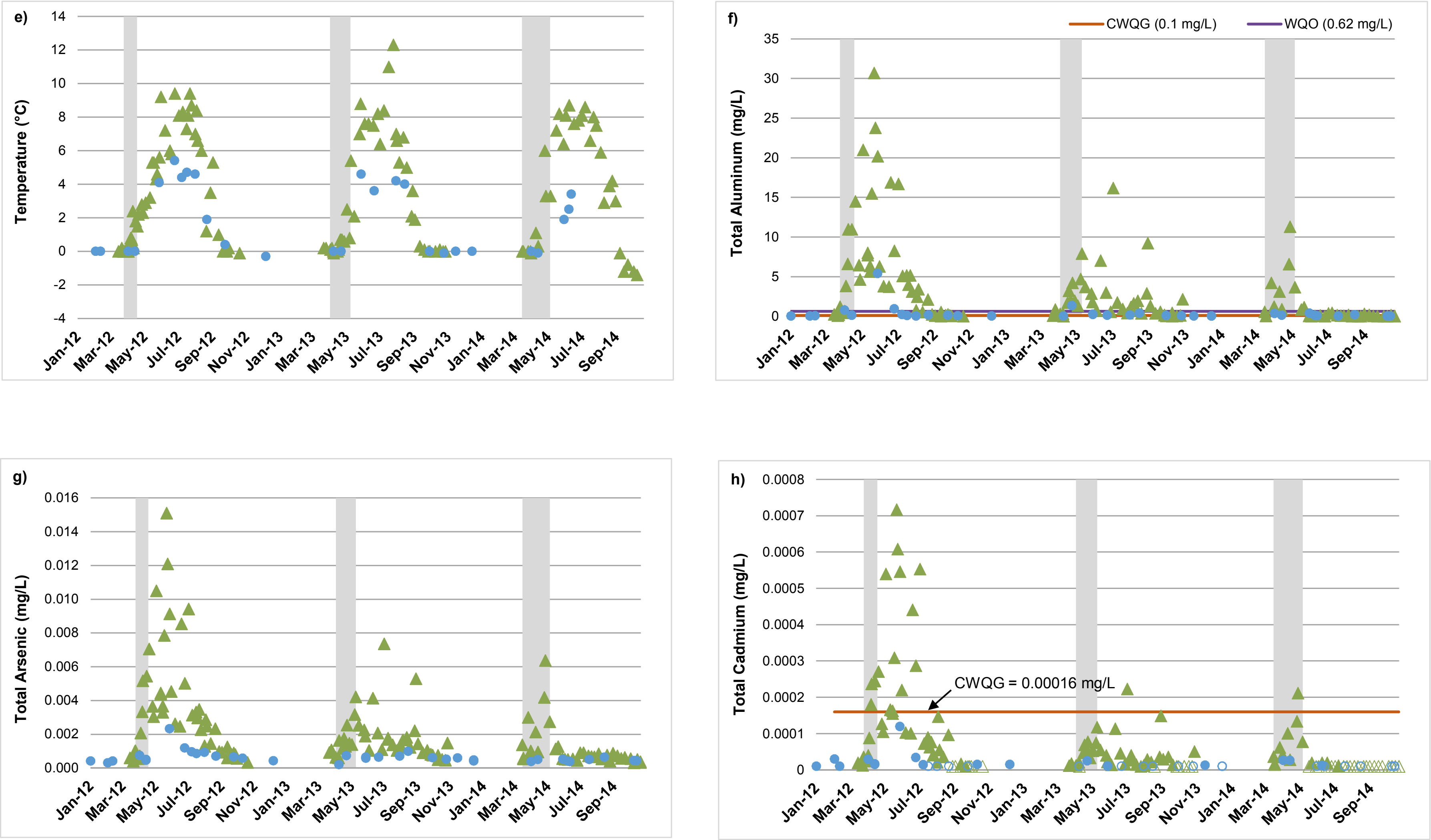
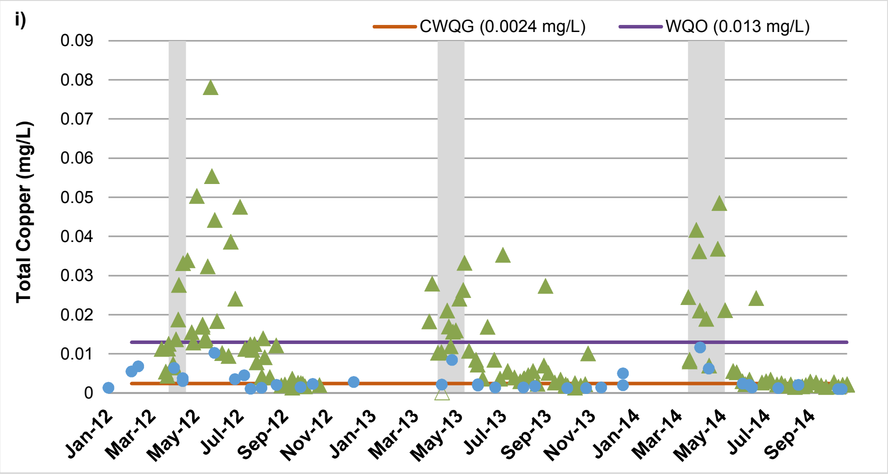


Figure D.1: Routine water quality monitoring from 2012 to 2014; e) temperature; f) total aluminum; g) total arsenic and h) total cadmium. Shaded areas indicate when the mine is discharging effluent. Green triangles represent area W2 and blue squares represent area W7. Open symbols represent values that are < MDL.



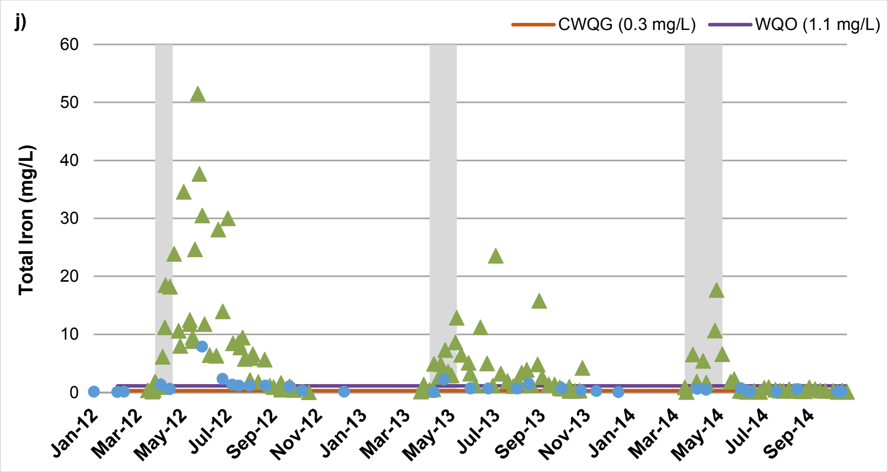


Figure D.1: Routine water quality monitoring from 2012 to 2014; i) total copper and j) total iron. Shaded areas indicate when the mine is discharging effluent. Green triangles represent area W2 and blue squares represent area W7. Open symbols represent values that are < MDL.

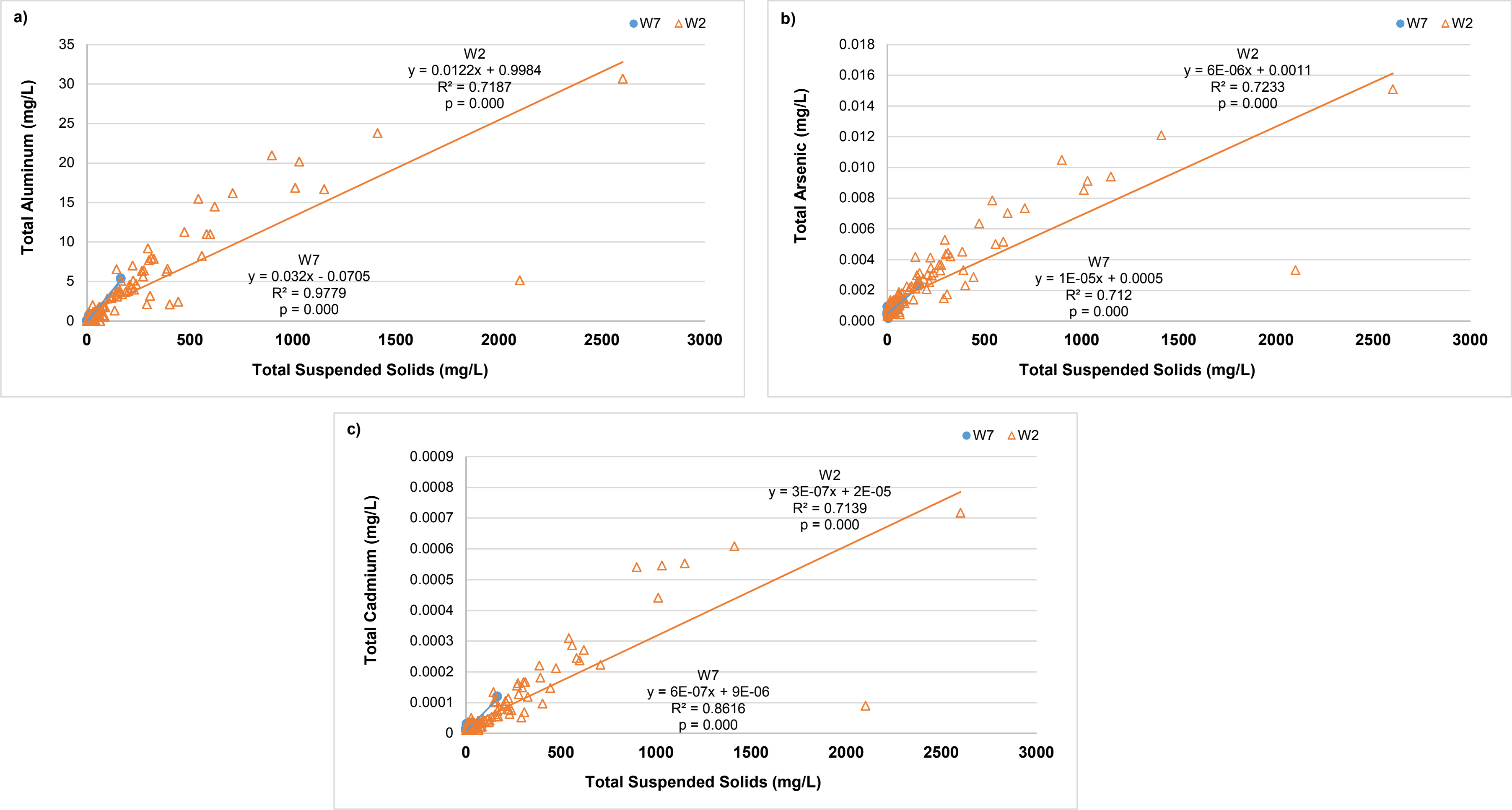
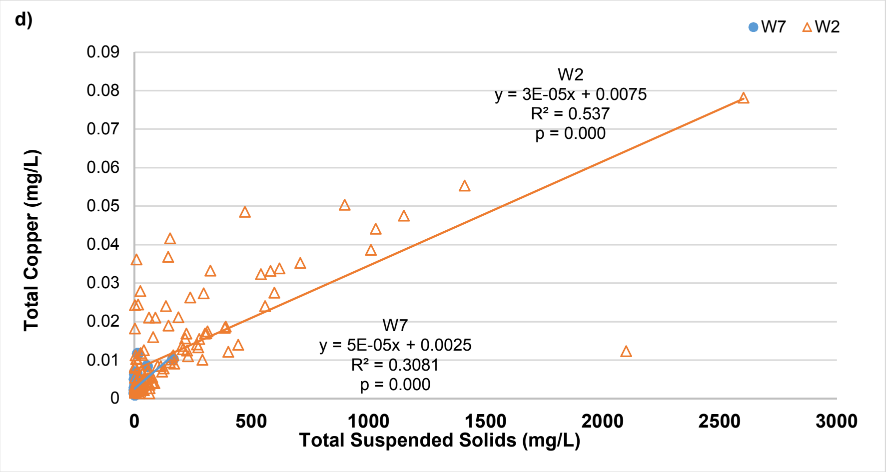


Figure D.2: Regression relationships between total suspended solids and a) total aluminum; b) total arsenic and c) total cadmium. Orange triangles represent area W2 and blue circles represent area W7.



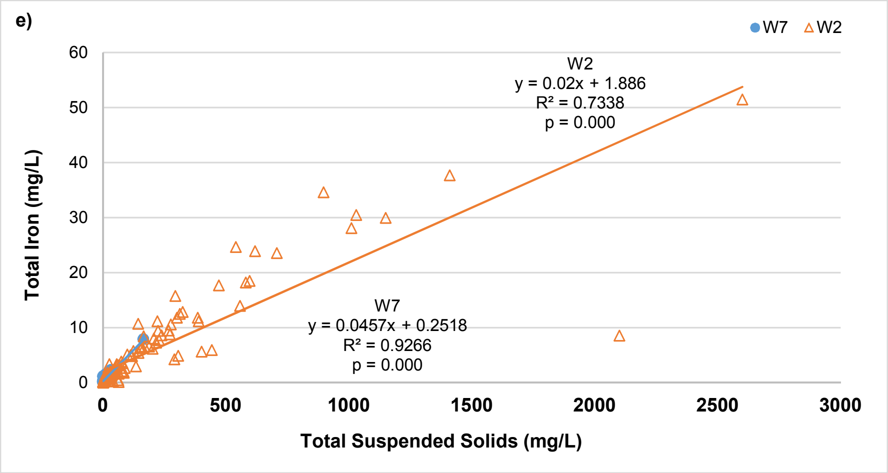


Figure D.2: Regression relationships between total suspended solids and d) total copper and c) total iron. Orange triangles represent area W2 and blue circles represent area W7.

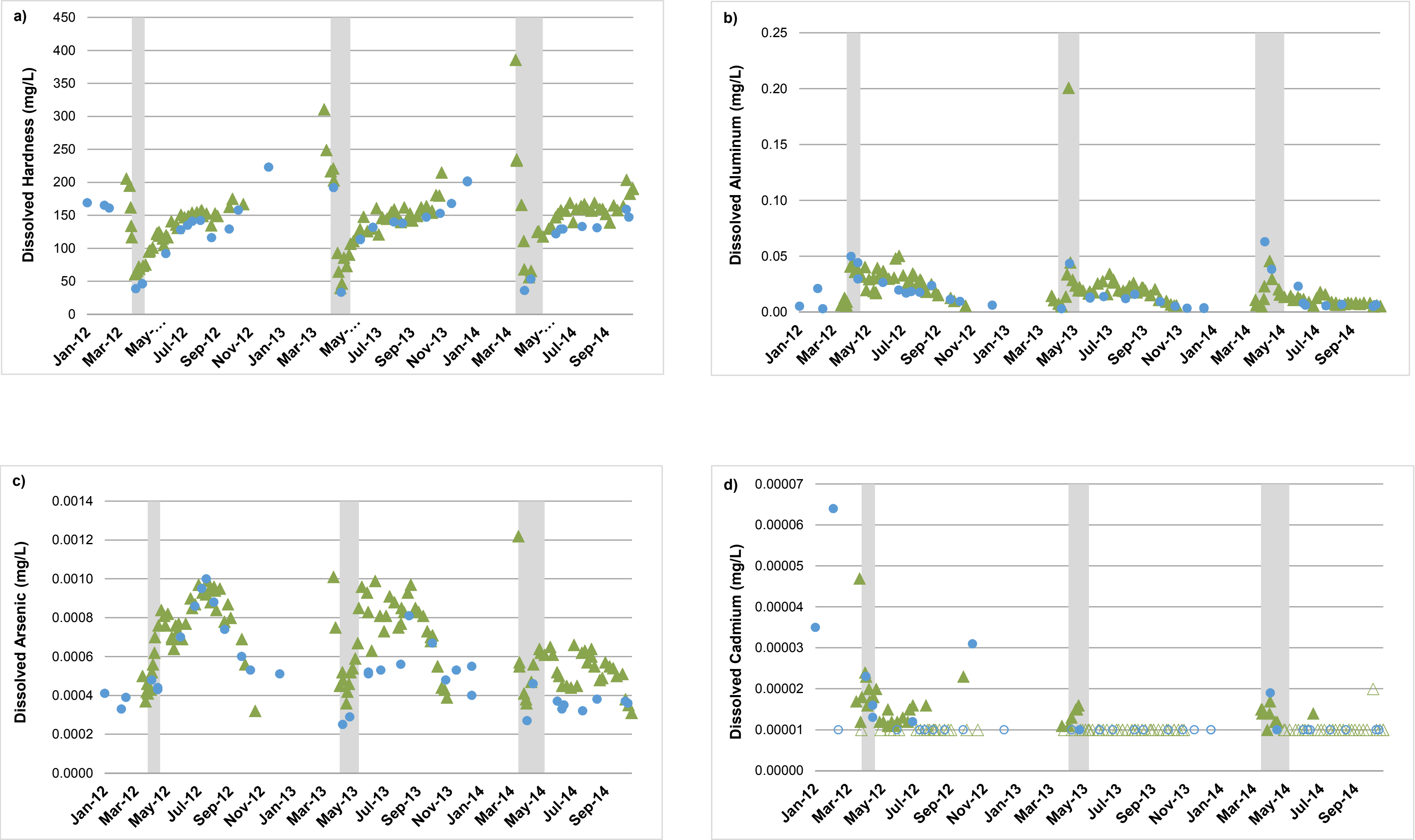


Figure D.3: Routine water quality monitoring from 2012 to 2014; a) dissolved hardness b) dissolved aluminum; c) dissolved arsenic and d) dissolved cadmium. Shaded areas indicate when the mine is discharging effluent. Green triangles represent area W2 and blue squares represent area W7. Open symbols represent values that are < MDL.

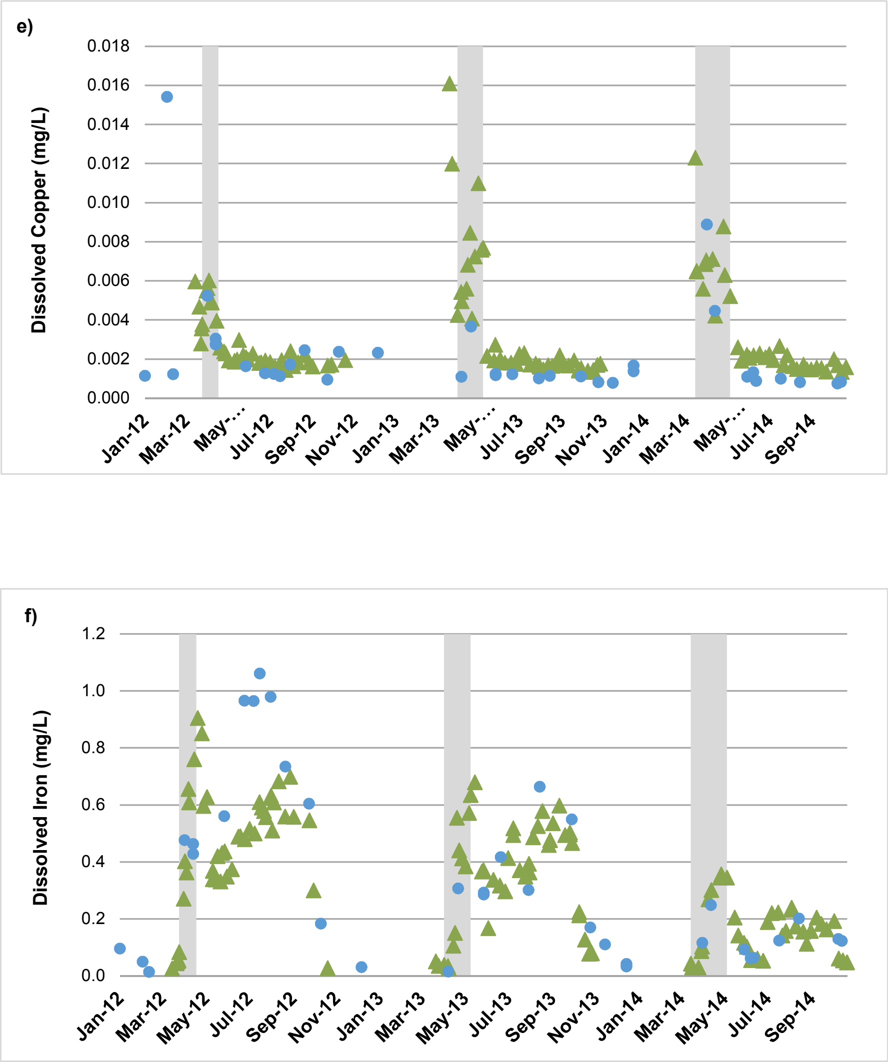


Figure D.3: Routine water quality monitoring from 2012 to 2014; e) dissolved copper and f) dissolved iron. Shaded areas indicate when the mine is discharging effluent. Green triangles represent area W2 and blue squares represent area W7. Open symbols represent values that are < MDL.

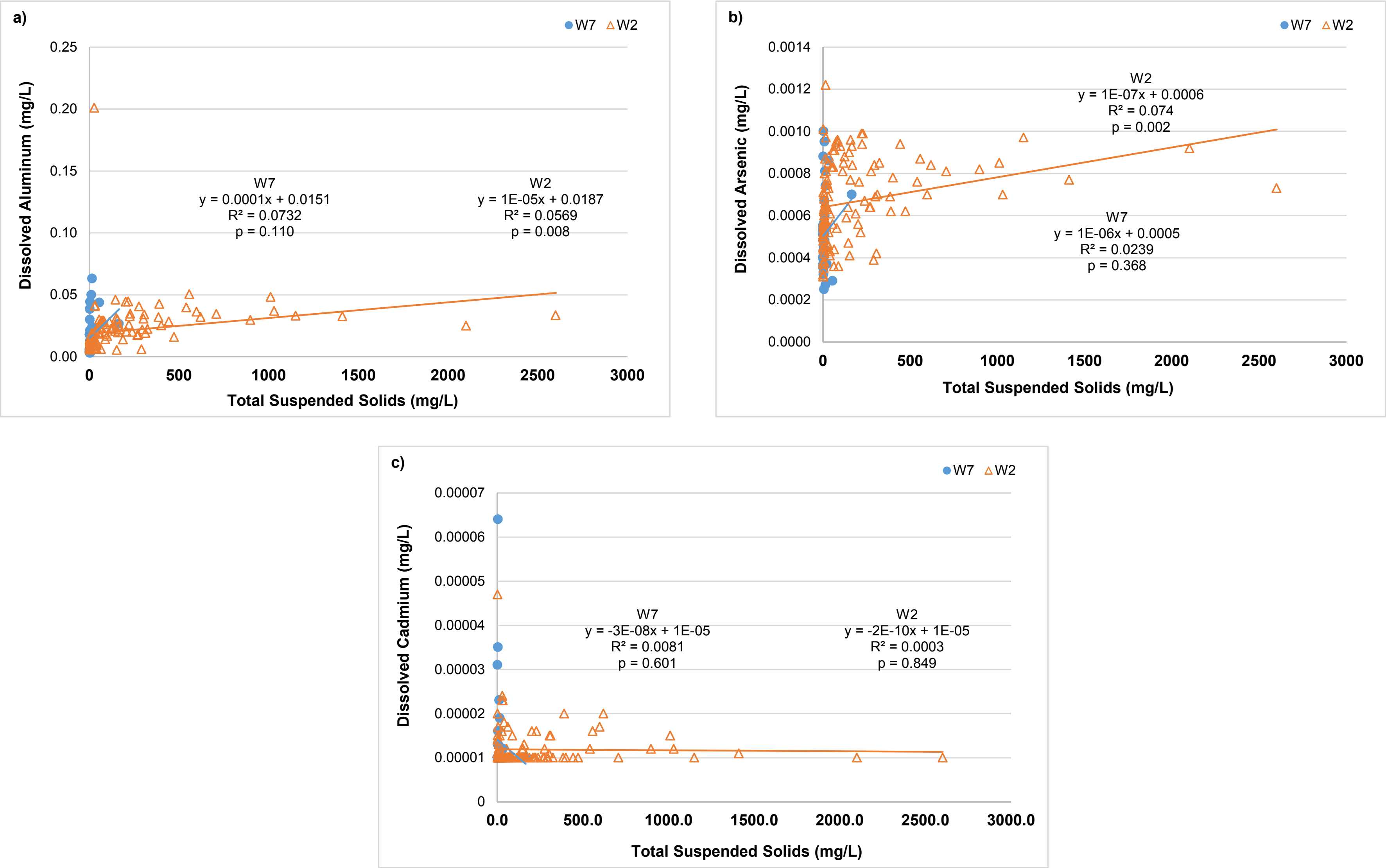


Figure D.4: Regression relationships between total suspended solids and a) dissolved aluminum; b) dissolved arsenic and c) dissolved cadmium. Orange triangles represent area W2 and blue circles represent area W7.

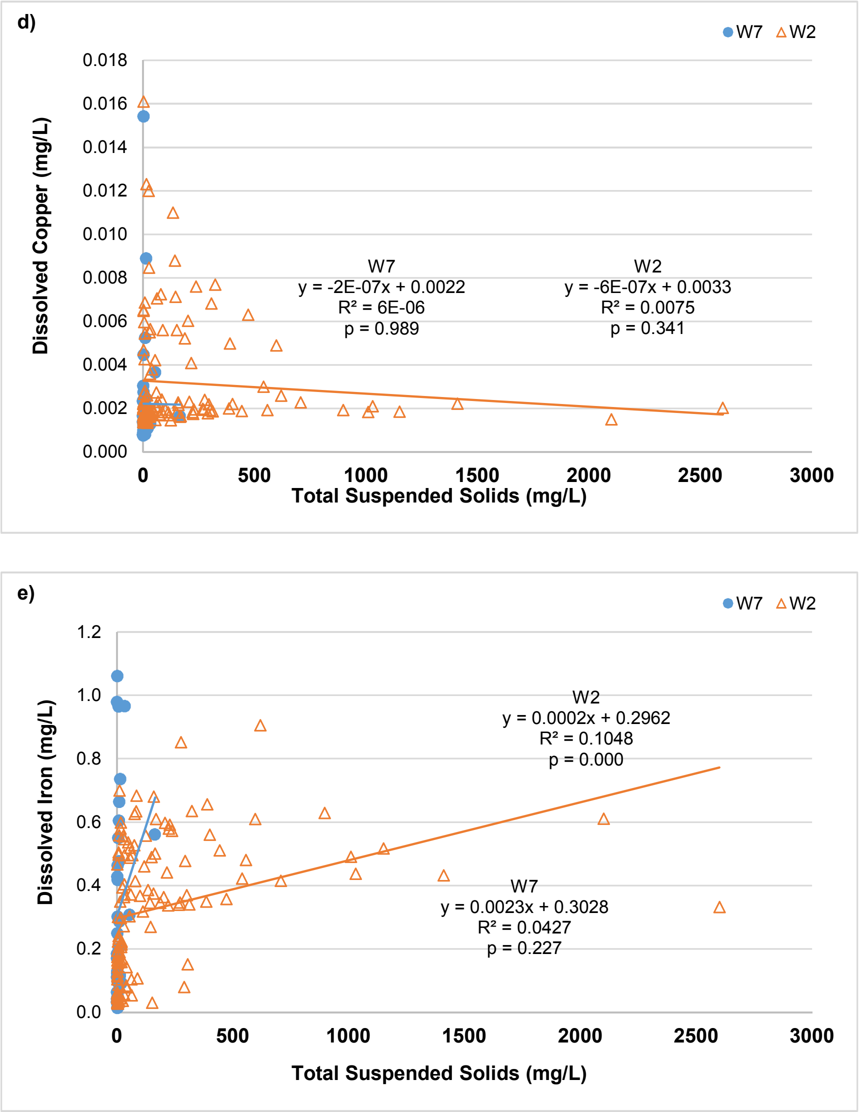


Figure D.4: Regression relationships between total suspended solids and d) dissolved copper and c) dissolved iron. Orange triangles represent area W2 and blue circles represent area W7.

MINNOW ENVIRONMENTAL INC.
ATTN: Lisa Bowron
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 15-SEP-14
Report Date: 29-SEP-14 15:49 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: **L1517600**
Project P.O. #: NOT SUBMITTED
Job Reference: MINNOW PROJECT 2537
C of C Numbers: 1
Legal Site Desc:

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517600-1	L1517600-2
	Description	Water	Water
	Sampled Date	10-SEP-14	11-SEP-14
	Sampled Time		
	Client ID	LMC	LWC
Grouping	**Analyte**		
WATER			
Physical Tests	Conductivity (uS/cm)	330	184
	Hardness (as CaCO3) (mg/L)	180	91.1
	pH (pH)	8.18	7.97
	Total Suspended Solids (mg/L)	3.3	3.3
	Total Dissolved Solids (mg/L)	229	156
	Turbidity (NTU)	1.13	1.38
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	173	84.6
	Ammonia, Total (as N) (mg/L)	0.0056	0.0075
	Chloride (Cl) (mg/L)	1.24	<0.50
	Fluoride (F) (mg/L)	0.384	0.119
	Nitrate (as N) (mg/L)	<0.0050	0.0167
	Nitrite (as N) (mg/L)	<0.0010	<0.0010
	Phosphorus (P)-Total Dissolved (mg/L)	0.0069	0.0072
	Phosphorus (P)-Total (mg/L)	0.0105	0.0068
	Sulfate (SO4) (mg/L)	15.7	15.0
Cyanides	Cyanide, Total (mg/L)	<0.0050	<0.0050
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	9.78 HTP	15.8
	Total Inorganic Carbon (mg/L)		17.5
	Total Organic Carbon (mg/L)	9.71	16.0
Total Metals	Aluminum (Al)-Total (mg/L)	0.0358	0.118
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00057	0.00050
	Barium (Ba)-Total (mg/L)	0.0585	0.0378
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050
	Boron (B)-Total (mg/L)	<0.010	0.014
	Cadmium (Cd)-Total (mg/L)	<0.000010	<0.000010
	Calcium (Ca)-Total (mg/L)	43.1	19.9
	Chromium (Cr)-Total (mg/L)	0.00029	0.00084
	Cobalt (Co)-Total (mg/L)	<0.00010	0.00013
	Copper (Cu)-Total (mg/L)	0.00157	0.00258
	Iron (Fe)-Total (mg/L)	0.243	0.287
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050
	Lithium (Li)-Total (mg/L)	0.00109	0.00137
	Magnesium (Mg)-Total (mg/L)	14.7	10.5
	Manganese (Mn)-Total (mg/L)	0.00634	0.0118

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517600-1	L1517600-2			
	Description	Water	Water			
	Sampled Date	10-SEP-14	11-SEP-14			
	Sampled Time					
	Client ID	LMC	LWC			
Grouping	**Analyte**					
WATER						
Total Metals	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Total (mg/L)	0.00141	0.000476			
	Nickel (Ni)-Total (mg/L)	0.00100	0.00186			
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30			
	Potassium (K)-Total (mg/L)	1.31	0.621			
	Selenium (Se)-Total (mg/L)	<0.00010	0.00011			
	Silicon (Si)-Total (mg/L)	6.18	5.44			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	8.44	6.38			
	Strontium (Sr)-Total (mg/L)	0.389	0.175			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
	Uranium (U)-Total (mg/L)	0.00150	0.000611			
	Vanadium (V)-Total (mg/L)	<0.0010	0.0015			
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030			
Dissolved Metals	Dissolved Mercury Filtration Location	FIELD	FIELD			
	Dissolved Metals Filtration Location	FIELD	FIELD			
	Aluminum (Al)-Dissolved (mg/L)	0.0086	0.0300			
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Dissolved (mg/L)	0.00053	0.00046			
	Barium (Ba)-Dissolved (mg/L)	0.0616	0.0350			
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050	<0.00050			
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010			
	Cadmium (Cd)-Dissolved (mg/L)	<0.000010	<0.000010			
	Calcium (Ca)-Dissolved (mg/L)	46.4	19.5			
	Chromium (Cr)-Dissolved (mg/L)	0.00022	0.00050			
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Dissolved (mg/L)	0.00151	0.00218			
	Iron (Fe)-Dissolved (mg/L)	0.167	0.147			
	Lead (Pb)-Dissolved (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Dissolved (mg/L)	0.00123	0.00176			
	Magnesium (Mg)-Dissolved (mg/L)	15.6	10.3			
	Manganese (Mn)-Dissolved (mg/L)	0.00341	0.00849			
	Mercury (Hg)-Dissolved (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Dissolved (mg/L)	0.00142	0.000448			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517600-1	L1517600-2			
	Description	Water	Water			
	Sampled Date	10-SEP-14	11-SEP-14			
	Sampled Time					
	Client ID	LMC	LWC			
Grouping	**Analyte**					
WATER						
Dissolved Metals	Nickel (Ni)-Dissolved (mg/L)	0.00108	0.00174			
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30			
	Potassium (K)-Dissolved (mg/L)	1.33	0.647			
	Selenium (Se)-Dissolved (mg/L)	0.00010	<0.00010			
	Silicon (Si)-Dissolved (mg/L)	6.39	5.23			
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Dissolved (mg/L)	8.73	6.49			
	Strontium (Sr)-Dissolved (mg/L)	0.394	0.171			
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010			
	Uranium (U)-Dissolved (mg/L)	0.00146	0.000553			
	Vanadium (V)-Dissolved (mg/L)	<0.0010	<0.0010			
	Zinc (Zn)-Dissolved (mg/L)	<0.0010	<0.0010			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1517600-1	LMC	WSMT	Water sample(s) for total mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Total Organic Carbon	MS-B	L1517600-1, -2
Matrix Spike	Dissolved Organic Carbon	MS-B	L1517600-2
Matrix Spike	Phosphorus (P)-Total	MS-B	L1517600-1, -2
Matrix Spike	Silicon (Si)-Total	MS-B	L1517600-1, -2
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1517600-1, -2
Matrix Spike	Barium (Ba)-Total	MS-B	L1517600-1, -2
Matrix Spike	Sodium (Na)-Total	MS-B	L1517600-1, -2
Matrix Spike	Strontium (Sr)-Total	MS-B	L1517600-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
HTP	Sample preparation or preservation hold time was exceeded.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-CL-IC-WR	Water	Chloride by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-F-IC-WR	Water	Fluoride by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-NO2-IC-WR	Water	Nitrite Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-NO3-IC-WR	Water	Nitrate Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-SO4-IC-WR	Water	Sulphate by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

Reference Information

CARBONS-TIC-VA Water Total inorganic carbon by CO2 purge APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CARBONS-TOC-VA Water Total organic carbon by combustion APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

CN-T-CFA-VA Water Total Cyanide in water by CFA ISO 14403:2002

This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.

EC-PCT-VA Water Conductivity (Automated) APHA 2510 Auto. Conduc.

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using a conductivity electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-DIS-LOW-CVAFS-VA Water Dissolved Mercury in Water by CVAFS(Low) EPA SW-846 3005A & EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by filtration (EPA Method 3005A) and involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

HG-TOT-LOW-CVAFS-VA Water Total Mercury in Water by CVAFS(Low) EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-DIS-ICP-VA Water Dissolved Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-TOT-ICP-VA Water Total Metals in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA Water Total P in Water by Colour APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

P-TD-COL-VA Water Total Dissolved P in Water by Colour APHA 4500-P Phosphorous

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

TDS-VA	Water	Total Dissolved Solids by Gravimetric	APHA 2540 C - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Dissolved Solids (TDS) are determined by filtering a sample through a glass fibre filter, TDS is determined by evaporating the filtrate to dryness at 180 degrees celsius.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 "Turbidity"

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

TURBIDITY-VA	Water	Turbidity by Meter	APHA 2130 Turbidity

This analysis is carried out using procedures adapted from APHA Method 2130 "Turbidity". Turbidity is determined by the nephelometric method.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

ALS Environmental

Chain of Custody / Analytical Requ
Canada Toll Free: 1 800 668 9
www.alsglobal.com

L1517600-COFC

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Page 1 of 1

Report To			
Company:	Minnow Environmental Inc.		
Contact:	Lisa Bowron		
Address:	101 - 1025 Hillside Ave. Victoria, BC		
Phone:	(250)595-1627 x21	Fax:	(250) 595-1625
Invoice To	Same as Report ?	☐ Yes	☑ No
Hardcopy of Invoice with Report?		☑ Yes	☐ No
Company:	Minto Explorations Ltd		
Contact:	Elvina Wong		
Address:	Suite 900-999 West Hastings St., Vancouver, BC		
Phone:	604-684-8894	Fax:	604-688-2120
Lab Work Order # (lab use only)	L1517600		

Report Format / Distribution

☑ Standard ☐ Other

☑ PDF ☑ Excel ☐ Digital ☐ Fax

Email 1: lbowron@minnow.ca

Email 2: pstecko@minnow.ca

Email 3:

Client / Project Information

Job #: Minnow Project 2537

PO / AFE:

LSD:

Quote #: Q41650

ALS Contact: Can Dang **Sampler:** Lisa Bowron

...alysis subject to availability)

● Regular (Standard Turnaround Times - Business Days)

○ Priority (2-4 Business Days) - 50% Surcharge - Contact ALS to Confirm TAT

○ Emergency (1-2 Bus. Days) - 100% Surcharge - Contact ALS to Confirm TAT

○ Same Day or Weekend Emergency - Contact ALS to Confirm TAT

Analysis Request

Please indicate below Filtered, Preserved or both (F, P, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Metals by CCMS & ICPOES	Mercury by CVAFS (Low)	Alkalinity by Auto Titration	Phosphorus in water by colour	Organic/Inorganic Carbon	Cyanide	Conductivity, Hardness and pH	TDS & TSS by Gravimetric	Turbidity by Meter	Anions by Ion Chromatography	Ammonia by Fluorescence	**See Complete Quote #Q41650	Number of Containers
	LMC	Sept 10/14		Water	X	X	X	X	X	X	X	X	X	X	X		8
	LWC	Sept 11/14		Water	X	X	X	X	X	X	X	X	X	X	X		10
							no TIC for LMC - Sep 10/14										

Special Instructions / Regulations with water or land use (CCME-Freshwater Aquatic Life/BC CSR - Commercial/AB Tier 1 - Natural, etc) / Hazardous Details

Small samples. The critical analyte of interest is selenium; please ensure best possible MDLs.

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as provided on a separate Excel tab.

Also provided on another Excel tab are the ALS location addresses, phone numbers and sample container / preservation / holding time table for common analyses.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date (dd-mmm-yy)	Time (hh-mm)	Received by:	Date:	Time:	Temperature:	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF
Lisa Bowron	12-Sept-14	8:00am		15-Sep/14	9:30	°C	1.1			

GENF 20.00 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Pierre Stecko
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 15-SEP-14
Report Date: 26-SEP-14 10:42 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1517681

Project P.O. #:	NOT SUBMITTED
Job Reference:	2535
C of C Numbers:	10-385704
Legal Site Desc:	

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517681-1	L1517681-2	L1517681-3	L1517681-4	L1517681-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	10-SEP-14	10-SEP-14	11-SEP-14	11-SEP-14	11-SEP-14
	Sampled Time					
	Client ID	NRC-1	NRC-2	NRC-3	NRC-4	NRC-4Z
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	97.0	40.0	90.7	131	129
	pH (pH)	7.99	7.65	7.91	8.05	8.07
	Total Suspended Solids (mg/L)	7.3	8.7	<3.0	4.0	9.3
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	94.7	32.8	61.3	83.9	81.0
	Ammonia, Total (as N) (mg/L)	0.0061	0.0188	<0.0050	0.0084	0.0111
	Nitrate (as N) (mg/L)	0.0723	0.104	0.335	0.0693	0.0699
	Total Kjeldahl Nitrogen (mg/L)	0.467	0.477	0.283	0.184	0.175
	Orthophosphate-Dissolved (as P) (mg/L)	0.0024	0.0130	<0.0010	0.0026	0.0025
	Phosphorus (P)-Total (mg/L)	0.0197	0.0373	0.0074	0.0115	0.0117
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	13.2	14.0	8.27	4.19	3.87
Total Metals	Aluminum (Al)-Total (mg/L)	0.159	0.395	0.0752	0.0735	0.0773
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Total (mg/L)	0.00057	0.00067	0.00020	0.00038	0.00027
	Barium (Ba)-Total (mg/L)	0.0629	0.0454	0.0651	0.0527	0.0516
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	<0.000010	0.000012	<0.000010	0.000011	0.000033
	Calcium (Ca)-Total (mg/L)	28.9	10.2	25.9	33.8	33.4
	Chromium (Cr)-Total (mg/L)	0.00061	0.00118	0.00031	0.00029	0.00029
	Cobalt (Co)-Total (mg/L)	0.00021	0.00070	<0.00010	0.00011	<0.00010
	Copper (Cu)-Total (mg/L)	0.00162	0.00335	0.00176	0.00081	0.00071
	Iron (Fe)-Total (mg/L)	0.437	1.27	0.098	0.173	0.177
	Lead (Pb)-Total (mg/L)	0.000070	0.000154	<0.000050	0.000080	0.000078
	Lithium (Li)-Total (mg/L)	0.00092	0.00074	0.00058	0.00555	0.00549
	Magnesium (Mg)-Total (mg/L)	6.04	3.54	6.33	11.4	11.2
	Manganese (Mn)-Total (mg/L)	0.0370	0.101	0.00844	0.0239	0.0206
	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Molybdenum (Mo)-Total (mg/L)	0.000259	0.000758	0.000442	0.000787	0.000767
	Nickel (Ni)-Total (mg/L)	0.00121	0.00142	<0.00050	0.00057	0.00056
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	<0.050
	Potassium (K)-Total (mg/L)	1.40	0.56	1.01	1.52	1.46
	Selenium (Se)-Total (mg/L)	<0.00010	0.00010	<0.00010	0.00056	0.00058
	Silicon (Si)-Total (mg/L)	7.61	6.86	4.31	6.93	6.83
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	4.90	3.18	2.79	4.76	4.62

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1517681-1	L1517681-2	L1517681-3	L1517681-4	L1517681-5
	Description	Water	Water	Water	Water	Water
	Sampled Date	10-SEP-14	10-SEP-14	11-SEP-14	11-SEP-14	11-SEP-14
	Sampled Time					
	Client ID	NRC-1	NRC-2	NRC-3	NRC-4	NRC-4Z
WATER						
Total Metals	Strontium (Sr)-Total (mg/L)	0.163	0.0596	0.225	0.173	0.172
	Sulfur (S)-Total (mg/L)	2.67	1.96	4.62	16.1	16.0
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.010	0.017	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	0.000268	0.000075	0.000439	0.00101	0.00101
	Vanadium (V)-Total (mg/L)	0.0013	0.0023	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Sample Submission Listed:

Qualifier	Description
WSMT	Water sample(s) for total mercury analysis was not submitted in glass or PTFE container with HCl preservative. Results may be biased low.

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Phosphorus (P)-Total	MS-B	L1517681-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Total	MS-B	L1517681-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Total	MS-B	L1517681-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Total	MS-B	L1517681-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-NO3-IC-WR	Water	Nitrate Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-TOT-LOW-CVAFS-VA	Water	Total Mercury in Water by CVAFS(Low)	EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-LOW-ICP-VA	Water	Total Metals in Water by ICPOES	EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

ALS Test Code	Matrix	Test Description	Method Reference**
P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

Reference Information

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

S-TOT-ICP-VA	Water	Total Sulfur in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

TKN-F-VA	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-385704

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

10- 385704

ALS Environmental

Chain of Custody / Analytica
Canada Toll Free: 1 80(
www.alsglobal.cc

L1517681-COFC

Page 1 of 1

Report To
Company: Minnow Environmental
Contact: Pierre Stecko
Address: 101 - 1025 Hillside Ave.
Victoria BC
Phone: 250-595-1627 Fax: 250-595-1625

Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
Copy of Invoice with Report? (circle) [✓ Yes] or No
Company:
Contact:
Address:
Phone: Fax:

Lab Work Order # (lab use only)

Report Format / Distribution
Standard: ✓ Other (specify):
Select: PDF ✓ Excel ✓ Digital Fax
Email 1: pstecko@minnow.ca
Email 2:

Client / Project Information
Job #: 2535
PO / AFE:
LSD:
Quote #:

ALS Contact: Can Dang
Sampler: Pierre Stecko

Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
☐ Regular (Standard Turnaround Times - Business Days)
☐ Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
☐ Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
☐ Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alk, pH, TSS	hardness	Total metals	TOC	Ammonia, TKN, TP	Nitrate, Phosphate							Number of Containers
	NRC-1	Sept 10		water	✓	✓	✓	✓	✓	✓							5
	NRC-2	Sept 10		water	✓	✓	✓	✓	✓	✓							5
	NRC-3	Sept 11		water	✓	✓	✓	✓	✓	✓							5
	NRC-4	Sept 11		water	✓	✓	✓	✓	✓	✓							5
	NRC-4Z	Sept 11		water	✓	✓	✓	✓	✓	✓							5

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date: Sept 12 '14	Time: 07:30	Received by:	Date: 15-Sep/14	Time: 9:30	Temperature: 4.1 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

GENF 18.01 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Pierre Stecko
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 12-SEP-14
Report Date: 23-SEP-14 11:53 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1517190

Project P.O. #: NOT SUBMITTED
Job Reference: 2535
C of C Numbers: 10-385707
Legal Site Desc:

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517190-1	L1517190-2	L1517190-3	L1517190-4	
	Description	Water	Water	Water	Water	
	Sampled Date	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	
	Sampled Time					
	Client ID	UMC-1	UMC-2	UMC-3	LMC-1	
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	233	236	233	164	
	pH (pH)	8.21	8.29	8.28	8.33	
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	<3.0	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	221	222	225	173	
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	3.1	
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<1.0	<1.0	<1.0	<1.0	
	Alkalinity, Total (as CaCO3) (mg/L)	221	223	225	176	
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050	<0.0050	
	Nitrate (as N) (mg/L)	0.288	0.294	0.295	0.0463	
	Total Kjeldahl Nitrogen (mg/L)	0.187	0.161	0.158	0.328	
	Phosphorus (P)-Total Dissolved (mg/L)	0.0036	0.0039	0.0042	0.0070	
	Phosphorus (P)-Total (mg/L)	0.0059	0.0061	0.0076	0.0142	
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	4.96	4.36	4.17	9.82	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0095	0.0130	0.0178	0.0470	
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Arsenic (As)-Total (mg/L)	0.00030	0.00031	0.00030	0.00061	
	Barium (Ba)-Total (mg/L)	0.0801	0.0812	0.0786	0.0562	
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Boron (B)-Total (mg/L)	0.017	0.020	0.019	<0.010	
	Cadmium (Cd)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Calcium (Ca)-Total (mg/L)	53.9	54.4	53.8	42.2	
	Chromium (Cr)-Total (mg/L)	0.00014	0.00014	0.00017	0.00039	
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010	<0.00010	0.00011	
	Copper (Cu)-Total (mg/L)	0.00187	0.00176	0.00174	0.00156	
	Iron (Fe)-Total (mg/L)	0.036	0.036	0.051	0.315	
	Lead (Pb)-Total (mg/L)	0.000065	0.000072	<0.000050	<0.000050	
	Lithium (Li)-Total (mg/L)	0.00231	0.00236	0.00225	0.00130	
	Magnesium (Mg)-Total (mg/L)	23.9	24.2	23.9	14.1	
	Manganese (Mn)-Total (mg/L)	0.0229	0.0237	0.0245	0.00912	
	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Molybdenum (Mo)-Total (mg/L)	0.00332	0.00324	0.00322	0.00136	
	Nickel (Ni)-Total (mg/L)	0.00054	0.00052	0.00056	0.00115	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Total (mg/L)	2.11	2.14	2.06	1.30	
	Selenium (Se)-Total (mg/L)	0.00025	0.00026	0.00024	0.00011	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517190-1	L1517190-2	L1517190-3	L1517190-4	
	Description	Water	Water	Water	Water	
	Sampled Date	09-SEP-14	09-SEP-14	09-SEP-14	09-SEP-14	
	Sampled Time					
	Client ID	UMC-1	UMC-2	UMC-3	LMC-1	
Grouping	**Analyte**					
WATER						
Total Metals	Silicon (Si)-Total (mg/L)	5.58	5.65	5.62	6.04	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Total (mg/L)	15.4	15.8	15.5	8.43	
	Strontium (Sr)-Total (mg/L)	0.724	0.736	0.726	0.415	
	Sulfur (S)-Total (mg/L)	15.0	15.2	14.8	4.94	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Total (mg/L)	0.00015	0.00016	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	0.00267	0.00268	0.00266	0.00145	
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Silicon (Si)-Total	MS-B	L1517190-1, -2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1517190-1, -2, -4
Matrix Spike	Nitrate (as N)	MS-B	L1517190-1, -2, -3, -4
Matrix Spike	Barium (Ba)-Total	MS-B	L1517190-1, -2, -3, -4
Matrix Spike	Manganese (Mn)-Total	MS-B	L1517190-1, -2, -3, -4
Matrix Spike	Sodium (Na)-Total	MS-B	L1517190-1, -2, -3, -4
Matrix Spike	Strontium (Sr)-Total	MS-B	L1517190-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

HG-TOT-LOW-CVAFS-VA	Water	Total Mercury in Water by CVAFS(Low)	EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-TOT-LOW-ICP-VA	Water	Total Metals in Water by ICPOES	EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

P-TD-COL-VA	Water	Total Dissolved P in Water by Colour	APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

Reference Information

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

S-TOT-ICP-VA	Water	Total Sulfur in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

TKN-F-VA	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-VA	Water	Total Suspended Solids by Gravimetric	APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-385707

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

L1517190-COFC

10- 385707

ALS

Chain of Custody / Analytical Request Form
Canada Toll Free: 1 800 668 9878
www.alsglobal.com

Page 1 of 1

Report To	**Report Format / Distribution**	**Service Request:**(Rush subject to availability - Contact ALS to confirm TAT)
Company: Minnow Environmental	Standard: ✓ Other (specify):	☐ Regular (Standard Turnaround Times - Business Days)
Contact: Pierre Stecko	Select: PDF ✓ Excel ✓ Digital Fax	☐ Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address: 101 - 1025 Hillside Ave.	Email 1: pstecko@minnow.ca	☐ Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
Victoria BC	Email 2:	☐ Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone: 250 595-1627 Fax: 250 595-1625		**Analysis Request**
Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)	**Client / Project Information**	(Indicate Filtered or Preserved, F/P)
Copy of Invoice with Report? (circle) [✓ Yes] or No	Job #: 2535	
Company:	PO / AFE:	
Contact:	LSD:	
Address:		
Phone: Fax:	Quote #:	
Lab Work Order # (lab use only)	**ALS Contact:** **Sampler:**	

Sample #	**Sample Identification** (This description will appear on the report)	**Date** (dd-mmm-yy)	**Time** (hh:mm)	**Sample Type**	AIK, pH, TSS	hardness,	P Metals	P TOC	P Ammonia, TKN, TP	Nitrate, Phosphate							Number of Containers
	UMC - 1	Sept 9 14		water	✓	✓	✓	✓	✓	✓							6
	UMC - 2	Sept 9 14		water	✓	✓	✓	✓	✓	✓							6
	UMC - 3	Sept 9 14		water	✓	✓	✓	✓	✓	✓							6
	LMC - 1	Sept 9 14		water	✓	✓	✓	✓	✓	✓							6

Short Holding Time

Rush Processing

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date: Sept 10	Time: 07:00	Received by:	Date:	Time:	Temperature: °C	Verified by: DJ	Date: Sep12/14	Time: 14:55	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

6.5°C

GENF 18.01 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Pierre Stecko
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 15-SEP-14
Report Date: 29-SEP-14 11:23 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1518163
Project P.O. #: NOT SUBMITTED
Job Reference: 2535
C of C Numbers: 10-385706
Legal Site Desc:

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518163-1	L1518163-2	L1518163-3	L1518163-4	
	Description	Water	Water	Water	Water	
	Sampled Date	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	
	Sampled Time					
	Client ID	UWC-1	URC-1	NRC-8	NRC-8 Z	
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	54.2	78.9	173	174	
	pH (pH)	7.87	8.00	8.30	8.32	
	Total Suspended Solids (mg/L)	<3.0	<3.0	<3.0	<3.0	
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	62.8	72.6	144	146	
	Ammonia, Total (as N) (mg/L)	0.0092	0.0062	<0.0050	<0.0050	
	Nitrate (as N) (mg/L)	0.0138	0.0566	0.152	0.152	
	Total Kjeldahl Nitrogen (mg/L)	0.486	0.348	0.147	0.137	
	Orthophosphate-Dissolved (as P) (mg/L)	<0.0010	0.0095	<0.0010	<0.0010	
	Phosphorus (P)-Total (mg/L)	0.0047	0.0113	<0.0020	<0.0020	
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	18.6	12.4	3.90	3.80	
Total Metals	Aluminum (Al)-Total (mg/L)	0.0963	0.0256	0.0229	0.0251	
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00019	0.00017	
	Arsenic (As)-Total (mg/L)	0.00026	0.00056	0.00079	0.00078	
	Barium (Ba)-Total (mg/L)	0.00870	0.0330	0.0660	0.0667	
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Cadmium (Cd)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Calcium (Ca)-Total (mg/L)	11.7	21.7	42.0	42.4	
	Chromium (Cr)-Total (mg/L)	0.00073	0.00042	0.00017	0.00010	
	Cobalt (Co)-Total (mg/L)	0.00018	0.00011	<0.00010	<0.00010	
	Copper (Cu)-Total (mg/L)	0.00154	0.00119	0.00062	0.00063	
	Iron (Fe)-Total (mg/L)	0.384	0.538	0.114	0.115	
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050	<0.000050	
	Lithium (Li)-Total (mg/L)	<0.00050	<0.00050	0.00174	0.00177	
	Magnesium (Mg)-Total (mg/L)	6.10	6.00	16.5	16.6	
	Manganese (Mn)-Total (mg/L)	0.0188	0.0334	0.0230	0.0231	
	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Molybdenum (Mo)-Total (mg/L)	0.000804	0.00106	0.000294	0.000311	
	Nickel (Ni)-Total (mg/L)	0.00089	0.00105	<0.00050	<0.00050	
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050	<0.050	
	Potassium (K)-Total (mg/L)	0.14	0.58	0.66	0.65	
	Selenium (Se)-Total (mg/L)	<0.00010	0.00031	0.00024	0.00026	
	Silicon (Si)-Total (mg/L)	6.47	6.28	2.88	2.90	
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Sodium (Na)-Total (mg/L)	7.82	4.04	1.28	1.28	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518163-1	L1518163-2	L1518163-3	L1518163-4	
	Description	Water	Water	Water	Water	
	Sampled Date	13-SEP-14	13-SEP-14	13-SEP-14	13-SEP-14	
	Sampled Time					
	Client ID	UWC-1	URC-1	NRC-8	NRC-8 Z	
Grouping	**Analyte**					
WATER						
Total Metals	Strontium (Sr)-Total (mg/L)	0.142	0.146	0.193	0.191	
	Sulfur (S)-Total (mg/L)	1.00	3.91	10.4	10.2	
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	
	Uranium (U)-Total (mg/L)	0.000265	0.000462	0.000913	0.000932	
	Vanadium (V)-Total (mg/L)	0.0021	<0.0010	<0.0010	<0.0010	
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030	<0.0030	

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Bismuth (Bi)-Total	DLA	L1518163-1, -2, -3, -4
Matrix Spike	Orthophosphate-Dissolved (as P)	MS-B	L1518163-1, -2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1518163-2, -3, -4
Matrix Spike	Total Organic Carbon	MS-B	L1518163-1
Matrix Spike	Calcium (Ca)-Total	MS-B	L1518163-1, -2, -3, -4
Matrix Spike	Silicon (Si)-Total	MS-B	L1518163-1, -2, -3, -4
Matrix Spike	Phosphorus (P)-Total	MS-B	L1518163-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 "Alkalinity"

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-PCT-VA	Water	Alkalinity by Auto. Titration	APHA 2320 Alkalinity

This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-NO3-IC-WR	Water	Nitrate Nitrogen by Ion Chromatography	EPA 300.1

This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-TOT-LOW-CVAFS-VA	Water	Total Mercury in Water by CVAFS(Low)	EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-LOW-ICP-VA	Water	Total Metals in Water by ICPOES	EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

ALS Test Code	Matrix	Test Description	Method Reference**
P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

S-TOT-ICP-VA	Water	Total Sulfur in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

TKN-F-VA	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	**Laboratory Location**
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-385706

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

10- 385706

ALS Environmental

Chain of Custody / Analytical Re
Canada Toll Free: 1 800 66
www.alsglobal.com

L1518163-COFC

Page 1 of 1

Report To
Company: Minnow Environmental
Contact: Pierre Stecko
Address: 101 - 1025 Hillside Ave.
Victoria BC V8R 3J2
Phone: 250-595-1627 Fax: 250 595 - 1625

Report Format / Distribution
Standard: ✓ Other (specify):
Select: PDF ✓ Excel ✓ Digital Fax
Email 1: pstecko@minnow.ca
Email 2:

Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
☐ Regular (Standard Turnaround Times - Business Days)
☐ Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
☐ Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
☐ Same Day or Weekend Emergency - Contact ALS to confirm TAT.

Invoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
Copy of Invoice with Report? (circle) [✓ Yes] or No
Company:
Contact:
Address:
Phone: Fax:

Client / Project Information
Job #: 2535
PO / AFE:
LSD:
Quote #:

Lab Work Order # (lab use only)

ALS Contact: Cam Dang
Sampler: Pierre Stecko

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alk, pH, TSS	hardness	Total Metals	TOC	Ammonia, TKN, TP	Nitrate, Phosphate								Number of Containers
							P		P									
	UWC-1	Sept13'14		water	✓	✓	✓	✓	✓	✓								5
	URC-1	Sept13'14		water	✓	✓	✓	✓	✓	✓								5
	NRC-8	Sept13'14		water	✓	✓	✓	✓	✓	✓								5
	NRC-8Z	Sept13'14		water	✓	✓	✓	✓	✓	✓								5

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date: Sept14/14	Time: 08:00	Received by:	Date: 16-Sep-14	Time: 5:15	Temperature: 5.0, 5.4 4.4, 4.4°C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

GENF 18.01 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Pierre Stecko
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 15-SEP-14
Report Date: 26-SEP-14 15:39 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: L1518236

Project P.O. #:	NOT SUBMITTED
Job Reference:	2535
C of C Numbers:	10-385705
Legal Site Desc:	

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518236-1	L1518236-2			
	Description	Water	Water			
	Sampled Date	14-SEP-14	14-SEP-14			
	Sampled Time					
	Client ID	NRC-9	NRC-10			
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	316	43.6			
	pH (pH)	8.38	7.87			
	Total Suspended Solids (mg/L)	<3.0	<3.0			
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	270	45.2			
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050			
	Nitrate (as N) (mg/L)	0.0486	0.0155			
	Total Kjeldahl Nitrogen (mg/L)	0.096	0.109			
	Orthophosphate-Dissolved (as P) (mg/L)	0.0036	<0.0010			
	Phosphorus (P)-Total (mg/L)	0.0029	<0.0020			
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	2.09	3.08			
Total Metals	Aluminum (Al)-Total (mg/L)	0.0070	0.0177			
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010			
	Arsenic (As)-Total (mg/L)	0.00048	0.00019			
	Barium (Ba)-Total (mg/L)	0.0881	0.0304			
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010			
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050			
	Boron (B)-Total (mg/L)	0.023	<0.010			
	Cadmium (Cd)-Total (mg/L)	0.000012	<0.000010			
	Calcium (Ca)-Total (mg/L)	84.4	12.7			
	Chromium (Cr)-Total (mg/L)	0.00012	0.00017			
	Cobalt (Co)-Total (mg/L)	<0.00010	<0.00010			
	Copper (Cu)-Total (mg/L)	<0.00050	<0.00050			
	Iron (Fe)-Total (mg/L)	<0.010	0.022			
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050			
	Lithium (Li)-Total (mg/L)	0.0114	0.00116			
	Magnesium (Mg)-Total (mg/L)	25.6	2.90			
	Manganese (Mn)-Total (mg/L)	DLB <0.00035	0.000619			
	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010			
	Molybdenum (Mo)-Total (mg/L)	0.00614	0.00105			
	Nickel (Ni)-Total (mg/L)	<0.00050	<0.00050			
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050			
	Potassium (K)-Total (mg/L)	1.61	0.39			
	Selenium (Se)-Total (mg/L)	0.00280	<0.00010			
	Silicon (Si)-Total (mg/L)	6.33	6.98			
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010			
	Sodium (Na)-Total (mg/L)	7.12	2.75			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1518236-1	L1518236-2			
	Description	Water	Water			
	Sampled Date	14-SEP-14	14-SEP-14			
	Sampled Time					
	Client ID	NRC-9	NRC-10			
Grouping	**Analyte**					
WATER						
Total Metals	Strontium (Sr)-Total (mg/L)	0.563	0.0424			
	Sulfur (S)-Total (mg/L)	20.5	1.86			
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010			
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010			
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010			
	Uranium (U)-Total (mg/L)	0.0264	0.000447			
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010			
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030			

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Bismuth (Bi)-Total	DLA	L1518236-1, -2
Matrix Spike	Orthophosphate-Dissolved (as P)	MS-B	L1518236-1, -2
Matrix Spike	Total Organic Carbon	MS-B	L1518236-1, -2
Matrix Spike	Calcium (Ca)-Total	MS-B	L1518236-1, -2
Matrix Spike	Silicon (Si)-Total	MS-B	L1518236-1, -2
Matrix Spike	Phosphorus (P)-Total	MS-B	L1518236-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLB	Detection Limit was raised due to detection of analyte at comparable level in Method Blank.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

<table>
<tr><th>ALS Test Code</th><th>Matrix</th><th>Test Description</th><th>Method Reference**</th></tr>
<tr><td>ALK-PCT-VA</td><td>Water</td><td>Alkalinity by Auto. Titration</td><td>APHA 2320 "Alkalinity"</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.</td></tr>
<tr><td>ALK-PCT-VA</td><td>Water</td><td>Alkalinity by Auto. Titration</td><td>APHA 2320 Alkalinity</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.</td></tr>
<tr><td>ANIONS-NO3-IC-WR</td><td>Water</td><td>Nitrate Nitrogen by Ion Chromatography</td><td>EPA 300.1</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.</td></tr>
<tr><td>CARBONS-TOC-VA</td><td>Water</td><td>Total organic carbon by combustion</td><td>APHA 5310 TOTAL ORGANIC CARBON (TOC)</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".</td></tr>
<tr><td>HARDNESS-CALC-VA</td><td>Water</td><td>Hardness</td><td>APHA 2340B</td></tr>
<tr><td colspan="4">Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.</td></tr>
<tr><td>HG-TOT-LOW-CVAFS-VA</td><td>Water</td><td>Total Mercury in Water by CVAFS(Low)</td><td>EPA 245.7</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).</td></tr>
<tr><td>MET-T-CCMS-VA</td><td>Water</td><td>Total Metals in Water by CRC ICPMS</td><td>APHA 3030 B&E / EPA SW-846 6020A</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).</td></tr>
<tr><td>MET-TOT-LOW-ICP-VA</td><td>Water</td><td>Total Metals in Water by ICPOES</td><td>EPA 3005A/6010B</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).</td></tr>
<tr><td>NH3-F-VA</td><td>Water</td><td>Ammonia in Water by Fluorescence</td><td>J. ENVIRON. MONIT., 2005, 7, 37-42, RSC</td></tr>
<tr><td colspan="4">This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.</td></tr>
<tr><td>P-T-PRES-COL-VA</td><td>Water</td><td>Total P in Water by Colour</td><td>APHA 4500-P Phosphorus</td></tr>
<tr><td colspan="4">This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.</td></tr>
<tr><td>PH-PCT-VA</td><td>Water</td><td>pH by Meter (Automated)</td><td>APHA 4500-H "pH Value"</td></tr>
</table>

Reference Information

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

PO4-DO-COL-VA	Water	Diss. Orthophosphate in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Dissolved Orthophosphate is determined colourimetrically on a sample that has been lab or field filtered through a 0.45 micron membrane filter.

S-TOT-ICP-VA	Water	Total Sulfur in Water by ICPOES	EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

TKN-F-VA	Water	TKN in Water by Fluorescence	APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-MAN-WR	Water	Total Suspended Solids by Gravimetric	APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-385705

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

10- 385705

ALS Environmental

Chain of Custody / Analytical Request F
Canada Toll Free: 1 800 668 9878
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L1518236-COFC

Page 1 of 1

eport To
ompany: Minnow Environmental
ontact: Pierre Stecko
ddress: 101 - 1625 Hillside Ave
Victoria, BC V8R 3J2
hone: 250-595-1627 Fax: 250-595-1625

nvoice To Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
Copy of Invoice with Report? (circle) [✓ Yes] or No
ompany:
ontact:
ddress:
hone: Fax:

Report Format / Distribution
Standard: ✓ Other (specify):
Select: PDF ✓ Excel ✓ Digital Fax
Email 1: pstecko@minnow.ca
Email 2:

Client / Project Information
Job #: 2535
PO / AFE:
LSD:
Quote #:

Lab Work Order # (lab use only)

ALS Contact: Can Dang **Sampler:** Pierre Stecko

LS to confirm TAT)

	Regular (Standard Turnaround Times - Business Days)
	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request
(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alk, pH, TSS	hardness	Total Metals	TOC	Ammonia, TKN, TP	Nitrate, Phosphate							Number of Containers
	NRC-9	Sept14'14			✓	✓	✓	✓	✓	✓							5
	NRC-10	Sept14'14			✓	✓	✓	✓	✓	✓							5

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date: Sept15'14	Time: 08:00	Received by:	Date: 16-Sep-14	Time: 5:15	Temperature: 5.0,5.4 4.4,4.4 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

GENF 18.01 Front

MINNOW ENVIRONMENTAL INC.
ATTN: Pierre Stecko
101 - 1025 Hillside Ave.
Victoria BC V8T 2A2

Date Received: 14-SEP-14
Report Date: 24-SEP-14 16:12 (MT)
Version: FINAL

Client Phone: 250-595-1627

Certificate of Analysis

Lab Work Order #: **L1517599**
Project P.O. #: NOT SUBMITTED
Job Reference: 2535
C of C Numbers: 10-385703
Legal Site Desc:

Can Dang
Senior Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

	Sample ID	L1517599-1	L1517599-2	L1517599-3		
	Description	water	water	water		
	Sampled Date	12-SEP-14	12-SEP-14	12-SEP-14		
	Sampled Time					
	Client ID	NRC-5	NRC-6	NRC-7		
Grouping	**Analyte**					
WATER						
Physical Tests	Hardness (as CaCO3) (mg/L)	146	297	137		
	pH (pH)	8.36	8.38	8.32		
	Total Suspended Solids (mg/L)	<3.0	3.4	<3.0		
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	176	187	133		
	Ammonia, Total (as N) (mg/L)	<0.0050	<0.0050	<0.0050		
	Nitrate (as N) (mg/L)	0.121	<0.050 DLM	0.0752		
	Total Kjeldahl Nitrogen (mg/L)	0.251	0.259	0.116		
	Phosphorus (P)-Total Dissolved (mg/L)	0.0201	0.0030	<0.0020		
	Phosphorus (P)-Total (mg/L)	0.0180	0.0028	<0.0020		
Organic / Inorganic Carbon	Total Organic Carbon (mg/L)	7.32	9.78	3.26		
Total Metals	Aluminum (Al)-Total (mg/L)	0.0146	0.0266	0.0133		
	Antimony (Sb)-Total (mg/L)	<0.00010	<0.00010	0.00025		
	Arsenic (As)-Total (mg/L)	0.00069	0.00029	0.00063		
	Barium (Ba)-Total (mg/L)	0.0432	0.0502	0.0461		
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050	<0.00050		
	Boron (B)-Total (mg/L)	0.028	<0.010	0.011		
	Cadmium (Cd)-Total (mg/L)	0.000040	0.000016	<0.000010		
	Calcium (Ca)-Total (mg/L)	34.6	71.1	29.6		
	Chromium (Cr)-Total (mg/L)	0.00043	0.00018	0.00033		
	Cobalt (Co)-Total (mg/L)	0.00013	<0.00010	<0.00010		
	Copper (Cu)-Total (mg/L)	0.00069	0.00133	0.00079		
	Iron (Fe)-Total (mg/L)	0.216	0.056	0.026		
	Lead (Pb)-Total (mg/L)	<0.000050	<0.000050	<0.000050		
	Lithium (Li)-Total (mg/L)	0.00171	0.00246	0.00799		
	Magnesium (Mg)-Total (mg/L)	14.4	28.9	15.4		
	Manganese (Mn)-Total (mg/L)	0.0340	0.00274	0.00656		
	Mercury (Hg)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Molybdenum (Mo)-Total (mg/L)	0.00167	0.00247	0.00189		
	Nickel (Ni)-Total (mg/L)	0.00112	0.00298	<0.00050		
	Phosphorus (P)-Total (mg/L)	<0.050	<0.050	<0.050		
	Potassium (K)-Total (mg/L)	0.49	4.00	0.82		
	Selenium (Se)-Total (mg/L)	0.00052	0.00016	0.00028		
	Silicon (Si)-Total (mg/L)	6.35	6.29	7.08		
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010		
	Sodium (Na)-Total (mg/L)	19.3	5.64	5.87		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte					
	Sample ID	L1517599-1	L1517599-2	L1517599-3		
	Description	water	water	water		
	Sampled Date	12-SEP-14	12-SEP-14	12-SEP-14		
	Sampled Time					
	Client ID	NRC-5	NRC-6	NRC-7		
WATER						
Total Metals	Strontium (Sr)-Total (mg/L)	0.598	0.508	0.266		
	Sulfur (S)-Total (mg/L)	2.72	40.0	6.72		
	Thallium (Tl)-Total (mg/L)	0.000012	<0.000010	<0.000010		
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010		
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010		
	Uranium (U)-Total (mg/L)	0.00129	0.00102	0.00255		
	Vanadium (V)-Total (mg/L)	0.0013	<0.0010	<0.0010		
	Zinc (Zn)-Total (mg/L)	<0.0030	<0.0030	<0.0030		

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Method Blank	Manganese (Mn)-Total	MB-LOR	L1517599-3
Matrix Spike	Barium (Ba)-Total	MS-B	L1517599-1, -2
Matrix Spike	Manganese (Mn)-Total	MS-B	L1517599-1, -2
Matrix Spike	Sodium (Na)-Total	MS-B	L1517599-1, -2
Matrix Spike	Strontium (Sr)-Total	MS-B	L1517599-1, -2

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MB-LOR	Method Blank exceeds ALS DQO. Limits of Reporting have been adjusted for samples with positive hits below 5x blank level.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2

This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.

ALS Test Code	Matrix	Test Description	Method Reference**
ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0

This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.

ALS Test Code	Matrix	Test Description	Method Reference**
CARBONS-TOC-VA	Water	Total organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

ALS Test Code	Matrix	Test Description	Method Reference**
HARDNESS-CALC-VA	Water	Hardness	APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO3 equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

ALS Test Code	Matrix	Test Description	Method Reference**
HG-TOT-LOW-CVAFS-VA	Water	Total Mercury in Water by CVAFS(Low)	EPA 245.7

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic fluorescence spectrophotometry or atomic absorption spectrophotometry (EPA Method 245.7).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-T-CCMS-VA	Water	Total Metals in Water by CRC ICPMS	APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

ALS Test Code	Matrix	Test Description	Method Reference**
MET-TOT-LOW-ICP-VA	Water	Total Metals in Water by ICPOES	EPA 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

ALS Test Code	Matrix	Test Description	Method Reference**
NH3-F-VA	Water	Ammonia in Water by Fluorescence	J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Waston et al.

ALS Test Code	Matrix	Test Description	Method Reference**
P-T-PRES-COL-VA	Water	Total P in Water by Colour	APHA 4500-P Phosphorus

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorus is determined colourimetrically after persulphate digestion of the sample.

ALS Test Code	Matrix	Test Description	Method Reference**
P-TD-COL-VA	Water	Total Dissolved P in Water by Colour	APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Dissolved Phosphorus is determined colourimetrically after persulphate digestion of a sample that has been lab or field filtered through a 0.45 micron membrane filter.

ALS Test Code	Matrix	Test Description	Method Reference**
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

Reference Information

It is recommended that this analysis be conducted in the field.

PH-PCT-VA Water pH by Meter (Automated) APHA 4500-H pH Value

This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode

It is recommended that this analysis be conducted in the field.

S-TOT-ICP-VA Water Total Sulfur in Water by ICPOES EPA SW-846 3005A/6010B

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).

Method Limitation: This method will not give total sulfur results for all samples. Sulfide or other volatile forms of sulfur that may be present in submitted samples, is often lost during the sampling, preservation and analysis process. The data reported as total and/or dissolved sulfur represents all non-volatile forms of sulfur present in a particular sample.

TKN-F-VA Water TKN in Water by Fluorescence APHA 4500-NORG D.

This analysis is carried out using procedures adapted from APHA Method 4500-Norg D. "Block Digestion and Flow Injection Analysis". Total Kjeldahl Nitrogen is determined using block digestion followed by Flow-injection analysis with fluorescence detection.

TSS-VA Water Total Suspended Solids by Gravimetric APHA 2540 D - GRAVIMETRIC

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids (TSS) are determined by filtering a sample through a glass fibre filter, TSS is determined by drying the filter at 104 degrees celsius.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

10-385703

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

10- 385703

ALS Environmental

Chain of Custody / Analytical Request Form

Canada Toll Free: 1 800 668 9878

www.alsglobal.com

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Report To	
Company:	Minnow Environmental
Contact:	Pierre Stecko
Address:	101- 1025 Hillside Ave Victoria, BC V8R 3J2
Phone: 250-595-1627	Fax: 250-595-1625
Invoice To	Same as Report ? (circle) [✓ Yes] or No (if No, provide details)
	Copy of Invoice with Report? (circle) [✓ Yes] or No
Company:	
Contact:	
Address:	
Phone:	
Lab Work Order # (lab	

L1517599-COFC

Report Format / Distribution	
Standard: ✓	Other (specify):
Select: PDF ✓ Excel ✓ Digital Fax	
Email 1:	pstecko@minnow.ca
Email 2:	
Client / Project Information	
Job #:	2535
PO / AFE:	
LSD:	
Quote #:	
ALS Contact: Can Dang	**Sampler:** Pierre Stecko

Service Request (Rush subject to availability - Contact ALS to confirm TAT)	
	Regular (Standard Turnaround Times - Business Days)
	Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
	Same Day or Weekend Emergency - Contact ALS to confirm TAT

Analysis Request

(Indicate Filtered or Preserved, F/P)

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Alk, pH, TSS	hardness	Total Metals	TOC	Ammonia, TKN, TP	Nitrate, Phosphate							Number of Containers
	NRC-5	Sept12-14		water	✓	✓	✓	✓	✓	✓							5
	NRC-6	Sept12-14		water	✓	✓	✓	✓	✓	✓							5
	NRC-7	Sept12-14		water	✓	✓	✓	✓	✓	✓							5

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY.

By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by:	Date: Sept13	Time: 08:30	Received by: RC	Date: Sept 14, 2014	Time: 12:50pm	Temperature: 5.0 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Appendix E

BENTHIC INVERTEBRATE COMMUNITY DATA

Table E.1: Summary of the reference site search process, Minto Mine IOC, September 2014

Search Order	Date	Initial Rank	Watershed Code	Outcome	Notes
1	9/10/2014	1	246	rejected	Looks OK from the air, but no helicopter landing sites.
2		2	241	NRC-1	Can see cobble from air and can land on an old roadway nearby.
3		3	172	NRC-2	Dense overgrowth, could not tell if cobble. Found landing spot about 300m away. Mostly sand, but a few rocky sites.
4		15	122	rejected	No helicopter landing sites.
5		20	115	rejected	Looks OK from the air, but no helicopter landing sites.
6		24	103	rejected	Heli pad for landing. Walked upstream and downstream about 500 m; no cobble - only sand and muck.
7		25	109	rejected	No helicopter landing, but can land near the larger creek. Larger creek has good substrate, but is too large.
8		7	213	rejected	No flow and no cobble.
9		14	344	rejected	No water. Some water downstream, but it is stagnant.
10		13	125	rejected	No water.
11		11	120	rejected	Water not flowing.
12		12	112	possible	Looks OK from the air, but only toe-in landing.
13	9/11/2014	23	33	rejected	Looks OK from the air, but no helicopter landing sites.
14		21	43	rejected	Looks OK from the air (some rocky substrate visible), but no helicopter landing sites.
15		19	298	rejected	Looks OK from the air (some rocky substrate visible), but no helicopter landing sites.
16		16	49	rejected	Does not look great from air, but found landing spot. Walked upstream and downstream about 500 m; no cobble - only sand and muck.
17		17	93	NRC-3	Cobble substrate and a landing site.
18		12	112	NRC-4	Returned due to slim pickings.
19	9/12/2014	36	355	NRC-5	Good cobble; helicopter landing spot.
20		22	352	NRC-6	A little steeper; substrate looks good. Can do a toe-in on the hillside above creek.
21		30	227	rejected	No water flow.
22		51	200	rejected	No water flow.
23		34	195	rejected	Does not look great from air, but found landing spot. Walked to creek - no flow.
24		37	330	NRC-7	Good cobble creek. No landing; could only drop us off.
25		35	107	possible	Lots of rock, but mostly large. Landing spot at edge of large bog.
26	9/13/2014			UWC	Upper Wolverine Creek = reference from last cycle.
27				URC	Upper Reference Creek (McGinty) = reference from last cycle.
28		46	128	rejected	Not much flow and no landing spot.
29		45	124	rejected	Looks OK from the air, but no helicopter landing sites.
30		55	127	rejected	Not much flow and no landing spot.
31		35	107	NRC-8	Returned due to slim pickings.
32	9/14/2014	4	23	NRC-9	Looks OK from air; toe-in drop-off.
33		6	28	rejected	Not much flow and is too close to NRC-9.
34		18	12	rejected	Looks poor from air … gradient too low and substrate muddy.
35		29	17	rejected	Looks OK from the air, but no helicopter landing sites.
36		28	290	rejected	Looks OK from the air and good helicopter landing site. Gravel areas but no cobble.
37		48	287	NRC-10	Good substrate and landing spot. Moved upstream a bit as creek a bit large near marked location.

🟨 yellow highlight indicates a selected reference site

Table E.2: Habitat characteristics of the benthic invertebrate community sampling sites, Minto Mine IOC, September 2014.

Characteristics														Exposure		
		URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
Date / Time		13-Sep-14 11:25	13-Sep-14 9:40	10-Sep-14 9:30	10-Sep-14 12:10	11-Sep-14 13:20	11-Sep-14 16:00	12-Sep-14 9:30	12-Sep-14 12:00	12-Sep-14 15:30	13-Sep-14 15:50	14-Sep-14 9:50	14-Sep-14 12:40	9-Sep-14 12:45	9-Sep-14 10:30	9-Sep-14 9:00
Latitude (dd mm ss.s)		62 39 44.0	62 33 12.8	62 28 32.9	62 43 03.6	62 55 14.7	62 54 38.1	62 33 45.9	62 38 21.9	62 54 06.8	62 59 14.5	63 19 09.6	63 20 06.9	62 37 40.1	62 37 40.0	62 37 40.2
Longitude (ddd mm ss.s)		137 17 00.3	137 33 13.0	137 03 47.4	137 36 02.1	138 17 57.3	137 04 38.0	137 14 44.6	136 09 58.1	136 01 20.8	135 48 23.9	136 43 33.6	137 07 34.8	137 11 42.1	137 11 40.8	137 11 39.8
Watershed Code		-	-	241	172	93	112	355	352	330	107	23	287	-	-	-
Approximate Length of Reach Assessed (m)		15	25	15	10	50	20	20	30	25	20	30	30	20	15	20
Gradient (%)		2.0	2.0	3.0	3.0	2.5	2.0	2.5	2.0	3.0	2.5	3.0	3.0	2.0	2.0	2.5
Water Appearance (clarity/colour)		clear, brown colour	clear, brown colour	clear, slight brown colour	brown colour, some turbidity	brown colour	very slightly brown, clear	clear, slight brown colour	clear, colourless	clear, colourless	very slightly brown, clear	clear, colourless	clear, colourless	slight brown colour	clear, slight brown colour	slight brown colour
Water Velocity (m/s)		0.21	0.22	0.23	0.28	0.23	0.24	0.26	0.18	0.28	0.23	0.12	0.24	0.13	0.16	0.14
Depth (m)	Mean	0.17	0.14	0.15	0.18	0.18	0.18	0.15	0.11	0.12	0.24	0.10	0.22	0.10	0.09	0.08
	Maximum	0.27	0.22	0.2	0.30	0.26	0.58	0.24	0.24	0.42	0.44	0.21	0.34	0.17	0.11	0.14
Width (m)	Wetted	1.0	1.4	1.1	1.0	3.1	1.8	1.1	2.2	2.4	2.4	0.8	3.2	1.1	1.6	1.5
	Bankfull	1.9	2.4	1.4	1.3	3.3	2.3	1.2	2.3	3.3	3.5	2.2	5.6	1.4	2.0	1.8
General Morphology	% pool	0	0	0	0	0	20	20	5	0	0	20	0	10	0	0
	% riffle	30	30	70	30	40	30	30	50	40	40	60	30	30	20	20
	% run	70	70	30	70	60	50	50	45	60	60	20	70	60	80	80
Bank Condition		moderate	moderate	moderate	moderate	stable	moderate	moderate	moderate	moderate	stable	stable	stable	moderate	moderate	moderate
Substrate Coverage	% bedrock	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	% boulder	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	% cobble	50	60	60	40	70	30	30	70	70	90	80	78	50	40	40
	% gravel	30	20	15	50	10	20	30	20	20	10	15	20	20	20	30
	% sand and finer	20	20	25	10	20	50	40	10	10	0	5	0	30	40	30
Instream Cover (% total Surface)	undercut banks	5	5	5	5	5	5	5	5	5	0	2	2	2	5	2
	woody debris	10	5	5	10	5	5	10	10	5	5	5	5	5	5	5
	deep pool	0	0	0	0	0	5	0	0	0	0	0	0	5	0	0
	macrophytes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	boulder	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Overhead Canopy	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	1 - 25	-	-	-	-	-	-	✓	-	-	-	-	-	✓	✓	-
	26 - 50	-	✓	-	-	✓	-	-	-	-	-	-	✓	-	-	✓
	51 - 75	-	-	-	-	-	✓	-	✓	✓	✓	✓	-	✓	-	-
	76 - 100	✓	-	✓	✓	-	-	-	-	-	-	-	-	-	-	-
Macrophyte Coverage	0	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-
	1 - 25	-	-	-	-	-	-	-	-	-	-	-	-	✓	✓	✓
	26 - 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	51 - 75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	76 - 100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aquatic Vegetation (% areal coverage and dominant species)	Emergent	0	0	0	0	0	0	0	0	0	0	0	0	2 (sedges)	2 (horsetail, sedge)	1 (sedge)
	Submergent	0	10 (some aquatic moss)	0	0	0	0	0	0	0	0	0	0	0	0	0
	Floating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Attached Algae	skim (green)	film (green)	5 (green)	0	5 (green)	0	film (green)	skim (green)	skim (green)	film (green/brown)	film (green)	film (green/brown)	1 (green)	0	2 (green)
Periphyton Coverage		1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
Riparian Vegetation (listed in order of descending		alder, willows, spruce, aspen	willow, spruce	alder, willow, spruce	alder, willow, spruce	willow, alder, spruce	willow, alder, spruce	willow, aspen, spruce	alder, spruce, aspen	willow, alder, spruce	alder, willow, spruce	willow, alder, spruce	alder, willow, spruce	willow, alder, spruce	willow, alder, spruce	willow, alder, aspen
Macrophyte type		none	none	none	none	none	none	none	none	none	none	none	none	sedges	horsetail, sedges	sedges
Surrounding Land Use		forested	forested	forested	forested	forested	forested	forested	forested	forested	forested	forested	forested	forested	forested	forested
Evidence of Anthropogenic		none	none	none	none	none	none	none	none	none	none	none	none	mine upstream	mine upstream	mine upstream
General Comments/Notes		-	-	Gradient was 3.5% at sampling riffle.	Gradient was 3.5% at sampling site.	-	-	-	-	Periphyton coverage was almost level 2. Gradient was <3% at sampling site.	-	Gradient went up to 4% within this reach.	Cobble was slightly larger than at other sites.	-	-	-

Table E.3: Benthic invertebrate counts (pooled abundance of 3 hess samples) at the lowest practical level of taxonomic resolution for RCA study, Minto Mine IOC, September 2014. Samples processed in the lab using a 500 µm sieve.

Taxa	URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Ameletidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ameletus	26	1	0	0	8	12	8	0	9	0	60	71	1	2	0
| Family: Baetidae	2	0	0	0	1	0	0	0	1	1	0	2	0	0	0
Baetis	1	0	0	1	4	0	0	0	0	4	0	0	0	0	2
Baetis bicaudatus	0	0	0	0	7	1	0	0	2	14	0	1	0	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	1	0	0	12	0	0	0	0	0
Drunella sp.	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0
| Family: Heptageniidae	1	0	0	0	3	0	2	0	12	2	0	6	0	0	0
Cinygmula sp.	1	0	0	0	0	0	0	0	0	0	0	8	0	0	0
Epeorus hesperus	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0
Epeorus sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Heptagenia	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
Rhithrogena	0	0	0	0	0	0	0	0	5	0	0	3	0	0	0
| Order: Plecoptera	1	6	0	3	0	0	2	1	0	1	8	2	0	0	0
| Family: Capniidae	0	2	0	1	0	0	1	2	1	1	60	4	3	5	6
Capnia sp.	4	0	0	0	0	0	0	0	0	0	11	0	0	0	2
| Family: Chloroperlidae	0	3	0	0	0	0	0	3	20	1	2	6	0	0	0
Suwallia	0	0	0	0	0	1	0	5	1	1	0	14	0	0	0
Sweltsa sp.	0	0	0	0	0	0	0	0	1	1	1	7	0	0	0
| Family: Leuctridae	0	0	0	0	0	0	0	0	2	0	1	1	0	0	0
Despaxia augusta	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0
| Family: Nemouridae	0	0	0	0	0	0	0	0	1	4	0	1	0	0	0
Nemoura	5	49	14	41	0	0	2	0	0	0	1	0	1	1	10
Zapada	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Zapada cinctipes	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Zapada columbiana	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Zapada oregonensis group	0	0	0	0	0	40	0	5	60	13	8	37	0	0	0
| Family: Perlodidae	0	0	0	0	1	4	0	0	0	0	0	0	0	0	0
Diura sp.	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Skwala	0	0	0	0	0	1	0	6	0	0	0	2	0	0	0
| Family: Taeniopterygidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taenionema	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
| Order: Trichoptera	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0
| Family: Apataniidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apatania	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
| Family: Limnephilidae	5	0	1	0	0	2	0	1	2	0	21	1	7	0	8
Chyranda centralis	0	0	0	0	0	0	0	0	0	0	0	0	0	12	0
Ecclisomyia sp.	0	0	0	0	0	1	1	0	2	0	6	3	17	10	24
Psychoglypha	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
| Family: Rhyacophilidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhyacophila	0	0	0	0	0	0	0	0	1	5	0	5	0	0	0
Rhyacophila vofixa group	0	0	0	0	0	0	0	0	5	6	0	0	0	0	0

Table E.3: Benthic invertebrate counts (pooled abundance of 3 hess samples) at the lowest practical level of taxonomic resolution for RCA study, Minto Mine IOC, September 2014. Samples processed in the lab using a 500 µm sieve.

Taxa	URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
| Order: Coleoptera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Chrysomelidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrrhalta sp.	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	2	0	0	0	10	6	0	0	0	0	0	0
| Family: Chironomidae	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diamesa	5	16	20	39	2	82	121	11	16	0	0	8	31	75	158
Pagastia	0	0	0	0	0	0	0	0	0	6	0	125	0	0	0
Pseudodiamesa sp.	3	1	2	0	0	0	7	1	4	0	21	5	9	24	54
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cricotopus	2	0	0	0	0	0	0	0	0	0	0	4	0	0	8
Diplocladius cultriger	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
Eukiefferiella	2	0	0	0	0	0	14	1	0	0	1	6	17	13	70
Hydrobaenus	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Orthocladius complex	0	0	0	0	0	1	0	0	0	79	0	0	4	0	0
Orthocladius lignicola	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Parametriocnemus	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Synorthocladius	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0
| Family: Empididae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chelifera/ Metachela	0	0	0	0	0	13	0	0	0	55	0	7	0	0	0
Clinocera sp.	0	0	0	0	0	0	0	0	0	0	43	5	0	0	0
Hemerodromia sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Oreogeton sp.	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0
| Family: Psychodidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Psychoda sp.	0	0	0	0	1	2	0	0	5	20	23	12	8	27	90
Telmatoscopus sp.	0	0	0	0	0	0	0	0	0	0	0	0	8	42	104
| Family: Simuliidae	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Prosimulium	0	10	4	0	0	0	0	0	0	0	0	0	0	0	0
Simulium	0	0	0	22	0	0	0	0	0	0	0	0	0	1	0
| Family: Tipulidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dicranota	19	2	0	5	0	3	23	0	0	2	0	0	13	54	62
Limnophila sp.	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Ormosia sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Table E.3: Benthic invertebrate counts (pooled abundance of 3 hess samples) at the lowest practical level of taxonomic resolution for RCA study, Minto Mine IOC, September 2014. Samples processed in the lab using a 500 µm sieve.

Taxa	URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
| Order: Lepidoptera	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
| Family: Lebertiidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lebertia	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	0	0	0	1	5	0	77	0	0	0
| Order: Sarcoptiformes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Hydrozetidae	0	0	0	3	0	1	0	0	0	0	52	0	0	16	12
Phylum: Mollusca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Gastropoda	0	0	0	1	0	0	0	0	0	0	2	0	1	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	3	0	0	13	30	0	5	1	46	3	0	7	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	0	0	0	0	3	1	0	0	0	0	2	23	0
Enchytraeus	4	30	0	0	0	0	0	0	0	0	0	0	0	0	40
| Family: Lumbricidae	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
| Family: Naididae	0	0	0	0	0	1	0	0	0	0	0	0	2	0	0
Nais	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Pristina	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
| Family: Tubificidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0

Table E.4: Benthic invertebrate counts (pooled abundance of 3 hess samples) at the Family level of taxonomic resolution for RCA study, Minto Mine, September 2014.Samples processed in the lab using a 500 µm sieve.

Family	URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
Ameletidae	26	1	0	0	8	12	8	0	9	0	60	71	1	2	0
Baetidae	3	0	0	1	12	1	0	0	3	19	0	3	0	0	2
Ephemerellidae	0	0	0	0	0	0	3	0	0	12	0	1	0	0	0
Heptageniidae	2	0	0	0	4	1	2	1	17	2	0	22	0	0	0
| **Order: Plecoptera**	1	6	0	3	0	0	2	1	0	1	8	2	0	0	0
Capniidae	4	2	0	1	0	0	1	2	1	1	71	4	3	5	8
Chloroperlidae	0	3	0	0	0	1	0	8	22	3	3	27	0	0	0
Leuctridae	0	0	0	0	0	0	0	0	2	0	13	1	0	0	0
Nemouridae	5	49	14	41	0	40	2	5	62	19	9	39	1	1	10
Perlodidae	0	0	0	0	1	5	0	6	0	1	0	2	0	0	0
Taeniopterygidae	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
| **Order: Trichoptera**	0	0	0	0	0	0	0	0	0	2	0	0	2	0	0
Apataniidae	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydropsychidae	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Limnephilidae	5	0	1	0	0	3	1	1	4	0	27	4	24	23	32
Rhyacophilidae	0	0	0	0	0	0	0	0	6	11	0	5	0	0	0
Chrysomelidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
| **Order: Diptera**	0	0	0	2	0	0	0	10	6	0	0	0	0	0	0
Chironomidae	23	18	22	43	2	86	144	15	20	85	22	148	64	114	290
Empididae	0	0	0	0	0	13	1	0	0	55	43	25	0	0	0
Psychodidae	0	0	0	0	1	2	0	0	5	20	23	12	16	69	194
Simuliidae	0	10	4	22	1	0	0	0	0	0	0	0	0	1	0
Tipulidae	19	2	0	5	0	3	24	0	0	5	0	0	13	54	62
| **Order: Lepidoptera**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
| **Class: Arachnida**	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hygrobatidae	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Lebertiidae	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Sperchontidae	0	0	0	0	0	0	0	0	1	5	0	77	0	0	0
Hydrozetidae	0	0	0	3	0	1	0	0	0	0	52	0	0	16	12
| **Class: Gastropoda**	0	0	0	1	0	0	0	0	0	0	2	0	1	0	0
Lumbriculidae	3	0	0	13	30	0	5	1	46	3	0	7	0	0	0
Enchytraeidae	4	30	0	0	0	0	3	1	0	0	0	0	2	23	40
Lumbricidae	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0
Naididae	0	0	3	0	0	1	0	1	0	0	0	0	2	0	0
Tubificidae	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0

Table E.5: Benthic invertebrate proportion (pooled abundance of 3 hess samples) at the Family level of taxonomic resolution for RCA study, Minto Mine IOC, September 2014. Samples processed in the lab using a 500 µm sieve.

Family	URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
Ameletidae	26.3	0.8	0.0	0.0	13.6	7.0	4.1	0.0	4.4	0.0	18.0	15.8	0.7	0.6	0.0
Baetidae	3.0	0.0	0.0	0.7	20.3	0.6	0.0	0.0	1.5	7.6	0.0	0.7	0.0	0.0	0.3
Ephemerellidae	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	4.8	0.0	0.2	0.0	0.0	0.0
Heptageniidae	2.0	0.0	0.0	0.0	6.8	0.6	1.0	1.9	8.3	0.8	0.0	4.9	0.0	0.0	0.0
| **Order: Plecoptera**	1.0	4.9	0.0	2.2	0.0	0.0	1.0	1.9	0.0	0.4	2.4	0.4	0.0	0.0	0.0
Capniidae	4.0	1.6	0.0	0.7	0.0	0.0	0.5	3.8	0.5	0.4	21.3	0.9	2.2	1.6	1.2
Chloroperlidae	0.0	2.4	0.0	0.0	0.0	0.6	0.0	15.1	10.7	1.2	0.9	6.0	0.0	0.0	0.0
Leuctridae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	3.9	0.2	0.0	0.0	0.0
Nemouridae	5.1	39.8	31.8	30.4	0.0	23.4	1.0	9.4	30.1	7.6	2.7	8.7	0.7	0.3	1.5
Perlodidae	0.0	0.0	0.0	0.0	1.7	2.9	0.0	11.3	0.0	0.4	0.0	0.4	0.0	0.0	0.0
Taeniopterygidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
| **Order: Trichoptera**	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	1.5	0.0	0.0
Apataniidae	0.0	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hydropsychidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3
Limnephilidae	5.1	0.0	2.3	0.0	0.0	1.8	0.5	1.9	1.9	0.0	8.1	0.9	17.6	7.4	4.9
Rhyacophilidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.9	4.4	0.0	1.1	0.0	0.0	0.0
Chrysomelidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0
| **Order: Diptera**	0.0	0.0	0.0	1.5	0.0	0.0	0.0	18.9	2.9	0.0	0.0	0.0	0.0	0.0	0.0
Chironomidae	23.2	14.6	50.0	31.9	3.4	50.3	73.5	28.3	9.7	34.0	6.6	32.9	47.1	36.9	44.5
Empididae	0.0	0.0	0.0	0.0	0.0	7.6	0.5	0.0	0.0	22.0	12.9	5.6	0.0	0.0	0.0
Psychodidae	0.0	0.0	0.0	0.0	1.7	1.2	0.0	0.0	2.4	8.0	6.9	2.7	11.8	22.3	29.8
Simuliidae	0.0	8.1	9.1	16.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
Tipulidae	19.2	1.6	0.0	3.7	0.0	1.8	12.2	0.0	0.0	2.0	0.0	0.0	9.6	17.5	9.5
| **Order: Lepidoptera**	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
| **Class: Arachnida**	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hygrobatidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
Lebertiidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0
Sperchontidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	2.0	0.0	17.1	0.0	0.0	0.0
Hydrozetidae	0.0	0.0	0.0	2.2	0.0	0.6	0.0	0.0	0.0	0.0	15.6	0.0	0.0	5.2	1.8
| **Class: Gastropoda**	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.7	0.0	0.0
Lumbriculidae	3.0	0.0	0.0	9.6	50.8	0.0	2.6	1.9	22.3	1.2	0.0	1.6	0.0	0.0	0.0
Enchytraeidae	4.0	24.4	0.0	0.0	0.0	0.0	1.5	1.9	0.0	0.0	0.0	0.0	1.5	7.4	6.1
Lumbricidae	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	0.0	0.0
Naididae	0.0	0.0	6.8	0.0	0.0	0.6	0.0	1.9	0.0	0.0	0.0	0.0	1.5	0.0	0.0
Tubificidae	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table E.6: List of 65 environmental variables used for RCA study, Minto Mine IOC, September 2014.

Category	Sub category	Variable	Variable abbreviation	Units	URC-1	UWC-1	NRC-1	NRC-2	NRC-3	NRC-4	NRC-5	NRC-6	NRC-7	NRC-8	NRC-9	NRC-10	UMC-1	UMC-2	UMC-3
GIS derived morphology from digital elevation model, digitized flow maps and satellite imagery	GIS derived morphology (catchment and stream)	Watershed	BaArea	km^2	13.45	6.42	9.02	10.01	30.96	4.78	22.33	16.29	24.03	3.86	3.31	32.01	11.35	11.35	11.35
		Perimeter	BaPerim	km	16.20	11.83	14.17	12.93	23.79	10.37	20.76	19.24	20.88	9.76	9.57	23.65	16.01	16.01	16.01
		Stream order	StrOrd	Strahler	2	1	2	2	3	2	3	3	3	2	2	3	2	2	2
		Distance from UMC	DtoUMC	km	5.95	20.21	18.24	23.08	65.16	32.08	7.71	52.77	67.20	81.33	80.64	78.91	0.00	0.00	0.00
		Stream density	StrDen	m/km^2	0.72	0.48	0.71	0.75	0.88	0.99	0.71	0.79	0.79	0.74	0.93	0.69	0.73	0.73	0.73
		Sum of stream length	StreLeng	km	9.72	3.08	6.39	7.55	27.26	4.75	15.78	12.86	18.98	2.85	3.10	22.09	8.34	8.34	8.34
		Source elevation	SourEle	m	849	1,239	819	822	970	1,027	900	909	1,028	696	736	1,017	871	871	871
		Change in elevation (source - station)	ChangEle	m	224	220	216	157	310	367	239	283	387	35	126	321	208	208	208
		Site elevation	SiteEle	m	625	1,019	603	665	660	660	661	626	641	661	610	696	663	663	663
		Length of main channel	LeMaChan	m	4,686	3,076	4,408	3,602	6,359	3,921	5,545	6,300	7,427	1,715	1,900	6,909	4,893	4,893	4,893
		Gradient of main channel	PGraMaCh	Ratio (m/m)	4.8	7.2	4.9	4.4	4.9	9.4	4.3	4.5	5.2	2.0	6.6	4.6	4.3	4.3	4.3
		Slope of basin (mean)	SlopeBa	Ratio (m/m)	8.2	9.6	10.4	11.3	16.5	11.7	8.8	7.8	11.7	7.1	3.5	10.2	9.0	9.0	9.0
		Aspect of basin (mean)	AspectBa	Compass Direction	182.5	187.7	123.4	138.9	150.3	212.7	151.9	197.4	159.6	86.0	143.1	157.8	173.8	173.8	173.8
GIS derived from satellite image	GIS derived landcover	20 - Water	OpWater	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.00	0.00	0.00
		32 - Rock/Rubble	Rock	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16	0.00	0.04	0.04	0.04
		33 - Exposed land	ExpLand	Percentage	0.77	0.00	21.06	0.46	0.56	0.00	2.70	0.00	0.00	0.00	2.12	0.00	4.50	4.50	4.50
		40 - Bryoids	Bryoids	Percentage	0.00	0.00	0.00	0.00	1.73	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		51 - Shrub Tall	ShrTall	Percentage	0.24	0.31	0.00	0.00	12.40	39.52	0.08	2.75	1.94	0.17	6.29	17.22	1.07	1.07	1.07
		52 - Shrub Low	ShrLow	Percentage	73.97	81.41	29.64	56.21	54.78	49.07	40.94	10.10	23.95	7.29	67.55	54.58	38.88	38.88	38.88
		82 - Wetland Shrub	ShrWet	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.05	0.00	0.00	3.88	0.00	0.00	0.00	0.00
		100 - Herb	Herb	Percentage	12.81	11.94	39.64	20.92	14.30	2.27	51.54	0.58	0.07	0.00	18.67	2.86	48.12	48.12	48.12
		211 - Coniferous Dense	ConDen	Percentage	0.00	0.00	0.00	0.02	0.00	0.82	0.00	2.53	2.35	1.36	0.00	7.36	0.00	0.00	0.00
		212 - Coniferous Open	ConOpen	Percentage	0.05	0.00	1.30	3.10	1.28	2.14	0.33	61.64	49.83	47.94	0.08	1.06	0.54	0.54	0.54
		213 - Coniferous Sparse	ConSpar	Percentage	12.17	6.35	8.37	19.28	13.78	5.01	3.76	21.29	20.95	42.78	0.25	15.63	6.75	6.75	6.75
		221 - Broadleaf Dense	BrLeDen	Percentage	0.00	0.00	0.00	0.00	0.29	0.89	0.00	0.19	0.20	0.00	0.00	1.26	0.05	0.05	0.05
		222 - Broadleaf Open	BrLeOp	Percentage	0.00	0.00	0.00	0.00	0.11	0.27	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.05	0.05
		232 - Mixedwood Open	MixOpen	Percentage	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.87	0.64	0.27	0.00	0.02	0.00	0.00	0.00
		233 - Mixedwood Sparse	MixSparse	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
GIS derived bedrock classifications from digitized geologic maps	General bedrock type	metamorphic	Meta	Percentage	0.00	0.00	0.00	75.13	99.78	100.00	0.00	100.00	43.65	47.68	0.00	0.00	0.00	0.00	0.00
		plutonic	Plut	Percentage	100.00	1.18	100.00	0.00	0.22	0.00	0.97	0.00	0.00	0.00	10.44	100.00	92.56	92.56	92.56
		sedimentary	Sedi	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	89.56	0.00	0.00	0.00	0.00
		unconsolidated	Uncon	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.32	0.00	0.00	0.00	0.00	0.00
		volcanic	Volan	Percentage	0.00	98.82	0.00	24.87	0.00	0.00	99.03	0.00	56.35	0.00	0.00	0.00	7.44	7.44	7.44
	Particular bedrock type	basalt/breccia/andesite/porphyry/dacite/trachyte	BBAPDT	Percentage	0.00	98.82	0.00	0.00	0.00	0.00	99.03	0.00	56.35	0.00	0.00	0.00	7.44	7.44	7.44
		basalt/tuff/breccia	BTB	Percentage	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		conglo	C	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	89.56	0.00	0.00	0.00	0.00
		granite/quartz monzonite/granodiorite	GQG	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.44	100.00	0.00	0.00	0.00
		granodiorite/diorite/monzodiorite	GDM	Percentage	100.00	0.00	100.00	24.84	0.22	0.00	0.97	0.00	0.00	0.00	0.00	0.00	92.56	92.56	92.56
		marble	Marble	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		orthogneiss	O	Percentage	0.00	0.00	0.00	75.13	82.88	100.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		quartz monzonite/granite/monzonite/syenite	QGMS	Percentage	0.00	1.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		quartzite/qt-ms-schist	QQ	Percentage	0.00	0.00	0.00	0.00	16.91	0.00	0.00	99.98	43.65	47.68	0.00	0.00	0.00	0.00	0.00
		silt/sand/gravel	SSG	Percentage	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.32	0.00	0.00	0.00	0.00	0.00
GIS derived burn scars from digitized maps	Fire History	1950-2009	F5009	Percentage	100.00	11.74	100.00	92.37	100.00	100.00	75.91	99.81	97.29	82.65	99.99	72.15	98.03	98.03	98.03
		1955-2009	F5509	Percentage	100.00	11.74	100.00	92.37	100.00	100.00	75.91	98.49	97.29	82.65	99.99	72.15	98.03	98.03	98.03
		1960-2009	F6009	Percentage	100.00	11.74	100.00	92.37	100.00	100.00	75.91	98.49	97.29	82.65	99.99	72.15	98.03	98.03	98.03
		1965-2009	F6509	Percentage	100.00	11.74	100.00	92.37	100.00	100.00	75.91	98.49	97.29	82.65	99.99	72.15	98.03	98.03	98.03
		1970-2009	F7009	Percentage	100.00	11.74	100.00	92.37	61.10	100.00	75.91	0.00	97.29	82.65	99.99	19.32	98.03	98.03	98.03
		1975-2009	F7509	Percentage	100.00	11.74	100.00	92.37	61.10	96.02	75.91	0.00	97.29	82.65	99.99	19.32	98.03	98.03	98.03
		1980-2009	F8009	Percentage	100.00	11.74	100.00	92.37	61.10	96.02	75.91	0.00	97.29	82.65	99.99	19.32	98.03	98.03	98.03
		1985-2009	F8509	Percentage	27.35	11.74	100.00	92.37	61.10	0.00	37.89	0.00	97.29	82.65	14.31	0.00	45.14	45.14	45.14
		1990-2009	F9009	Percentage	27.35	11.74	100.00	92.37	61.10	0.00	37.89	0.00	97.29	82.65	14.31	0.00	45.14	45.14	45.14
		1995-2009	F9509	Percentage	27.35	0.00	100.00	0.00	61.10	0.00	30.12	0.00	97.29	82.65	14.31	0.00	45.14	45.14	45.14
		2000-2009	F0009	Percentage	0.00	0.00	0.00	0.00	61.10	0.00	0.00	0.00	97.29	82.65	0.00	0.00	0.00	0.00	0.00
		2005-2009	F0509	Percentage	0.00	0.00	0.00	0.00	61.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Field sheet measures	Measurements	Water velocity	AvWatVel	m/s	0.23	0.28	0.23	0.24	0.26	0.18	0.28	0.23	0.12	0.24	0.21	0.22	0.13	0.16	0.14
		Average depth	DepAve	m	0.15	0.18	0.16	0.15	0.16	0.12	0.14	0.19	0.18	0.22	0.19	0.14	0.12	0.11	0.12
		Median intermediate axis length	MedCob	cm	4.6	3.2	4.5	3.7	3.6	3.8	4.2	4.7	4.6	5.0	4.4	4.2	4.0	4.3	3.5
		Median embeddedness	MedEmbed	Percentage	50.0	37.5	25.0	25.0	37.5	50.0	50.0	25.0	25.0	25.0	25.0	50.0	37.5	50.0	50.0
		Gradient of stream reach	Gradient	Percentage	3.0	3.0	2.5	2.0	2.5	2.0	3.0	2.5	3.0	3.0	2.0	2.0	2.0	2.0	2.5
		Wetted width of stream	WetWid	m	1.1	1.0	3.1	1.8	1.1	2.2	2.4	2.4	0.8	3.2	1.0	1.4	1.1	1.6	1.5
		Bankfull width of stream	BanWid	m	1.4	1.3	3.3	2.3	1.2	2.3	3.3	3.5	2.2	5.6	1.9	2.4	1.4	2.0	1.8
	Total = 100% (bedrock not present at sample sites)	Cobble - Visual estimation of sample area	Cobble	Percentage	70	70	70	60	70	80	80	90	90	90	70	80	50	60	70
		Gravel - Visual estimation of sample area	Gravel	Percentage	20	20	20	30	20	10	10	10	10	5	20	15	30	30	20
		Sand and finer - Visual estimation of sample area	Sand	Percentage	10	10	10	10	10	10	10	0	0	5	10	5	20	10	10

Table E.7: CA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores of twelve reference stations, Minto Mine IOC, September 2014.

		Axis 1	Axis 2
Eigenvalue		0.460	0.422
% Variance explained		23.2	21.3
Monte Carlo *p*		0.088	0.002
Reference stations	URC-1	11.5	40.3
	UWC-1	-110	-86.4
	NRC-1	-89.8	-52.4
	NRC-2	-40.9	-64.1
	NRC-3	253	-83.3
	NRC-4	-51.9	2.24
	NRC-5	-52.9	-4.33
	NRC-6	-39.1	-19.5
	NRC-7	67.6	-55.0
	NRC-8	5.60	53.9
	NRC-9	31.3	240
	NRC-10	1.63	32.8

Table E.8: Spearman correlation of reference area CA axis scores with 65 environmental variables, Minto Mine IOC, September 2014.

Taxa	Pearson Correlation Coefficient		P-Value [a]	
	CA Axis-1 (23.2%)	CA Axis-2 (21.3%)	CA Axis-1 (23.2%)	CA Axis-2 (21.3%)
AvWatVel	-0.102	-0.325	0.751	0.302
DepAve	0.307	0.596	0.332	0.041
Cobble	0.295	0.361	0.353	0.249
Gravel	-0.329	-0.277	0.297	0.383
Sand	-0.084	-0.460	0.796	0.132
MedCob	0.385	0.459	0.216	0.134
MedEmbed	-0.473	-0.626	0.120	0.029
Gradient	0.231	0.041	0.470	0.899
WetWid	0.274	-0.183	0.388	0.570
BanWid	0.432	0.042	0.161	0.897
BaArea	0.273	-0.357	0.391	0.255
BaPerim	0.287	-0.392	0.366	0.208
StrOrd	0.428	-0.043	0.165	0.895
DtoUMC	0.559	0.329	0.059	0.297
StrDen	0.545	0.154	0.067	0.633
StreLeng	0.406	-0.273	0.191	0.391
SourEle	-0.112	-0.545	0.729	0.067
ChangEle	0.182	-0.259	0.572	0.417
SiteEle	-0.298	-0.316	0.346	0.317
LeMaChan	0.322	-0.280	0.308	0.379
PGraMaCh	-0.049	-0.189	0.880	0.557
Meta	0.187	-0.209	0.561	0.514
Plut	-0.131	0.210	0.686	0.512
Sedi	0.306	0.480	0.334	0.114
Uncon	0.131	0.393	0.685	0.206
Volan	-0.366	-0.512	0.242	0.089
BBAPDT	-0.321	-0.386	0.309	0.216
BTB	-0.131	-0.306	0.685	0.334
C	0.306	0.480	0.334	0.114
GQG	0.242	0.500	0.449	0.098
GDM	-0.179	-0.187	0.577	0.560
Marble	-0.044	-0.044	0.893	0.893
O	0.073	-0.312	0.821	0.323
QGMS	-0.480	-0.480	0.114	0.114
QQ	0.462	-0.071	0.131	0.827
SSG	0.131	0.393	0.685	0.206
OpWater	0.131	0.393	0.685	0.206
Rock	0.306	0.480	0.334	0.114
ExpLand	-0.063	0.101	0.845	0.755
Bryoids	0.480	-0.393	0.114	0.206
ShrTall	0.389	0.175	0.212	0.586
ShrLow	-0.042	-0.147	0.897	0.649
ShrWet	0.009	0.358	0.977	0.253
Herb	-0.315	-0.168	0.319	0.602
ConDen	0.160	0.153	0.618	0.635
ConOpen	0.175	-0.091	0.587	0.779
ConSpar	0.322	-0.119	0.308	0.713
BrLeDen	0.312	-0.086	0.324	0.791
BrLeOp	0.165	-0.037	0.608	0.910
MixOpen	0.554	-0.140	0.062	0.663
MixSparse	0.393	-0.218	0.206	0.495
SlopeBa	0.063	-0.671	0.846	0.017
AspectBa	-0.140	-0.140	0.665	0.665
F5009	0.280	0.189	0.379	0.557
F5509	0.280	0.189	0.379	0.557
F6009	0.280	0.189	0.379	0.557
F6509	0.280	0.189	0.379	0.557
F7009	0.112	0.371	0.729	0.236
F7509	0.203	0.371	0.527	0.236
F8009	0.203	0.371	0.527	0.236
F8509	0.134	-0.275	0.678	0.388
F9009	0.134	-0.275	0.678	0.388
F9509	0.305	0.029	0.336	0.929
F0009	0.624	-0.119	0.030	0.712
F0509	0.480	-0.393	0.114	0.206

Table E.9: PCA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores of twelve reference stations and the average value of exposed stations UMC, Minto Mine IOC, September 2014.

	Axis 1	Axis 2
Eigenvalue	2.8	2.1
% Variance explained	31	24
Monte Carlo p	0.22	0.16
URC-1	1.4	0.63
UWC-1	-3.2	2.4
NRC-1	-0.41	0.33
NRC-2	0.38	0.40
NRC-3	-0.060	-2.8
NRC-4	0.72	-0.71
NRC-5	-0.89	1.3
NRC-6	-1.2	-1.2
NRC-7	-2.1	-1.7
NRC-8	1.6	-0.98
NRC-9	2.4	0.22
NRC-10	2.2	1.9
UMC-ave	-0.81	0.24

Table E.10: PCA axis scores Spearman correlation with significant environmental variable predictors of BMI community structure, Minto Mine IOC, September 2014.

Taxa	Spearman Correlation Coefficient		P-Value [a]	
	PCA Axis-1 (31.1%)	PCA Axis-2 (23.5%)	PCA Axis-1 (31.1%)	PCA Axis-2 (23.5%)
DepAve	0.811	0.274	0.001	0.365
MedEmbed	-0.864	0.047	0.000	0.879
StrDen	0.231	-0.813	0.448	0.001
SourEle	-0.544	0.049	0.055	0.873
Volan	-0.667	0.360	0.013	0.227
GQG	0.620	0.253	0.024	0.404
MixOpen	-0.138	-0.661	0.653	0.014
SlopeBa	-0.286	-0.198	0.344	0.517
F0009	-0.085	-0.669	0.781	0.012

Table E.11: CA results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores of twelve reference stations and three exposure stations, Minto Mine IOC, September 2014.

		Axis 1	**Axis 2**
Eigenvalue		0.490	0.375
% Variance explained		24.1	18.4
Monte Carlo *p*		0.00899	0.00500
Reference stations	URC-1	0.634	54.9
	UWC-1	-29.9	-139.6
	NRC-1	-36.2	-105.0
	NRC-2	19.2	-96.1
	NRC-3	301.4	54.4
	NRC-4	-29.8	-28.9
	NRC-5	-49.4	-4.49
	NRC-6	3.82	-55.5
	NRC-7	124.3	-43.4
	NRC-8	-3.64	41.6
	NRC-9	-48.8	178.2
	NRC-10	14.0	19.5
Exposed stations	UMC-1	-86.0	32.2
	UMC-2	-92.9	45.9
	UMC-3	-90.1	33.9

Table E.12: Statistical comparison of component analysis results displaying; eigen value, percent variance explained, Monte Carlo randomization p-values of axis significance, and station scores of twelve reference stations with exposure stations, a) UMC-1, b) UMC-2, and c) UMC-3, Minto Mine IOC, September 2014.

a)

		Axis 1	Axis 2
Eigenvalue		0.464	0.405
% Variance explained		23.0	20.0
Monte Carlo *p*		0.0509	0.00400
URC-1		2.88	49.63
UWC-1		-67.4	-117
NRC-1		-62.4	-84.8
NRC-2		-10.3	-81.1
NRC-3		280	1.03
NRC-4		-45.7	-16.7
NRC-5		-49.9	-11.5
NRC-6		-20.6	-37.9
NRC-7		93.0	-42.1
NRC-8		-14.3	46.3
NRC-9		-39.5	223
NRC-10		-2.09	27.1
Reference Mean		4.37	-3.88
UMC-1	Value	-69.7	49.9
	cP	0.0224	0.0603
	ncP	1.00	1.00

b)

		Axis 1	Axis 2
Eigenvalue		0.466	0.403
% Variance explained		23.0	19.9
Monte Carlo *p*		0.0360	0.00500
URC-1		-4.27	53.1
UWC-1		-61.8	-119
NRC-1		-56.0	-93.1
NRC-2		-6.09	-83.3
NRC-3		281	19.7
NRC-4		-43.1	-23.6
NRC-5		-49.2	-13.3
NRC-6		-16.9	-45.8
NRC-7		96.3	-39.8
NRC-8		-12.6	43.1
NRC-9		-55.3	209
NRC-10		-1.54	21.8
Reference Mean		5.84	-5.92
UMC-2	Value	-78.7	60.2
	cP	0.0113	0.0233
	ncP	0.999	1.00

c)

		Axis 1	Axis 2
Eigenvalue		0.464	0.402
% Variance explained		22.5	19.5
Monte Carlo *p*		0.0599	0.00699
URC-1		2.88	49.6
UWC-1		-67.4	-117
NRC-1		-62.4	-84.8
NRC-2		-10.3	-81.1
NRC-3		280	1.03
NRC-4		-45.7	-16.7
NRC-5		-49.9	-11.5
NRC-6		-20.6	-37.9
NRC-7		93.0	-42.1
NRC-8		-14.3	46.3
NRC-9		-39.5	223
NRC-10		-2.09	27.1
Reference Mean		5.32	-3.76
UMC-3	Value	-74.4	41.4
	cP	0.0154	0.104
	ncP	1.00	1.00

cP - probability that metric value at exposure area is the same as the mean for reference areas.

ncP - probability that metric value at exposure area is inside the range of reference values

🟧	Different from exposure mean (cP<0.1) or reference range (ncP<0.1).
🟫	Uncertain with respect to being similar to or different from reference (0.1< ncP<0.9).
🟩	Similar to reference mean (cP>0.1) or within reference range (ncP>0.9).

Table E.13: Descriptive statistics of benthic metrics and supporting measures of RCA study, Minto Mine IOC, September 2014.

Variable	12 Reference Stations									3 Exposed Stations		
	n	Median	Standard Deviation	Standard Error	95% Confidence Interval (Mean)		Min	Max	Mean	UMC-1	UMC-2	UMC-3
					Lower Bound	Upper Bound						
Abundance	12	153	122	35	122	14,835	44	450	177	136	309	652
Richness	12	11	3.3	1.0	3.3	11	5.0	16	11	11	11	10
Evenness (Simpson's)	12	0.398	0.129	0.037	0.129	0.017	0.160	0.632	0.398	0.316	0.394	0.331
BC Distance	12	0.6	0.2	0.0	0.2	0.0	0.3	0.8	0.6	0.7	0.8	0.9
% EPT	12	41.3	13.9	4.01	13.9	193	9.69	62.1	40.7	22.8	10.4	8.28
% Ephemeroptera	12	10.7	13.0	3.75	13.0	169	0.0	40.7	13.1	0.735	0.647	0.307
% Plecoptera	12	29.1	16.2	4.68	16.2	263	1.69	48.8	24.8	2.94	1.94	2.76
% Trichoptera	12	1.9	2.5	0.72	2.5	6.2	0.0	8.1	2.8	19	7.8	5.2
% Diptera (excluding Chironomidae)	12	12	8.2	2.4	8.2	67	3.4	32	14	21	40	39
% Chironomidae	12	30.1	20.6	5.95	20.6	426	3.39	73.5	29.9	47.1	36.9	44.5
% Arachnida	12	0.54	6.1	1.8	6.1	38	0.0	17	3.5	0.0	5.2	1.8
% Oligocheata	12	6.24	14.8	4.26	14.8	218	0.0	50.8	11.3	8.09	7.44	6.13
Diversity (Simpson's)	12	0.77	0.12	0.034	0.12	0.014	0.43	0.86	0.73	0.71	0.77	0.70

Table E.14: Statistical comparison of benthic endpoints between all twelve RCA reference stations and each exposure station, Minto Mine IOC, September 2014.

Area	Station ID		Density / Abundance	Richness	Evenness (Simpson's)	B-C Distance	Diversity (Simpson's)	%EPT	%Ephemeroptera	%Plecoptera	%Trichoptera	%Diptera (excluding Chironomidae)	%Chironomidae	%Arachnida	%Oligocheata
Reference stations	URC-1	Value	99	12	0.48	0.43	0.83	46.5	31.3	10.1	5.1	19.2	23.2	2.0	7.1
	UWC-1	Value	123	9	0.41	0.55	0.73	51.2	0.8	48.8	1.6	9.8	14.6	0.0	24.4
	NRC-1	Value	44	5	0.55	0.27	0.64	34.1	0.0	31.8	2.3	9.1	50.0	0.0	6.8
	NRC-2	Value	135	9	0.44	0.52	0.75	34.1	0.7	33.3	0.0	21.5	31.9	2.2	9.6
	NRC-3	Value	59	8	0.38	0.73	0.68	42.4	40.7	1.7	0.0	3.4	3.4	0.0	50.8
	NRC-4	Value	171	14	0.22	0.54	0.68	36.8	8.2	26.9	1.8	10.5	50.3	0.6	1.8
	NRC-5	Value	196	11	0.16	0.68	0.43	9.7	6.6	2.6	0.5	12.8	73.5	0.0	4.1
	NRC-6	Value	53	11	0.45	0.48	0.80	45.3	1.9	41.5	1.9	18.9	28.3	0.0	5.7
	NRC-7	Value	206	14	0.39	0.58	0.82	62.1	14.1	43.2	4.9	5.3	9.7	0.5	22.3
	NRC-8	Value	250	16	0.33	0.68	0.81	28.4	13.2	10.0	5.2	32.0	34.0	4.4	1.2
	NRC-9	Value	333	11	0.63	0.77	0.86	57.4	18.0	31.2	8.1	19.8	6.6	15.6	0.0
	NRC-10	Value	450	16	0.34	0.77	0.82	40.2	21.6	16.7	2.0	8.2	32.9	17.1	1.6
	Mean		**177**	**11**	**0.40**	**0.58**	**0.73**	**40.7**	**13.1**	**24.8**	**2.8**	**14.2**	**29.9**	**3.5**	**11.3**
	SD		122	3	0.13	0.15	0.12	13.9	13.0	16.2	2.5	8.2	20.6	6.1	14.8
Exposure stations	UMC-1	Value	136	11	0.32	0.71	0.71	22.8	0.7	2.9	19.1	21.3	47.1	0.0	8.1
		cP	0.273	0.734	0.049	0.015	0.52	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5
		ncP	1.000	1.000	1.000	1.000	1.00	1.0	1.0	0.9	0.0	1.0	1.0	1.0	1.0
	UMC-2	Value	309	11	0.39	0.84	0.77	10.4	0.6	1.9	7.8	40.1	36.9	5.2	7.4
		cP	0.003	0.734	0.913	0.000	0.33	0.0	0.0	0.0	0.0	0.0	0.3	0.4	0.4
		ncP	0.992	1.000	1.000	0.733	1.00	0.4	1.0	0.9	0.5	0.1	1.0	1.0	1.0
	UMC-3	Value	652	10	0.33	0.90	0.70	8.3	0.3	2.8	5.2	39.3	44.5	1.8	6.1
		cP	0.000	0.191	0.097	0.000	0.30	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.3
		ncP	0.011	1.000	1.000	0.458	1.00	0.3	1.0	0.9	1.0	0.1	1.0	1.0	1.0

cP - probability that metric value at exposure area is the same as the mean for reference areas.

ncP - probability that metric value at exposure area is inside the range of reference values

🟧 Different from exposure mean (cP<0.1) or reference range (ncP<0.1).

🟨 Uncertain with respect to being similar to or different from reference (0.1<ncP<0.9).

🟩 Similar to reference mean (cP>0.1) or within reference range (ncP>0.9).

Table E.15: CA axis scores of benthic invertebrate families and Spearman correlation of family proportion with CA station scores of UMC-1 and 12 reference station CA biplot, Minto Mine IOC, September 2014.

Taxa	Spearman Correlation Coefficient [a]		P-Value [a]	
	CA Axis-1 (23.0%)	CA Axis-2 (20.0%)	CA Axis-1 (23.0%)	CA Axis-2 (20.0%)
Ameletidae	0.393	0.423	0.184	0.149
Baetidae	0.858	0.136	0.000	0.658
Ephemerellidae	0.089	0.409	0.772	0.166
Heptageniidae	0.808	0.096	0.001	0.755
Capniidae	-0.127	0.331	0.679	0.269
Chloroperlidae	0.147	-0.101	0.631	0.742
Leuctridae	0.308	0.271	0.305	0.370
Nemouridae	-0.258	-0.780	0.394	0.002
Perlodidae	0.310	0.056	0.302	0.855
Limnephilidae	-0.176	0.384	0.566	0.195
Rhyacophilidae	0.476	0.216	0.100	0.480
Chironomidae	-0.511	0.027	0.074	0.929
Empididae	-0.003	0.605	0.992	0.029
Psychodidae	0.168	0.685	0.584	0.010
Simuliidae	-0.174	-0.698	0.569	0.008
Tipulidae	-0.217	0.211	0.477	0.489
Sperchontidae	0.468	0.230	0.107	0.449
Hydrozetidae	-0.089	0.052	0.772	0.866
Lumbriculidae	0.797	-0.153	0.001	0.619
Enchytraeidae	-0.376	-0.113	0.206	0.714
Naididae	-0.483	-0.181	0.094	0.554

Table E.16: CA axis scores of benthic invertebrate families and Spearman correlation of family proportion with CA station scores of UMC-2 and 12 reference station CA biplot, Minto Mine IOC, September 2014.

Taxa	Spearman Correlation Coefficient [a]		P-Value [a]	
	CA Axis-1 (23.1%%)	CA Axis-2 (19.9%)	CA Axis-1 (23.1%)	CA Axis-2 (19.9%)
Ameletidae	0.343	0.543	0.252	0.055
Baetidae	0.844	0.205	0.000	0.501
Ephemerellidae	0.123	0.249	0.690	0.412
Heptageniidae	0.836	0.136	0.000	0.659
Capniidae	-0.232	0.320	0.446	0.286
Chloroperlidae	0.165	-0.170	0.591	0.578
Leuctridae	0.238	0.320	0.434	0.287
Nemouridae	-0.137	-0.813	0.655	0.001
Perlodidae	0.363	-0.013	0.222	0.968
Limnephilidae	-0.312	0.446	0.299	0.127
Rhyacophilidae	0.461	0.152	0.113	0.619
Chironomidae	-0.423	-0.093	0.150	0.762
Empididae	-0.047	0.470	0.879	0.105
Psychodidae	0.035	0.699	0.910	0.008
Simuliidae	-0.247	-0.517	0.415	0.071
Tipulidae	-0.237	0.263	0.436	0.385
Sperchontidae	0.476	0.175	0.100	0.568
Hydrozetidae	-0.396	0.362	0.180	0.224
Lumbriculidae	0.842	-0.057	0.000	0.854
Enchytraeidae	-0.482	-0.025	0.095	0.935
Naididae	-0.264	-0.464	0.384	0.110

Table E.17: CA axis scores of benthic invertebrate families and Spearman correlation of family proportion with CA station scores of UMC-3 and 12 reference station CA biplot, Minto Mine IOC, September 2014.

Taxa	Spearman Correlation Coefficient [a]		P-Value [a]	
	CA Axis-1 (22.5%)	CA Axis-2 (19.5%)	CA Axis-1 (22.5%)	CA Axis-2 (19.5%)
Ameletidae	0.469	0.497	0.106	0.084
Baetidae	0.774	0.317	0.002	0.292
Ephemerellidae	0.033	0.305	0.914	0.311
Heptageniidae	0.786	0.175	0.001	0.567
Capniidae	-0.110	0.343	0.719	0.252
Chloroperlidae	0.153	-0.133	0.617	0.665
Leuctridae	0.308	0.271	0.305	0.370
Nemouridae	-0.187	-0.769	0.541	0.002
Perlodidae	0.282	0.069	0.351	0.823
Limnephilidae	-0.150	0.393	0.624	0.184
Rhyacophilidae	0.420	0.160	0.153	0.602
Chironomidae	-0.555	-0.110	0.049	0.721
Empididae	-0.056	0.523	0.855	0.067
Psychodidae	0.064	0.607	0.837	0.028
Simuliidae	-0.081	-0.658	0.794	0.015
Tipulidae	-0.234	0.234	0.441	0.441
Sperchontidae	0.420	0.182	0.153	0.552
Hydrozetidae	-0.268	0.221	0.375	0.467
Lumbriculidae	0.825	-0.023	0.001	0.942
Enchytraeidae	-0.470	-0.044	0.105	0.887
Naididae	-0.305	-0.416	0.311	0.157

Table E.18: Spearman correlation of metals PCA axis scores with actual metal concentrations, Minto Mine IOC, September 2014.

Taxa	Spearman Correlation Coefficient		P-Value [a]	
	PCA Axis-1 (39.7%)	PCA Axis-2 (17.5%)	PCA Axis-1 (39.7%)	PCA Axis-2 (17.5%)
Al	0.821	0.168	0.000	0.550
Sb	-0.139	0.447	0.622	0.095
As	0.054	-0.143	0.849	0.611
Ba	-0.746	-0.439	0.001	0.101
B	-0.693	-0.492	0.004	0.063
Cd	-0.121	-0.513	0.667	0.050
Ca	-0.943	-0.446	0.000	0.095
Cr	0.848	0.152	0.000	0.587
Co	0.768	-0.157	0.001	0.576
Cu	0.140	-0.453	0.620	0.090
Fe	0.760	0.002	0.001	0.995
Pb	0.149	-0.500	0.597	0.058
Li	-0.811	-0.331	0.000	0.229
Mg	-0.922	-0.450	0.000	0.092
Mn	0.457	-0.239	0.087	0.390
Mo	-0.793	-0.529	0.000	0.043
Ni	0.386	-0.433	0.156	0.107
K	-0.754	-0.511	0.001	0.052
Se	-0.537	-0.299	0.039	0.278
Si	0.432	0.046	0.108	0.869
Na	-0.489	-0.561	0.064	0.030
Sr	-0.861	-0.457	0.000	0.087
S	-0.843	-0.396	0.000	0.143
Sn	-0.501	-0.411	0.057	0.129
Ti	0.433	-0.433	0.107	0.107
U	-0.950	-0.389	0.000	0.152
V	0.659	-0.246	0.008	0.378

Table E.19 Habitat characteristics of the lower creek benthic invertebrate community sampling stations, Minto Mine IOC, September 2014.

Characteristics		Lower Wolverine Creek (Reference)					Lower Minto Creek (Exposure)				
		LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Date/Time		11-Sep-14	11-Sep-14	11-Sep-14 15:48	12-Sep-14 11:20	12-Sep-14 13:53	9-Sep-14 16:15	10-Sep-14 13:04	10-Sep-14 16:35	13-Sep-14 17:05	14-Sep-14 11:31
Latitude (dd mm ss.s)		62 42 10.7	62 42 15.5	62 42 18.3	62 42 24.6	62 42 28.6	62 38 49.9	62 38 49.8	62 38 49.3	62 38 49.6	62 38 51.3
Longitude (dd mm ss.s)		137 17 53.1	137 17 53.6	137 17 52.0	137 17 46.1	137 17 45.3	137 06 18.0	137 06 16.4	137 06 09.8	137 06 08.8	137 06 07.1
Sampling Device		Hess	Hess	Hess	Hess	Hess	Hess	Hess	Hess	Hess	Hess
Sampler Size (m^2)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Mesh Size (µm)		500	500	500	500	500	500	500	500	500	500
Grabs in Comosite		3	3	3	3	3	3	3	3	3	3
Water Velocity (m/s)		0.25	0.27	0.35	0.25	0.30	0.18	0.27	0.37	0.38	0.26
Depth (m)		0.11	0.14	0.13	0.14	0.16	0.13	0.09	0.08	0.10	0.12
Number of Jars		1	1	1	1	1	1	1	1	1	1
Average Depth (cm) (Sampler pushed into substrate)		2	2	2	2	2	8	3	3	3	3
Average Depth (cm) (Substrate is sampled/cleaned)		3	5	5	3	3	5 - 8	5	5	3	2
Average Sampling Time per Grab (min)		10	10	10	10	10	7 - 10	10	10	10	10
Macrophytes (in sample)		none	none	none	none	sparse (terrestrial plants, seeds, sticks, leaves etc)	none	none	none	none	none
Algae (in sample)		none	none	none	none	none	none	none	none	none	none
Sample Texture	% cobble	90	90	90	90	85	70	95	95	85	85
	% gravel	5	5	5	5	10	20	5	2.5	5	5
	% sand and finer	5	5	5	5	5	10	0	2.5	10	10
	% organic	0	0	0	0	0	0	0	0	0	0
Water Quality	Temperature	4.55	5.01	5.88	4.17	4.80	1.46	3.37	4.42	7.22	5.27
	DO (mg/L)	12.67	12.68	12.38	12.54	12.43	13.25	12.70	12.51	11.56	11.76
	DO (%)	98.1	99.3	99.3	96.1	97.0	94.5	95.4	96.6	95.9	92.8
	Conductivity (uS/cm)	-	-	105	-	-	-	174	-	-	190
	Specific Conductivity (uS/cm)	165	165	165	170	170	211	297	296	300	304
	pH	7.71	7.82	7.76	7.75	7.80	8.30	8.06	8.22	8.05	7.99

Table E.20: Benthic invertebrate counts (pooled abundance of 3 hess samples) at the lowest practical level of taxonomic resolution for CI study, Minto Mine IOC, September 2014. Samples processed in the lab using a 500 µm sieve.

Taxa	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Phylum: Arthropoda	0	0	0	0	0	0	0	0	0	0
Subphylum: Hexapoda	0	0	0	0	0	0	0	0	0	0
| Class: Insecta	0	0	0	0	0	0	0	0	0	0
| Order: Ephemeroptera	1	0	0	0	0	0	0	0	0	0
| Family: Baetidae	1	0	0	0	1	0	0	0	0	0
Baetis flavistriga	0	0	0	0	0	1	0	0	0	0
Baetis tricaudatus	0	1	1	0	0	0	0	0	0	0
| Family: Ephemerellidae	0	0	0	0	0	0	0	0	0	0
Drunella doddsii	0	0	1	0	0	0	0	0	0	0
Ephemerella dorothea/excrucians	0	1	0	1	1	0	0	0	0	0
| Family: Heptageniidae	0	4	2	3	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
| Order: Plecoptera	1	0	0	0	0	0	1	0	0	0
| Family: Capniidae	0	0	1	0	0	3	1	1	1	1
| Family: Chloroperlidae	0	0	0	1	0	0	0	0	0	0
| Family: Nemouridae	0	0	0	0	0	2	170	225	56	139
Nemoura	0	0	0	0	0	23	1	72	57	76
Podmosta sp.	0	0	0	0	0	0	1	0	0	0
Zapada oregonensis group	0	1	0	0	0	0	0	0	0	0
| Family: Perlodidae	1	0	0	0	0	0	0	0	0	0
Isoperla sp.	0	6	2	0	3	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
| Order: Trichoptera	0	0	0	0	0	1	0	0	0	0
| Family: Hydropsychidae	0	0	0	0	0	0	0	0	0	0
Hydropsyche	0	0	0	0	0	1	2	0	0	0
| Family: Limnephilidae	0	0	0	0	0	0	1	0	0	0
Ecclisomyia sp.	2	1	0	0	1	0	0	1	0	4
	0	0	0	0	0	0	0	0	0	0
| Order: Diptera	0	0	0	0	0	0	0	0	5	0
| Family: Ceratopogonidae	0	0	0	1	0	0	0	0	0	0
| Family: Chironomidae	0	0	0	0	0	0	0	0	0	0
| Subfamily: Chironominae	0	0	0	0	0	0	0	0	0	0
| Tribe: Tanytarsini	0	0	0	0	0	0	0	0	0	0
Micropsectra	0	0	0	0	0	7	0	0	0	7
| Subfamily: Diamesinae	0	0	0	0	0	0	0	0	0	0
| Tribe: Diamesini	0	0	0	0	0	0	0	0	0	0
Diamesa	0	0	0	0	0	0	6	4	0	2
Pagastia	0	0	1	1	1	1	0	1	0	0
Pseudodiamesa sp.	0	0	0	0	0	1	0	0	1	0
| Subfamily: Orthocladiinae	0	0	0	0	0	0	0	0	0	0
Eukiefferiella	0	0	0	0	0	5	121	54	22	67
Heleniella sp.	0	0	0	0	0	1	0	1	0	0
Hydrobaenus	0	0	0	0	0	12	0	0	0	0
Orthocladius complex	1	17	53	21	12	0	0	0	3	1
Parakiefferiella	0	0	0	0	0	18	0	0	2	0
Pseudosmittia sp.	1	3	1	0	0	0	0	0	0	0
| Family: Empididae	0	0	0	0	3	1	0	1	0	1
Chelifera/ Metachela	0	0	0	0	0	0	0	2	0	0
Clinocera sp.	0	0	0	0	0	0	5	0	0	0
| Family: Psychodidae	0	0	0	0	0	1	0	0	0	0
| Family: Simuliidae	0	0	0	0	0	0	1	0	0	1
| Family: Tipulidae	0	0	0	0	6	0	0	0	0	0
Dicranota	0	0	0	8	0	4	0	5	0	8
	0	0	0	0	0	0	0	0	0	0
Subphylum: Chelicerata	0	0	0	0	0	0	0	0	0	0
| Class: Arachnida	0	0	0	1	0	0	0	0	0	0
| Order: Trombidiformes	0	0	0	0	0	0	0	0	0	0
| Family: Hygrobatidae	0	0	0	0	0	0	0	0	0	0
Hygrobates	0	1	0	0	0	0	0	0	0	0
| Family: Sperchontidae	0	0	0	0	0	0	0	0	0	0
Sperchon	0	0	0	0	0	2	4	3	1	3
	0	0	0	0	0	0	0	0	0	0
| Order: Oribatei	0	0	0	0	0	0	0	0	0	0
| Family: Oribatidae	0	0	0	0	0	0	0	0	0	0
Oribatida	0	0	0	0	0	1	0	0	0	0
	0	0	0	0	0	0	0	0	0	0
Phylum: Annelida	0	0	0	0	0	0	0	0	0	0
Subphylum: Clitellata	0	0	0	0	0	0	0	0	0	0
| Class: Oligochaeta	0	0	0	0	0	0	0	0	0	1
| Order: Lumbriculida	0	0	0	0	0	0	0	0	0	0
| Family: Lumbriculidae	0	0	5	0	243	0	0	1	0	0
	0	0	0	0	0	0	0	0	0	0
| Order: Tubificida	0	0	0	0	0	0	0	0	0	0
| Family: Enchytraeidae	0	0	7	3	0	0	4	4	0	0
Enchytraeus	1	34	0	0	0	0	0	0	0	0
Fridericia	0	0	0	0	0	15	0	0	0	0
| Family: Naididae	0	0	0	0	0	0	0	0	1	0

Table E.21: Benthic analyses: index values for lower creek benthic sample stations, Minto Mine IOC, September 2014.

	Lower Wolverine Creek (reference)					Lower Minto Creek (effluent-exposed)				
	LWC-1	LWC-2	LWC-3	LWC-4	LWC-5	LMC-1	LMC-2	LMC-3	LMC-4	LMC-5
Cordillera Number of Taxa	8	10	10	9	9	19	13	14	10	13
Cordillera Number of Individuals	9	69	74	40	271	100	318	375	149	311
Ephemeroptera (%)	22.2	8.7	5.4	10.0	0.7	1.0	0.0	0.0	0.0	0.0
Plecoptera (%)	22.2	10.1	4.1	2.5	1.1	28.0	54.7	79.5	76.5	69.5
Trichoptera (%)	22.2	1.4	0.0	0.0	0.4	2.0	0.9	0.3	0.0	1.3
EPT (%)	66.7	20.3	9.5	12.5	2.2	31.0	55.7	79.7	76.5	70.7
Chironomids (%)	22.2	29.0	74.3	55.0	4.8	45.0	39.9	16.0	18.8	24.8
Oligochaetes (%)	11.1	49.3	16.2	7.5	89.7	15.0	1.3	1.3	0.7	0.3
Number of Individuals	9	69	74	40	271	100	318	375	149	311
Density (Ind./m2)	30	230	247	133	903	333	1,060	1,250	497	1,037
LPL Number of Taxa	6	10	9	9	9	16	11	11	8	12
LPL Simpson's D	0.81	0.68	0.46	0.67	0.19	0.86	0.71	0.35	0.39	0.47
LPL Simpson's E	0.90	0.30	0.20	0.30	0.10	0.40	0.30	0.10	0.20	0.20
LPL Simpson's E (Krebs)	0.98	0.76	0.52	0.75	0.22	0.91	0.78	0.39	0.45	0.52
LPL-BC Dissimilarity	0.70	0.31	0.36	0.38	0.81	0.80	0.97	0.97	0.95	0.98
Minto LPL CA-1 (46.4%)	-1.19	-1.20	-1.14	-0.85	-0.74	0.46	0.72	0.58	0.58	0.60
Minto LPL CA-2 (14.9%)	0.86	0.20	-0.11	-0.50	-0.01	-0.78	0.52	0.25	-0.32	0.25
Minto LPL CA-3 (13.2%)	1.26	0.19	0.02	-0.98	-0.22	0.45	-0.10	-0.25	0.23	-0.10
Minto LPL CA-4 (8.6%)	-0.26	0.26	0.41	0.10	-0.61	-0.26	0.07	-0.06	0.67	-0.10
FL Number of Taxa	5	9	7	8	8	10	9	8	5	9
FL Simpson's D	0.79	0.66	0.42	0.64	0.19	0.71	0.54	0.35	0.38	0.46
FL Simpson's E	0.95	0.33	0.25	0.35	0.15	0.34	0.24	0.19	0.32	0.21
FL Simpson's E (Krebs)	0.99	0.74	0.49	0.74	0.22	0.79	0.61	0.40	0.47	0.52
FL-BC Dissimilarity	0.71	0.28	0.33	0.34	0.81	0.53	0.86	0.87	0.78	0.87
Minto FL CA-1 (47.8%)	-1.03	-0.85	-0.78	-0.46	-0.62	0.28	0.57	0.47	0.64	0.51
Minto FL CA-2 (18.4%)	-1.33	0.00	0.17	0.98	-0.07	0.03	-0.16	0.03	-0.02	-0.07
Minto FL CA-3 (11.4%)	0.05	0.33	0.41	-0.09	-0.61	-0.09	0.06	-0.12	0.48	-0.10
Minto FL CA-4 (9.4%)	-0.41	-0.03	0.20	-0.31	0.15	0.39	0.25	-0.13	-0.03	-0.43
Water Velocity (m/s)	0.25	0.27	0.35	0.25	0.30	0.18	0.27	0.37	0.38	0.26
Depth (m)	0.11	0.14	0.13	0.14	0.16	0.13	0.09	0.08	0.10	0.12
Average Depth (cm) sampler pushed into substrate	2	2	2	2	2	8	3	3	3	3
Average Depth (cm) substrate is sampled	3	5	5	3	3	7	5	5	3	2
Macrophytes (in sample)	none	none	none	none	sparse	none	none	none	none	none
Algae (in sample)	none	none	none	none	none	none	none	none	none	none
% cobble	90	90	90	90	85	70	95	95	85	85
% gravel	5	5	5	5	10	20	5	3	5	5
% sand and finer	5	5	5	5	5	10	0	3	10	10
% organic	0	0	0	0	0	0	0	0	0	0
Temperature (°C)	4.6	5.0	5.9	4.2	4.8	1.5	3.4	4.4	7.2	5.3
DO (mg/L)	12.67	12.68	12.38	12.54	12.43	13.25	12.70	12.51	11.56	11.76
DO (%)	98.1	99.3	99.3	96.1	97.0	94.5	95.4	96.6	95.9	92.8
Conductivity (µS/cm)	.	.	105	.	.	.	174	.	.	190
Specific Conductivity (µS/cm2)	165	165	165	170	170	211	297	296	300	304
pH	7.71	7.82	7.76	7.75	7.80	8.30	8.06	8.22	8.05	7.99
Median Intermediate Axis Length (cm)	4.0	4.0	3.8	4.8	4.5	4.3	4.7	3.7	3.5	4.3
Median Embeddedness (%)	25	13	25	13	25	25	50	13	13	0

Table E.22: Statistical characteristics of benthic metrics and supporting measures at lower creek stations, Minto IOC, September 2014.

							95% Confidence Interval			
	Area	n	Median	Mean	Deviation	Error	Lower Bound	Upper Bound	Minimum	Maximum
Ephemeroptera (%)	L. Wolverine Ck.	5	8.70	9.41	8.00	3.58	-0.53	19.35	0.74	22.22
	L. Minto Ck.	5	0.00	0.20	0.45	0.20	-0.36	0.76	0.00	1.00
Plecoptera (%)	L. Wolverine Ck.	5	4.05	8.01	8.66	3.87	-2.75	18.76	1.11	22.22
	L. Minto Ck.	5	69.45	61.63	21.09	9.43	35.44	87.82	28.00	79.47
Trichoptera (%)	L. Wolverine Ck.	5	0.37	4.81	9.75	4.36	-7.30	16.92	0.00	22.22
	L. Minto Ck.	5	0.94	0.90	0.80	0.36	-0.10	1.89	0.00	2.00
EPT (%)	L. Wolverine Ck.	5	12.50	22.23	25.67	11.48	-9.65	54.11	2.21	66.67
	L. Minto Ck.	5	70.74	62.73	20.00	8.94	37.90	87.56	31.00	79.73
Chironomids (%)	L. Wolverine Ck.	5	28.99	37.07	27.55	12.32	2.85	71.28	4.80	74.32
	L. Minto Ck.	5	24.76	28.90	12.91	5.77	12.87	44.93	16.00	45.00
Oligochaetes (%)	L. Wolverine Ck.	5	16.22	34.75	34.90	15.61	-8.58	78.09	7.50	89.67
	L. Minto Ck.	5	1.26	3.72	6.32	2.83	-4.13	11.57	0.32	15.00
Density (Ind./m2)	L. Wolverine Ck.	5	230	309	344	154	-118	735	30	903
	L. Minto Ck.	5	1037	835	397	177	343	1328	333	1250
LPL Number of Taxa	L. Wolverine Ck.	5	9.0	8.6	1.5	0.7	6.7	10.5	6.0	10.0
	L. Minto Ck.	5	11.0	11.6	2.9	1.3	8.0	15.2	8.0	16.0
LPL Simpson's D	L. Wolverine Ck.	5	0.67	0.56	0.24	0.11	0.26	0.87	0.19	0.81
	L. Minto Ck.	5	0.47	0.56	0.22	0.10	0.29	0.83	0.35	0.86
LPL Simpson's E	L. Wolverine Ck.	5	0.32	0.38	0.30	0.14	0.00	0.75	0.14	0.90
	L. Minto Ck.	5	0.21	0.25	0.12	0.05	0.10	0.40	0.14	0.44
LPL-BC Dissimilarity	L. Wolverine Ck.	5	0.38	0.51	0.23	0.10	0.23	0.79	0.31	0.81
	L. Minto Ck.	5	0.97	0.93	0.08	0.03	0.84	1.03	0.80	0.98
FL Number of Taxa	L. Wolverine Ck.	5	8.00	7.400	1.517	0.678	5.517	9.283	5.000	9.000
	L. Minto Ck.	5	9.00	8.200	1.924	0.860	5.812	10.588	5.000	10.000
FL Simpson's D	L. Wolverine Ck.	5	0.64	0.542	0.236	0.106	0.248	0.835	0.193	0.790
	L. Minto Ck.	5	0.46	0.487	0.146	0.065	0.306	0.668	0.347	0.708
FL Simpson's E	L. Wolverine Ck.	5	0.33	0.407	0.315	0.141	0.015	0.798	0.155	0.953
	L. Minto Ck.	5	0.24	0.261	0.068	0.030	0.177	0.345	0.191	0.343
FL-BC Dissimilarity	L. Wolverine Ck.	5	0.34	0.49	0.25	0.11	0.19	0.80	0.28	0.81
	L. Minto Ck.	5	0.86	0.78	0.15	0.07	0.60	0.97	0.53	0.87
Minto LPL CA-1 (46.4%)	L. Wolverine Ck.	5	-1.14	-1.02	0.22	0.10	-1.29	-0.76	-1.20	-0.74
	L. Minto Ck.	5	0.58	0.59	0.09	0.04	0.47	0.70	0.46	0.72
Minto LPL CA-2 (14.9%)	L. Wolverine Ck.	5	-0.01	0.09	0.50	0.23	-0.54	0.71	-0.51	0.86
	L. Minto Ck.	5	0.25	-0.02	0.53	0.23	-0.67	0.63	-0.78	0.52
Minto LPL CA-3 (13.2%)	L. Wolverine Ck.	5	0.02	0.05	0.81	0.36	-0.95	1.06	-0.98	1.26
	L. Minto Ck.	5	-0.10	0.05	0.28	0.13	-0.31	0.40	-0.25	0.45
Minto FL CA-1 (47.8%)	L. Wolverine Ck.	5	-0.78	-0.75	0.22	0.10	-1.02	-0.48	-1.03	-0.46
	L. Minto Ck.	5	0.51	0.49	0.14	0.06	0.32	0.66	0.28	0.64
Minto FL CA-2 (18.4%)	L. Wolverine Ck.	5	0.00	-0.05	0.83	0.37	-1.08	0.98	-1.33	0.98
	L. Minto Ck.	5	-0.02	-0.04	0.08	0.04	-0.14	0.06	-0.16	0.03
Minto FL CA-3 (11.4%)	L. Wolverine Ck.	5	0.05	0.02	0.40	0.18	-0.48	0.52	-0.61	0.41
	L. Minto Ck.	5	-0.09	0.05	0.25	0.11	-0.27	0.36	-0.12	0.48
Water Velocity (m/s)	L. Wolverine Ck.	5	0.27	0.28	0.04	0.02	0.23	0.34	0.25	0.35
	L. Minto Ck.	5	0.27	0.29	0.08	0.04	0.19	0.40	0.18	0.38
Depth (m)	L. Wolverine Ck.	5	0.14	0.135	0.020	0.009	0.110	0.159	0.107	0.160
	L. Minto Ck.	5	0.10	0.104	0.021	0.009	0.078	0.130	0.080	0.130
Average Depth (cm) (Sampler pushed into substrate)	L. Wolverine Ck.	5	2.0	2.0	0.0	0.0	2.0	2.0	2.0	2.0
	L. Minto Ck.	5	3.0	4.0	2.2	1.0	1.2	6.8	3.0	8.0
Average Depth (cm) (Substrate is sampled/cleaned)	L. Wolverine Ck.	5	3.0	3.8	1.1	0.5	2.4	5.2	3.0	5.0
	L. Minto Ck.	5	5.0	4.3	1.8	0.8	2.1	6.5	2.0	7.0
% cobble	L. Wolverine Ck.	5	90.0	89.0	2.2	1.0	86.2	91.8	85.0	90.0
	L. Minto Ck.	5	85.0	86.0	10.2	4.6	73.3	98.7	70.0	95.0
% gravel	L. Wolverine Ck.	5	5.0	6.0	2.2	1.0	3.2	8.8	5.0	10.0
	L. Minto Ck.	5	5.0	7.5	7.1	3.2	-1.3	16.3	3.0	20.0
% sand and finer	L. Wolverine Ck.	5	5.0	5.0	0.0	0.0	5.0	5.0	5.0	5.0
	L. Minto Ck.	5	10.0	6.5	4.9	2.2	0.5	12.6	0.0	10.0
% organic	L. Wolverine Ck.	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	L. Minto Ck.	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Temperature (ºC)	L. Wolverine Ck.	5	4.8	4.9	0.6	0.3	4.1	5.7	4.2	5.9
	L. Minto Ck.	5	4.4	4.3	2.1	1.0	1.7	7.0	1.5	7.2
DO (%)	L. Wolverine Ck.	5	98.1	98.0	1.4	0.6	96.2	99.7	96.1	99.3
	L. Minto Ck.	5	95.4	95.0	1.5	0.7	93.2	96.9	92.8	96.6
Specific Conductivity (µS/cm^2)	L. Wolverine Ck.	5	165	167	3	1	164	170	165	170
	L. Minto Ck.	5	297	282	40	18	232	331	211	304
pH	L. Wolverine Ck.	5	7.76	7.77	0.04	0.02	7.71	7.82	7.71	7.82
	L. Minto Ck.	5	8.06	8.12	0.13	0.06	7.96	8.29	7.99	8.30
Median Intermediate Axis Length (cm)	L. Wolverine Ck.	5	4.0	4.2	0.4	0.2	3.7	4.7	4.0	5.0
	L. Minto Ck.	5	4.3	4.1	0.5	0.2	3.5	4.7	4.0	5.0
Median Embeddedness (%)	L. Wolverine Ck.	5	25.0	20.0	6.8	3.1	11.5	28.5	13.0	25.0
	L. Minto Ck.	5	12.5	20.0	19.0	8.5	-3.5	43.5	0.0	50.0

Note: n=5 for all estimates

Table E.23: Benthic invertebrate community metrics - ANOVA results, Minto IOC, September 2014.

Dependent Variable	Mean Square	F (ANOVA)	p-value	Observed Power
Ephemeroptera (%)	212	6.6	0.0331	0.758
Plecoptera (%)	7,189	28	0.000766	0.999
Trichoptera (%)	38	0.80	0.398	0.211
EPT (%)	4,101	7.7	0.0238	0.814
Chironomids (%)	167	0.36	0.565	0.151
Oligochaetes (%)	2,408	3.8	0.0861	0.557
Density (Ind./m2)	693,444	5.0	0.0551	0.657
LPL Number of Taxa	23	4.2	0.0733	0.594
LPL Simpson's D	0.00014	0.0026	0.960	0.100
LPL Simpson's E	0.042	0.78	0.402	0.209
LPL-BC Dissimilarity	0.45	16	0.0042	0.974
FL Number of Taxa	1.6	0.53	0.486	0.175
FL Simpson's D	0.0074	0.19	0.672	0.127
FL Simpson's E	0.053	1.0	0.341	0.241
FL-BC Dissimilarity	0.21	5.1	0.0542	0.661
Minto LPL CA-1 (46.4%)	6.5	237	0.000000300	1.00
Minto LPL CA-2 (14.9%)	0.027	0.10	0.757	0.115
Minto LPL CA-3 (13.2%)	0.00021	0.00056	0.982	0.100
Minto FL CA-1 (47.8%)	3.8	116	0.00000490	1.00
Minto FL CA-2 (18.4%)	0.00059	0.0017	0.968	0.100
Minto FL CA-3 (11.4%)	0.0019	0.017	0.901	0.102
Water Velocity (m/s)	0.00016	0.037	0.853	0.0533
Depth (m)	0.0023	5.7	0.0438	0.556
Average Depth (cm) sampler pushed into substrate	10	4.0	0.0805	0.421
Average Depth (cm) substrate sampled/cleaned	0.63	0.28	0.609	0.0759
% cobble	23	0.41	0.540	0.0875
% gravel	5.6	0.20	0.663	0.0686
% sand and finer	5.6	0.47	0.511	0.0935
% organic	0	.	.	.
Temperature (°C)	0.71	0.28	0.608	0.0759
DO (%)	21	10	0.0125	0.801
Specific Conductivity (µS/cm^2)	32,833	42	0.000197	1.00
pH	0.32	34	0.000403	0.999
Median Intermediate Axis Length (cm)	0.036	0.18	0.679	0.0668
Median Embeddedness (%)	0	0	1.00	0.0500

🟨 yellow shading indicates statistical significance at $p < 0.10$

Table E.24a: Benthic taxon scores from Correspondence Analysis of Lowest Practical Level samples collected from lower creek areas, Minto Mine IOC, September 2014.

	Minto LPL CA-1 (46.4%)	Minto LPL CA-2 (14.9%)	Minto LPL CA-3 (13.2%)	Minto LPL CA-4 (8.6%)
| Family: Baetidae	-1.040	0.269	1.055	-0.334
Ephemerella dorothea/excrucians	-1.196	-0.237	-0.813	-0.258
| Family: Heptageniidae	-1.369	-0.277	-0.611	0.730
| Family: Capniidae	0.416	-0.317	0.239	0.203
Nemoura	0.766	0.097	0.013	0.229
| Family: Perlodidae	-1.379	0.493	0.644	-0.103
Hydropsyche	0.758	-0.299	0.421	-0.279
| Family: Limnephilidae	-0.185	0.834	0.423	-0.369
Micropsectra	0.682	-0.601	0.415	-0.533
Diamesa	0.827	0.821	-0.365	-0.035
Pagastia	-0.434	-0.526	-0.472	-0.256
Pseudodiamesa sp.	0.675	-1.223	0.799	0.693
Eukiefferiella	0.785	0.260	-0.047	0.240
Heleniella sp.	0.669	-0.599	0.245	-0.476
Orthocladius complex	-1.005	-0.174	-0.286	0.361
Parakiefferiella	0.638	-1.468	0.926	0.032
Pseudosmittia sp.	-1.523	0.654	1.002	0.495
| Family: Empididae	0.389	0.340	-0.236	-0.527
| Family: Simuliidae	0.849	0.869	-0.246	-0.033
| Family: Tipulidae, probably Dicranota	-0.026	-0.323	-0.627	-0.526
| Class: Arachnida	0.396	0.003	-0.128	0.097
| Class: Oligochaeta: incl. F. Enchytraeidae, F. Naididae	-0.543	-0.071	-0.027	-0.250

Table E.24b: Benthic taxon scores from Correspondence Analysis of Family Level samples collected from lower creek areas, Minto Mine IOC, September 2014.

	Minto FL CA-1 (47.8%)	Minto FL CA-2 (18.4%)	Minto FL CA-3 (11.4%)	Minto FL CA-4 (9.4%)
Family: Baetidae	-1.065	-0.944	0.073	0.046
Family: Ephemerellidae	-1.116	0.713	0.036	0.007
| Family: Heptageniidae	-1.149	1.000	0.705	-0.242
| Family: Capniidae	0.462	0.005	0.264	0.345
Family: Nemouridae	0.775	-0.107	0.177	-0.092
| Family: Perlodidae	-1.342	-0.662	0.184	-0.052
Family: Hydropsychidae	0.696	-0.170	-0.051	1.189
| Family: Limnephilidae	-0.182	-0.831	-0.204	-0.653
Family: Chironomidae	0.014	0.092	0.150	-0.010
Family: Empididae	0.374	-0.167	-0.582	0.285
| Family: Simuliidae	0.890	-0.302	-0.061	-0.334
| Family: Tipulidae	0.034	0.534	-0.672	-0.348
| Class: Arachnida, incl. F. Hygrobatidae, F. Sperchontidae, F. C	0.462	0.135	0.073	-0.038
| Class: Oligochaeta: incl. F. Enchytraeidae, F. Naididae	-0.501	0.037	-0.208	0.258

🟥 shading highlights the highest taxon scores on CA axis 1

Table E.25a: Eigenvalues of correspondence analysis of lowest practical level (LPL) samples from Minto lower creek stations, Minto Mine IOC, September 2014.

	Minto LPL CA-1 (46.4%)	Minto LPL CA-2 (14.9%)	Minto LPL CA-3 (13.2%)	Minto LPL CA-4 (8.6%)
Eigenvalue	0.605	0.194	0.171	0.111
Relative Inertia (%)	46.400	14.880	13.160	8.550
Cumulative Inertia (%)	46.400	61.280	74.430	82.980

Table E.25b: Eigenvalues of correspondence analysis of family level (FL) samples from Minto lower creek stations, Minto Mine IOC, September 2014.

	Minto FL CA-1 (47.8%)	Minto FL CA-2 (18.4%)	Minto FL CA-3 (11.4%)	Minto FL CA-4 (9.4%)
Eigenvalue	0.367	0.142	0.088	0.072
Relative Inertia (%)	47.780	18.400	11.380	9.410
Cumulative Inertia (%)	47.780	66.180	77.550	86.970

Table E.26a: Summary statistics from multivariate analysis of variance (MANOVA) of benthic metrics at lowest practical level (LPL) from Minto lower creek stations, Minto Mine IOC, September 2014.

Effect		Value	F	Hypothesis df	Error df	Sig.	Observed Power
Intercept	Pillai's Trace	0.998	68.73	8	1	0.093	0.720
	Wilks' Lambda	0.002	68.73	8	1	0.093	0.720
	Hotelling's Trace	549.838	68.73	8	1	0.093	0.720
	Roy's Largest Root	549.838	68.73	8	1	0.093	0.720
AREA	Pillai's Trace	0.999	142.913	8	1	0.065	0.880
	Wilks' Lambda	0.001	142.913	8	1	0.065	0.880
	Hotelling's Trace	1143.301	142.913	8	1	0.065	0.880
	Roy's Largest Root	1143.301	142.913	8	1	0.065	0.880

Table E.26b: Summary statistics from multivariate analysis of variance (MANOVA) of benthic metrics at family level (FL) from Minto lower creek stations, Minto Mine IOC, September 2014.

Effect		Value	F	Hypothesis df	Error df	Sig.	Observed Power
Intercept	Pillai's Trace	1.000	70431.254	8	1	0.003	1.000
	Wilks' Lambda	0.000	70431.254	8	1	0.003	1.000
	Hotelling's Trace	563450.033	70431.254	8	1	0.003	1.000
	Roy's Largest Root	563450.033	70431.254	8	1	0.003	1.000
AREA	Pillai's Trace	0.975	4.843	8	1	0.338	0.123
	Wilks' Lambda	0.025	4.843	8	1	0.338	0.123
	Hotelling's Trace	38.741	4.843	8	1	0.338	0.123
	Roy's Largest Root	38.741	4.843	8	1	0.338	0.123

▨ shading indicates statsitical significance at p<0.10

Table E.27: Correlations between benthic metrics and environmental supporting measurements at Minto Mine upper creek areas (RCA study), Minto Mine IOC, September 2014.

	Variable	Density/ Abundance		Richness		Evenness (Simpson's)		B-C Distance		Diversity (Simpson's)		%EPT		%Ephemeroptera		%Plecoptera		%Trichoptera		%Diptera (excluding Chironomidae)		%Chironomidae		%Arachnida		%Oligocheata		Benthic Invertebrate Community CA 1		Benthic Invertebrate Community CA 2	
		r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p
Potential mine impacted variable	PCA1 Metals	-0.38	0.1606	-0.28	0.3176	0.00	0.9939	-0.54	0.0376	-0.16	0.5711	0.09	0.7613	-0.06	0.8360	0.28	0.3171	-0.53	0.0439	-0.29	0.2869	0.05	0.8603	-0.29	0.3014	0.20	0.4823	0.21	0.4477	-0.68	0.0051
	PCA2 Metals	-0.01	0.9668	0.43	0.1071	-0.19	0.5072	-0.08	0.7698	0.16	0.5699	0.37	0.1799	0.58	0.0244	0.01	0.9828	-0.25	0.3642	-0.46	0.0858	-0.27	0.3266	0.10	0.7189	0.30	0.2805	0.45	0.0900	-0.02	0.9305
	Temperature	-0.25	0.3643	0.55	0.0340	0.06	0.8451	-0.19	0.4937	0.43	0.1077	0.53	0.0441	0.46	0.0819	0.23	0.4031	-0.20	0.4741	-0.26	0.3444	-0.40	0.1358	0.17	0.5402	0.07	0.8147	0.45	0.0898	0.09	0.7415
	Specific Conductivity	0.29	0.2999	0.03	0.9039	0.08	0.7899	0.44	0.1040	0.08	0.7749	-0.26	0.3413	-0.30	0.2771	-0.19	0.4869	0.55	0.0340	0.54	0.0367	0.10	0.7353	0.07	0.8154	-0.31	0.2569	-0.39	0.1476	0.51	0.0516
	Dissolved Oxygen (mg/L)	0.08	0.7697	0.08	0.7814	0.05	0.8482	-0.13	0.6352	0.03	0.9206	0.17	0.5381	-0.22	0.4403	0.43	0.1068	-0.36	0.1828	-0.04	0.8845	-0.01	0.9798	0.18	0.5258	-0.25	0.3695	-0.37	0.1746	-0.27	0.3344
	Dissolved Oxygen (%)	-0.18	0.5173	0.50	0.0563	0.10	0.7360	-0.28	0.3086	0.37	0.1715	0.57	0.0256	0.24	0.3921	0.51	0.0515	-0.43	0.1099	-0.27	0.3372	-0.33	0.2241	0.27	0.3233	-0.14	0.6295	0.10	0.7320	-0.11	0.6851
	pH	0.13	0.6390	-0.07	0.8048	0.10	0.7284	0.22	0.4311	0.16	0.5633	0.26	0.3572	-0.12	0.6696	0.40	0.1391	-0.21	0.4573	-0.19	0.4937	-0.41	0.1334	0.17	0.5500	0.38	0.1611	0.27	0.3361	-0.27	0.3262
	Hardness	0.30	0.2709	0.12	0.6689	-0.03	0.9295	0.36	0.1885	0.11	0.7084	-0.19	0.5030	-0.23	0.4047	-0.23	0.4084	0.65	0.0093	0.48	0.0721	0.12	0.6708	0.02	0.9453	-0.39	0.1552	-0.56	0.0289	0.38	0.1658
	Total Suspended Solids	-0.50	0.0553	-0.30	0.2702	0.26	0.3469	-0.66	0.0080	-0.29	0.2886	-0.04	0.8968	-0.38	0.1674	0.44	0.0968	-0.42	0.1193	-0.05	0.8711	0.28	0.3129	-0.17	0.5437	-0.02	0.9483	0.22	0.4407	-0.60	0.0179
	Alkalinity	0.41	0.1320	0.07	0.8162	-0.04	0.8894	0.42	0.1212	0.06	0.8199	-0.29	0.3019	-0.35	0.1961	-0.26	0.3549	0.74	0.0017	0.55	0.0337	0.22	0.4354	0.05	0.8704	-0.37	0.1773	-0.73	0.0021	0.37	0.1728
	Ammonia	-0.46	0.0818	-0.29	0.2985	0.28	0.3109	-0.66	0.0075	-0.14	0.6233	0.19	0.5043	-0.16	0.5703	0.49	0.0643	-0.45	0.0940	-0.08	0.7863	0.04	0.8863	-0.09	0.7378	0.28	0.3148	0.17	0.5343	-0.49	0.0617
	Nitrate	0.16	0.5585	-0.23	0.4062	-0.44	0.1045	0.44	0.1014	-0.45	0.0924	-0.65	0.0082	-0.23	0.4051	-0.75	0.0012	0.16	0.5756	0.35	0.1961	0.23	0.4051	-0.10	0.7339	0.27	0.3278	-0.24	0.3977	0.38	0.1641
	Total Kjehldahl Nitrogen	-0.83	0.0001	-0.67	0.0068	0.26	0.3549	-0.64	0.0097	-0.47	0.0786	0.00	1.0000	-0.28	0.3147	0.20	0.4829	-0.57	0.0265	-0.14	0.6205	0.02	0.9496	-0.60	0.0178	0.59	0.0208	0.14	0.6205	-0.49	0.0642
	Total Dissolved Solids	0.08	0.7639	-0.15	0.5842	0.03	0.9035	-0.02	0.9491	-0.10	0.7251	-0.43	0.1054	-0.32	0.2433	-0.24	0.3966	0.12	0.6700	0.57	0.0271	0.35	0.2011	0.07	0.8046	-0.06	0.8182	-0.43	0.1087	0.15	0.5854
	Total Phosphorus	-0.29	0.3027	-0.50	0.0574	0.02	0.9521	-0.40	0.1365	-0.43	0.1121	-0.25	0.3664	-0.26	0.3488	0.04	0.8857	-0.34	0.2170	-0.03	0.9019	0.37	0.1752	-0.31	0.2685	-0.06	0.8312	-0.06	0.8226	-0.41	0.1269
	Total Organic Carbon	-0.58	0.0227	-0.61	0.0148	0.25	0.3606	-0.66	0.0074	-0.18	0.5148	0.18	0.5145	-0.16	0.5658	0.41	0.1275	-0.39	0.1461	-0.26	0.3477	-0.08	0.7752	-0.47	0.0776	0.29	0.2860	0.06	0.8239	-0.69	0.0044
	Chlorophyll *a*	0.15	0.5942	0.27	0.3379	0.11	0.6835	0.17	0.5484	0.42	0.1164	0.01	0.9689	0.04	0.8941	-0.22	0.4202	0.73	0.0019	0.39	0.1491	-0.16	0.5583	-0.08	0.7732	-0.10	0.7234	-0.16	0.5788	0.38	0.1673
Non mine influenced variable	Water Velocity	-0.35	0.1966	0.13	0.6456	-0.30	0.2804	-0.45	0.0893	-0.25	0.3696	0.22	0.4329	0.17	0.5483	0.29	0.3018	-0.68	0.0049	-0.56	0.0292	0.06	0.8387	-0.24	0.3845	0.24	0.3833	0.47	0.0781	-0.57	0.0260
	Average Depth	0.05	0.8477	0.38	0.1592	0.12	0.6677	-0.09	0.7604	0.23	0.4134	0.32	0.2432	0.57	0.0260	-0.01	0.9656	-0.33	0.2297	-0.30	0.2711	-0.16	0.5600	0.59	0.0209	-0.16	0.5772	0.24	0.3983	0.22	0.4257
	Cobble	0.23	0.4135	0.35	0.2017	0.34	0.2183	0.04	0.8908	0.44	0.1033	0.51	0.0523	0.28	0.3043	0.40	0.1381	-0.38	0.1584	-0.16	0.5787	-0.46	0.0871	0.57	0.0253	-0.09	0.7463	0.19	0.4897	0.12	0.6610
	Gravel	-0.17	0.5398	-0.33	0.2293	-0.32	0.2522	0.02	0.9444	-0.43	0.1124	-0.55	0.0342	-0.27	0.3234	-0.43	0.1072	0.33	0.2297	0.26	0.3574	0.45	0.0920	-0.49	0.0627	0.03	0.9050	-0.26	0.3461	-0.04	0.8945
	Sand	-0.27	0.3260	-0.31	0.2663	-0.30	0.2730	-0.13	0.6504	-0.36	0.1873	-0.34	0.2211	-0.24	0.3865	-0.26	0.3424	0.39	0.1508	-0.04	0.8794	0.37	0.1756	-0.59	0.0213	0.17	0.5514	-0.04	0.8907	-0.24	0.3893
	Median Intermediate Axis Length	0.04	0.8945	0.24	0.3917	0.37	0.1757	0.06	0.8204	0.44	0.1028	0.36	0.1835	0.51	0.0539	-0.05	0.8500	0.13	0.6440	-0.20	0.4811	-0.41	0.1261	0.56	0.0287	0.08	0.7783	0.21	0.4489	0.36	0.1874
	Median Embeddedness	0.01	0.9673	-0.44	0.0977	0.09	0.7619	-0.14	0.6196	-0.16	0.5691	-0.18	0.5105	-0.70	0.0034	0.33	0.2271	0.02	0.9323	0.20	0.4844	0.14	0.6306	-0.45	0.0946	0.06	0.8304	-0.27	0.3216	-0.56	0.0291
	Gradient of Stream Reach	0.24	0.3911	-0.05	0.8618	0.33	0.2236	0.00	0.9971	0.08	0.7847	0.24	0.3871	0.14	0.6265	0.21	0.4517	-0.26	0.3486	-0.26	0.3410	-0.16	0.5795	0.45	0.0924	-0.02	0.9377	0.25	0.3717	0.04	0.8767
	Wetted Width of Stream	0.11	0.7092	0.44	0.0980	-0.26	0.3490	0.24	0.3892	0.22	0.4306	0.20	0.4795	0.47	0.0771	-0.07	0.8148	-0.30	0.2717	-0.29	0.2878	-0.32	0.2470	0.17	0.5332	0.41	0.1316	0.64	0.0099	0.02	0.9389
	Bankful Width of Stream	0.28	0.3069	0.62	0.0138	-0.07	0.7950	0.27	0.3236	0.45	0.0900	0.37	0.1792	0.51	0.0526	0.04	0.8802	-0.20	0.4689	-0.29	0.2914	-0.40	0.1350	0.56	0.0285	0.15	0.5940	0.43	0.1113	0.16	0.5652
	Watershed Area	0.02	0.9361	0.12	0.6718	-0.26	0.3563	0.19	0.5075	-0.15	0.5909	0.07	0.7929	0.51	0.0512	-0.23	0.4178	-0.28	0.3135	-0.48	0.0722	-0.13	0.6561	0.09	0.7469	0.47	0.0763	0.62	0.0129	0.02	0.9317
	Watershed Perimeter	0.01	0.9697	0.03	0.9019	-0.26	0.3531	0.17	0.5393	-0.20	0.4773	-0.03	0.9194	0.39	0.1465	-0.27	0.3393	-0.19	0.4962	-0.37	0.1686	-0.04	0.8819	-0.02	0.9379	0.43	0.1054	0.52	0.0458	0.00	0.9995
	Stream Order	-0.01	0.9661	0.25	0.3643	-0.24	0.3904	0.12	0.6625	-0.14	0.6239	0.05	0.8543	0.40	0.1428	-0.17	0.5366	-0.24	0.3819	-0.35	0.2023	0.02	0.9414	0.10	0.7352	0.17	0.5542	0.51	0.0504	0.17	0.5435
	Distance from UMC	0.04	0.8928	0.46	0.0858	0.23	0.4110	0.10	0.7292	0.48	0.0701	0.61	0.0163	0.50	0.0594	0.30	0.2826	-0.23	0.4099	-0.35	0.2020	-0.56	0.0307	0.53	0.0414	0.12	0.6652	0.52	0.0488	0.27	0.3223
	Stream Density	-0.01	0.9817	0.17	0.5399	0.04	0.8850	0.11	0.6907	0.11	0.7082	0.15	0.5956	0.33	0.2263	-0.11	0.7082	0.02	0.9303	-0.07	0.7951	-0.10	0.7189	0.15	0.6025	-0.04	0.8771	0.26	0.3426	0.50	0.0575
	Sum of Stream Length	-0.04	0.9013	0.08	0.7808	-0.23	0.4166	0.18	0.5120	-0.14	0.6212	0.11	0.6938	0.58	0.0244	-0.24	0.3954	-0.28	0.3071	-0.49	0.0642	-0.20	0.4825	0.04	0.9010	0.56	0.0295	0.73	0.0022	0.07	0.7934
	Source Elevation	-0.12	0.6793	0.01	0.9812	-0.29	0.2868	-0.08	0.7773	-0.12	0.6585	0.30	0.2780	-0.01	0.9796	0.38	0.1575	-0.29	0.2896	-0.54	0.0386	-0.18	0.5131	-0.21	0.4479	0.46	0.0874	0.23	0.4123	-0.52	0.0451
	Change in Elevation	-0.12	0.6585	0.10	0.7241	-0.29	0.3020	-0.13	0.6363	-0.13	0.6439	0.28	0.3075	0.21	0.4583	0.20	0.4765	-0.26	0.3496	-0.62	0.0147	-0.06	0.8251	-0.18	0.5167	0.35	0.2031	0.41	0.1332	-0.27	0.3395
	Site Elevation	-0.04	0.8787	-0.08	0.7680	-0.14	0.6294	0.01	0.9583	-0.05	0.8630	0.15	0.6042	-0.20	0.4698	0.34	0.2177	-0.16	0.5751	-0.16	0.5643	-0.19	0.4937	-0.12	0.6698	0.30	0.2809	-0.07	0.8171	-0.47	0.0793
	Length of Main Channel	-0.02	0.9539	0.06	0.8403	-0.26	0.3459	0.03	0.9077	-0.14	0.6256	0.03	0.9221	0.21	0.4467	-0.09	0.7475	-0.14	0.6236	-0.38	0.1632	0.01	0.9798	-0.15	0.5988	0.35	0.2059	0.42	0.1174	-0.16	0.5789
	Gradient of Main Channel	-0.13	0.6334	-0.07	0.8165	0.03	0.9294	-0.20	0.4767	-0.04	0.8824	0.41	0.1286	-0.01	0.9853	0.46	0.0855	-0.18	0.5321	-0.45	0.0935	-0.13	0.6447	0.00	0.9948	0.06	0.8275	-0.02	0.9335	-0.15	0.5981
	Metamorphic	-0.41	0.1284	0.07	0.7990	-0.14	0.6216	-0.22	0.4212	0.06	0.8376	0.26	0.3496	0.19	0.4969	0.23	0.4000	-0.42	0.1202	-0.26	0.3517	-0.22	0.4331	-0.33	0.2346	0.34	0.2113	0.58	0.0239	-0.20	0.4637
	Plutonic	0.34	0.2163	-0.11	0.7042	0.14	0.6098	0.10	0.7174	0.10	0.7278	-0.37	0.1695	-0.07	0.8021	-0.44	0.1009	0.43	0.1067	0.32	0.2380	0.27	0.3302	0.21	0.4581	-0.29	0.2940	-0.41	0.1310	0.18	0.5307
	Sedimentary	0.20	0.4808	-0.02	0.9472	0.57	0.0256	0.23	0.4000	0.32	0.2448	0.36	0.1849	0.16	0.5621	0.18	0.5301	0.21	0.4435	0.04	0.8826	-0.37	0.1706	0.61	0.0151	-0.22	0.4321	-0.13	0.6317	0.62	0.0139
	Unconsolidated	0.06	0.8339	0.45	0.0931	-0.15	0.5982	0.08	0.7776	0.19	0.4879	-0.11	0.6875	0.06	0.8394	-0.17	0.5498	0.05	0.8648	0.33	0.2243	0.02	0.9371	0.05	0.8460	-0.19	0.4879	-0.01	0.9733	0.15	0.6023
	Volcanic	-0.12	0.6682	-0.10	0.7233	-0.35	0.2047	-0.05	0.8503	-0.49	0.0653	0.00	0.9871	-0.26	0.3479	0.27	0.3357	-0.25	0.3767	-0.29	0.3004	0.13	0.6434	-0.31	0.2571	0.20	0.4703	-0.05	0.8689	-0.45	0.0887
	Basalt/Breccia/Andesite/ Porphyry/Dacite/Trachyte	-0.10	0.7342	-0.06	0.8267	-0.37	0.1771	-0.02	0.9420	-0.49	0.0632	0.01	0.9770	-0.22	0.4320	0.23	0.4163	-0.20	0.4772	-0.30	0.2798	0.13	0.6426	-0.30	0.2778	0.20	0.4676	-0.06	0.8431	-0.39	0.1497
	Basalt/Tuff/Breccia	-0.13	0.6388	-0.21	0.4618	0.13	0.6347	-0.18	0.5228	0.04	0.8744	-0.02	0.9430	-0.22	0.4401	0.21	0.4522	-0.25	0.3713	0.08	0.7726	-0.01	0.9755	-0.05	0.8498	-0.02	0.9505	0.05	0.8488	-0.33	0.2308
	Conglomerate	0.20	0.4808	-0.02	0.9472	0.57	0.0256	0.23	0.4000	0.32	0.2448	0.36	0.1849	0.16	0.5621	0.18	0.5301	0.21	0.4435	0.04	0.8826	-0.37	0.1706	0.61	0.0151	-0.22	0.4321	-0.13	0.6317	0.62	0.0139
	Granite/Quartz Monzonite/ Granodiorite	0.41	0.1255	0.45	0.0940	-0.04	0.8743	0.26	0.3442	0.26	0.3586	0.12	0.6734	0.26	0.3536	-0.04	0.8830	-0.11	0.6899	-0.23	0.4049	-0.03	0.9078	0.75	0.0012	-0.21	0.4523	0.03	0.9283	0.14	0.6314
	Granodiorite/Diorite/Monzodiorite	0.11	0.7046	-0.39	0.1485	0.19	0.4870	-0.06	0.8194	-0.03	0.9047	-0.47	0.0807	-0.25	0.3724	-0.41	0.1258	0.49	0.0667	0.48	0.0670	0.30	0.2720	-0.21	0.4495	-0.19	0.4936	-0.44	0.1045	0.07	0.8144
	Marble	-0.27	0.3331	-0.02	0.9472	0.13	0.6318	-0.25	0.3746	0.16	0.5606	0.16	0.5597	-0.19	0.4963	0.34	0.2113	-0.14	0.6161	0.02	0.9466	-0.06	0.8319	-0.16	0.5590	-0.10	0.7209	0.01	0.9683	-0.19	0.4997
	Orthogneiss	-0.28	0.3171	-0.10	0.7198	-0.21	0.4493	-0.11	0.7034	-0.17	0.5548	0.08	0.7870	0.24	0.3923	0.01	0.9733	-0.39	0.1516	-0.30	0.2849	-0.07	0.8055	-0.22	0.4231	0.36	0.1831	0.47	0.0778	-0.13	0.6345
	Quartz Monzonite/Granite/ Monzonite/Syenite	-0.15	0.5884	-0.21	0.4618	0.04	0.8821	-0.13	0.6332	-0.02	0.9496	0.26	0.3470	-0.21	0.4436	0.46	0.0841	-0.16	0.5789	-0.20	0.4762	-0.26	0.3545	-0.16	0.5590	0.29	0.2913	-0.08	0.7701	-0.48	0.0703
	Quartzite/Qt-ms-schist	-0.26	0.3483	0.23	0.4038	0.06	0.8346	-0.20	0.4801	0.29	0.2895	0.29	0.2965	-0.02	0.9534	0.33	0.2224	-0.13	0.6373	-0.01	0.9627	-0.24	0.3956	-0.20	0.4668	0.05	0.8530	0.27	0.3327	-0.14	0.6296
	Silt/Sand/Gravel	0.06	0.8339	0.45	0.0931	-0.15	0.5982	0.08	0.7776	0.19	0.4879	-0.11	0.6875	0.06	0.8394	-0.17	0.5498	0.05	0.8648	0.33	0.2243	0.02	0.9371	0.05	0.8460	-0.19	0.4879	-0.01	0.9733	0.15	0.6023
	Water	0.06	0.8339	0.45	0.0931	-0.15	0.5982	0.08	0.7776	0.19	0.4879	-0.11	0.6875	0.06	0.8394	-0.17	0.5498	0.05	0.8648	0.33	0.2243	0.02	0.9371	0.05	0.8460	-0.19	0.4879	-0.01	0.9733	0.15	0.6023
	Rock/Rubble	0.22	0.4244	-0.02	0.9333	0.57	0.0276	0.27	0.3388	0.32	0.2446	0.33	0.2301	0.14	0.6128	0.15	0.5961	0.25	0.3678	0.08	0.7820	-0.36	0.1865	0.61	0.0154	-0.23	0.4154	-0.16	0.5693	0.64	0.0110
	Exposed Land	-0.12	0.6585	-0.63	0.0112	0.32	0.2479	-0.37	0.1728	-0.33	0.2257	-0.26	0.3545	-0.34	0.2121	-0.03	0.9196	0.10	0.7307	0.00	0.9886	0.38	0.1675	-0.16	0.5599	-0.14	0.6151	-0.27	0.3306	-0.21	0.4475
	Bryoids	-0.26	0.3521	-0.30	0.2783	-0.01	0.9776	0.16	0.5729	-0.15	0.5908	0.12	0.6805	0.66	0.0075	-0.30	0.2732	-0.25	0.3713	-0.35	0.1983	-0.42	0.1194	-0.16	0.5590	0.85	0.0001	0.84	0.0001	0.19	0.4957
	Shrub Tall	0.05	0.8718	0.35	0.1971	-0.33	0.2324	0.04	0.8783	-0.02	0.9521	0.15	0.5847	0.25	0.3741	0.03	0.9114	-0.22	0.4280	-0.35	0.1942	0.06	0.8403	0.18	0.5247	-0.03	0.9113	0.17	0.5553	0.08	0.7859
	Shrub Low	0.00	0.9967	-0.21	0.4510	0.22	0.4317	0.03	0.9150	0.05	0.8685	0.27	0.3282	0.31	0.2568	0.06	0.8190	-0.10	0.7255	-0.25	0.3666	-0.31	0.2638	0.25	0.3754	0.21	0.4451	0.03	0.9255	0.09	0.7377
	Wetland Shrub	0.19	0.5012	-0.02	0.9377	0.48	0.0684	0.25	0.3772	0.19	0.5027	0.29	0.2908	0.15	0.6051	0.13	0.6413	0.17	0.5335	0.02	0.9429	-0.27	0.3253	0.58	0.0228	-0.24	0.3826	-0.16	0.5743	0.61	0.0150
	Herb	0.22	0.4271	-0.51	0.0522	-0.14	0.6078	0.29	0.2975	-0.58	0.0234	-0.76	0.0009	-0.43	0.1075	-0.54	0.0371	0.38	0.1668	0.42	0.1179	0.57	0.0250	-0.19	0.4893	-0.14	0.6311	-0.48	0.0712	0.10	0.7116
	Coniferous Dense	0.29	0.3012	0.61	0.0151	-0.12	0.6664	0.12	0.6750	0.35	0.1959	0.25	0.3705	0.20	0.4855	0.15	0.5904	-0.18	0.5315	-0.27	0.3230	-0.08	0.7692	0.56	0.0304	-0.19	0.4954	0.14	0.6257	-0.03	0.9280
	Coniferous Open	-0.18	0.5308	0.39	0.1555	0.01	0.9596	-0.19	0.4889	0.35	0.2006	0.31	0.2620	-0.07	0.8171	0.37	0.1694	-0.07	0.7967	0.02	0.9532	-0.22	0.4390	-0.17	0.5355	-0.04	0.9014	0.21	0.4461	-0.15	0.5821
	Coniferous Sparse	-0.11	0.6985	0.45	0.0962	-0.06	0.8414	-0.13	0.6523	0.38	0.1676	0.14	0.6300	0.14	0.6077	0.07	0.8008	-0.16	0.5795	0.12	0.6820	-0.19	0.4993	-0.05	0.8680	0.02	0.9546	0.32	0.2497	-0.12	0.6717
	Broadleaf Dense	0.23	0.4031	0.52	0.0465	-0.32	0.2414	0.13	0.6330	0.13	0.6527	0.16	0.5805	0.27	0.3287	0.02	0.9437	-0.24	0.3963	-0.39	0.1522	0.04	0.8797	0.44	0.1036	-0.09	0.7420	0.17	0.5348	0.01	0.9793
	Broadleaf Open	0.00	0.9994	0.14	0.6107	-0.44	0.0999	0.10	0.7098	-0.19	0.5046	-0.12	0.6584	0.09	0.7487	-0.18	0.5272	-0.04	0.8770	-0.12	0.6816	0.18	0.5303	-0.17	0.5355	0.09	0.7459	0.10	0.7240	0.06	0.8413
	Mixedwood Open	-0.34	0.2095	0.04	0.8940	0.06	0.8300	-0.10	0.7225	0.18	0.5206	0.40	0.1441	0.34	0.2189	0.21	0.4574	-0.23	0.4001	-0.30	0.2793	-0.47	0.0740	-0.27	0.3267	0.55	0.0342	0.72	0.0026	-0.06	0.8387
	Mixedwood Sparse	-0.01	0.9606	0.26	0.3456	0.01	0.9817	-0.09	0.7587	0.22	0.4330	0.44	0.1004	0.08	0.7865	0.37	0.1745	0.03	0.9201	-0.31	0.2687	-0.33	0.2320	-0.14	0.6190	0.25	0.3715	0.35	0.2068	-0.15	0.6010
	Slope of Basin (mean)	-0.29	0.2870	-0.23	0.4048	-0.31	0.2529	-0.12	0.6587	-0.30	0.2746	0.02	0.9399	0.29	0.2910	-0.08	0.7664	-0.39	0.1492	-0.49	0.0653	-0.10	0.7281	-0.44	0.0999	0.74	0.0014	0.71	0.0030	-0.40	0.1432
	Aspect of Basin (mean)	-0.04	0.8932	0.01	0.9622	-0.20	0.4743	-0.02	0.9328	-0.01	0.9716	0.08	0.7815	-0.12	0.6624	0.16	0.5798	0.04	0.8749	-0.10	0.7146	0.02	0.9437	-0.22	0.4242	0.04	0.8909	-0.15	0.5938	-0.15	0.5834
	Fire History: 1950-2009	0.02	0.9427	-0.01	0.9835	0.16	0.5723	0.02	0.9489	0.11	0.6879	-0.14	0.6289	0.18	0.5229	-0.34	0.2217	0.24	0.3855	0.22	0.4372	0.09	0.7528	-0.01	0.9821	-0.16	0.5764	0.11	0.6996	0.45	0.0927
	Fire History: 1955-2009	0.02	0.9314	-0.01	0.9843	0.16	0.5765	0.02	0.9385	0.11	0.6937	-0.14	0.6221	0.18	0.5155	-0.34	0.2135	0.24	0.3804	0.22	0.4369	0.09	0.7500	0.00	0.9889	-0.16	0.5793	0.11	0.6995	0.45	0.0898
	Fire History: 1960-2009	0.02	0.9314	-0.01	0.9843	0.16	0.5765	0.02	0.9385	0.11	0.6937	-0.14	0.6221	0.18	0.5155	-0.34	0.2135	0.24	0.3804	0.22	0.4369	0.09	0.7500	0.00	0.9889	-0.16	0.5793	0.11	0.6995	0.45	0.0898
	Fire History: 1965-2009	0.02	0.9314	-0.01	0.9843	0.16	0.5765	0.02	0.9385	0.11	0.6937	-0.14	0.6221	0.18	0.5155	-0.34	0.2135	0.24	0.3804	0.22	0.4369	0.09	0.7500	0.00	0.9889	-0.16	0.5793	0.11	0.6995	0.45	0.0898
	Fire History: 1970-2009	0.13	0.6444	-0.08	0.7834	0.05	0.8662	0.05	0.8464	-0.09	0.7591	-0.27	0.3309	-0.02	0.9338	-0.36	0.1919	0.38	0.1627	0.32	0.2510	0.22	0.4385	-0.10	0.7173	-0.20	0.4846	-0.19	0.5018	0.35	0.2046
	Fire History: 1975-2009	0.13	0.6374	-0.09	0.7617	0.06	0.8343	0.06	0.8339	-0.08	0.7688	-0.27	0.3270	-0.02	0.9378	-0.36	0.1855	0.39	0.1553	0.32	0.2404	0.21	0.4523	-0.10	0.7263	-0.19	0.4944	-0.19	0.5051	0.35	0.1983
	Fire History: 1980-2009	0.13	0.6374	-0.09	0.7617	0.06	0.8343	0.06	0.8339	-0.08	0.7688	-0.27	0.3270	-0.02	0.9378	-0.36	0.1855	0.39	0.1553	0.32	0.2404	0.21	0.4523	-0.10	0.7263	-0.19	0.4944	-0.19	0.5051	0.35	0.1983
	Fire History: 1985-2009	-0.17	0.5377	-0.29	0.2898	0.14	0.6298	-0.22	0.4409	-0.10	0.7124	-0.10	0.7266	-0.08	0.7714	-0.04	0.8986	0.00	0.9934	0.05	0.8628	0.00	0.9893	-0.34	0.2089	0.25	0.3719	0.27	0.3340	-0.22	0.4249
	Fire History: 1990-2009	-0.17	0.5377	-0.29	0.2898	0.14	0.6298	-0.22	0.4409	-0.10	0.7124	-0.10	0.7266	-0.08	0.7714	-0.04	0.8986	0.00	0.9934	0.05	0.8628	0.00	0.9893	-0.34	0.2089	0.25	0.3719	0.27	0.3340	-0.22	0.4249
	Fire History: 1995-2009	-0.07	0.8008	-0.14	0.6221	0.07	0.7937	-0.09	0.7482	-0.09	0.7537	-0.08	0.7654	0.08	0.7656	-0.20	0.4773	0.19	0.5004	0.02	0.9470	-0.01	0.9734	-0.29	0.2990	0.24	0.3804	0.25	0.3723	0.04	0.8969
	Fire History: 2000-2009	-0.09	0.7411	0.34	0.2197	-0.09	0.7444	0.06	0.8331	0.21	0.4443	0.31	0.2635	0.40	0.1410	0.03	0.9219	-0.06	0.8198	-0.18	0.5220	-0.42	0.1155	-0.15	0.6057	0.45	0.0884	0.64	0.0104	0.07	0.7989
	Fire History: 2005-2009	-0.26	0.3521	-0.30	0.2783	-0.01	0.9776	0.16	0.5729	-0.15	0.5908	0.12	0.6805	0.66	0.0075	-0.30	0.2732	-0.25	0.3713	-0.35	0.1983	-0.42	0.1194	-0.16	0.5590	0.85	0.0001	0.84	0.0001	0.19	0.4957

🟨	correlation scatterplot inspected; p < 0.01
🟩	significant correlation at p <0.001

Note: n = 15 for all correlations

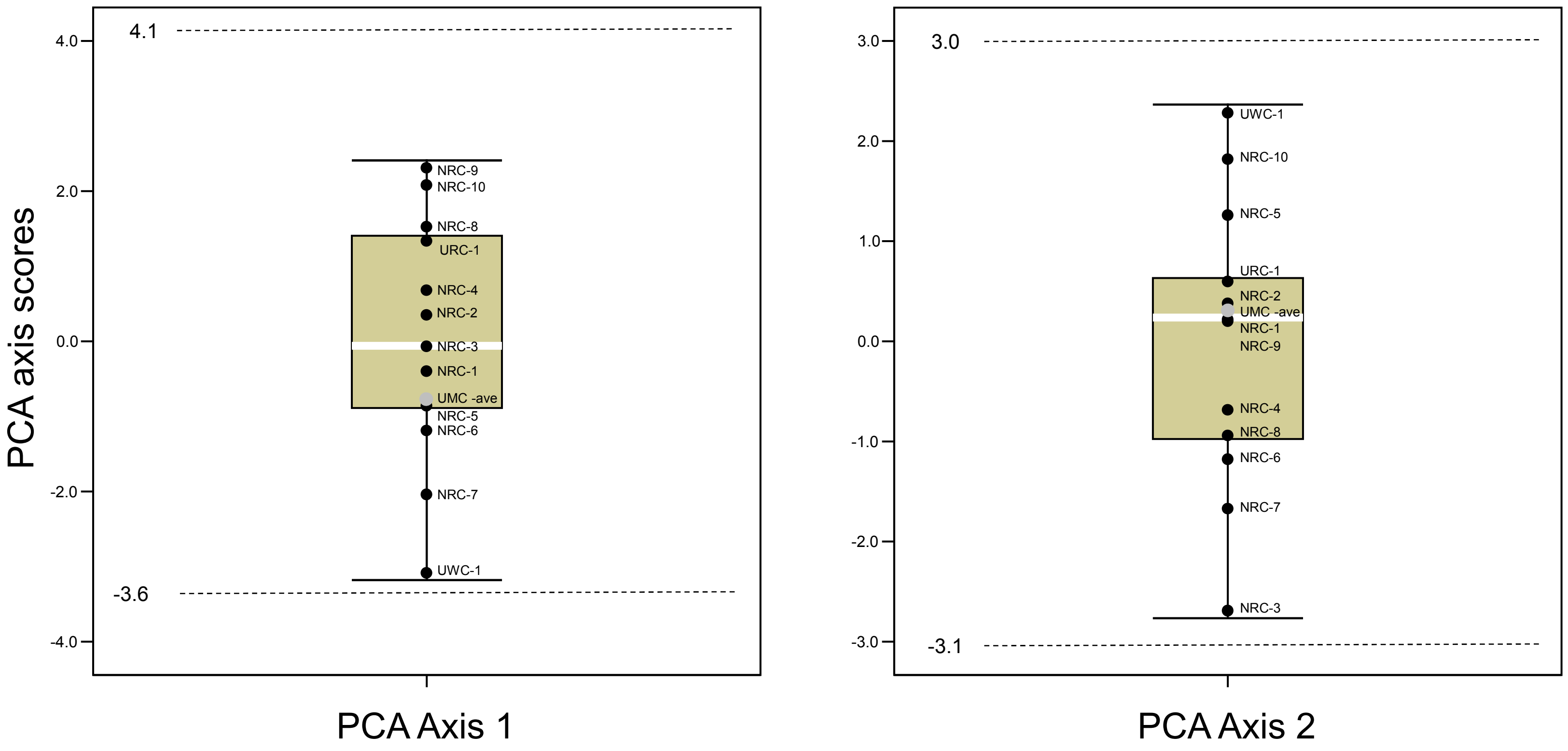

Figure E.1: **Boxplot of principal components analyses site scores, Minto Mine September 2014. The grey circle represents the average of UMC mine-exposed stations and a black circle represents reference stations. No site scores were identified as outliers, defined as 1.5 times the interquartile distance from each quartile and displayed as dotted lines.**

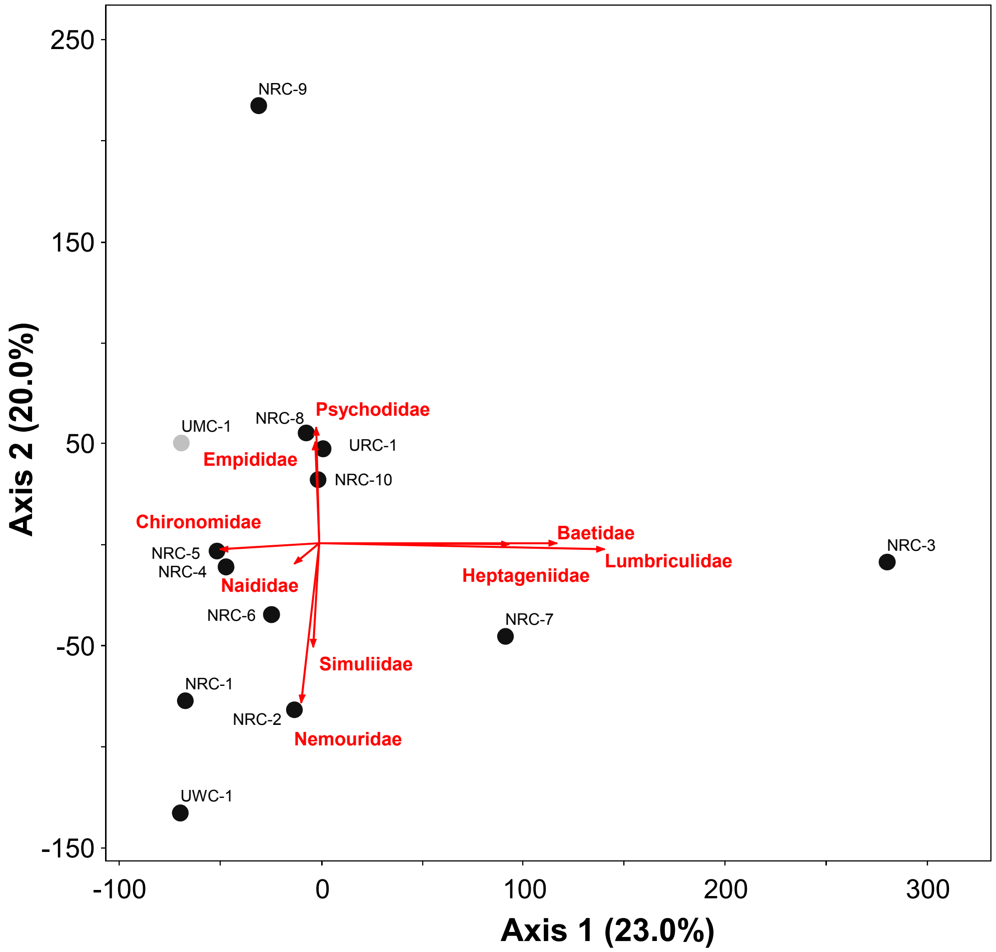

Figure E.2: Biplot of correspondence analyses of RCA reference stations (n-12) and exposed station UMC-1, Minto Mine, September 2014. Analyses conducted at the family level of taxonomy and processed at 400 µm. Vector length is proportional to the magnitude of taxon correlation with each axis. Only families with Pearson p-value<0.10 are presented.

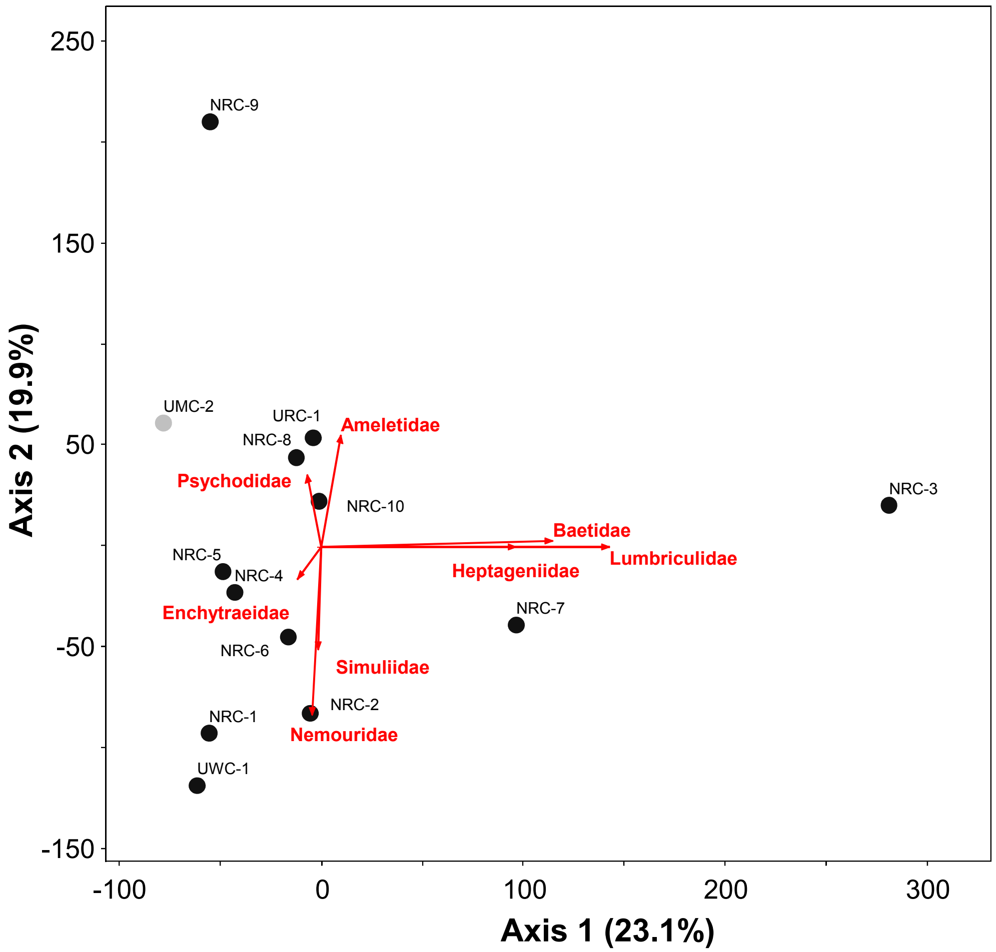

Figure E.3: Biplot of correspondence analyses of RCA reference stations (n-12) and exposed station UMC-2, Minto Mine, September 2014. Analyses conducted at the family level of taxonomy and processed at 400 µm. Vector length is proportional to the magnitude of taxon correlation with each axis. Only families with Pearson p-value<0.10 are presented.

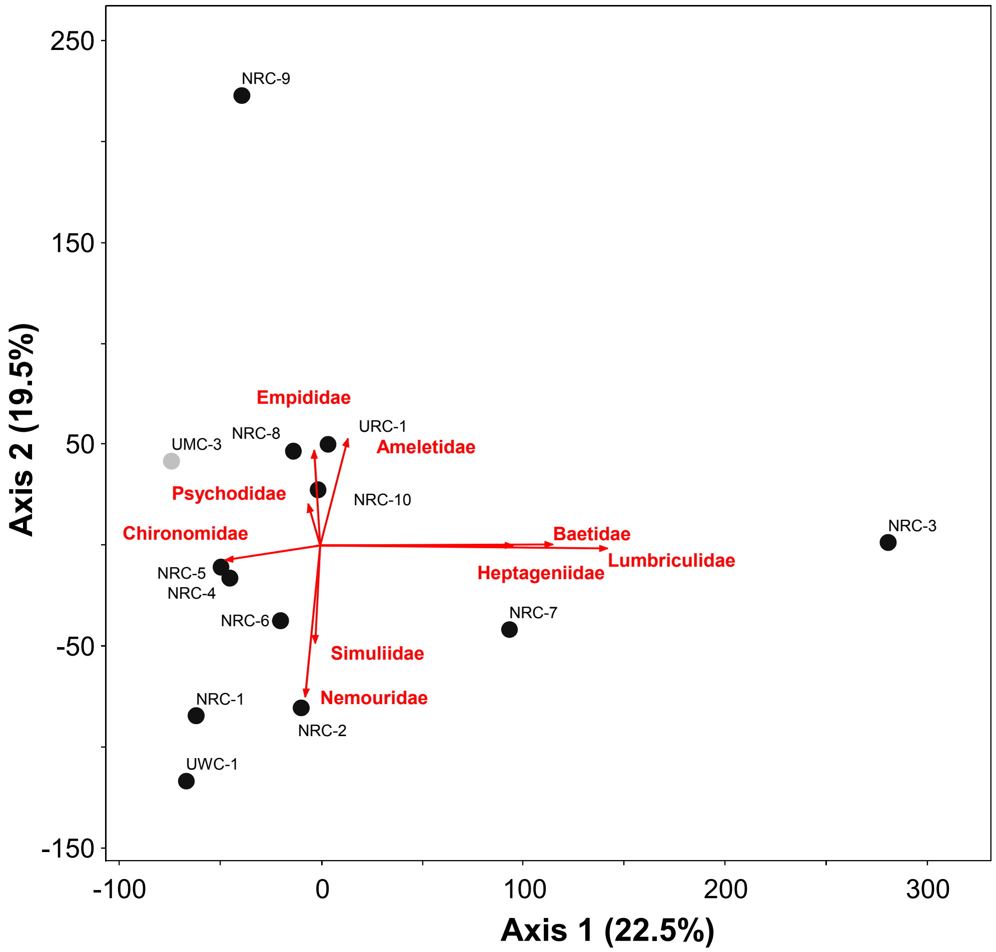

Figure E.4: **Biplot of correspondence analyses of RCA reference stations (n-12) and exposed station UMC-3, Minto Mine, September 2014. Analyses conducted at the family level of taxonomy and processed at 400 µm. Vector length is proportional to the magnitude of taxon correlation with each axis. Only families with Pearson p-value<0.10 are presented.**

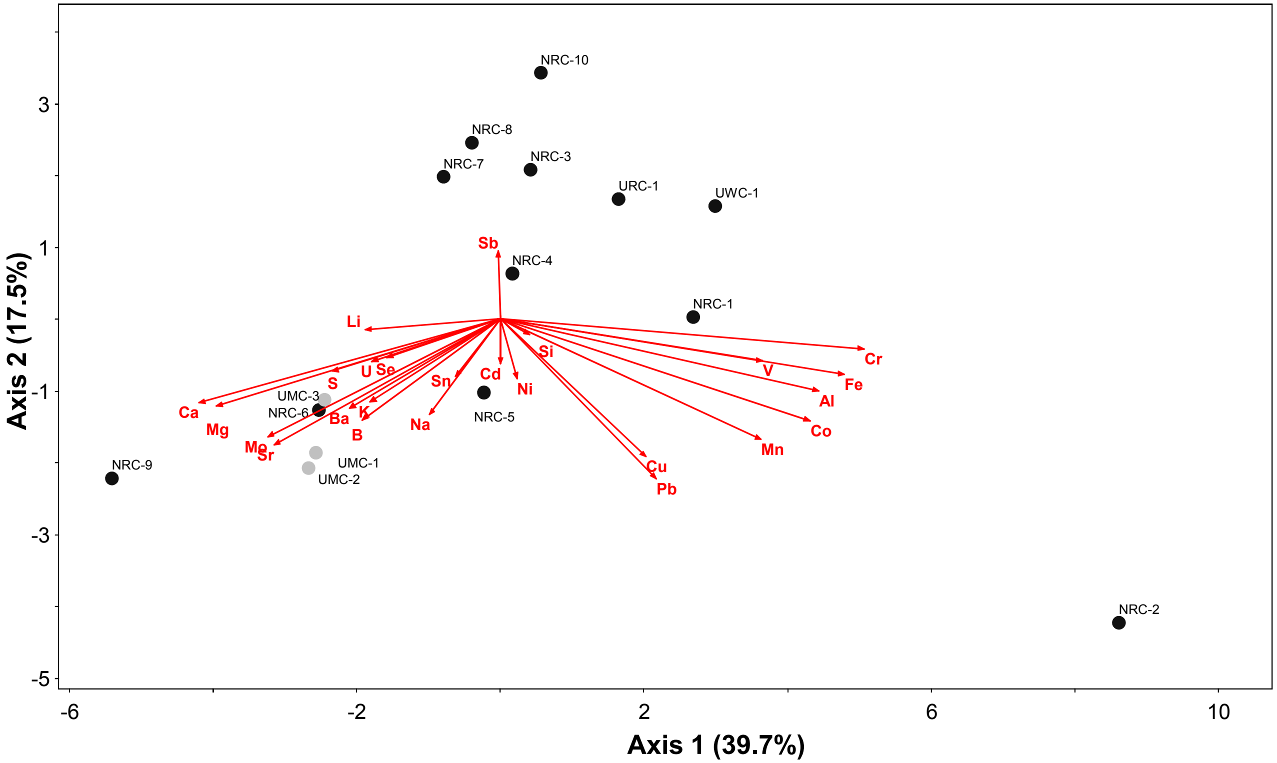

Figure E.5: Biplot of principal components analyses of dissolved metal concentrations of RCA study areas, Minto Mine, September 2014. The grey circles represents each UMC (mine-exposed) replicate and black circles represent reference stations. Vector length is proportional to the magnitude of metals concentration correlation with each axis. Only variables with Spearman correlation p-values<0.01 are displayed.

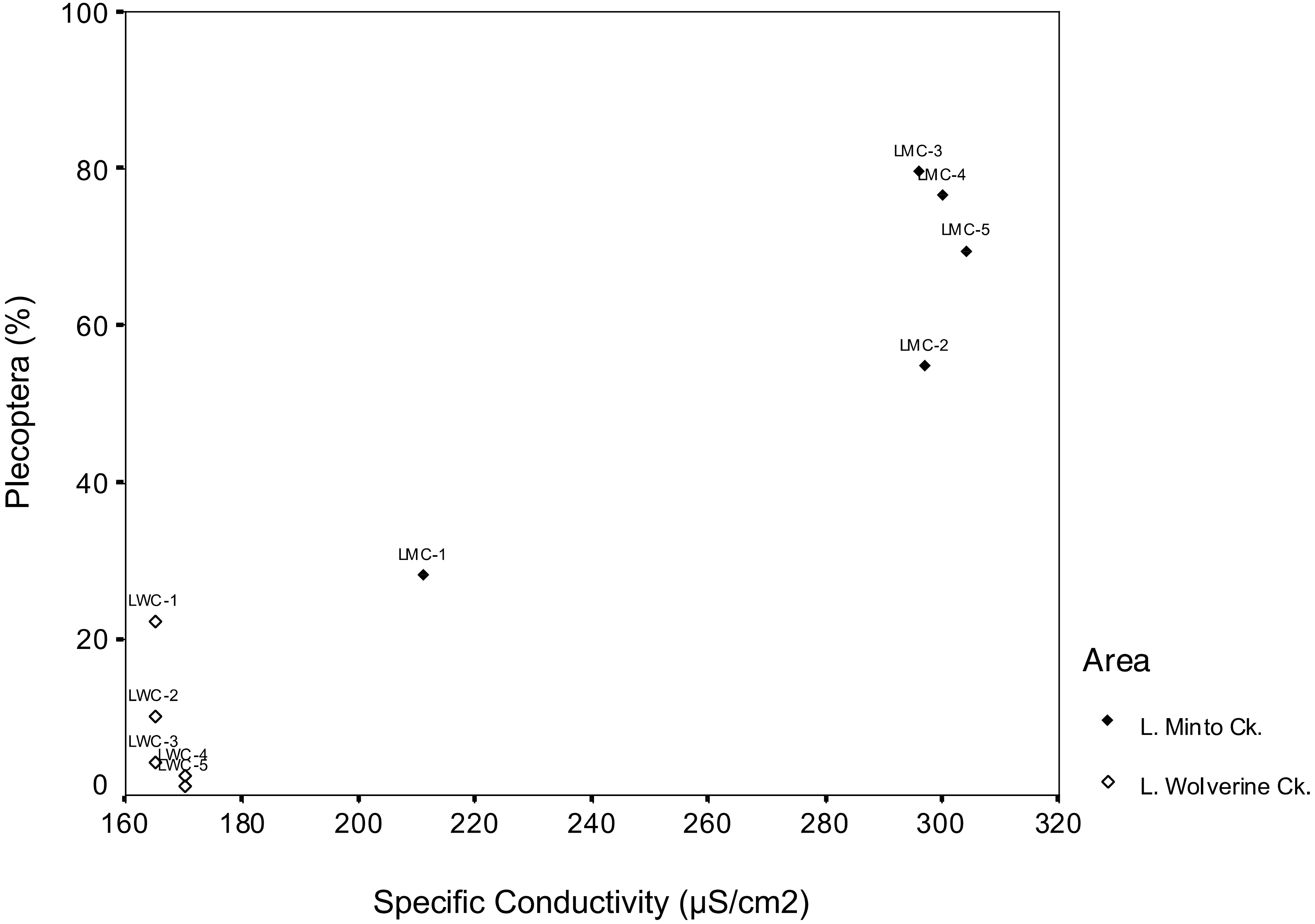

Figure E.6: Biplot of % Plecoptera versus specific conductivity, Minto lower creek areas, Minto Mine IOC, September 2014

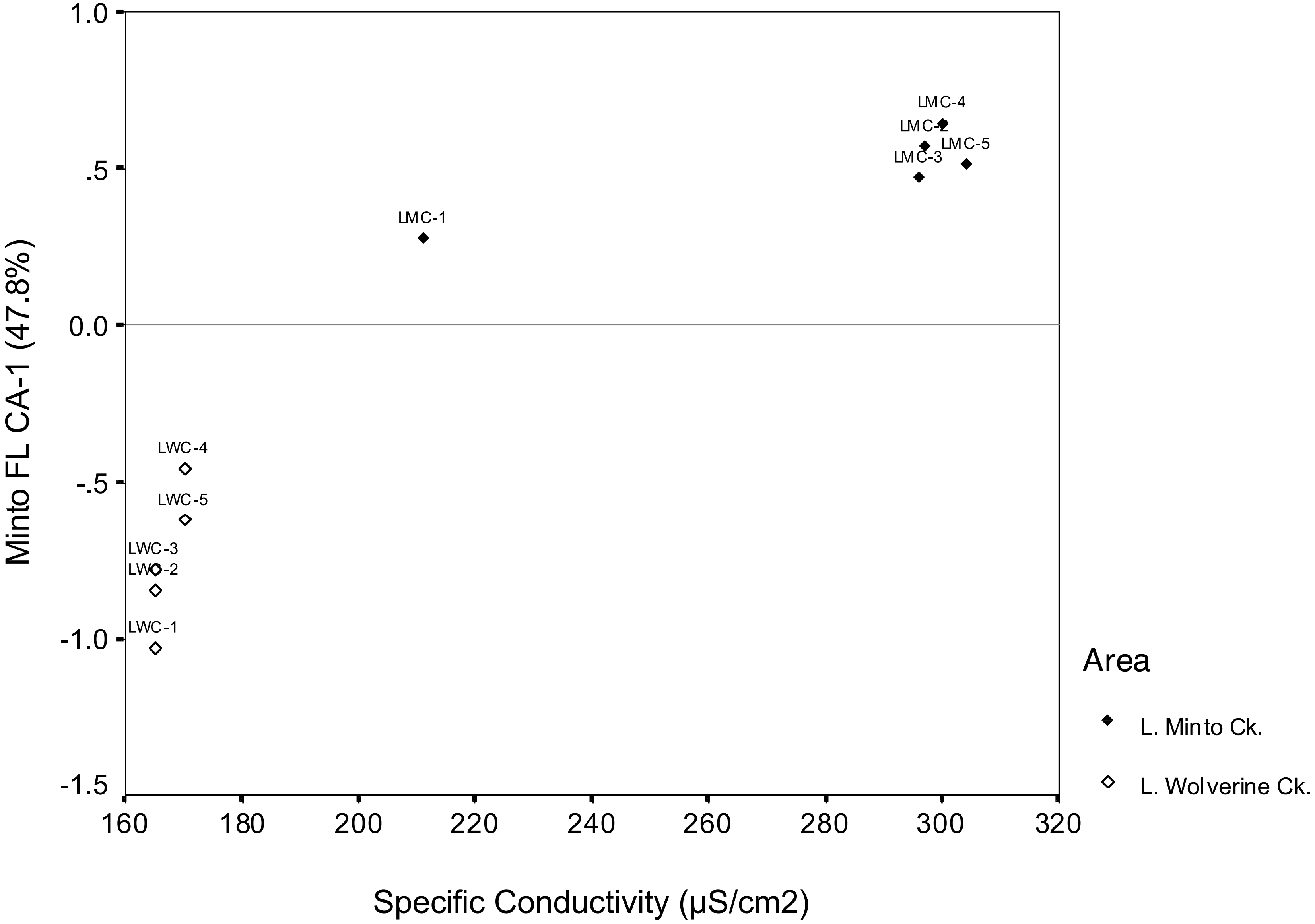

Figure E.7: Biplot of FL Ca Axis 1 scores versus specific conductivity, Minto lower creek areas, Minto Mine IOC, September 2014

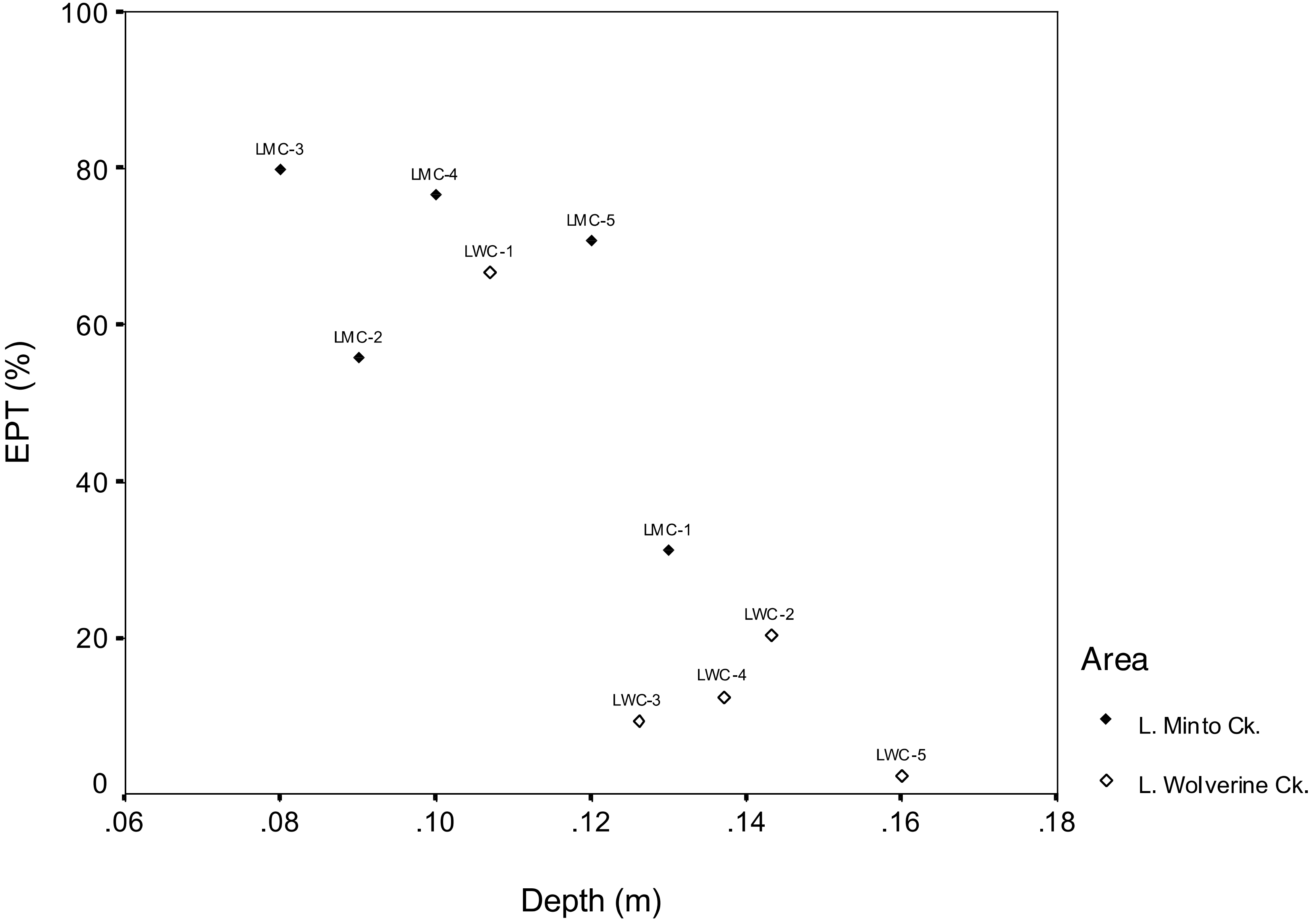

Figure E.8: Biplot of % EPT taxa versus depth, Minto lower creek areas, Minto Mine IOC, September 2014

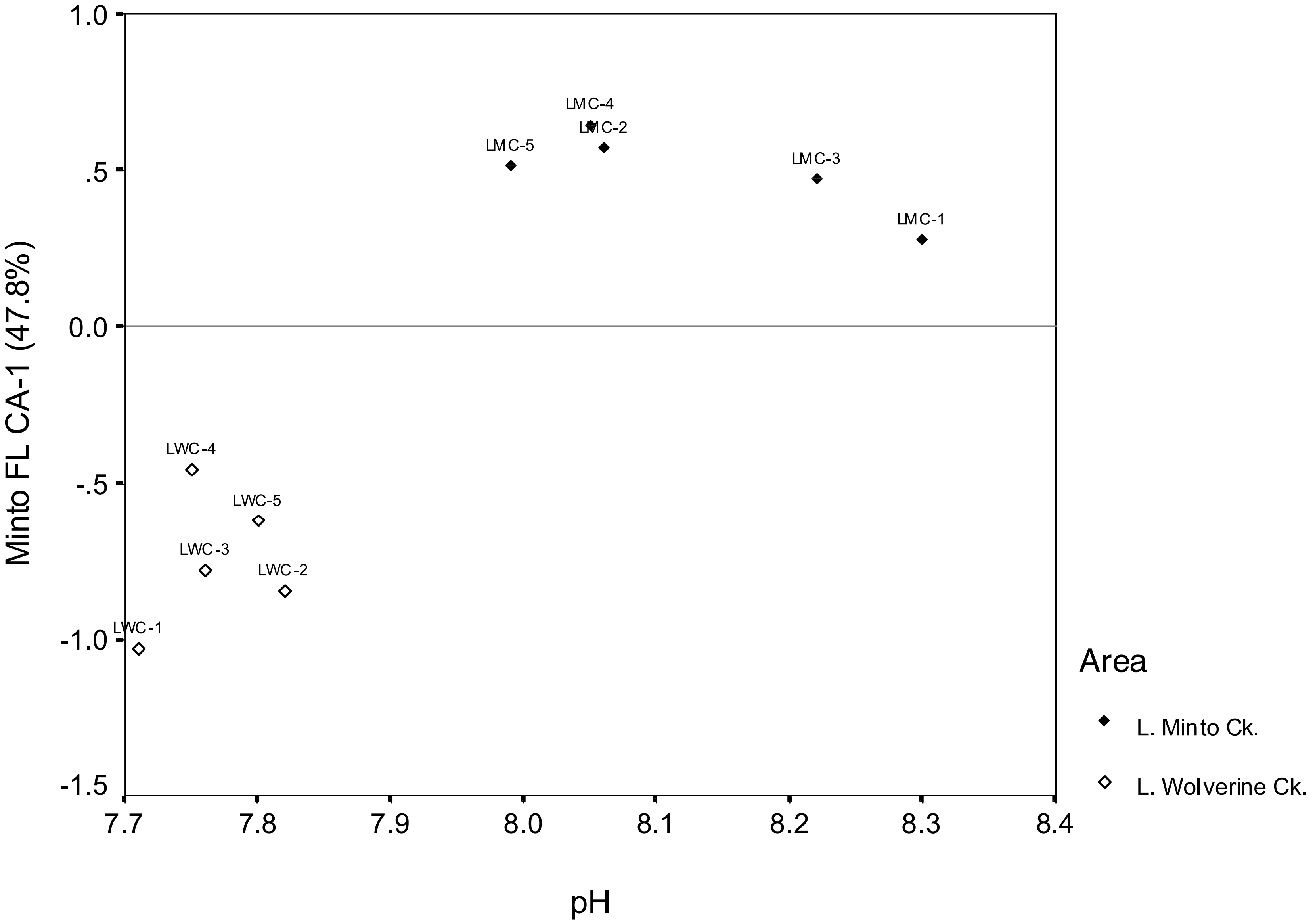

Figure E.9: Biplot of FL Ca Axis 1 scores versus pH, Minto lower creek areas, Minto Mine IOC, September 2014

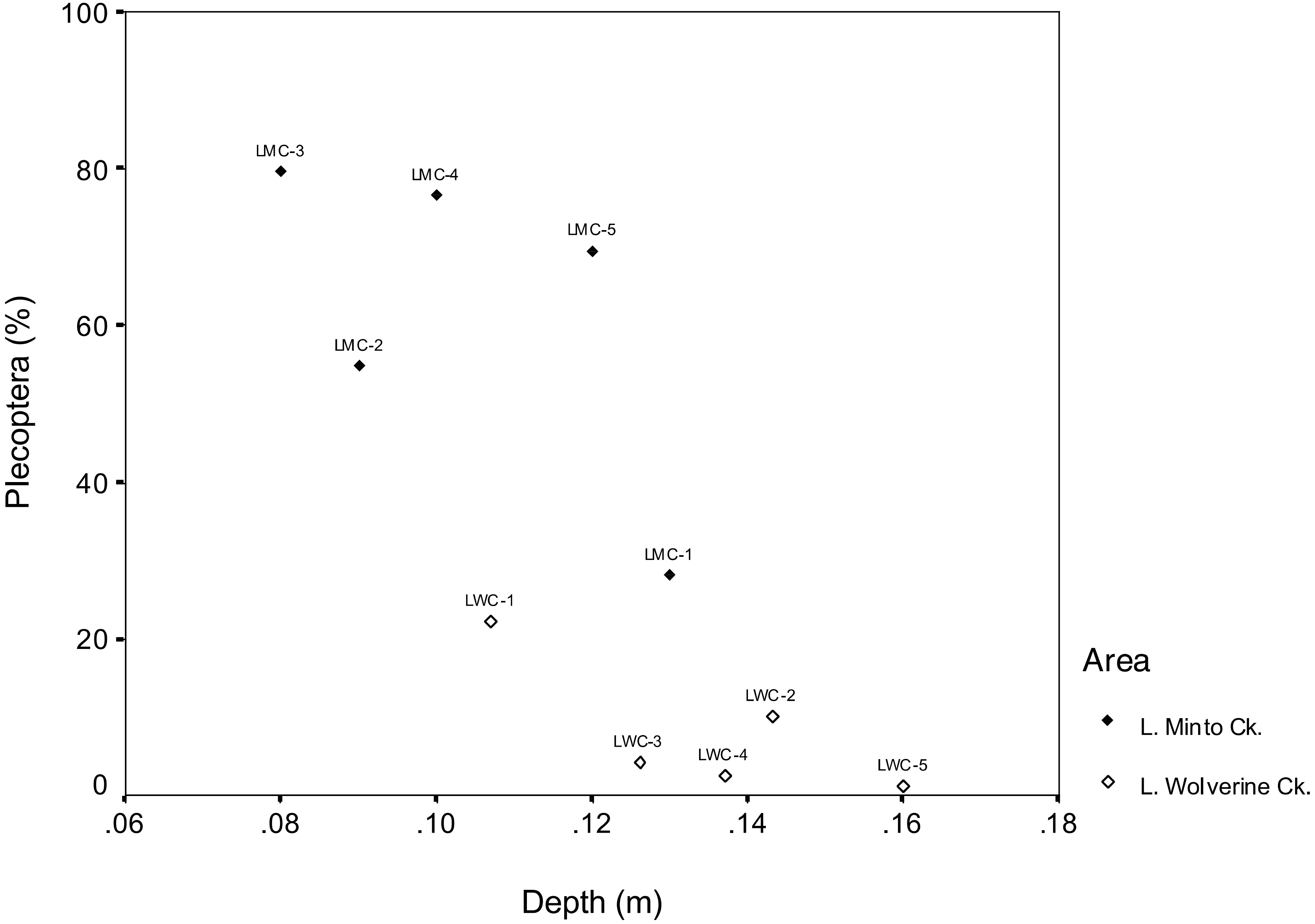

Figure E.10: Biplot of % Plecoptera versus depth, Minto lower creek areas, Minto Mine IOC, September 2014

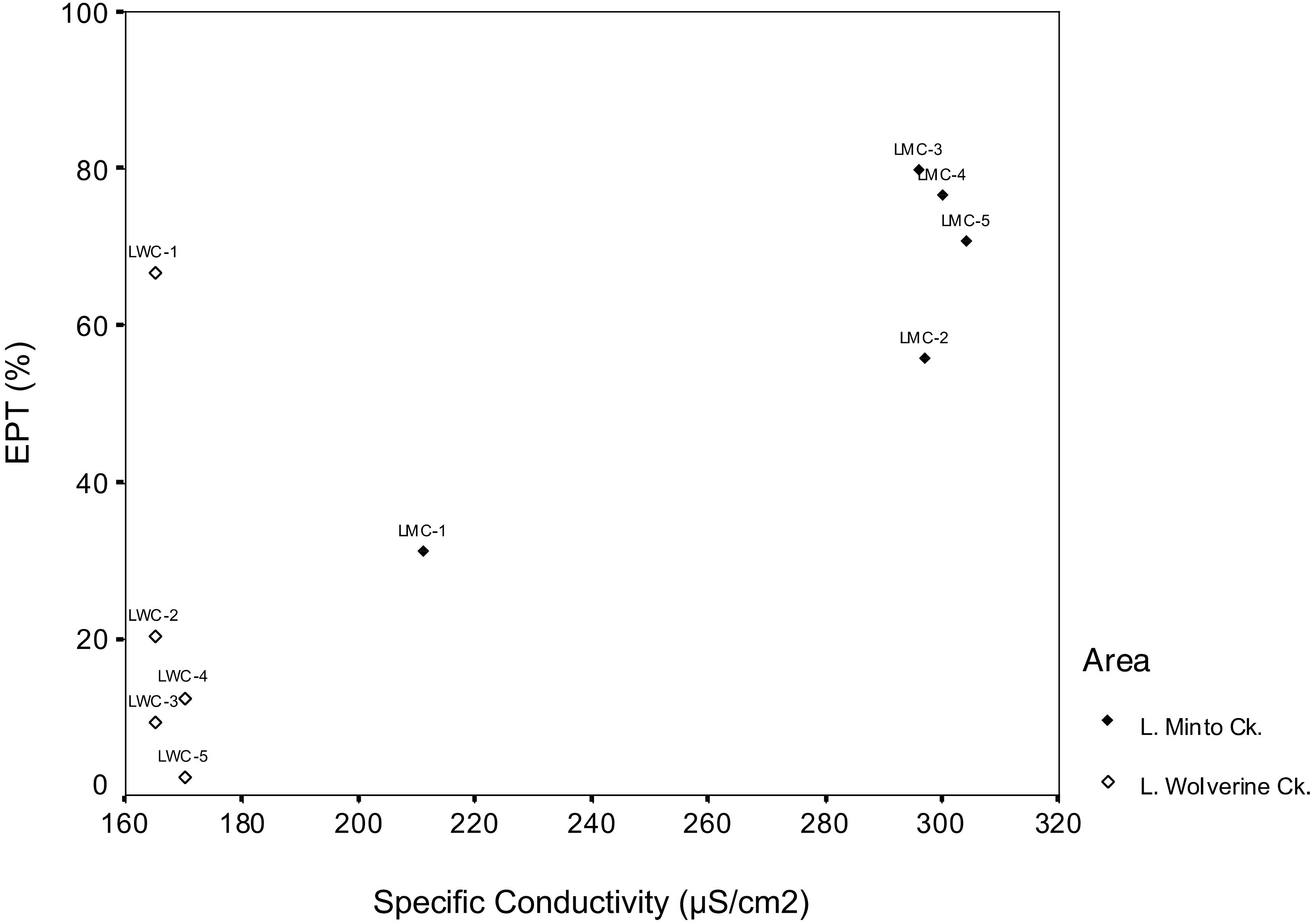

Figure E.11: Biplot of % EPT versus specific conductivity, Minto lower creek areas, Minto Mine IOC, September 2014

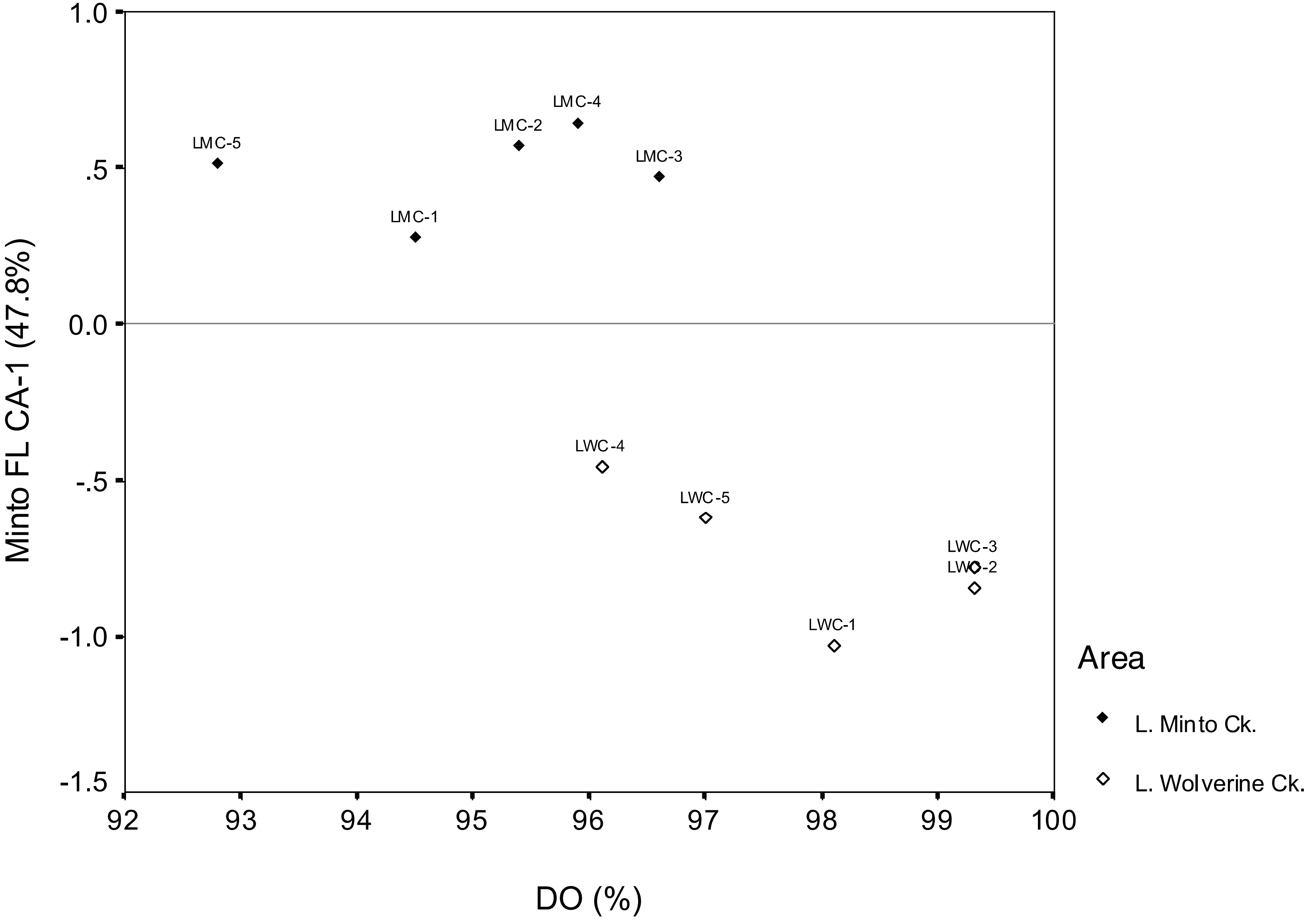

Figure E.12: Biplot of FL Ca Axis 1 scores versus dissolved oxygen (%), Minto lower creek areas, Minto Mine IOC, September 2014

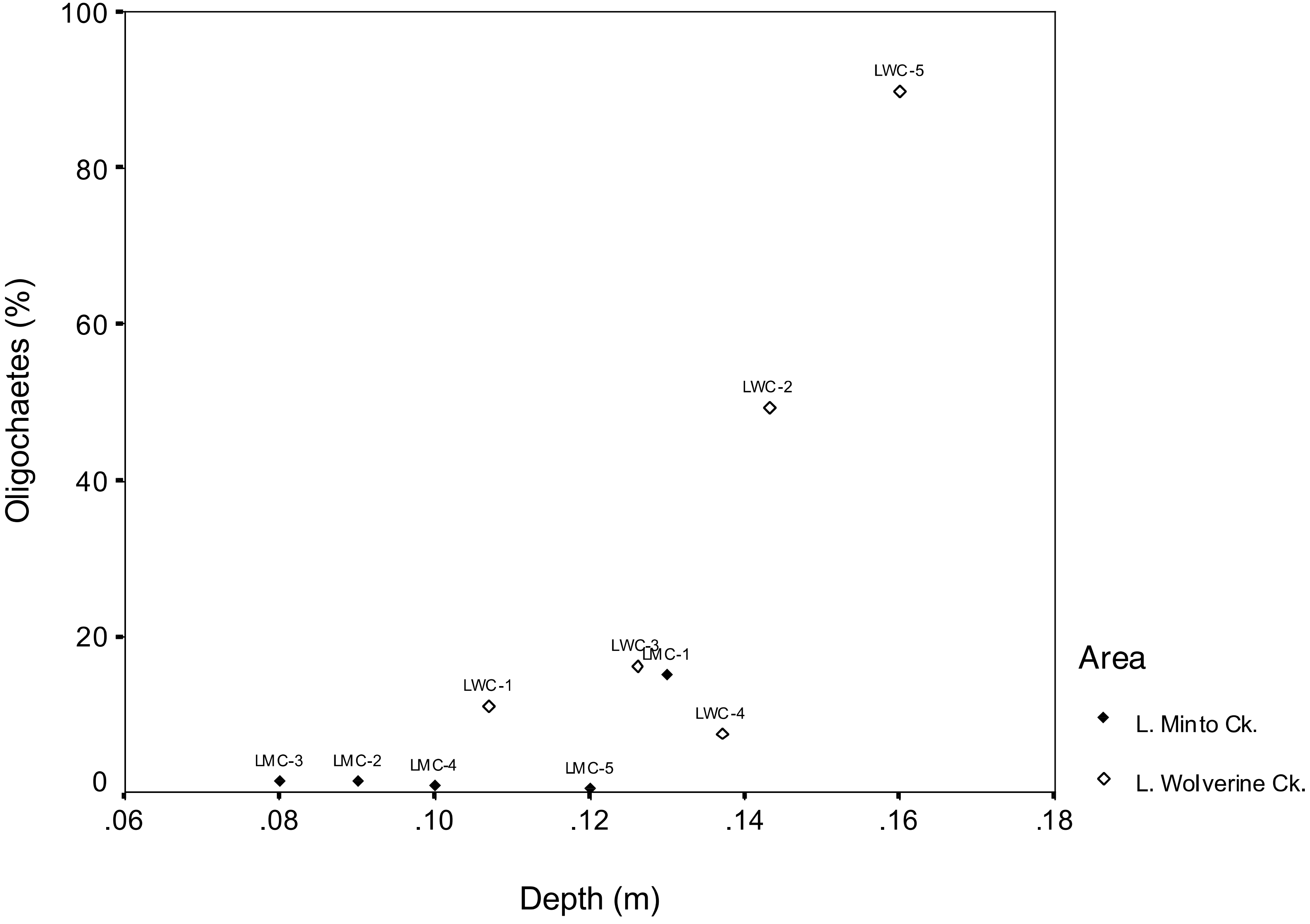

Figure E.13: Biplot of % Oligochaetes versus depth, Minto lower creek areas, Minto Mine IOC, September 2014

Appendix F

SUPPORTING PHOTOGRAPHS

Photo 1: Upper Minto Creek (UMC-2), September 9, 2014.

Photo 2: Upper Minto Creek (UMC-3), September 9, 2014.

Photo 3: Lower Minto Creek (LMC-1), September 10, 2014.

Photo 4: New Reference Creek 1 (NRC-1), September 10, 2014.

Photo 5: New Reference Creek 2 (NRC-2), September 10, 2014.

Photo 6: New Reference Creek 3 (NRC-3), September 11, 2014.

Photo 7: New Reference Creek 4 (NRC-4), September 11, 2014.

Photo 8: New Reference Creek 5 (NRC-5), September 12, 2014.

Photo 9: New Reference Creek 6 (NRC-6), September 12, 2014.

Photo 10: New Reference Creek 7 (NRC-7), September 12, 2014.

Photo 11: New Reference Creek 8 (NRC-8), September 13, 2014.

Photo 12: New Reference Creek 9 (NRC-9), September 14, 2014.

Photo 13: New Reference Creek 10 (NRC-10), September 14, 2014.

Photo 14: Upper Wolverine Creek (UWC [reference]), September 13, 2014.

Photo 15: Upper McGinty Creek (URC [reference]), September 13, 2014.

Photo 16: Lower Wolverine Creek (Reference for Lower Minto), September 11, 2014

Appendix K – 2014 Water Balance and Water Quality Model Summary for the Minto Mine Site

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Memo

To:	James Spencer, Ryan Herbert	**Client:**	Minto Explorations Ltd.
From:	Soren Jensen	**Project No:**	1CM002.024
Cc:	Jennie Gjertsen (Minto), Dylan MacGregor (SRK)	**Date:**	March 24, 2015
Subject:	2014 Water Balance and Water Quality Model Summary for the Minto Mine Site		

1 Introduction and Background

This memorandum provides a summary of the 2014 water balance and water quality model updates for the Minto Mine site. The update covers the period January 1, 2014 through December 31, 2014.

The water balance update includes a review and summary of precipitation, flow and water inventory data for the Mine site. The water quality update includes a comparison of water quality data collected in 2014 to water quality model predictions for Phase V/VI of the Mine development.

2 Water Balance Update

2.1 Precipitation

Table 1 shows a summary of monthly precipitation measured at the Mine site in 2013 and 2014 along with precipitation data from the regional station at Pelly Ranch (Climate ID: 2100880)[1]. Approximately 236 mm of precipitation was collected at the Mine site in the 2014 hydrological year. This roughly corresponds to a 1 in 20 dry year.

Minto's Campbell Scientific meteorological station measures total precipitation using a tipping bucket rain gauge. From October through May, the rain gauge is equipped with a snowfall conversion adaptor, which allows it to measure snowfall as snow water equivalent. In November 2014 Minto added a Geonor precipitation gauge to the Campbell Scientific station (Figure 1). A Geonor precipitation gauge collects precipitation in a bucket. In the winter months, the bucket is partially filled with an antifreeze solution that melts any snow collected. Total precipitation is recorded by measuring the weight of the bucket.

The Pelly Ranch meteorological station is located approximately 25 km north of the Mine site and is the closest regional station with a long-term data record, including total precipitation measurements. Table 1 shows that total precipitation measurements collected on site and at the regional station were generally in reasonable agreement in 2014.

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[1] Pelly Ranch Data: obtained from Meteorological Service of Canada, Environment Canada.

Table 1 Precipitation Records for the Minto Mine Site and Pelly Ranch

		Total Precipitation	
Year	**Month**	**Campbell Scientific (Minto Mine)**	**Pelly Ranch[A] (Climate ID 2100880)**
		mm/month	mm/month
2013	Oct	13.6	25.8
2013	Nov	36.6	n/a
2013	Dec	27	n/a
2014	Jan	16.9	16.2
2014	Feb	8.0	6.5
2014	Mar	0.0	0.0
2014	Apr	3.8	7.1
2014	May	15.0	n/a
2014	Jun	12.0	25.4
2014	Jul	50.5	n/a
2014	Aug	13.4	n/a
2014	Sept	30.5	n/a
2014	Oct	22.0	n/a
2014	Nov	2.9	n/a
2014	Dec	19.4	n/a
SUM Hydrological Year, Nov. 2013 to Oct. 2014		236	n/a

Source: Minto Site Data: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2014_Water_Balance_Update \ 2014 Met Station 1 and 2 Data Summary 20150316 SRJ.xlsx
Notes:
[A] Data: obtained from Meteorological Service of Canada, Environment Canada.
n/a – not available at time of publication. It is uncertain whether data for these months will be available at a future date.

Figure 1 Minto's Geonor Precipitation Gauge

2.2 Snow Course Data

Snow course surveys were completed at the three established snow survey stations at the Mine site in 2014. Table 2 shows a summary of the snow survey data from 2009 to 2014. The depth and water equivalent of the snow pack provides an indication of the volume of surface runoff that must be managed the following freshet. Between January and late May 2014, approximately 400,000 m^3 of surface runoff was collected from catchments at the Mine site upstream of the Water Storage Dam. This volume corresponds to roughly 40 mm of runoff, or about 60% of the snow pack water equivalent measured in April 2014.

Table 2 Summary of Snow Survey Data for the Minto Mine Site

Year	February			March			April		
	Snow Depth (cm)	Snow Density (%)	Water Equivalent (mm)	Snow Depth (cm)	Snow Density (%)	Water Equivalent (mm)	Snow Depth (cm)	Snow Density (%)	Water Equivalent (mm)
2009	55.6	16.6	92.7	70.2	15.7	110.0	67.4	22.3	150.7
2010	60.5	17.8	107.7	58.1	20.7	120.7	40.4	[A]13.9	56.0
2011	57.2	18.7	106.0	70.3	20.1	141.7	52.3	22.8	111.7
2012	54.7	20.3	111.0	64.6	19.6	127.0	61.3	21.5	132.7
2013	58.7	15.7	91.3	45.8	25.0	106.0	33.7	15.4	62.7
2014	44.3	19.0	84.3	45.8	22.3	99.7	41.0	25.7	67.3

Source: SRK: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2014_Water_Balance_Update\MintoSnowMaster_Clean.xlsx
Note:
n/a – not available.
[A]zero snow at #3, density is an average of snowpack at #1 and #2, average depth and water-equivalent is average of all three sites

2.3 Water Management

Water that is suitable for release into Minto Creek is (to the extent possible) conveyed to the Water Storage Pond (WSP), while water collected from active mine areas is routed to the Main Pit Tailings Management Facility (MPTMF). Since November 2012, the MPTMF has also been used for subaqueous deposition of tailings.

Other water management features on the Mine site include:

- W15 sump: collects surface runoff and seepage from:
  - The Southwest Waste Dump;
  - Part of the Main Waste Dump; and
  - Adjacent undisturbed catchments.

Most of the water collected at W15 was routed to the WSP in 2014.

- W35a sump: collects surface runoff from the minimally disturbed southern catchments. Water collected at W35a in 2014 was piped to the WSP.

- W36 sump (formerly known as W37 sump): collects surface runoff and seepage from the mill valley, including contributions from the Dry Stack Tailings Storage Facility. Water collected at the W36 sump is pumped to the MPTMF.
- South Diversion Ditch: diverts water from minimally disturbed southern catchments to the WSP (can also be routed to the MPTMF).
- WSP: reservoir for water that meets discharge criteria and is destined for discharge to Minto Creek.

2.4 2014 Water Balance

Table 3 summarizes the monthly water and tailings inventory in Minto's MPTMF and water inventory in the WSP. In 2014, the MPTMF gained (net) approximately 220,000 m^3 of water while the water inventory of the WSP increased by about 20,000 m^3 (January 1 to December 31, 2014). The relatively minor increase in the MPTMF water inventory was the combined result of the dry conditions in 2014 and of efforts made by Minto to divert and release clean water to Minto Creek. In 2014, approximately 530,000 BCM[2] of tailings were deposited in the MPTMF.

Table 4 shows a summary of the 2014 water balance for the Mine site. The total surface runoff collected on site was estimated to be 610,000 m^3 based on the change in the water inventory and the known volume of water released to Minto Creek. The total catchment upstream of the Water Storage Dam measures approximately 1,040 ha. Therefore, 610,000 m^3 of runoff from 1,040 ha gives a unit yield of approximately 59 mm/year.

The water and load balance model that is used for forecasting surface runoff volumes uses a site-wide annual average runoff coefficient, which has been derived based on previous years' water balance results. The runoff coefficient is estimated based on the total annual precipitation as follows:

- For dry years with less than 190 mm total precipitation: runoff coefficient = 0.15
- For average to wet years with more than 309 mm total precipitation: runoff coefficient = 0.30
- Runoff coefficients for years with total precipitation between 190 mm and 309 mm: interpolated values between 0.15 and 0.30.

In 2014 (hydraulic year) the estimated total precipitation was 236 mm (Table 1), which corresponds to a modelled runoff coefficient of 0.21 (for details, see one of the water and load balance model reports (e.g. Minto Mine Phase V/VI Expansion: Water and Load Balance Model Report, July 2013, prepared by SRK Consulting)).

Using this, the estimated runoff yield for 2014 (50 mm) and the estimated total annual precipitation, the site-wide runoff coefficient is:

$$\textit{Annual Yield/ Total Annual Precipitation} = \textit{Runoff Coefficient} \rightarrow \quad 59\ mm/236mm = 0.25$$

The calculated value for the annual site-wide runoff coefficient agrees reasonably well with the value used in the water balance model for the Mine site.

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[2] Bank Cubic Meters

Table 3 2014 Water Inventory and Release to Minto Creek

Month/ Year	MPTMF Volume Occupied (Water + Tailings)[A]	Change in MPTMF Water Inventory	Tailings Solids	WSP Volume[A]	Change in WSP Water Inventory
	m^3	m^3/month	BCM/month	m^3	m^3/month
Jan 2014	3,463,119	45,268	45,038	159,355	-993
Feb 2014	3,553,425	26,835	40,679	158,362	-2,875
Mar 2014	3,620,939	37,368	45,038	155,487	-8,660
Apr 2014	3,703,345	83,308	43,585	146,827	-13,582
May 2014	3,830,239	22,734	45,038	133,245	-77,550
Jun 2014	3,898,010	-1,003	43,585	55,695	37,804
Jul 2014	3,940,592	-21,034	45,038	93,499	21,172
Aug 2014	3,964,595	9,778	45,038	114,671	11,928
Sep 2014	4,019,411	30,283	43,585	126,598	69,789
Oct 2014	4,093,279	6,190	45,038	196,388	22,455
Nov 2014	4,144,507	-2,605	43,585	218,842	1,258
Dec 2014	4,185,487	-16,398	45,038	220,101	-39,862
Jan 2015	4,214,127		45,038	180,238	
SUM		**220,725**	**530,283**		**20,883**

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2014_Water_Balance_Update\
2014 Water Balance Update REV00 SRJ
Notes: A – on the first day of the month.

Table 4 Water Balance Summary of the Minto Mine Site, 2014 (Jan to Dec)

	Units	
Pit Volume Increase 2014 (water + tailings)	m^3	660,000
Tailings to MPTMF, total	BCM	530,000
MPTMF Water Volume Increase 2014	m^3	220,000
WSP Net Water Volume Increase 2014	m^3	20,000
Water stored in DSTSF tailings	m^3	0
Water Discharged to Minto Creek in 2014	m^3	488,000
Estimated groundwater inflow to Area 2 Pit	m^3	120,000
Total Surface Runoff Above WSP in 2014	$\mathbf{m^3}$	**610,000**

Source: X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2014_Water_Balance_Update\
2014 Water Balance Update REV00 SRJ

3 Water Quality Model Update

Table 5 shows model predictions of water quality in the Water Storage Pond (WSP) and in the MPTMF for 2014 along with measured concentrations. The MPTMF was the primary mine water reservoir on site. Therefore, a comparison of measured MPTMF water quality with concentrations predicted for pit water for the Phase V/VI environmental assessment provides a good measure of actual vs. expected geochemical performance of the site. Water collected in the WSP includes clean (non-contact) runoff and effluent from Minto's water treatment plant.

Most measured median concentrations are well below predicted maximum concentrations for both the WSP and MPTMF. The model predictions were developed as conservative estimates that are unlikely to be exceeded during the Phase IV and later the Phase V/VI operation.

Molybdenum concentrations in both the WSP and MPTMF exceeded predictions. The greater –than-forecast concentrations of molybdenum in the MPTMF may be related to the combination of recycling of process water through the mill and lower-than-average precipitation in both 2013 and 2014; however; the precise cause remains unexplained at present. Average total molybdenum concentrations in the WSP in 2014 were about 10 times lower than the Canadian Environmental Water Quality Guideline for the Protection of Aquatic Life of 0.073 mg/L.

Table 5 Water Quality Model Predictions and Measured Concentrations in 2014

		Water Use License QZ96-006				Modelling Predictions of WSP Water Quality (2014)	Measured Water Quality in WSP (Station W16 in 2014)	Modelling Predictions of MPTMF Water Quality	Measured Water Quality in MPTMF (Station W16 in 2014/2015)
		From WTP to Minto Creek	**Freshet[A] at W50 and W17**	**Non-Freshet at W50 and W17**	**Non-Freshet at W2**	**Median**	**Median**	**Median**	**Median**
Ammonia	mg/L	0.89	0.89	0.89	0.35	1.04	0.072	n/a	1.4
N-NO$_2$	mg/L	0.15	0.15	0.15	0.06	0.64	0.031	n/a	0.20
N-NO$_3$	mg/L	7.65	7.65	7.65	2.9	22.7	2.7	n/a	14
Al-Total	mg/L	2.7	2.7	2.7	0.62	0.73	0.072	0.55	0.15
Al-Dissolved	mg/L					0.10	0.0061	0.48	0.020
As-Total	mg/L	-	-	-	0.005	0.00070	0.00051		0.00051
As-Dissolved	mg/L					0.00070	0.00044	0.0017	0.00048
Cd-Total	mg/L	0.00015	0.00015	0.00015	0.00004	0.00012	0.000018		0.000023
Cd-Dissolved	mg/L					0.00007	0.000016	0.00010	0.000019
Cr-Total	mg/L	0.008	0.008	0.008	0.002	0.0022	0.0010		0.0060
Cr-Dissolved	mg/L					0.0014	<0.0010	0.0022	<0.0010
Cu-Total	mg/L	0.05	0.08	0.05	0.013	0.035	0.024		0.014
Cu-Dissolved	mg/L					0.027	0.014	0.057	0.0043
Fe-Total	mg/L	3.5	3.5	3.5	1.1	1.52	0.21		0.23
Fe-Dissolved	mg/L					0.59	0.043	0.44	0.014
Pb-Total	mg/L	0.02	0.02	0.02	0.004	0.0005	0.00031		0.0044
Pb-Dissolved	mg/L					0.0002	<0.00020	0.0007	<0.00020
Mo-Total	mg/L	0.4	0.4	0.4	0.073	0.0033	0.0074		0.060
Mo-Dissolved	mg/L					0.0028	0.0081	0.046	0.058
Ni-Total	mg/L	0.5	0.5	0.5	0.11	0.0019	0.0013		0.0025
Ni-Dissolved	mg/L					0.0019	0.0011	0.0030	0.0023
Se-Total	mg/L	0.003	0.003	0.003	0.001	0.0020	0.00092		0.0055
Se-Dissolved	mg/L					0.0020	0.00088	0.0094	0.0062
Zn-Total	mg/L	0.15	0.15	0.15	0.03	0.015	0.0085		0.010
Zn-Dissolved	mg/L					0.008	0.0075	0.012	0.0074

Source: SRK, X:\01_SITES\Minto\1CM002.024_Water_Balance_Support\2014_Water_Balance_Update\All_Model_Results_for_WQ_Model_Comparison_for_2014_An_Report_SRJ_Rev00.xlsx

Notes: [A] April 1 to May 31; [B] Model Results from: X:\01_SITES\Minto\!020_Site_Wide_Data\Water_and_Load_Balance_Files\01_Project_Phases\07_Phase_V_VI\Minto_Phase_5_6_Long_Term_1CM002.003_Rev49_SRJ.gsm [C] Analytical data from Minto's water quality monitoring program.

Appendix L – Wildlife Tracking 2014

Date	Time	Type of Animal	# of individuals	Location	Description: Size/Color/Markings and Additional Notes
04/01/2014	6:00 AM	Fox	1	Capstone and Pelly lodge	Med. Size. I yelled and it darted away
12/01/2014	7:55 AM	Fox	1	Main dry stair case	
13/01/2014	7:00 PM	Fox	1	Climbing on Nuway Pile	Moving quickly up hill
18/01/2014	4:00 PM	Fox	1	Area 118 pit	Middle of pit
24/01/2014	5:30 AM	Fox	1	Roadway by Capstone Lodge	Running away
29/01/2014	3:30 PM	Wolf tracks		W3/W17/W50	Tracks near W3 and along W3 access W17, W50
07/02/2014	5:30 PM	Wolf tracks		Mill Valley Laydown	Near the Copco parts trailer. Wandering by all the garbage bins
10/02/2014	AM	Owl with rabbit	1	KM1	Brown owl flying with rabbit
12/02/2014	11:00 AM	Fox	1	Landfill	Checking out the garbage
13/02/2014	4:30 AM	Rabbit	1	SK	Sitting.
14/02/2014	10:00 PM	Fox	1	In front of waste in front of mill	Looking for food in garbage
25/02/2014	AM	Hawk Owl	1	W17	Dead. Marks in snow show it had fallen down bank
02/03/2014	5:30 PM	Red Fox	1	D51 Ramp	Sitting there
02/03/2014	10:30 AM	Red Fox	1	Pelly Laydown	Crossing road
08/03/2014	5:30 PM	Red Fox	1	Pelly Laydown	Crossing road into pelly yard
14/03/2014	7:00 AM	Fox	1	Smoke shack	Not scared looking for food
19/03/2014	5:20 AM	Fox	1	Bottom of M zone 708 Sump	Sat there staring at me
20/03/2014	5:00 AM	Fox	1	At camp by main entrance	Healthy not afraid of me
30/03/2014	5:00 PM	Bear	1	On road	Brown, not afraid
05/04/2014	11:30 PM	Fox	1	Pit 1	Looks to have a broken leg
11/04/2014	7:00 AM	Fox	1	Open pit 118	Same fox as above
14/04/2014	evening	Bear	3	New warehouse building	Sow and two cubs
14/04/2014	10:00 PM	Black Bear	2	Parking lot behide new warehouse	looked healthy adult.
15/04/2014	7:00 PM	Bear	1	Big Creek	Black/ Brown bear. Male size. No shoulder hump
17/04/2014	8:00 PM	Black Bear	1	Above camp cut bank	Black bear and brown muzzle - sniffing at camp odours deterred with pistol
17/04/2014	8:30 PM	Black Bear	1	lower warehouse pad	Dark cinnamon bear med-size - deterred with truck and pistol, good response to deterrent
18/04/2014	PM	Bear	1	DST Tailings	Safety got call of bear on tailings but did not see it
18/04/2014	PM	Bear tracks	1	TDD	Deer tracks
19/04/2014	10:00 PM	Black Bear	1	Behind Sherwood near cutbank	Too dark to telll. Bear responded well to the air horn and took off into bush....did not return to camp.
19/04/2014		Black Bear	1	KM.5	same as above
21/04/2014	4:32 AM	Black Bear	1	Portal Road	Walking down road from water shack
22/04/2014	3:00 PM	Bear	1	WMA	Big russet coloured. Investigating landfill and WMA area
23/04/2014	7:00 PM	Black Bear	1	Camp new construction	Ran at sight of truck. Brown
27/04/2014	8:00 PM	Black Bear	1	Camp new construction	same as previous bear. Hazed.
28/04/2014	3:00 PM	Black Bear	1	WMA	Large, good condition, chocolate brown. Walked away as soon as I arrived.
28/04/2014	8:00 PM	Black Bear	1	W3	Tracks. med/sm size

Date	Time	Type of Animal	# of individuals	Location	Description: Size/Color/Markings and Additional Notes
30/04/2014	7:45 AM	Black Bear	1	.5 KM Cut back	Hazed with bangers bear did not respond. Slowly walked away
01/05/2014	11:00 AM	Black Bear	1	Landfill	Calm, scared easy when yelled at
01/05/2014	7:30 PM	Black Bear	1	Fuel farm	Calm scared easy when yelled at
01/05/2014	11:00 AM	Black Bear	1	Landfill	He was along the tree line of the landfill
01/05/2014	7:30 PM	Black Bear	1	Fuel farm	walking aorund fuel farm
07/05/2014	7:00 PM	Bear	1	W2	Right at water quality station. Observed by Seb as he drove down the road.
08/05/2014	8:00 PM	Bear	1	Above Pelly laydown	When enviro got there the bear could not be located
09/05/2014	2:00 PM	Black Bear	1	Was spotted at D-51 bench above Pelly (by Pelly) and then just before the magazine road at Dyno	Large bear, dark chocolate brown colour. Ran when truck approached it and then calmy walked away when screamers were used
09/05/2014	10:00 AM	Swallows	1	Pipe sticking out of tailings building facing tailings chute.	Nesting in pipe.
10/05/2014	2:00 PM	Black Bear	1	MWD on the grass. Was chased across the top of the dump and into the forest	Looks like the same bear from the day before. Large bear, dark chocolate brown colour. Ran when truck approached and calmy left when screamers/ air horn and yelling were used.
10/05/2014	4:00 PM	Fox	1	Dry stack	Sleeping
11/05/2014	10:00 AM	Black Bear	2	D-51 and then up at Sewage lagoon	Same chocolately brown coloured bear that has been seen the last few days.
11/05/2014	3:00 PM	Black Bear	1	W3	Looked like and behaved like the bear that has been seen around the Pelly yard. Walked away slowly when hazed.
12/05/2014	1:00 PM	Swallows	0	New warehouse building	We realized the new warehouse building would be prime habitat for swallows due to the open space and open doors. Talked to Bob in warehouse to cover up the entrances to prevent nesting.
13/05/2014	9:00 AM	Bear	1	On Dyno access road	Enviro did not go check out. Asked Greg to call again if Bear started to approach Pelly laydown.
13/05/2014	5:20 PM	Hare	1	on side of raod KM2	White grey changing colour
14/05/2014	11:30 AM	Fox	1	MCDS	Hopping on 3 legs, back left leg injured. Adult redfox looked healthy.
14/05/2014	2:30 PM	Black Bear	1	Pad 2 then behind Dumas	Black bear spotted at Pad 2. Moved down to corner of airport rd behind laydown. Could not be located after that. Jasmin went in to Dumas to let them know to use the air horn when working behind the shop and to haze with air horn if they see the bear again.
14/05/2014	4:00 PM	Black Bear	1	Corner of airport access rd.	
14/05/2014	3:00 PM	Black Bear	1	beside airstrip	Grazing its way along valley above TDD
14/05/2014	12:30 PM	Black Bear	1	d-51	walking to pelly laydown unconcerned about truck
15/05/2014	9:00 AM	Black Bear	1	Mill Valley Laydown	Dave Crottey went to haze with rubber bullets. Got to the bear and yelled at it and it ran away; did not get the rubber.
15/05/2014	6:00 PM	Black Bear	1	KM 3	Ran off when yelled at. One smaller sized bear, assumed it was a yearling. Did not see mother around.

Date	Time	Type of Animal	# of individuals	Location	Description: Size/Color/Markings and Additional Notes
16/05/2014	8:30 AM	Swallows	0	Potential nesting site on missing soffit on Dumas shop, west side of the building	Potential nesting area pointed out by Ryan Faulds. Potential work going to happen in that area late summer. No birds nesting but if Ryan notices them nesting in that area he will let us know in case work does get planned.
16/05/2014	12:30 PM	Swallows	1	Pipe in behind of mill	Birds seen nesting in a pipe behind the mill. Jasmin went to look at it with Darrly, Bill and Eric and the valves leading to this pipe are shut off. The pipe is used to purge air from the mill but has not been used in 6 years. Going to leave the birds for the spring and once they have left Jasmin will manage getting the pipe capped so they don't nest in that spot next year.
17/05/2014	10:00 AM	Black Bear	1	Corner of airport rd, by Dumas	Very black bear, medium size, good condition. Eating greenery. Reluctant to move off when yelled at. Hazed with screamers, air horn. Ran small way and resumed eating. Gary van B (on May 19th) says that he saw he had a rip on his back, like he had been in a fight. Maybe this one has been edged out of territory.
17/05/2014	5:00 PM	Black Bear	1	Corner of airport rd, by Dumas	Same black bear as this earlier on the same day. Very black bear, medium size, good condition. Eating greenery and stretching on the powerline pole. Alert to horn honking, picked head up. Hazed with screamers, air horn. Ran off into the bush and was not observed thereafter.
17/05/2014	8:00 PM	Black Bear	1	Corner of airport rd, by Dumas	Same black bear as this earlier on the same day. Very black bear, medium size, good condition. Eating greenery and stretching on the powerline pole. Alert to horn honking, picked head up.
17/05/2014	10:00 AM	Swallows	1	Behide mill	Building nest in pipe on mill building
17/05/2014	7:50 PM	Black Bear	1	Road up to airstrip	Eating still there ten minutes later
18/05/2014	3:00 PM	Black Bear	1	Corner of airport rd, by Dumas	Black bear with a bit of brown. Different bear on the grass than yesterday, could be the one that was seen up near the Pelly yard last week. Shaun hazed and it ran for a short bit and then started to walk. Headed up old exploration road.
19/05/2014	10:30 AM	Black Bear	1	WMA	Large, brown. Same one from April 28th. Dave Crottey came up and fired a cracker shell, but he had just gone down bank by where barrels are stacked.
20/05/2014	10:00 PM	Black Bear tacks	1	Portal Road	bear tracks around wooden shack up at portal where we hook up water truck
21/05/2014	8:00 PM	Black Bear	1	In camp: near Pelly Manor	Brown, medium size. Took off down bank toward access road. Reported after half hour delay by Sodexo house keeping staff - they didn't know who to call. Followed up with John. He met with staff and explained call-in procedure. Bear was thought by observer to be grizzly cub, but more likely a black bear.
21/05/2014	2:00 PM	Black Bear	1	Beside airstrip	
22/05/2014	7:30 AM	Black Bear	1	Near new camp	Unknown size & colour. Investigated by PE & CH but not seen again.

Date	Time	Type of Animal	# of individuals	Location	Description: Size/Color/Markings and Additional Notes
22/05/2014	8:00 AM	Black Bear	1	On bank between Dunas shop and airport road.	MC & Mark Goebel went and found medium sized brown bear grazing amonst willows between pole barn and Dumas shop. Hit with a rubber bullet and crackers. Ran but we couldn't find tracks so don't know where he went.
22/05/2014	8:15 AM	Black Bear	1	At 118 Pit, above chain link fence	MC went to investigate but did not find. Unsure if it was the same one that had just been hazed at airport laydown. Dave C arrived but didn't see it either.
22/05/2014	9:30 AM	Black Bear	1	300m North of Dyno yard call point	Medium sized brown bear with caramel coloured snout. Eating grass and roots around pond. Danny vanB had seen him at same spot 5 days before. Dale at Dyno informed.
23/05/2014	7:30 AM	Black Bear		Corner of airport rd, by Dumas	Good sized jet black bear grazing on veg by the power pole. Did not respond to shouts. Hit with a rubber bullet and crackers. Ran but stooped after a few yards, acting dopey. Climbed up onto road. We chased him down off road with truck and hit him again with rubber bullet and crackers and he disappeared into bushes. This is not our regular visitor to this corner.
23/05/2014	5:00 PM	Black Bear	2	KM 2/ KM 5	Large and healthy looking
24/05/2014	8:50 AM	Otter	1	Big Creek	Adult heading up stream
25/05/2014	1:00 PM	Mule Deer	1	AN laydown	looking at me
27/05/2014	6:30 AM	Black Bear	1	Corner of airport rd, by Dumas	Small to medium sized, light brown bear, grazing by power pole. Air horn and screamers chased him onto road and along the old road to the grounding grid. After a couple of screamers, he ignored them, but grazed his way away from the road.
27/05/2014	7:00 AM	Brown Bear	1	Pond below Eskay site	Eating plants- unconcered
30/05/2014	1:00 PM	Cinamon	1	"	"
31/05/2014	11:00 AM	Black Bear`	1	Airport laydown	walking foragraing
09/06/2014	5:30 AM	Fox	1	Dumas Shop	Not afraid, Just wary
09/06/2014	2:50 PM	Brown Bear	1	KM1 Access Road	Minding his own business
09/06/2014	11:25 AM	Fox	1	Camp ,new construction	Yelping on outer grounds
10/06/2014	3:45 PM	Black Bear	1	Portal Road	Ran when appraoched with truck. Fair size(med) shot banger and screamer at it and ran down hill side
13/06/2014	5:15 PM	Black Bear	1	300m North of Dyno yard call point	Good sized light brown bear foraging and relaxing, not going anywhere. Let him be and called Dyno to let them know it was there.
15/06/2014		Black Bear	1	Near incinerator at WMA	Small black coloured bear. New visitor. Went to haze, but did not find. Was in trees beteen airstrip road and incinerator. Unresponsive to shouts and people working on other side of electric fence.
15/06/2014	7:00 AM	Black Bear	1	Underground shop	eating grass/ not scared
15/06/2014	8:10 AM	Mule doe	1	KM .5	On road moving along towards WSP
15/06/2014	9:00 AM	Fox	1	KM9	Skittish/ mottled coat, running off road and up hill
17/06/2014	7:00 AM	Moose	3	Airsprip	cow and 2 calves, ran down the airstrip

Date	Time	Type of Animal	# of individuals	Location	Description: Size/Color/Markings and Additional Notes
18/06/2014	9:00 PM	Rabbit	1	KM3	Ran as soon as it noticed us
20/06/2014	7:00 PM	Deer	1	KM2	Ran across access road
26/06/2014	1:00 PM	Brown Bear	1	DSI road	Ran into bush. Good size
27/06/2014	9:35 AM	Moose	2	Airport road	Cow and calf, beside core shack
27/06/2014	8:30 AM	Black Bear	1	DSI road	same bear
28/06/2014	3:30 PM	Black Bear	1	Dumas SHop	Took off after we yelled and clapped up exploration Rd.
01/07/2014	6:30 AM	Fox	1	KM6	Standing mid road, ran to the side when vehicle approached
03/07/2014	8:30 PM	Grey wolf	1	Powerline Road	Beautiful
09/07/2014	1:30 PM	Eagle	1	KM21	Big and hungry looking
12/07/2014		Black Bear	1	Near incinerator at WMA	Called in by Site Services. Went to look but was gone.
12/07/2014	1:00 PM	Fox	1	At tug	Skinny
13/07/2014	10:00 AM	Young grizzly	1	KM12	Running across road
13/07/2014	2:30 PM	Ptarmigan	1	KM 21	good
14/07/2014	11:00 AM	Mule deer	4	KM10	3 fawn, 1 doe hopping along to road
16/07/2014		Black Bear	1	In front of Dumas shop	Medium sized brown coloured bear. Called in an hour after the fact. Dumas staff scared it off. It went round to the back of the shop. Scared again and took off toward airstrip. Gone by the thime I went to look (MC).
16/07/2014	7:00 AM	Black Bear	1	KM6.5	Did not run away until we were beside it
16/07/2014	4:15 PM	Grizzly Bear	1	KM5	looked curious, didn't move when vehicle passed by
16/07/2014	7:00 AM	Brown Bear	1	Dumas Shop	Bear scared off to rear of shop
17/07/2014	6:00 AM	Black Bear	1	KM16	Ran into bushes as soon as it noticed vehicles approaching
18/07/2014	1:00 PM	Black Bear	1	KM6.5	Relaxing by the roadside laying in the sun
18/07/2014	11:30 AM	Black Bear	1	West landing	Bear was swimming across the yukon river got out of the water just down stream of the barge.
18/07/2014	5:55 AM	Black Bear	1	KM13	Stood still while driving by
23/07/2014	4:30 AM	Brown Bear	1	KM5	Brown bear up at 5KM sitting in pong , must have been hot
01/08/2014	10:00 AM	Bald eagle	1	Airport Lay Down	Fighting with ravens over food waste from overflowing bin
01/08/2014	2:45 PM	Deer, Fawns	4	Fuel Farm	Good healthy, 3 Fawns 2.5ft.,Doe 5ft. tall,
01/08/2014	11:00 AM	Brown Bear	1	Dyno	Walking around
02/08/2014	7:00 AM	Grouse	4	Above Camp cut bank	Healthy looking
07/08/2014	7:00 PM	Bunny	3	KM3.5	Hares hanging out on the road
08/08/2014	7:40 PM	Brown Bear	1	Airstrip	Coming from core shack area
09/08/2014	3:40 PM	Black Bear	1	Near #2 pad at 118 portal	Brown coloured bear eating grass by road. Had gone by the time I got there (MC). Pic from Matt S.
11/08/2014	8:00 PM	Bald eagle	1	KM2	
12/08/2014	8:00 PM	Deer	1	New warehouse building	Healthy, curious
16/08/2014	7:00 PM	Grouse	13	KM25-KM15	
16/08/2014	8:00 PM	Porcupine	1	KM5	
20/08/2014	7:30 AM	Moose	3	KM21	2 Cows, 1 Bull

Date	Time	Type of Animal	# of individuals	Location	Description: Size/Color/Markings and Additional Notes
20/08/2014	9:00 AM	Black Bear	1	Km 5	Big bear
23/08/2014	7:00 AM	Sandhill Cranes	150	Over Camp	3 big V formations, looking for thermals or somwhere to land
27/08/2014	5:30 AM	Moose	1	Km 11	Cow moose jogging down road
01/09/2014	10:30 AM	Black Bear	1	Km10	Small, on road by disabled machine(looking for lunch)
02/09/2014	4:30 PM	Black Bear	1	Km25	Large Black Bear limping on left foot
03/09/2014	3:00 AM	Fox	1	Behind kitchen ,smoke area	Running, medium size
05/09/2014	?	Wolf	5	North Dyno yard	2 Adults, 3 pups, seen crossing yard ,black+tan marks, reported by Dyno Dale
06/09/2014	3:20 PM	Fox	1	Barge	Skinny looking for food, young ,muddy
10/09/2014	9:45 AM	Moose	3	KM7	Cow and two calfs
12/09/2014	7:00 PM	Fox	1	Km3	Black/Ginger
13/09/2014	8:30 AM	Raptor	1	Km6	Brown/White
17/09/2014	9:00 AM	Moose	1	KM 5	Lg cow
22/09/2014	8:30 AM	Moose	1	KM 8	Young adult
28/09/2014	10:00 AM	Wold	1	km11	Headed to KM 10
01/10/2014	9:00 AM	Unknown Bird	3	New warehouse building	3 birds in building
03/10/2014	1:30 PM	Bear Tracks		KM 24	Bear tracks on Access rd.
12/10/2014	4:30 AM	Mule Deer (does)	7	9Km	2 lg, 5 small
13/10/2014	7:30 AM	Fox	1	Arctic Corridor	ran underneath corridor heading south
17/10/2014	3:20 AM	Moose	2	KM 12.5	2 young bulls
20/10/2014	12:30 PM	squirrel	1	smoke shack at camp	Heading towards luggage stoage
23/10/2014	3:00 PM	Ptarmigan	5	Airport rd. Corner of W35	Saw them when they flew away
23/10/2014	6:45 AM	Fox	1	on slope behide new camp	Walked up slope ; didn’t approch
27/10/2014	10:00 AM	Loon	1	Main pit	Swimming/diving around near tails line
27/10/2014	5:00 PM	Duck	1	ERT shack	Landed on ERT shack, fell off. Walking around looking injured, flew away!
27/10/2014	1:00 PM	Fox	1	outside mine tech office	Adult red fox, not too concerned with people
01/11/2014	5:45 AM	Fox	1	Assay lab	
01/11/2014	10:00 AM	Fox	1	Barge Km 27	Red, yellowish, orange, black paws
01/11/2014	9:00 AM	Tracks of a Coyote I think	1	chemical tent laydown area	1 set of tracks
02/11/2014	8:00 AM	Red Fox	1	Out back of kitchen smoke area	walked right by me when sitting out back "good condition"
04/11/2014	9:00 AM	Red Fox	1	Out back of kitchen smoke area	Good behaviour
13/11/2014	2:00 PM	Wolf	1	Dyno	Scared running away from vehicle
03/12/2014	7:30 AM	Fox	1	Km2	followed me while I was jogging for approx 1/4 KM
2014-09	1:00 PM	Gray Jays	2	Dumas Shop	Very curious birds

Appendix M – 2014 Annual Socio-Economic Monitoring Report

capstone
MINTO MINE

Minto Mine
2014 Annual Socio Economic Monitoring Report

Prepared by:
Minto Explorations Ltd.
Minto Mine
January 2015

Contents

1 Introduction

This report has been prepared by Minto Explorations Ltd., a subsidiary of Capstone Mining Corporation, in regards to the Minto Mine property (Minto), located in central Yukon. The following report summarizes the results of the socio economic available data at Minto for 2014, as required by the Socio Economic Monitoring Program framework.

The Minto Mine Socio-economic Monitoring Program (Minto Explorations, Yukon Government, Selkirk First Nation, 2014) is a program that has been developed in conjunction with Selkirk First Nation and the Yukon Government to monitor the socio economic effects of Minto Mine on SFN. The primary components of the program include; the mine providing information relating to SFN (e.g. employment data, training information etc.), a community based survey (conducted by SFN and YG), and information from SFN and YG relating to Pelly Crossing or SFN. The information from all of those components is then used in the preparation of an annual report produced by a third party consultant.

Not all of the data that has been requested from historical records is available. Going forward Minto will collect the required and necessary data in order to provide more accurate information for the bi-annual reports. Minto has given best efforts to collect and obtain historical data and going forward accuracy of information and data collection will continue to be further refined.

1.1 Factors at Minto that may have a socio-economic impact

The Minto Mine is an open pit and underground copper mine located 240 kilometres north of Whitehorse in central Yukon, Canada. Minto is located on Selkirk First Nation Category “A” land.

An initial cooperation agreement (CA) between Selkirk First Nation and Minto was agreed upon and signed in 1997, and was later amended in 2009. The agreement serves as a formal document that covers governance, business partnerships, training and employment, and royalties of the Minto Mine on Selkirk First Nations land.

The community of Pelly Crossing is located along the Klondike Highway on the banks of the Pelly River, 282 kilometers northwest of Whitehorse. Pelly Crossing is home to SFN people which includes 336 people (2011 census) 305 which are first nation. The average income of population aged 15 years and over in Pelly Crossing is $26,585 with the average house price being $274,106 (2011 National Household Survey). The median population age of Pelly Crossing is 38 years of age (2011 census).

The city of Whitehorse is the capital of Yukon and is the largest community in the territory with a population of 27,889 (Yukon government website) or 76% of the total population.

The remote location and access to Minto dictates a fly in fly out (FIFO) camp operation. In Yukon, there is a general shortage of available professional and skilled workers. The location also is impacted by low amount of manufacturing of goods locally/ locally sources supply

The advanced and post-secondary education and training available in the Yukon is fairly limited and there are a lack of local candidates possessing mining careers related experience and educational backgrounds.

Recruitment of local candidates is also impacted by low literacy rates and shortage of candidates possessing valid driver's license.

Other factors that may have impacted socio economic items include:

- Implementation of socio-economic monitoring program
- Regulatory delays
- Declining copper prices in the latter part of 2014

2 Minto and Contractors Safety Statistics

The below table (Table 2-1) summarises the safety statistics for Minto Employees and site contractors for 2014. The total incidents include minor first aids treated at the site, any property damage, near-misses that could have resulted in an incident, medical aids (where treatment is required off site) and lost-time accidents where a worker would be unable to return to their duties and had to miss work. In 2014 there were 3 Lost time accidents, all of which involved contractors on site.

2014 Total incidents	Minto	Contractors
186	107	79

3 Employment

Minto utilizes a preferential hiring recruitment approach as outlined in the Cooperation Agreement. Our preferential hiring involves the following –positions are first advertised and offered in the following order of priority, to SFN, OFN, Yukon, and Western Canada.

3.1 Employment Income and Distribution

The following sections outline information and figures that demonstrate salaries are higher for those who are in major centres and/or employed outside of Yukon. Potential reasons for this for Minto include:

- 7 out of 9 managerial staff live outside Yukon
- The majority of professional, supervisory and designated staff are residents of the rest of Canada

Other factors for this could potentially be linked to lack of candidate pool in Yukon of professional and managerial experienced staff. Further the post-secondary education requirements for these roles cannot be obtained in Yukon.

The Company operates a fly in fly out (FIFO) camp model which is attractive to employees who can stay in their current hometowns and not have to move to Yukon. This approach has become somewhat of a standard practice for the mining industry in Western Canada, our peer group, and Minto operates in a fashion to be competitive in this market. Employees expect a FIFO in a remote mining location.

Major centres of Whitehorse and Rest of Canada have the highest income. Reasons for this could include a larger candidate qualified candidate pool. Outlying areas including Pelly Crossing and Rest of Yukon have less availability of qualified candidates for skilled, professional and managerial positions.

3.1.1 Minto - Average employment income by Residency

	Pelly	Whitehorse	Yukon	Rest of Canada
Minto	$68,798	$97,964	$84,869	$115,438

3.1.2 Contractors - Average employment income by Residency

	Pelly	Whitehorse	Yukon	Rest of Canada
Contractor A	$81,000	n/a	$117,000	$126,000
Contractor B	$38,650	$50,094	$43,291	$39,063
Contractor C	$12,928	Included in Yukon*	$34,027*	$47,492

Potential contributing factors include:

- Dumas Contracting is located in eastern Canada indicating hiring from a preferred talent pool in this location
- Pelly Construction is located in Whitehorse, YT and a majority of staff are located in Whitehorse. In 2014 Pelly Construction processed 2 major layoffs and laid off approximately 90 employees due to delays receiving Water Use License
- The majority of Sodexo employees are entry-level non-skilled workers. Sodexo has high turnover rate for most of their remote staff and turnover at Minto for 2014 Sodexo was 90%.

3.1.3 Minto and Contractors – Annual and cumulative total employee income by Group

	Pelly Crossing	Whitehorse	Yukon	Rest of Canada
Minto	$488,975	$2,989,611	$1,299,015	$ 10,528,274
Contractor A	$91,000	n/a	$234,000	$5,292,000
Contractor B	$154,598	$2,263,588	$822,535	$1,132,846
Contractor C	$90,493	Included in Yukon*	$442,345*	$617,396

3.1.4 Minto - Employment by Group

	SFN	OFN	Other Yukon	Other Canadians	Total
Minto	13	23	33	103	172

3.1.5 Minto - Employment by Residency

	Pelly Crossing	Yukon	Canada	Total
Minto	9	59	104	172

3.1.6 Contractor - Employment by Residency

	Pelly Crossing	Yukon	Canada	Total
Contractor A	1	3	42	46
Contractor B	8	60	29	97
Contractor C	7	21	5	33

3.1.7 Minto – 2014 New Hires by Group

	SFN	OFN	Other Yukon	Other Canadians	Total
Minto	9	11	22	42	84

3.1.8 Minto - Employment by Job Categories and Group

	SFN	OFN	Other Yukon	Other Canadians	Total
Management			2	7	9
Professional		2	10	46	58
Skilled	2	4	7	42	55
Semi-skilled	8	11	11	7	37
Entry Level	3	6	3	1	13
TOTAL	13	23	33	103	172

3.1.9 Minto and Contractors – Annual and cumulative total employees by group

	Aboriginal	Yukon (Non-FN)	Total Yukon	Other Canadian	Total
Minto	36	33	59	103	172
Contractor A	13	4	15	91	123
Contractor B	25	43	68	29	97
Contractor C	20	8	28	5	33

3.2 Results of voluntary exit surveys

In 2014 Minto had 16 salary and 18 hourly for a total of 34 employees voluntarily leave employment which represents a voluntary turnover rate of 19.65%.

The results of voluntary exit surveys indicate the following main reasons for resignations:

- Family reasons and/or to be closer to home
- Enhanced opportunity

4 Business

As part of Minto and SFN’s cooperation agreement there is a requirement for the company to provide preferred opportunity notification to SFN to negotiate and potentially be awarded a contract to supply the requirement. SFN has developed partnerships with a number of Minto’s vendors for which the details of financial benefit Minto is not privy to. As such, this section summarizes expenditures by the company that is the primary vendor and does not account for any SFN proportional expenditures as a result of those partnerships.

In 2014, Minto and SFN worked jointly to establish new or maintained contracts to ensure involvement from SFN and support our First Nations partners. The contractual arrangements highlighted below represent the majority of the opportunities that SFN and Minto share with service providers. As well as financial gain, SFN also does benefit from employment opportunities on some contracts.

- Parkland Fuel- Fuel Supply
- Dyno Nobel Canada- Blasting supplies and services
- Pelly Construction- Mining Services
- Manitoulin Transport- Freight Hauling
- Sodexo- Catering Services
- Air North- Primary Air Services
- Tintina Air- Secondary Air Support
- Standard Bus- Bussing of Staff/Contractors
- Driftwood Drilling- Exploration Drilling
- Glacier Water Services- Water Hauling
- Northern Vacuum Services- Vacuum Truck Rental
- Selkirk Development Corp- Office Lease
- Pelly Construction- 988 loader rental
- Dumas- UG Mining
- Yukon Inn- Employee lodging

In addition to support of our First Nations partners, Minto also strives to support Yukon based companies and service providers based on ability to service our needs and meets commercial acceptance criteria. In analyzing a business for suitability Minto follows best practice guidelines and the Six rights of procurement in selecting potential suppliers.

In 2014, over 40% of total Minto spend stayed in the Yukon, supporting local business and developing partnerships for long term mutual benefit. Minto selects the appropriate local vendors based on vendors that meet selection criteria that support Minto’s corporate social responsibility. Such partnerships are built on transparency, human rights and labor compliance, supplier status, financial, geographical, and environmental compliancy. The framework for successful local suppliers is based on common shared goals, continuous improvement, and vendors that support Minto’s policies and procedures.

The six rights of procurement must be met in selection of such vendor relationships.

- Right Materials (to fill need)

- Right Place (Yukon preference)
- Right Quantity and Quality (High quality and ability to supply)
- Right Supplier (Service, technical and aftermarket support, value added service)
- Right moment (product available when needed)
- Right price (competitive commercial price)

Minto will continue to maintain and increase its spend with local suppliers as they invest in supporting the mining industry and Minto is committed to sustainability in developing the relationships for long term mutual benefit.

4.1 Mine Operations Expenditures

No discernible way to break down expenditure by group. Currently data is not tracked in this manner.

4.2 Capital Expenditures

No discernible way to break down expenditure by group. Currently data is not tracked in this manner.

4.3 Yukon business names by group

See attached **Appendix "A"** noting all Yukon Business Names. The information is not sorted by group. Further, no all business are captured due to some expenditure by employees and reimbursed through expenses and all contractor purchased items.

4.4 Minto Royalty Payments

The 2014 royalty payment to SFN was $1,878,572 (January to October 2014) as per the cooperation agreement. This reflects current mining and milling rates, con production and copper price.

4.5 Minto property tax payments and other fees

The 2014 property tax payment amount paid was $297,645. Property tax is exclusive to Yukon. Fees to SFN are paid via contracts with vendors. Indirect sales tax paid to the Yukon Government through monthly filings.

5 Training - High Level Description of Skill Development Programs and Initiatives 2007 - 2014

2007 – Training consisted primarily of Site Orientation for all employees, contractors and visitors. Mill operational training utilizing Jim Pire and Associates modules. No specific details are on file.

2008 – Training expanded to include Big 5 Safety Training (Confined Space, Hot Work, Fall Protection and WHMIS) for all Minto Explorations Ltd. Employees. Some operational training recorded (no dates or specifics only names and completions) for Mill Operations employees around Crushing, Grinding, Tailings, Flotation and Control with a program in place purchased from Jim Pire and Associates. Emergency Response Team initial mine rescue training of 40 hours for 8 people. No specific details on file.

2009 – Similar to 2008

2010- Similar to 2009 Expanded Emergency Response Team Training with retention of in house certified instructor.

2011 – Training expanded to include advanced Fall Protection and Confined Space, Bear Awareness, Various Mobile Equipment, Red Cross First Aid, Driving in the Active Mine, Live Fire Suppression and Indoor Crane. Records maintained in Simply Safety Software suite with 419 records for the year see report attached. Emergency Response Team Training – 2073 total hours.

2012 – Training expanded to include YWCHSB First Line Supervisor Certification, Can Scott Supervisor Skills, Joint Occupational Health and Safety Committee, Underground specific safety training, NFPA 472 Hazardous Materials Response Awareness and Operations Training, Mine Rescue Certification, Crosby Rigging and Slinging and expanded mobile equipment training. 873 records for the year. Expanded Emergency Response Team Training with 2 Instructors Active total 6018 hours.

2013 – Training Expanded to include Environmental Awareness, Gas Testing, DOT Drug and Alcohol Testing, Fire Extinguisher Theory, Fire Extinguisher Maintenance and Inspection, DNV Modern Safety Management, Fatigue Management and expanded mobile equipment with 1064 records for the year – see report attached. Advanced Emergency Response Team and Alternate Medic training with 8150 hours in total.

2014 – Training Expanded to include Explosives Awareness, Drug and Alcohol Awareness and Spill Awareness with a total of 1532 records for the year. Emergency Response Team Training 7944 total hours.

In addition to the above training, the Health and Safety Department was grown to include 6 staff with various certification advancement completed during the 2010-2014 period specifically; advanced first aid, mine rescue instruction, construction safety officer, COR required mandatories, gas testing train the trainer, internal auditor, Canadian registered safety professional mandatories, certified health and safety consultant mandatories and advanced rope rescue certification.

5.1.1 Selkirk First Nation and Other First Nation specific training in 2014

Heavy Equipment Operator training

- With our Partners, we delivered a twelve week HEO program to ten SFN citizens

Intro to Mining Program

- With our Partners, we established a training opportunity for new workers entering the Mining sector

Pre-Apprenticeship training

- One SFN student is completing pre-apprenticeship requirements in partnership with Yukon College (LD Mechanic)

Apprenticeship training

- One SFN student in apprenticeship training (Electrical)
- One SFN student hired Warehouse Apprenticeship position
- One OFN hired for Millwright Apprenticeship

HEO Training

- Selected, promoted and currently training one long term SFN employee in Site Services in Heavy Equipment Operator on the job training

Environmental Monitor-in-Training; Two positions

- Extensively interviewed for these two positions but unfortunately we were unable to fill these roles with Selkirk citizens for a variety of reasons. One of the ways we are looking to mitigate this is to sponsor Driver's Education classes being held in Pelly Crossing to enable SFN citizens to obtain their license and this way be considered for roles in which a license is a requirement. Hired two OFN employees for these positions.

6 Cultural well-being and Community wellness

Management approach to community investment is based upon opportunity to further build and maintain our social license, maintain good relationships with our partners and maintain local presence and good reputation in community where we operate and our employees live and work. The purpose is to strengthen accountability and working partnerships with stakeholders while providing a foundation to understand and consider the needs, opinions and interests of the community.

Minto employs several methods of community engagement with different levels of involvement from the community and other stakeholders. These methods include formal and informal ways that are best suited for the various stakeholders. While Minto currently employs many different engagement methods, they are largely utilized in an ad hoc way for the most part. 2015 plans include a strategy to start the process of formalizing when and how the methods are used. In the absence of signed, guiding document the current general strategy is that management reviews ways we engage and uses management best efforts and discretion for methods of engagement.

Examples of community and cultural engagement initiatives include the following.

- Fort Selkirk educational tours with Selkirk citizens and Minto employees and contractors
- Sports Sponsorship
- Fish Subsidy Program
- Turkey Distribution
- High school Bursary

In 2014 Capstone spending included the following to protect SFN cultural and community wellbeing;

- $500 provided to each of the 6 SFN graduating students in 2014
- $500 for a revival tent meeting to support traditional practices

- $150 for printing costs for Native Spiritual Voices booklets about traditional healing
- $8800 worth of sockeye salmon to support SFN traditional methods of harvesting salmon & traditional food supply
- $6933.93 worth of turkeys, hand delivered to each home in Pelly Crossing for Christmas
- $2000 provided to support local sports teams & tournaments
- $1000 contribution to Yukon Fish & Game Assoc. to support Outdoor Education Camps

Minto supported several sporting and recreation events and organizations including Dog Powered Sports Association Cinnamon Bun Run dog sled race, Yukon Indian Hockey Association's Native Hockey Tournament, Special Olympics- Team Yukon, Glacier Bears Swim Team and the Yukon River Quest Paddling Race. Minto also sponsored the Yukon Learn- PGI Golf Tournament which raised money to help improve literacy across the territory.

In honour of those who have passed away on the job, Minto contributed $2500 to the Yukon Workers Compensation Health & Safety Board's Fallen Worker's fund.

Minto has also supported several industry events and initiatives including the Geoscience Forum and Trade Show which is the territory's largest conference and industry event. We also sponsored the 2014 Opportunities North conference which is hosted by Yukon Chamber of Commerce, NWT Chamber of Commerce and the Edmonton Chamber of Commerce and promotes developing business in the North. Our largest and most notable donation was the $20,000 contribution to the Yukon Hospital Foundation's Festival of Trees events which raised money to upgrade Whitehorse General Hospital's medical imaging equipment and advancing medical technology. We also provided a tree and prizes for the silent auction at one of the events; the tree was auctioned off for $4000 with the money going towards the YHF.

Appendix N – Waste Rock Management Verification Program Results 2014

Location	Waste Type	Month	Sample ID	Date Sampled	Easting	Northing	Elevation	Sample Type	Assay Cert.	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
SWD	LGW	Jul'14	SWD-01	2-Aug-14	6944921.266	383581.898	903.33	Grab	WRV - 0714 - complete	<0.01	0.198	0.013	16.49	0.41	40.6	Pass
SWD	LGW	Jul'14	SWD-02	2-Aug-14	6944905.805	383603.936	903.108	Grab	WRV - 0714 - complete	<0.01	0.26	0.003	21.66	0.09	231.02	Pass
SWD	LGW	Jul'14	SWD-03	2-Aug-14	6944880.775	383608.931	902.864	Grab	WRV - 0714 - complete	0.03	0.257	0.015	21.41	0.47	45.67	Pass
SWD	LGW	Jul'14	SWD-04	2-Aug-14	6944855.302	383615.38	902.867	Grab	WRV - 0714 - complete	<0.01	0.549	0.005	45.73	0.16	292.68	Pass
SWD	LGW	Jul'14	SWD-05	2-Aug-14	6944830.02	383618.345	902.322	Grab	WRV - 0714 - complete	<0.01	0.292	0.001	24.32	0.03	778.36	Pass
SWD	LGW	Jul'14	SWD-06	2-Aug-14	6944804.287	383614.481	902.501	Grab	WRV - 0714 - complete	0.04	0.222	0.005	18.49	0.16	118.35	Pass
SWD	LGW	Jul'14	SWD-07	2-Aug-14	6944790.482	383592.958	902.534	Grab	WRV - 0714 - complete	<0.01	0.15	0.001	12.5	0.03	399.84	Pass
SWD	LGW	Jul'14	SWD-08	2-Aug-14	6944407.356	383719.399	879.967	Grab	WRV - 0714 - complete	0.02	0.169	0.002	14.08	0.06	225.24	Pass
SWD	LGW	Jul'14	SWD-09	2-Aug-14	6944399.004	383736.342	880.176	Grab	WRV - 0714 - complete	0.03	0.244	0.001	20.33	0.03	650.41	Pass
SWD	LGW	Jul'14	SWD-10	2-Aug-14	6944374.819	383729.799	880.214	Grab	WRV - 0714 - complete	0.04	0.193	0.001	16.08	0.03	514.46	Pass
SWD	LGW	Jul'14	SWD-11	2-Aug-14	6944350.039	383723.095	880.115	Grab	WRV - 0714 - complete	0.27	0.251	0.026	20.91	0.81	25.73	Pass
SWD	LGW	Jul'14	SWD-12	2-Aug-14	6944325.82	383716.805	880.567	Grab	WRV - 0714 - complete	0.05	0.336	0.001	27.99	0.03	895.64	Pass
SWD	LGW	Jul'14	SWD-13	2-Aug-14	6944312.057	383695.603	880.899	Grab	WRV - 0714 - complete	0.67	0.392	0.278	32.65	8.69	3.76	Pass
SWD	LGW	Jul'14	SWD-14	2-Aug-14	6944332.736	383681.156	880.285	Grab	WRV - 0714 - complete	0.04	0.134	0.018	11.16	0.56	19.84	Pass
SWD	LGW	Jul'14	SWD-15	2-Aug-14	6944357.39	383688.101	880.115	Grab	WRV - 0714 - complete	0.71	0.232	0.006	19.33	0.19	103.07	Pass
SWD	LGW	Jul'14	SWD-16	2-Aug-14	6944381.272	383696.128	879.802	Grab	WRV - 0714 - complete	0.17	0.162	0.104	13.49	3.25	4.15	Pass
D5-1	MGW	Jul'14	D5-1-01	2-Aug-14	6943871.67	383666.342	909.052	Grab	WRV - 0714 - complete	0.16	0.263	0.08	21.91	2.5	8.76	Pass
D5-1	MGW	Jul'14	D5-1-02	2-Aug-14	6943895.265	383658.073	909.029	Grab	WRV - 0714 - complete	0.39	0.285	0.182	23.74	5.69	4.17	Pass
D5-1	MGW	Jul'14	D5-1-03	2-Aug-14	6943919.987	383652.191	909.352	Grab	WRV - 0714 - complete	0.41	0.478	0.155	39.82	4.84	8.22	Pass
D5-1	MGW	Jul'14	D5-1-04	2-Aug-14	6943940.318	383636.838	909.2	Grab	WRV - 0714 - complete	0.13	0.272	0.107	22.66	3.34	6.78	Pass
D5-1	MGW	Jul'14	D5-1-05	2-Aug-14	6943962.21	383624.014	909.429	Grab	WRV - 0714 - complete	0.52	0.566	0.231	47.15	7.22	6.53	Pass
D5-1	MGW	Jul'14	D5-1-06	2-Aug-14	6943982.903	383609.962	909.734	Grab	WRV - 0714 - complete	0.02	0.229	0.007	19.08	0.22	87.2	Pass
D5-1	MGW	Jul'14	D5-1-07	2-Aug-14	6944004.997	383597.443	909.635	Grab	WRV - 0714 - complete	0.19	0.174	0.012	14.49	0.38	38.65	Pass
D5-1	MGW	Jul'14	D5-1-08	2-Aug-14	6944029.6	383592.366	909.377	Grab	WRV - 0714 - complete	0.16	0.249	0.077	20.74	2.41	8.62	Pass
D5-1	MGW	Jul'14	D5-1-09	2-Aug-14	6944052.111	383579.818	909.475	Grab	WRV - 0714 - complete	0.09	0.258	0.005	21.49	0.16	137.54	Pass
D5-1	MGW	Jul'14	D5-1-10	2-Aug-14	6944072.723	383566.127	909.548	Grab	WRV - 0714 - complete	0.03	0.152	0.001	12.66	0.03	405.17	Pass
SWD	LGW	Aug'14	SWD-01	29-Aug-14	6944369	383764.6	880.79	Grab	WRV - 0814 - complete	<0.01	0.401	0.001	33.4	0.03	1068.91	Pass
SWD	LGW	Aug'14	SWD-02	29-Aug-14	6944343	383760.3	881.706	Grab	WRV - 0814 - complete	0.05	0.254	0.001	21.16	0.03	677.06	Pass
SWD	LGW	Aug'14	SWD-03	29-Aug-14	6944313	383756.6	881.338	Grab	WRV - 0814 - complete	<0.01	0.194	0.001	16.16	0.03	517.13	Pass
SWD	LGW	Aug'14	SWD-04	29-Aug-14	6944284	383749.7	880.951	Grab	WRV - 0814 - complete	<0.01	0.198	0.001	16.49	0.03	527.79	Pass
SWD	LGW	Aug'14	SWD-05	29-Aug-14	6944250	383743.7	880.583	Grab	WRV - 0814 - complete	<0.01	0.183	0.001	15.24	0.03	487.8	Pass
SWD	LGW	Aug'14	SWD-06	29-Aug-14	6944226	383732.7	881.684	Grab	WRV - 0814 - complete	<0.01	0.195	0.001	16.24	0.03	519.79	Pass
SWD	LGW	Aug'14	SWD-07	29-Aug-14	6944191	383729.2	880.83	Grab	WRV - 0814 - complete	<0.01	0.187	0.001	15.58	0.03	498.47	Pass
SWD	LGW	Aug'14	SWD-08	29-Aug-14	6944159	383724.8	881.436	Grab	WRV - 0814 - complete	0.01	0.186	0.001	15.49	0.03	495.8	Pass
D5-1	MGW	Aug'14	D5-1-01	29-Aug-14	6944064	383629.4	899.008	Grab	WRV - 0814 - complete	0.12	0.609	0.178	50.73	5.56	9.12	Pass
D5-1	MGW	Aug'14	D5-1-02	29-Aug-14	6944078	383649.6	898.681	Grab	WRV - 0814 - complete	0.23	0.379	0.196	31.57	6.13	5.15	Pass
D5-1	MGW	Aug'14	D5-1-03	29-Aug-14	6944066	383669.8	899.568	Grab	WRV - 0814 - complete	0.29	0.45	0.114	37.49	3.56	10.52	Pass
D5-1	MGW	Aug'14	D5-1-04	29-Aug-14	6944036	383678.4	899.088	Grab	WRV - 0814 - complete	0.02	0.223	0.001	18.58	0.03	594.43	Pass
D5-1	MGW	Aug'14	D5-1-05	29-Aug-14	6944009	383688.9	900.614	Grab	WRV - 0814 - complete	0.01	0.129	0.001	10.75	0.03	343.86	Pass
D5-1	MGW	Aug'14	D5-1-06	29-Aug-14	6943975	383700.8	899.178	Grab	WRV - 0814 - complete	0.59	0.311	0.164	25.91	5.13	5.05	Pass
D5-1	MGW	Aug'14	D5-1-07	29-Aug-14	6943947	383711.6	899.361	Grab	WRV - 0814 - complete	0.02	0.379	0.001	31.57	0.03	1010.26	Pass
D5-1	MGW	Aug'14	D5-1-08	29-Aug-14	6943920	383718.4	899.891	Grab	WRV - 0814 - complete	0.03	0.349	0.001	29.07	0.03	930.29	Pass
SWD	LGW	Sep '14	NWD-01	6-Oct-14	6945559.615	383659.629	938.211	Grab	WRV - 0914 - complete	0.44	0.713	0.219	59.39	6.84	8.68	Pass

Location	Waste Type	Month	Sample ID	Date Sampled	Easting	Northing	Elevation	Sample Type	Assay Cert.	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP	Pass/Fail
SWD	LGW	Sep '14	NWD-02	6-Oct-14	6945584.822	383650.714	939.193	Grab	WRV - 0914 - complete	<0.01	0.234	0.001	19.49	0.03	623.75	Pass
SWD	LGW	Sep '14	NWD-03	6-Oct-14	6945561.487	383633.367	937.835	Grab	WRV - 0914 - complete	0.16	0.458	0.049	38.15	1.53	24.92	Pass
SWD	LGW	Sep '14	LGW-01	6-Oct-14	6944248.217	383734.661	880.025	Grab	WRV - 0914 - complete	<0.01	0.187	0.008	15.58	0.25	62.31	Pass
SWD	LGW	Sep '14	LGW-02	6-Oct-14	6944268.439	383745.465	879.892	Grab	WRV - 0914 - complete	<0.01	0.164	0.005	13.66	0.16	87.43	Pass
SWD	LGW	Sep '14	LGW-03	6-Oct-14	6944292.131	383747.365	879.915	Grab	WRV - 0914 - complete	0.07	0.349	0.041	29.07	1.28	22.69	Pass
SWD	LGW	Sep '14	LGW-04	6-Oct-14	6944313.215	383752.803	880.066	Grab	WRV - 0914 - complete	<0.01	0.202	0.006	16.83	0.19	89.74	Pass
SWD	LGW	Sep '14	LGW-05	6-Oct-14	6944338.364	383756.162	880.107	Grab	WRV - 0914 - complete	<0.01	0.215	0.003	17.91	0.09	191.03	Pass
SWD	LGW	Sep '14	LGW-06	6-Oct-14	6944358.691	383758.725	880.143	Grab	WRV - 0914 - complete	<0.01	0.196	0.004	16.33	0.13	130.61	Pass
SWD	LGW	Sep '14	LGW-07	6-Oct-14	6944382.144	383762.944	880.053	Grab	WRV - 0914 - complete	0.04	0.178	0.019	14.83	0.59	24.97	Pass
SWD	LGW	Sep '14	LGW-08	6-Oct-14	6944403.797	383765.671	880.125	Grab	WRV - 0914 - complete	<0.01	0.176	0.005	14.66	0.16	93.83	Pass
SWD	LGW	Sep '14	LGW-09	6-Oct-14	6944424.768	383770.63	880.052	Grab	WRV - 0914 - complete	<0.01	0.16	0.002	13.33	0.06	213.25	Pass
D5-1	MGW	Sep '14	MGW-01	7-Oct-14	6943907.459	383691.352	908.052	Grab	WRV - 0914 - complete	0.2	0.348	0.069	28.99	2.16	13.44	Pass
D5-1	MGW	Sep '14	MGW-02	7-Oct-14	6943939.196	383681.195	908.401	Grab	WRV - 0914 - complete	0.01	0.23	0.01	19.16	0.31	61.31	Pass
D5-1	MGW	Sep '14	MGW-03	7-Oct-14	6943958.209	383669.394	908.405	Grab	WRV - 0914 - complete	0.2	0.35	0.402	29.16	12.56	2.32	Fail
D5-1	MGW	Sep '14	MGW-04	7-Oct-14	6943981.067	383650.119	908.486	Grab	WRV - 0914 - complete	<0.01	0.574	0.022	47.84	0.69	69.58	Pass
D5-1	MGW	Sep '14	MGW-05	7-Oct-14	6944000.045	383634.327	908.709	Grab	WRV - 0914 - complete	0.49	0.367	0.345	30.57	10.78	2.84	Fail
D5-1	MGW	Sep '14	MGW-06	7-Oct-14	6944025.962	383620.588	908.746	Grab	WRV - 0914 - complete	0.04	0.298	0.046	24.82	1.44	17.27	Pass
D5-1	MGW	Sep '14	MGW-07	7-Oct-14	6944052.296	383603.315	909.121	Grab	WRV - 0914 - complete	<0.01	0.24	0.013	19.99	0.41	49.21	Pass
D5-1	MGW	Sep '14	MGW-08	7-Oct-14	6944073.709	383575.307	909.451	Grab	WRV - 0914 - complete	0.3	0.294	0.126	24.49	3.94	6.22	Pass

	Month	Waste Type	Cu%	%C(Tot)	%S(Tot)	NP	AP	NP/AP
SWD	Aug	LGW	0.188	0.253	0.030	21.04	0.94	272
	Sep	LGW	0.030	0.225	0.001	18.72	0.03	599
	Oct	LGW	0.178	0.269	0.030	22.44	0.94	131
D5-1	Aug	MGW	0.210	0.293	0.086	24.37	2.68	71
	Sep	MGW	0.164	0.354	0.082	29.46	2.56	364
	Oct	MGW	0.207	0.338	0.129	28.13	4.04	28

The Cu% values in the table reflect the average with the < in place, did not want to alter original values; Cu% values in table below are average without < signs (0.01%)

Average ABA Parameter Values: Month By Location								
Location	Month	Waste Type	Cu%	C% (Tot)	S% (Tot)	NP	AP	NP/AP
SWD	Jul	LGW	0.133	0.253	0.030	21.04	0.94	272
	Aug	LGW	0.030	0.225	0.001	18.72	0.03	599
	Sep	LGW	0.066	0.269	0.030	22.44	0.94	131
D5-1	Jul	MGW	0.210	0.293	0.086	24.37	2.68	71
	Aug	MGW	0.164	0.354	0.082	29.46	2.56	364
	Sep	MGW	0.207	0.338	0.129	28.13	4.04	28

Appendix O – Minto Mine Water Licence QZ96-006 July-December 2014 Semi-Annual ABA Report

Minto Mine
Water Licence QZ96-006
July-December 2014 ABA Semi-annual Report

Prepared by:
Minto Explorations Ltd.
Minto Mine

March, 2015

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1.0 Objectives

This report is submitted to meet requirements under Minto Explorations Ltd., (a subsidiary of Capstone Mining Corporation), Minto Mine (Minto) Type "A" Water Use License QZ96-006 (WUL), specifically Clause 87 and Appendix 6 – ABA Test Program. The WUL requires submission of ABA sampling results and interpretation semi-annually.

The objective of the ABA Program is to determine the Neutralization Potential Ratio, otherwise referred to as the NPR (Neutralizing Potential divided by Acid Potential [NP/AP]) for overburden and waste rock. An NPR value of 3 or greater generally indicates non-acid generating material. Between July and December 2014 (reporting period) 66 waste rock and overburden samples were collected and analyzed. Samples were collected from the Area 2 and Area 118 pits.

A separate, parallel ABA program was administered to determine the NPR of the tailings solids. In the reporting period, six monthly tailings composites were collected and analyzed. Although an NPR value of 3 or greater is generally considered to indicate non-acid generating material, Appendix 6 of the WUL states that the monitoring objective is to confirm that the NPR of tailings solids is greater than 4.

2.0 Waste Rock and Overburden

2.1 Frequency of Sampling

In general, for open pit mining, a sample of drill cuttings was collected from waste blasts with a frequency of approximately one sample for every seven holes drilled. A composite sample for ABA analysis was then assembled from the drill cuttings from approximately 4-5 individual samples. The underground ABA sampling procedure assembles a composite sample every 3300 tonnes (equivalent to approximately 50 m of development) using a grab sample technique. For the reporting period, 4 ABA samples were collected for the Area 118 underground mining operation however results for those samples were not ready in time for this report.

2.2 Sample Preparation

All composite samples were reduced to 1-2 kg in mass using a riffle splitter. The resulting split sample was labeled according to the ABA Program sample naming standards and shipped to an accredited laboratory (SGS Canada Inc. [SGS], 6927 Antrim Avenue, Burnaby, BC, V5J 4M5). The labeling methodology was consistent with the Mine Environmental ABA Database throughout the reporting period,

2.3 Test Work and Evaluation

SGS conducted ABA analysis by the BC Research Method as required by the WUL. Reported results were entered into the Mine Environmental ABA Database.

Waste rock and overburden composite samples were also analyzed for total metals for the entire duration of the reporting period. The results obtained from SGS were entered into the Mine Environmental ABA Database.

In order to confirm that the predominant neutralizing mineral was calcite, the residual liquid phase from one out of approximately every ten NP determinations was submitted for multi-element ICP analysis (including calcium, magnesium, aluminium and iron after filtration at 0.45 µm). Calcium values for the residual liquid phase and inorganic carbon values for the sample were compared with values reported in *An Assessment of the Results of Acid Base Accounting (ABA) and Mineralogical Test work of Eight Samples for the Proposed Minto, Yukon Territory, Minesite* (Mills, C. (1997), Report to The Selkirk First Nation, Pelly Crossing, Yukon Territory, 30p.) [the Mills report]. It should be further noted that calcite has been observed on fracture faces and small veinlets within the current mining area.

For the reporting period, the results obtained from SGS were compared against past results found in the Mine Environmental ABA Database and the results are presented in Section 2.5.

2.4 Discussion

Blasts are numbered by bench (denoted by the toe elevation) and by the sequential blast number for that bench (e.g. 784-01; 784 being the toe elevation of the bench and 01 being the first blast of the bench). Images depicting the location of all samples collecting during the reporting period are provided in Appendix A.

The primary lithology of the deposit is granodiorite. The graniodiorite is divided into sub-units and classified as equigranular granodiorite (eG), porphyroblastic granodiorite (pG), and foliated granodiorite (fG). Locally, very highly-weathered granodiorite near the surface is described as residuum, and surface materials comprised of organics and soil is termed overburden. Other minor lithological units are described as pegmatite (Peg), andesite (And) and aplite (Ap).

2.5 Results

The 66 samples collected in the reporting period were analyzed by SGS and results were reported according to the BC Research Method. In the reporting period, the NPR values ranged from 0.6 to 155 with a mean NP/mean AP of 4.62 and a median of 30.6. A summary of the results for ABA analysis are attached as Appendix B. Additionally, the SGS raw lab result files are provided in Appendix C.

2.5.1 NPR

The reporting period NPR results are compared to the results from 2013 and the first half of 2014 in Table 1 below.

Table 1. NPR Results Summary for 2013, January 1st to June 22nd, 2014 and July 1st to December 31st, 2014.

NPR Values from SGS				
Period Ending	**Minimum (NPR)**	**Maximum (NPR)**	**(Mean NP)/(Mean AP)**	**Median (NPR)**
2013 (January to December, 2013)	0.40	406.40	6.18	15.85
2014 (January to June, 2014)	0.70	136.00	6.25	22.90
2014 (July -December, 2014)	0.60	155.00	4.62	30.60

During the reporting period, 6 samples returned NPR values below the threshold of 3.0. Of the 6 samples with a NPR value less than 3:

- Five were found to have an increased sulphide sulphur content (and therefore AP) consequently decreasing the NPR;
- One sample represented areas of Low Grade Waste;
- Four samples represented areas of Medium Grade Waste;
- One sample represented areas of High Grade Waste;
- Four samples had corresponding waste rock deposited at the Main Pit below the closure high water level; and
- Two samples had waste rock dispatched to as per the *Waste Rock Overburden Management Plan*.

All waste associated with samples above a NPR of 3 was dispatched based on Minto's *Waste Rock and Overburden Management Plan*.

2.5.2 Paste pH

The paste pH results for the reporting period were between 7.95 and 9.43 with a mean value of 8.76 and a median value of 8.80. The results are all well above the minimum required paste pH value of 5.0 and are comparable to the 2013 results and January to June 2014 results. The paste pH results for 2013, January to June 2014 and the reporting period are displayed in Table 2 below.

Table 2. Paste pH Results Summary for 2013, January 1st to June 22nd, 2014 and July 1st to December 31st, 2014.

Paste pH from SGS				
Period Ending	**Minimum (pH)**	**Maximum (pH)**	**Mean (pH)**	**Median (pH)**
2013 (January to December, 2013)	7.57	9.63	8.67	8.69
2014 (January to June, 2014)	6.79	9.32	8.55	8.66
2014 (July -December, 2014)	7.95	9.43	8.76	8.80

2.5.3 Sulphide Sulphur

The sulphide sulphur content "$S(S^2)\%$" results for the reporting period ranged from <0.01 to 3.26%, with a mean value of 0.19% and a median value of 0.02% as summarized in Table 3. The sulphide sulphur content during the reporting period was lower than what was found in 2013.

Table 3. Sulphide Sulphur Results Summary for 2013, January 1st to June 22nd, 2014 and July 1st to December 31st, 2014.

Sulphide-Sulphur % from SGS				
Period Ending	**Minimum ($S(S^{2-})$)**	**Maximum ($S(S^{2-})$)**	**Mean ($S(S^{2-})$)**	**Median ($S(S^{2-})$)**
2013 (January to December, 2013)	0.01	6.54	0.18	0.07
2014 (January to June, 2014)	0.01	2.02	0.08	0.02
2014 (July -December, 2014)	<0.01	3.26	0.19	0.02

A total of twelve samples exceeded the sulphide sulphur threshold for construction rock of 0.3% during the reporting period. Furthermore, five of the twelve samples also had a NPR of less than 3. The waste material represented by nine of the twelve samples that had sulphide sulphur greater than 0.3% and NPR greater than 3 was mined and placed in the SAT dump as it was identified by onsite analysis to be SAT waste.

Figure 1, below, is a plot of sulphide sulphur versus (vs) NPR for all samples analyzed during the reporting period. Figure 1 illustrates that 12 samples had sulphide sulphur content greater than 0.3% and 7 samples had a NPR threshold of less than 3.

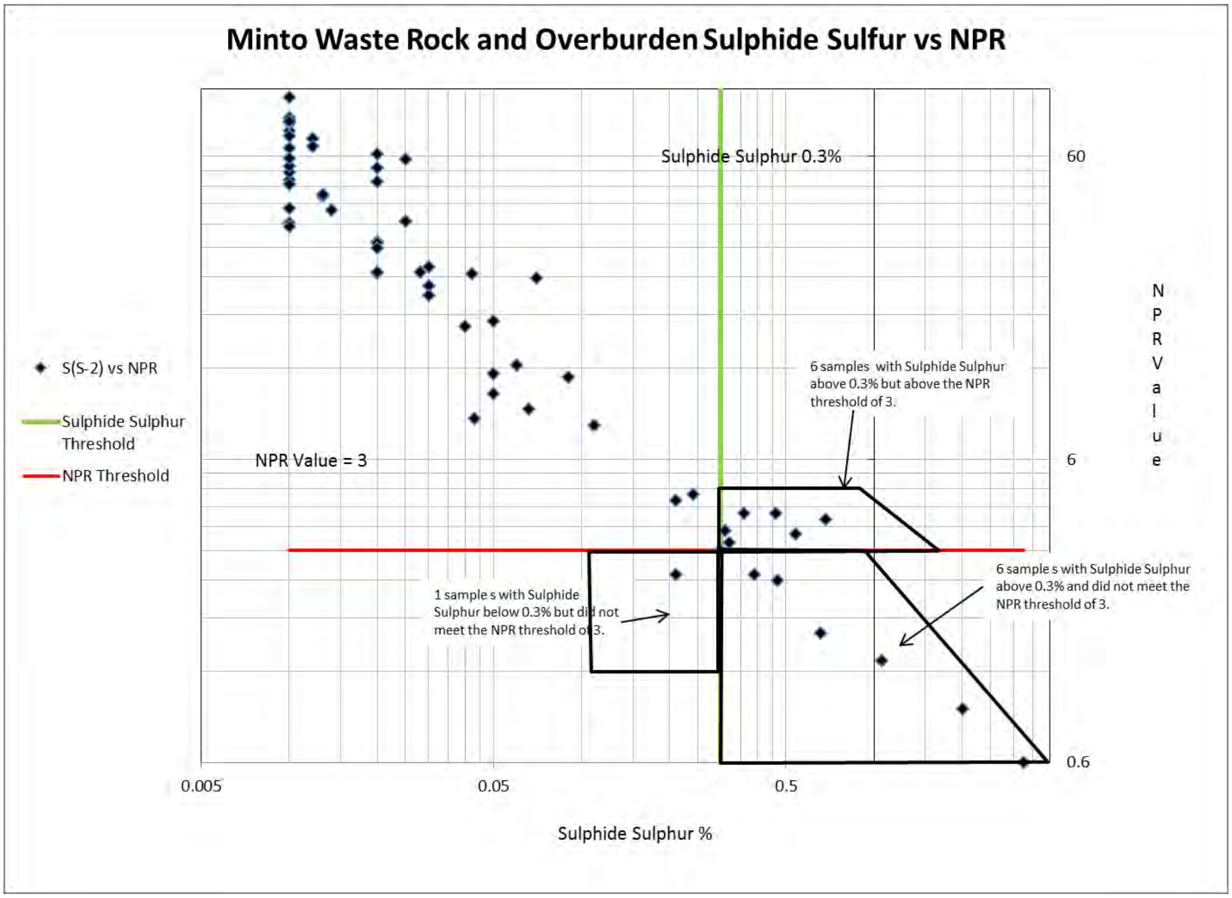


Figure 1. Minto Waste Rock and Overburden Sulphide Sulfur vs NPR (July 1 – December 31, 2014).

2.6 NP Leachate Analyses

During the reporting period a total of 9 samples had ICP-OES analyses performed on the residual liquid phase following NP determinations in accordance with the BC Research NP Procedure. For discussion purposes, Section 2.6 compares results from the Mills report with the waste rock results from the reporting period.

Using Table 2.4 from the Mills report as the basis of comparison for calcium (Ca) content:

- The range of the Ca content of the liquid residue from the NP determination on the Mills report samples was 36.1 to 479.4 ppm with a mean of 272.38 ppm and a median of 285.25 ppm.

- In comparison, the Ca content of the liquid residue from the NP determination for the samples in this reporting period ranged from 354 to 722 mg/L (equivalent to ppm) with a mean of 540 mg/L (ppm) and a median of 557 mg/L (ppm).

Using Table 2.1 from the Mills report as a basis for comparison of inorganic carbon values:

- The TIC (Total Inorganic Carbon) for the Mills Report samples ranged from <0.05% to 0.79% with a mean of 0.48% and a median of 0.46%
- In comparison, the TIC for the 9 samples submitted for analysis during the reporting period ranged from 0.10 to 0.52% with a mean of 0.26% and a median of 0.21%

See Figure 2, below, for the comparison between the reporting period and Mills report Ca ICP and TIC results.

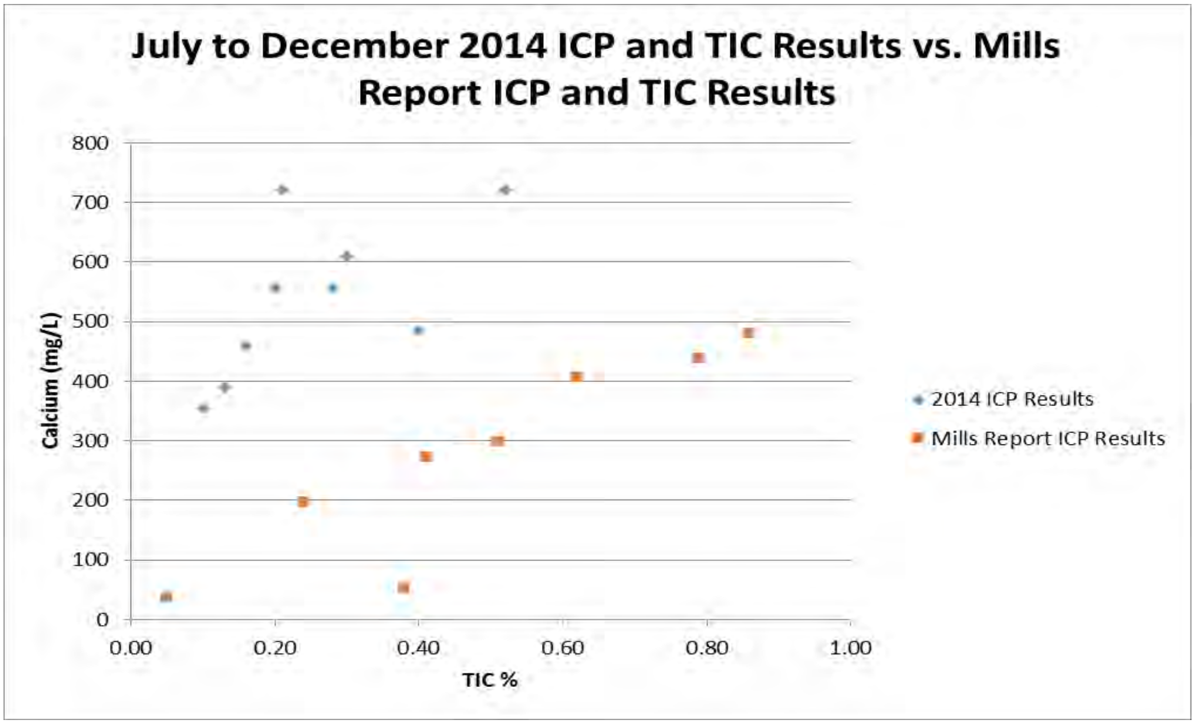


Figure 2. July 1st to December 31st, 2014 vs. Mills report Ca ICP and TIC Results.

The reporting period minimum carbonate equivalent value was significantly higher than the minimum from the Mills report (8.8 compared to <1.1). The maximum carbonate equivalent value was slightly lower than what was reported in the Mills report (18.0 compared to 19.5).

The Mills report compared Ca and Mg concentrations in the NP test leachate (by way of a ratio Ca/Mg) and found that, for the eight samples tested, the leachates had a mean Ca/Mg ratio of 19.7. From the high Ca/ low Mg concentrations in the NP test leachate, the Mills report concluded that the dominant mineral providing acid neutralization potential was calcite (calcium carbonate, $CaCO_3$). For the reporting period, calculations of the mean Ca/mean Mg ratio yields a mean value of 4.86. On this basis, the reporting period results for NP test leachate analysis indicate that calcite continues to be the predominant neutralizing mineral. For a summary of NP test leachate results for Calcium (Ca), Magnesium (Mg), Aluminum (Al), and Iron (Fe) see Table 4. For complete NP test leachate results see Appendix D. Raw lab results are presented in Appendix C.

Table 4. Leachate ICP and TIC Results, July 1 –December 31, 2014.

July 2014 to December 2014 Leachate ICP results					
Sample Number	Ca (mg/L)	Mg (mg/L)	Al (mg/L)	Fe (mg/L)	TIC (%)
86083	722	24.1	65.5	87.6	0.21
86085	354	17	28.6	70.6	0.1
87426	557	16.5	28.5	67.9	0.2
87431	610	81.8	38.8	287	0.3
87439	722	193	49.2	506	0.52
87444	390	24.3	27.8	102	0.13
103104	557	94.3	55.8	302	0.28
103108	486	125	46.8	414	0.4
103118	459	28.2	51.5	126	0.16

3.0 Tailings

3.1 Frequency of Sampling and Sample Preparation

Since April 2013, Minto has collected a weekly sample of final tailings. The weekly samples have been filtered and dried in the onsite lab and then combined into a monthly sample which is then riffled down to produce a 1-2 kg composite. Samples are labelled according to the labeling protocol established in the Mine Environmental ABA Database.

3.2 Test work and Evaluation

For the reporting period, the monthly tailings composites were sent to SGS who performed ABA analysis according to the BC Research Method. During analysis, SGS determined the AP from percent sulphide sulphur (obtained by subtracting percent sulphate sulphur from percent total sulphur). Additionally, paste pH and total inorganic carbon (TIC) were determined.

3.3 Results

The results from the SGS laboratory tests indicate that the reporting period tailings samples were within the threshold of NPR greater than 4 and contain lower sulphide sulphur content as presented in Figure 3, below. The tailings results are summarized in Appendix E and the raw lab results are presented in Appendix C.

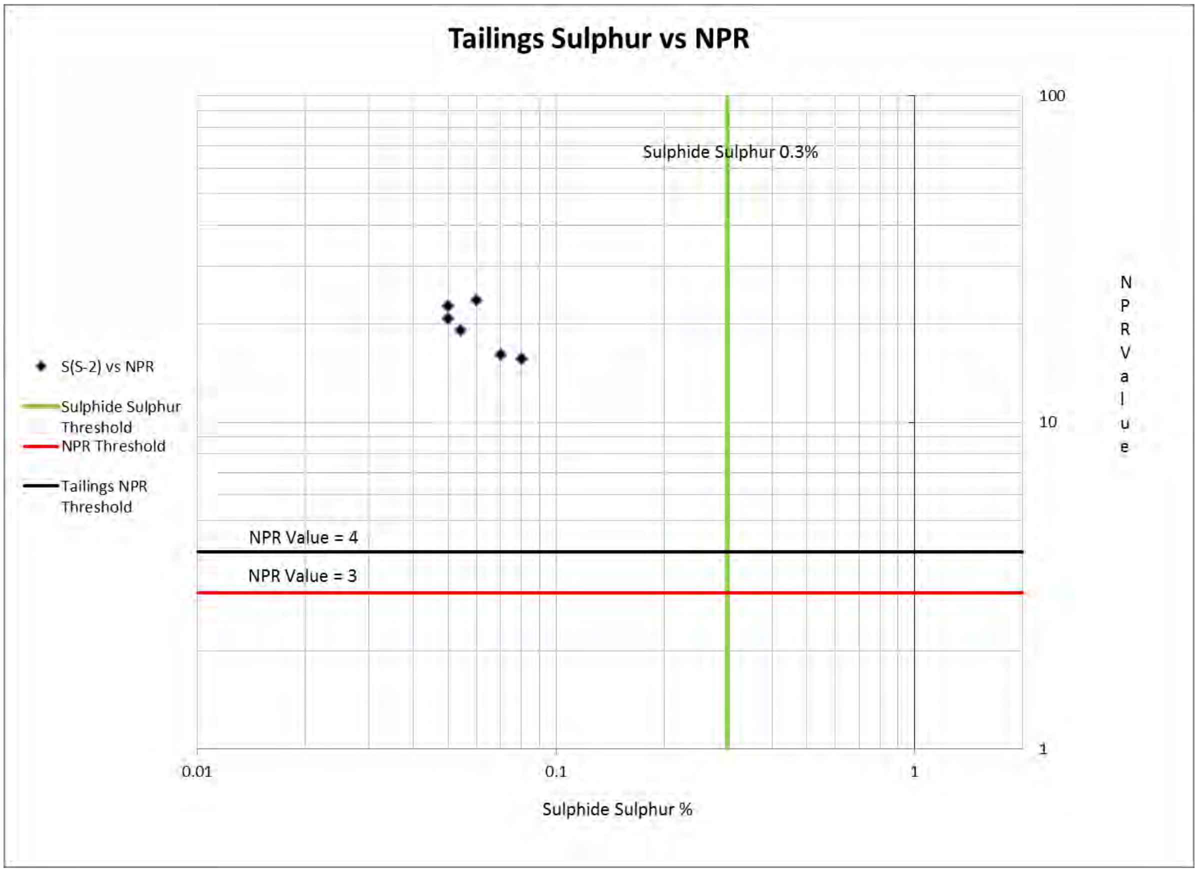
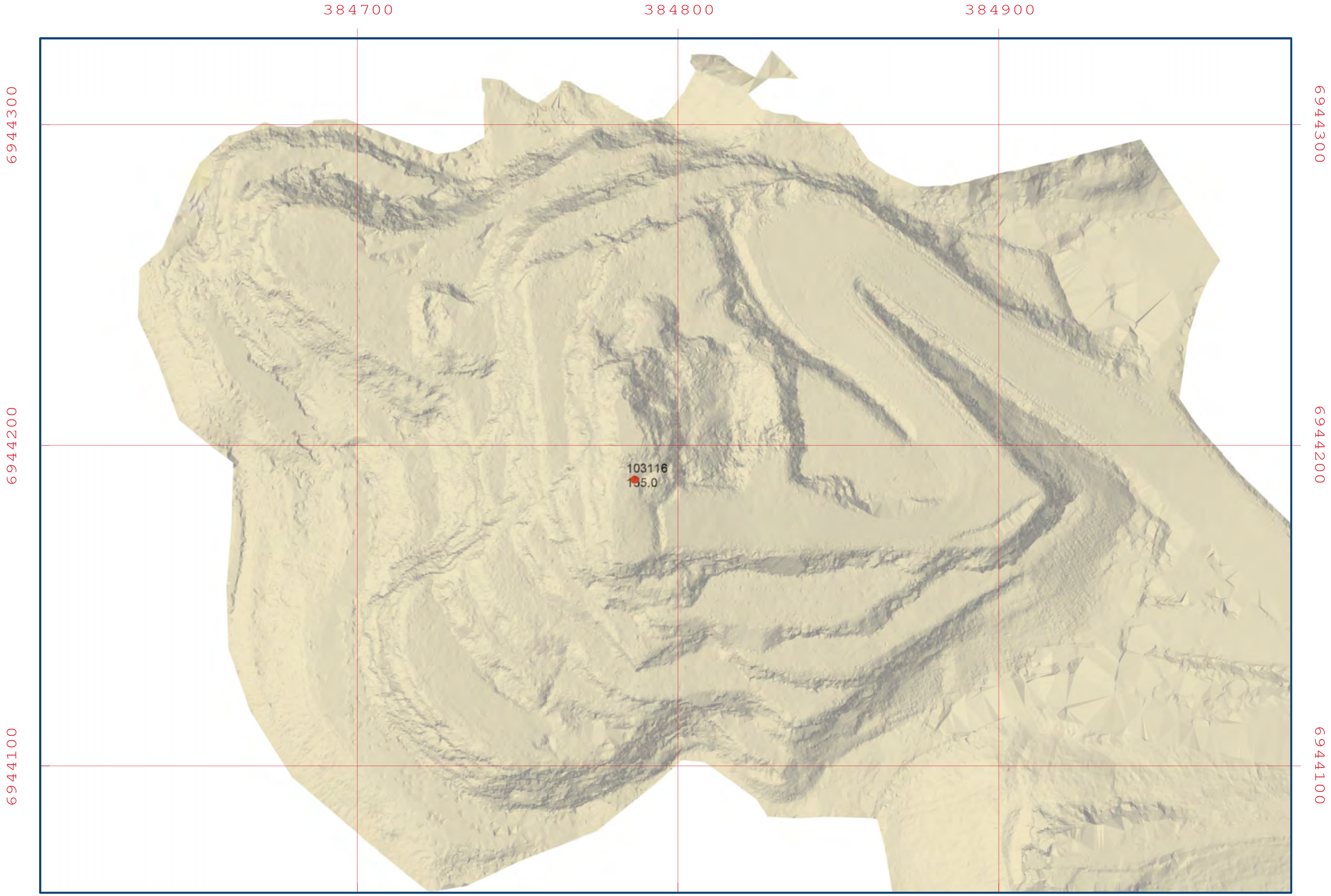


Figure 3. Tailings Sulphide Sulphur vs NPR, July – December 2014.

4.0 Conclusion

The results displayed in this report combined with the previous reporting periods are the foundation for the Mine Environmental ABA Database. Preliminary assessment indicates that sulphide sulphur values greater than 0.3% mainly occurs in Medium and High Grade Waste areas. Overburden and waste rock development will continue through the subsequent phases of mining and milling and will be sampled, analyzed and reported as required by the WUL.

Appendix A: Sample Location Images



ABA Sample Locations
118 Pit – 826L

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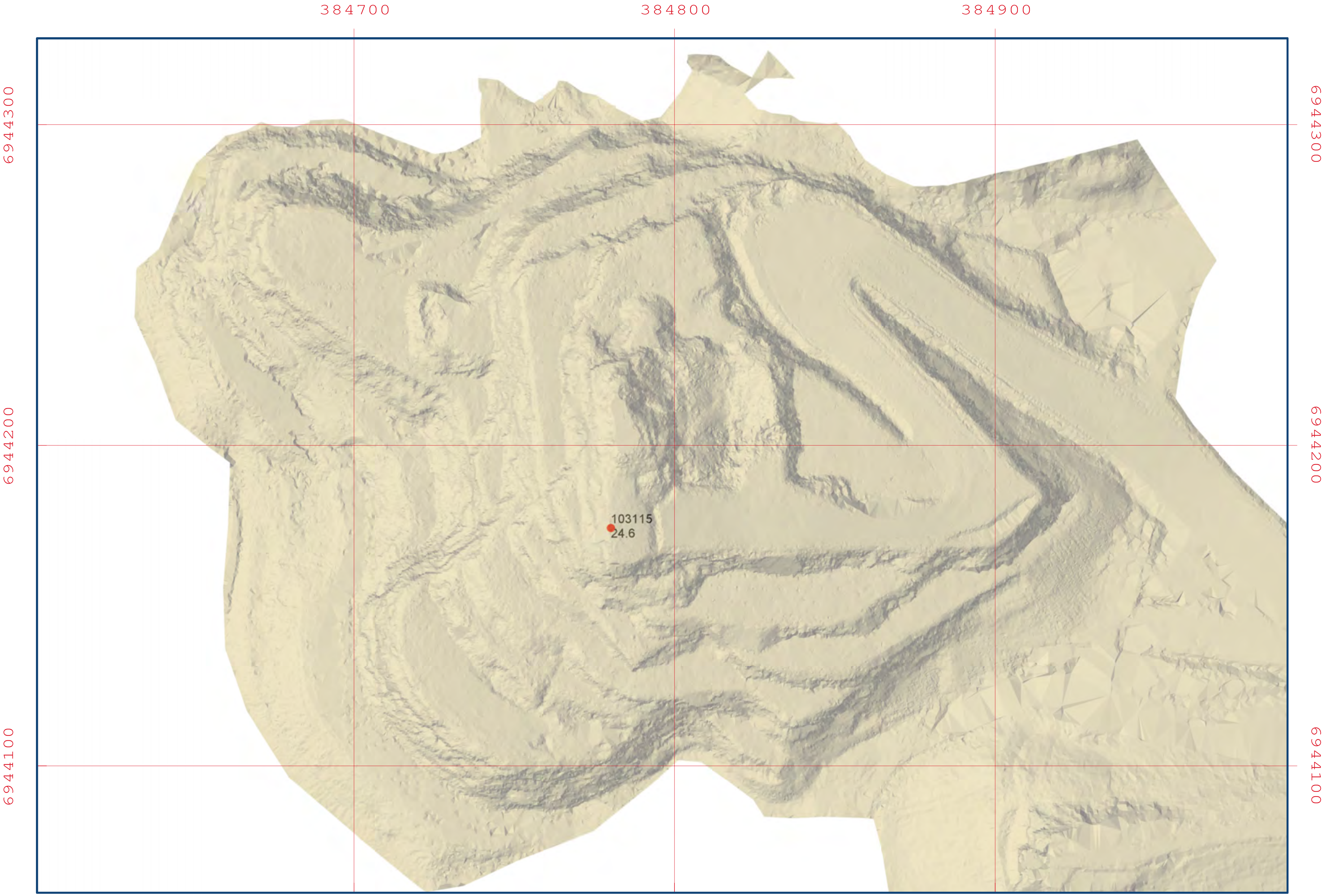
CHECKED BY:	DRAWING#:
DESIGNED BY:	SCALE: 1:1500

CAPSTONE MINING CORP.
MINTO MINE



ABA Sample Locations
118 Pit – 832L

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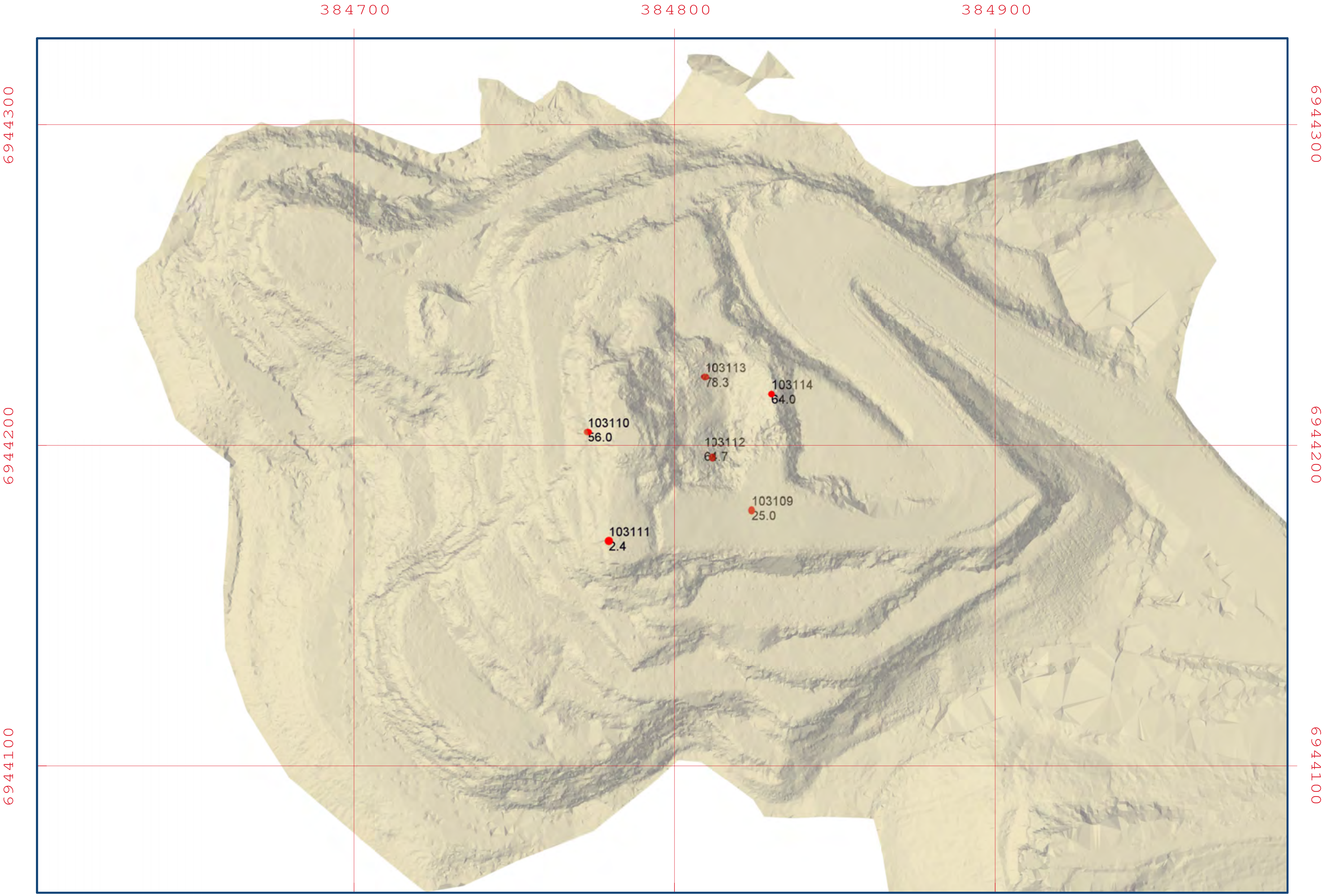
CHECKED BY:	DRAWING#:
DESIGNED BY:	SCALE: 1:1500

CAPSTONE MINING CORP.

MINTO MINE



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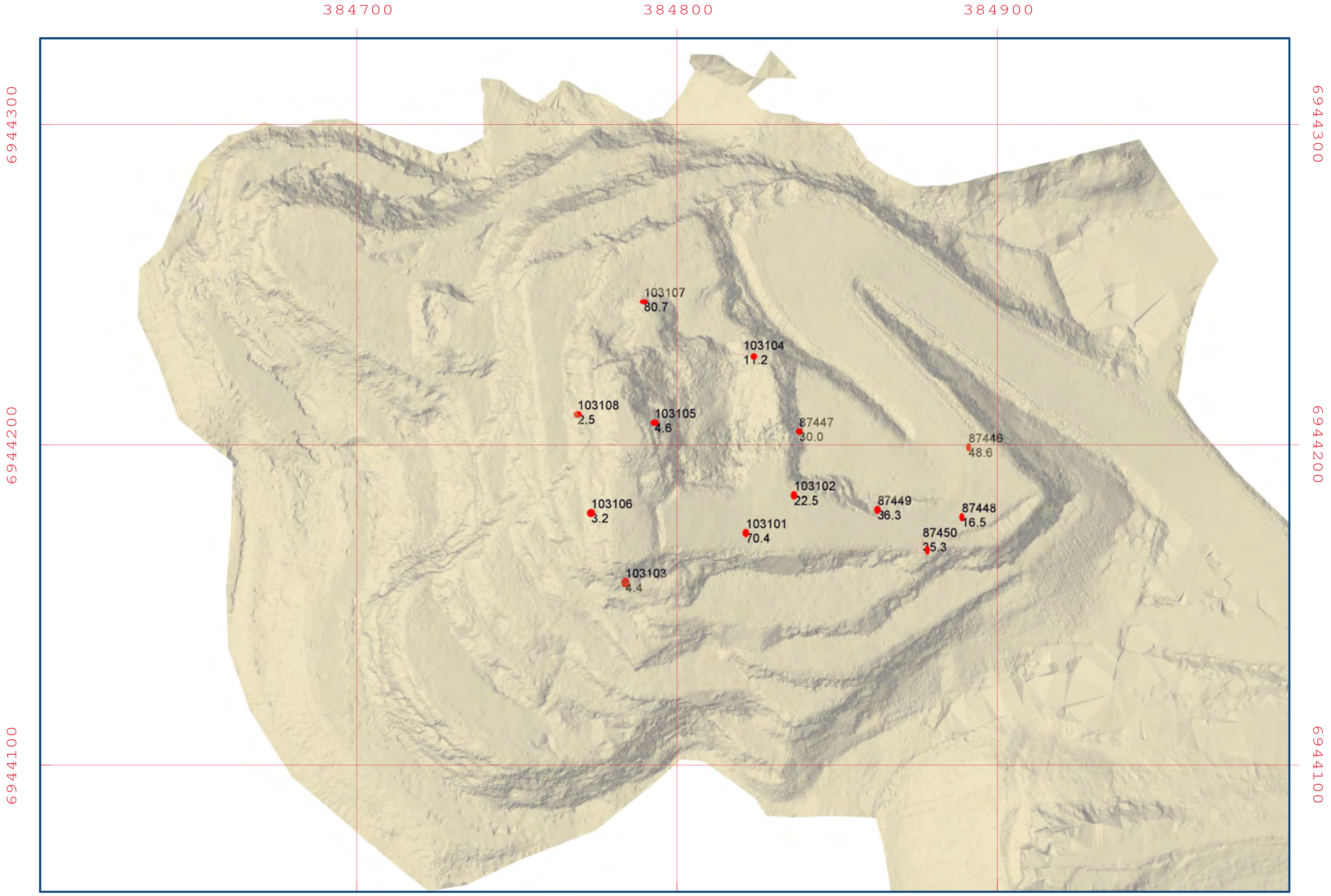
DESIGNED BY:		SCALE:	1:1500

ABA Sample Locations
118 Pit – 838L

CAPSTONE MINING CORP.
MINTO MINE



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MO	18-Mar-2015
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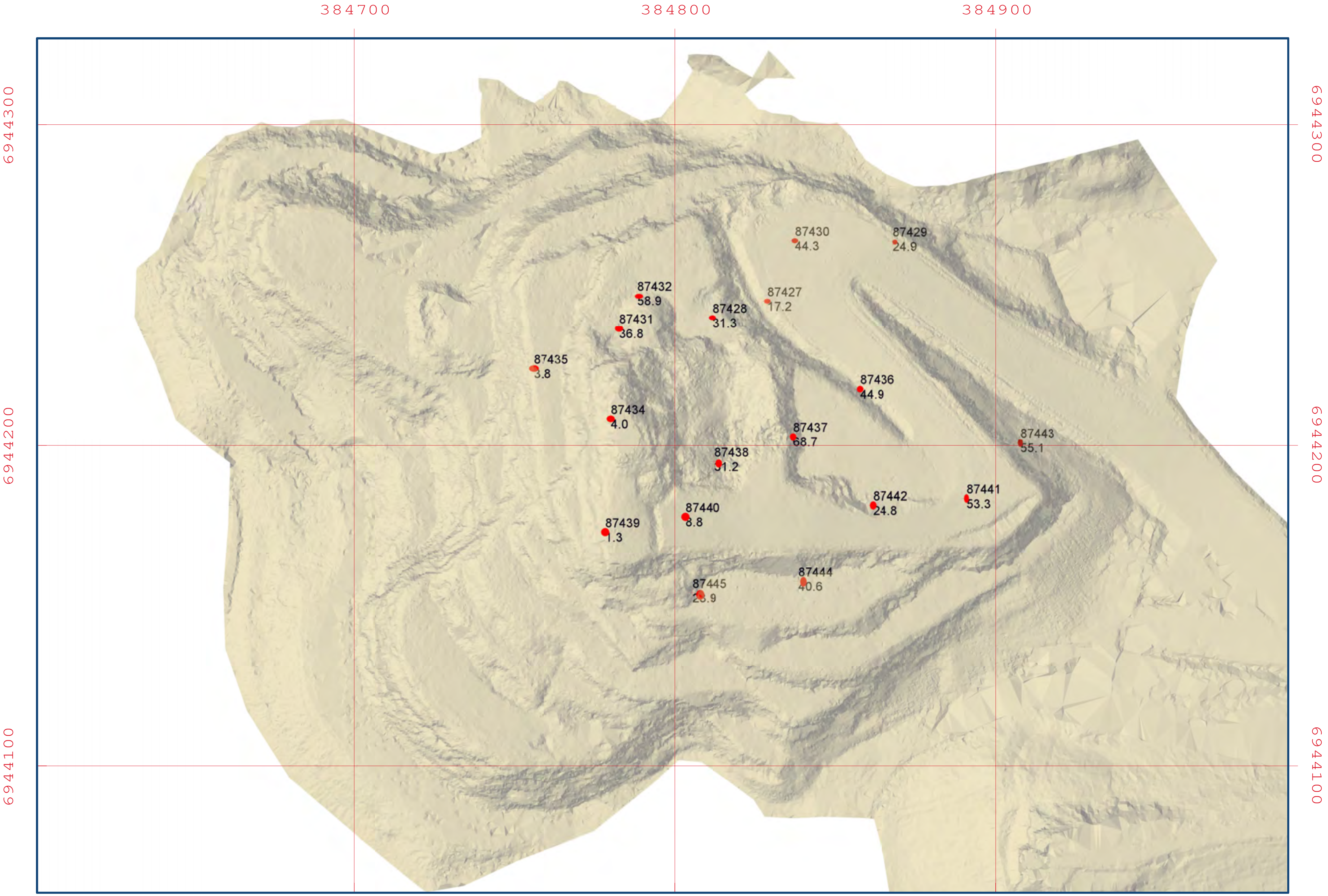
DESIGNED BY:	SCALE: 1:1500

ABA Sample Locations
118 Pit – 844L

CAPSTONE MINING CORP.
MINTO MINE



ABA Sample Locations
118 Pit – 850L

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CHECKED BY:	DRAWING#:
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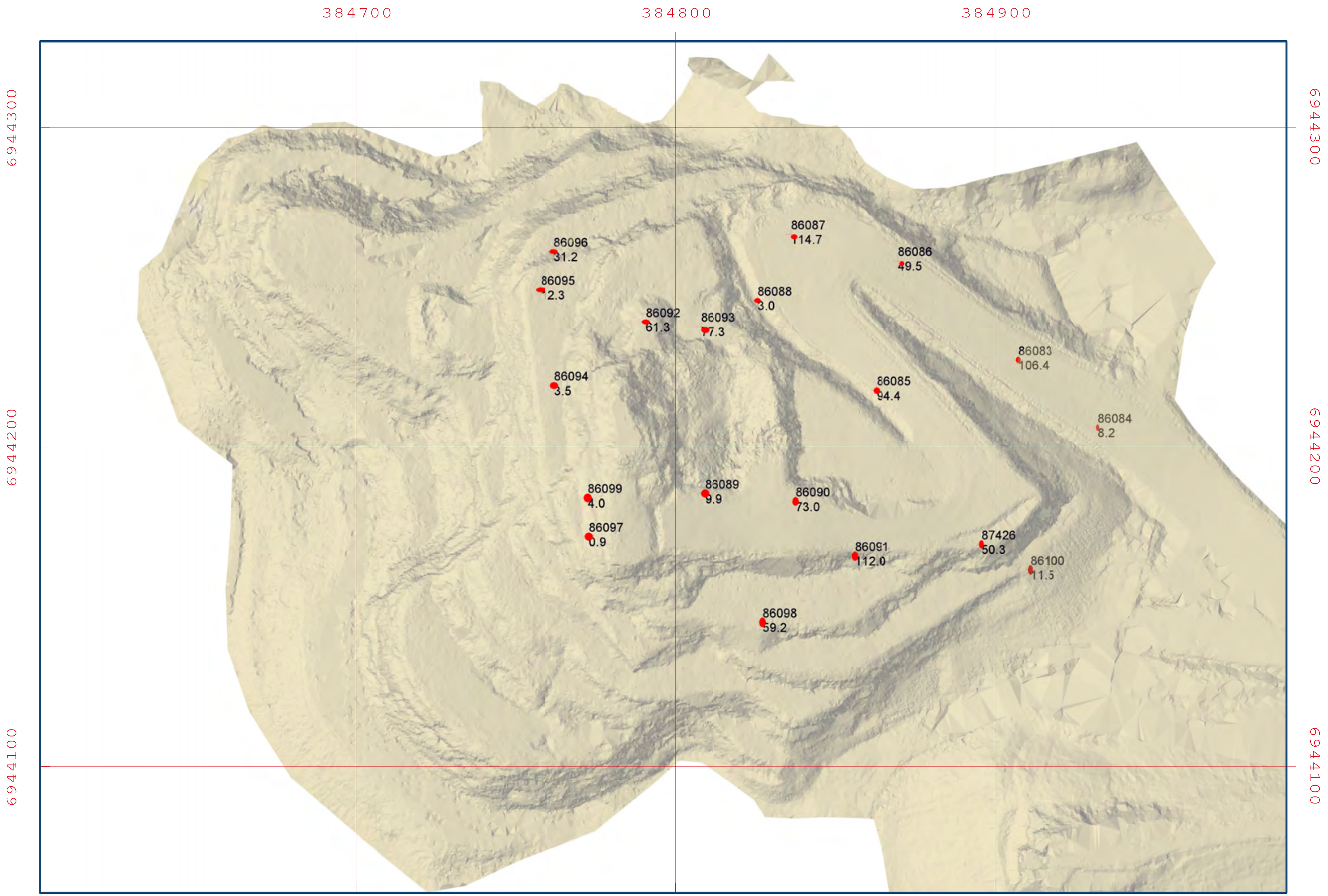
MINTO MINE



ABA Sample Locations
118 Pit - 856L

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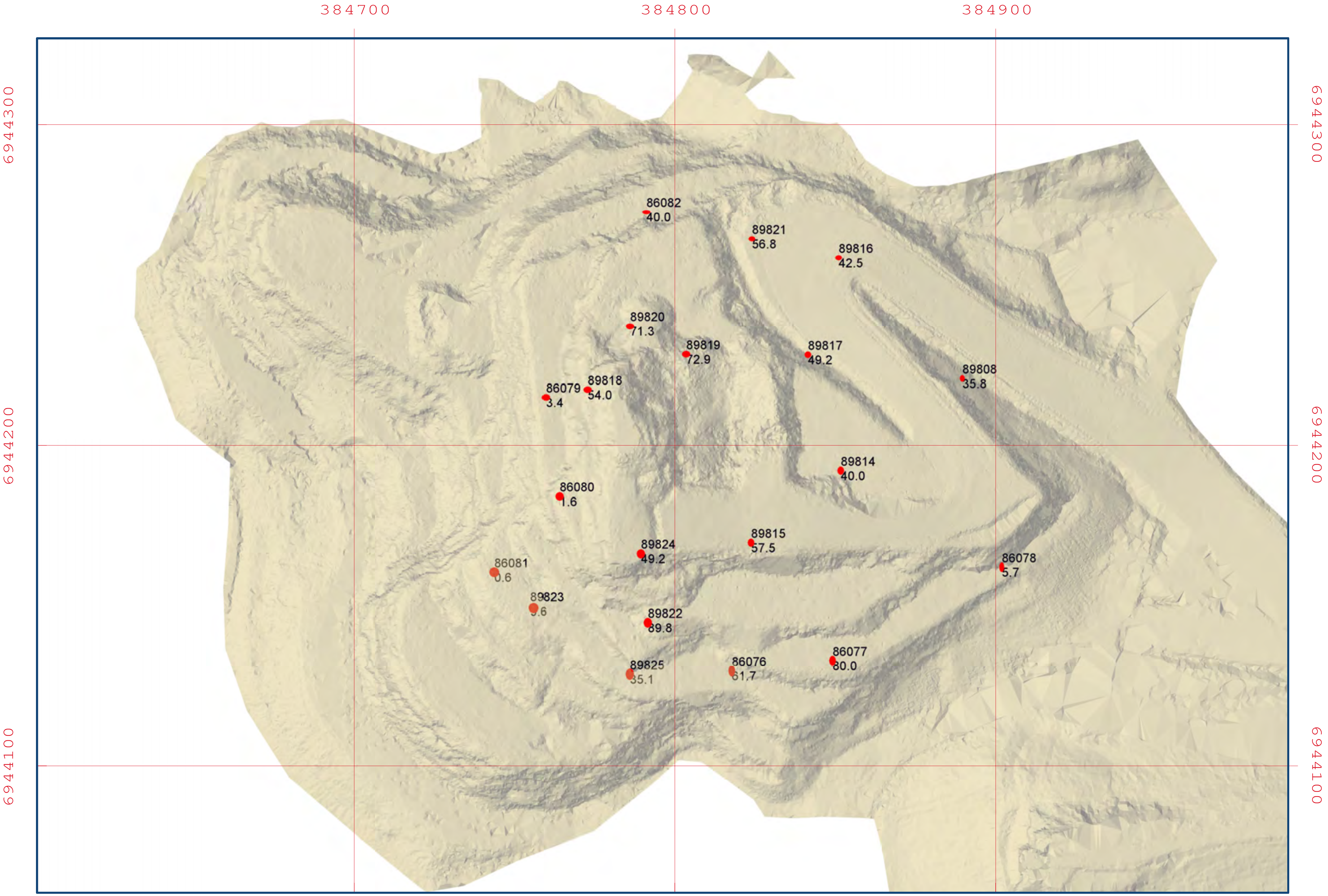
CAPSTONE MINING CORP.
MINTO MINE



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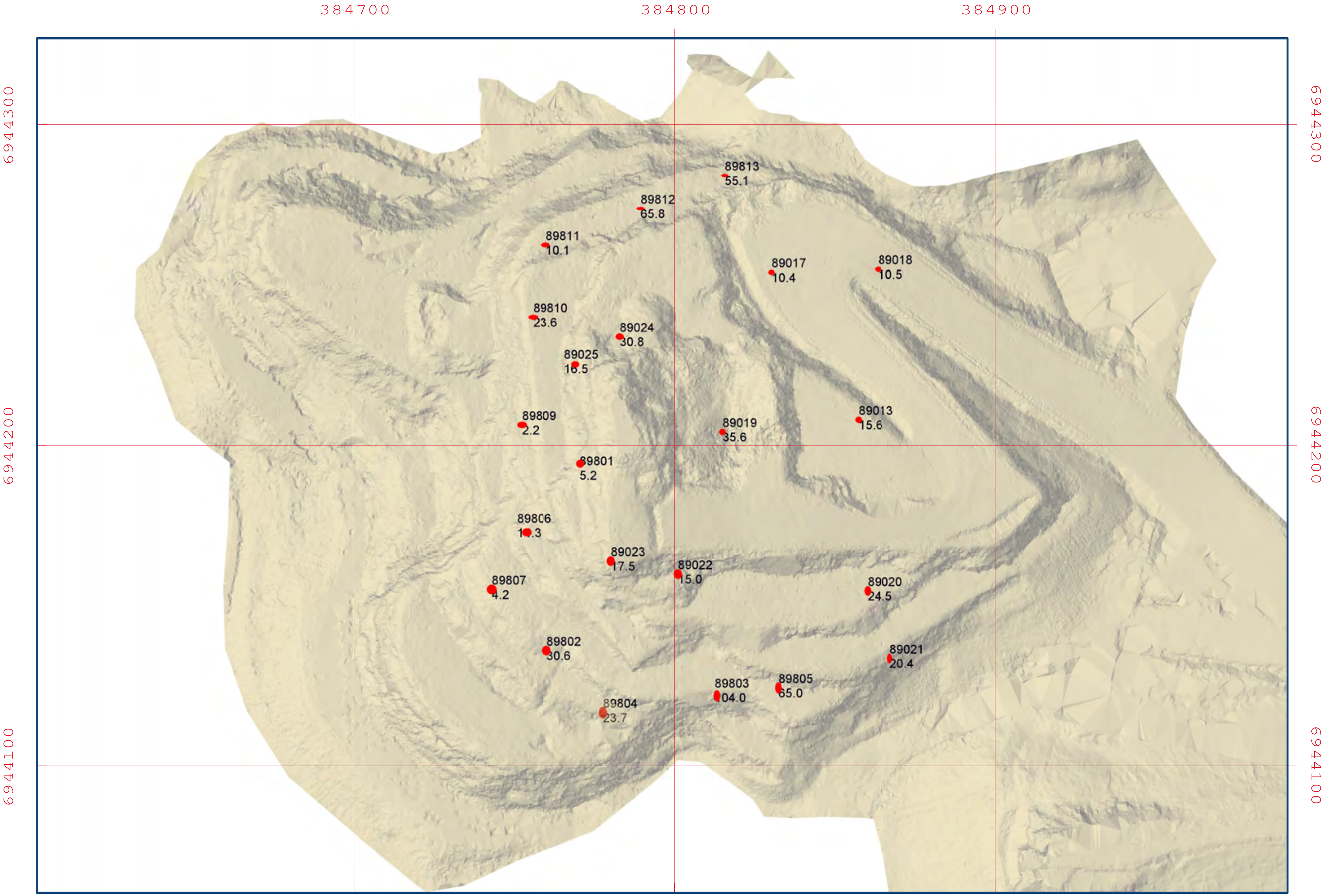
ABA Sample Locations
118 Pit - 862L

CAPSTONE MINING CORP.
MINTO MINE



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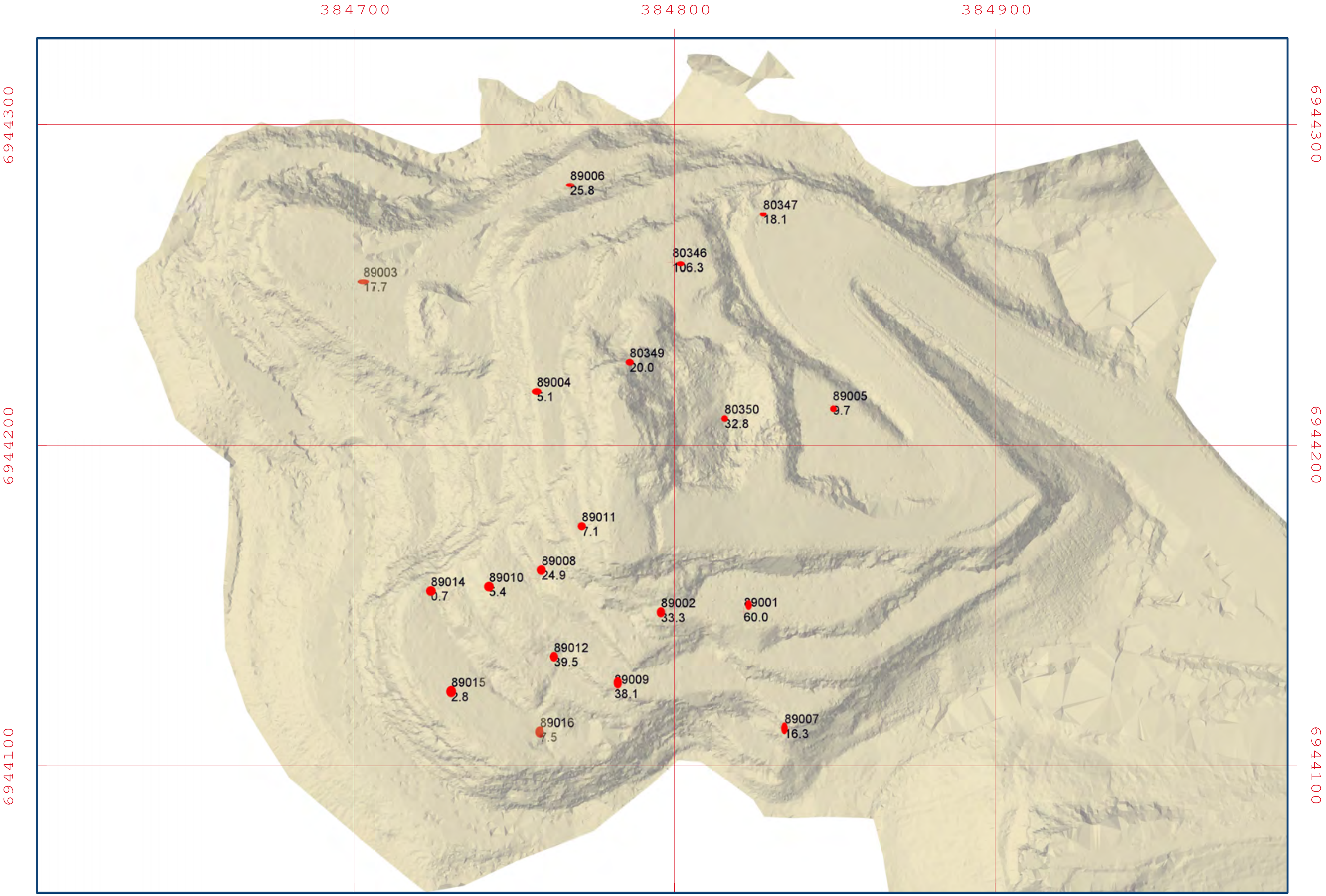
DESIGNED BY:	SCALE: 1:1500

ABA Sample Locations
118 Pit – 868L

CAPSTONE MINING CORP.
MINTO MINE



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DRAWN BY: MO

DATE: 18-Mar-2015

CHECKED BY:

DRAWING#:

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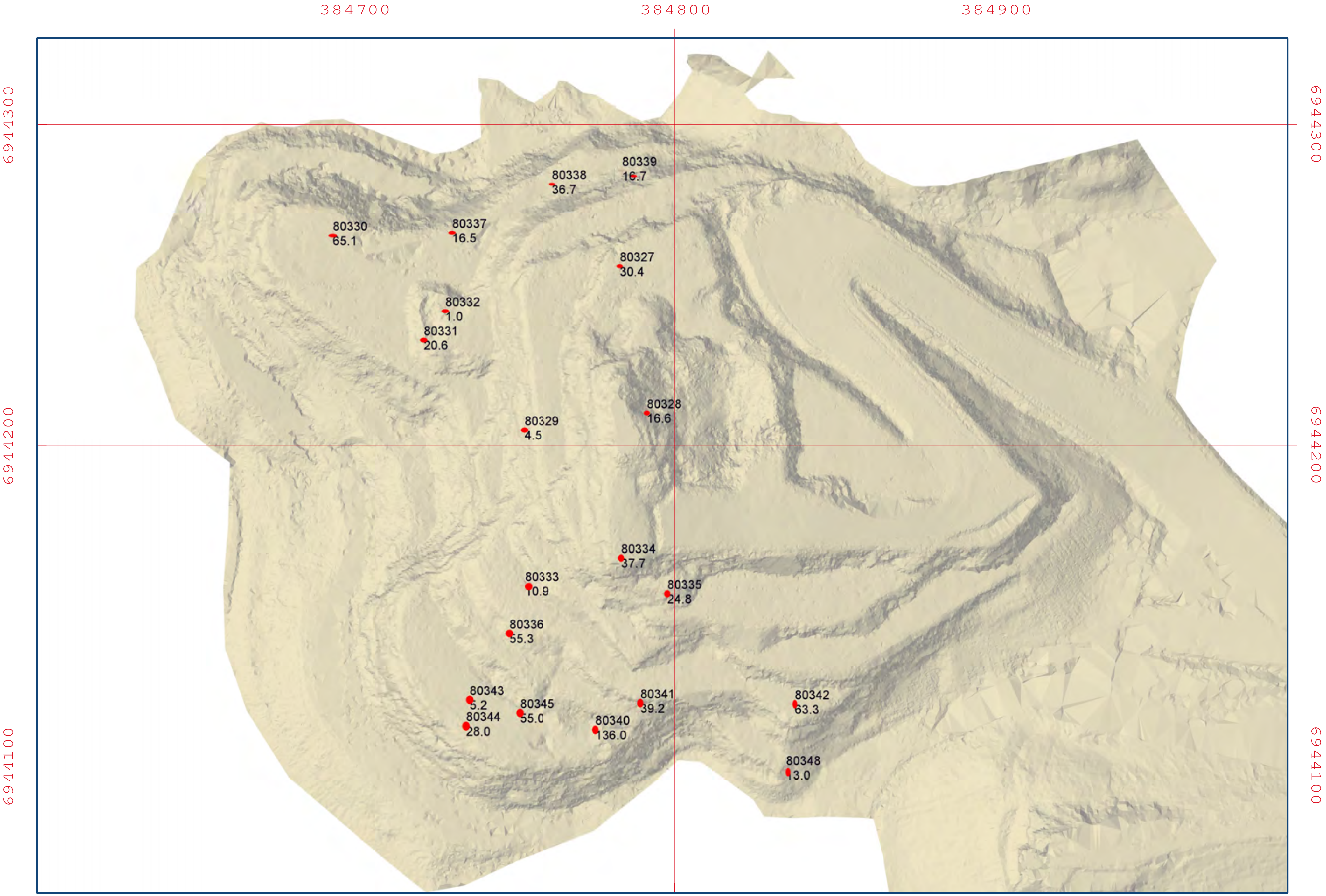
SCALE: 1:1500

384700 384800 384900

ABA Sample Locations
118 Pit - 874L

CAPSTONE MINING CORP.
MINTO MINE



ABA Sample Locations
118 Pit - 880L

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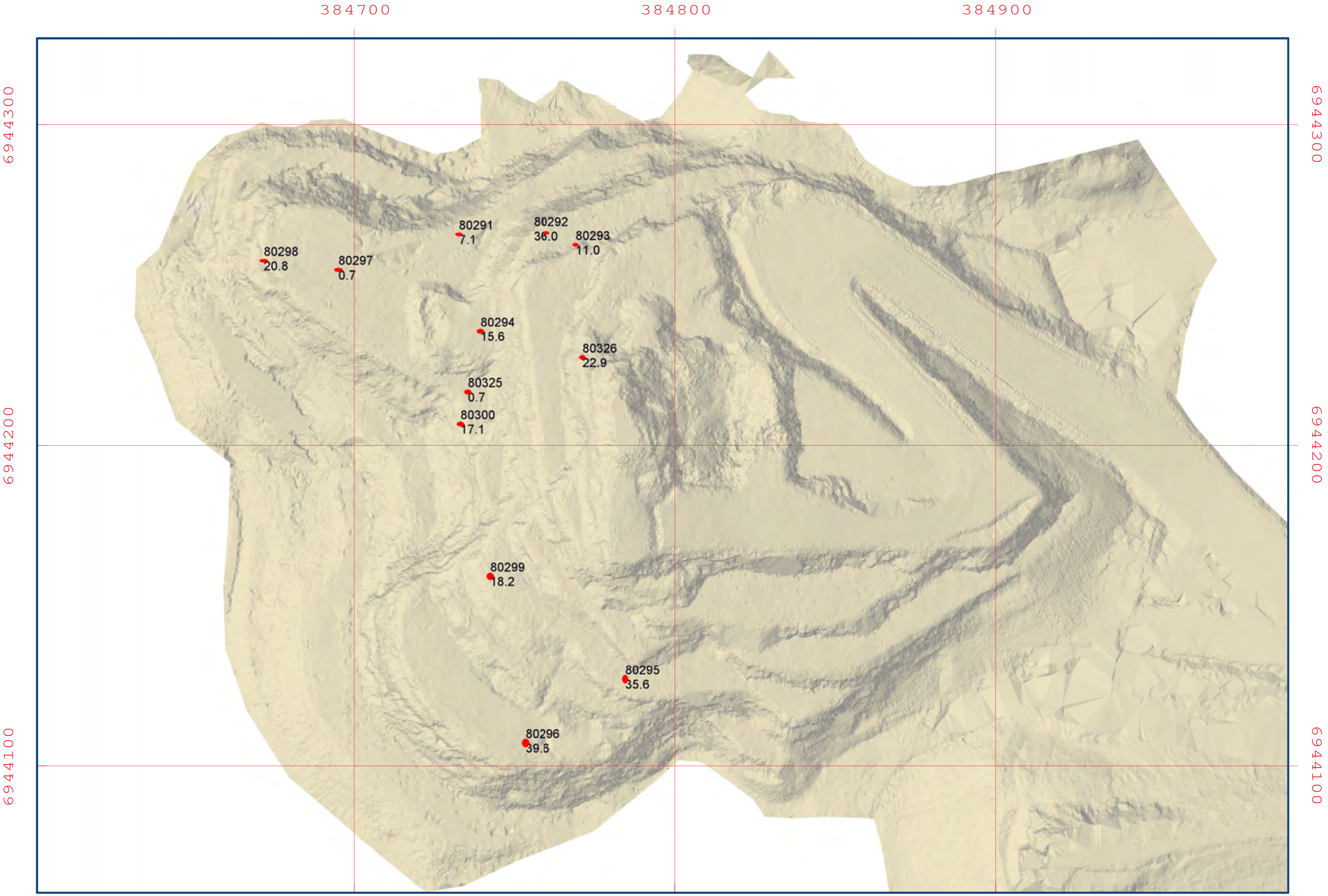
DRAWN BY: MO	DATE: 18-Mar-2015
CHECKED BY:	DRAWING#:
DESIGNED BY:	SCALE: 1:1500

CAPSTONE MINING CORP.
MINTO MINE



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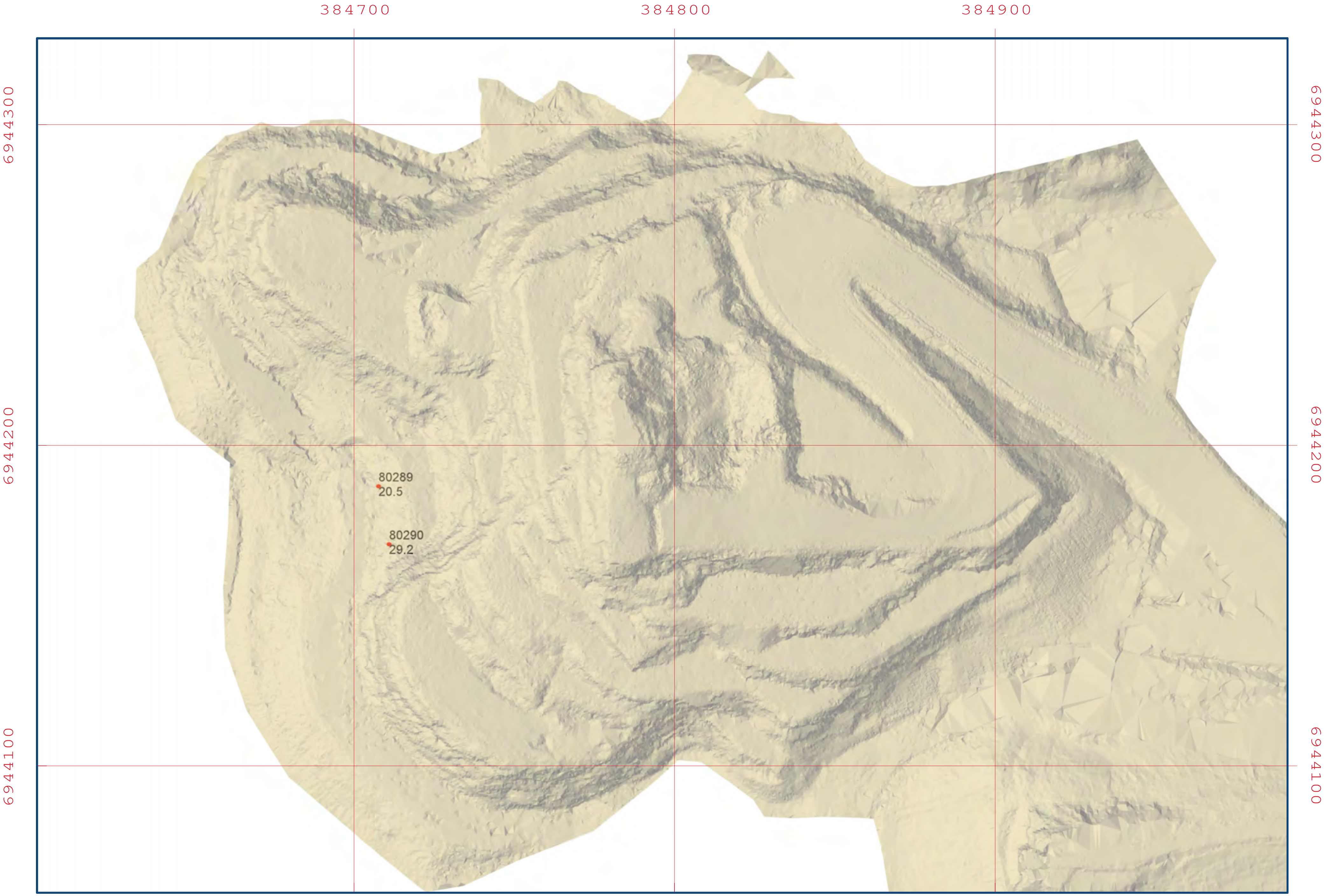
ABA Sample Locations
118 Pit – 886L

CAPSTONE MINING CORP.
MINTO MINE



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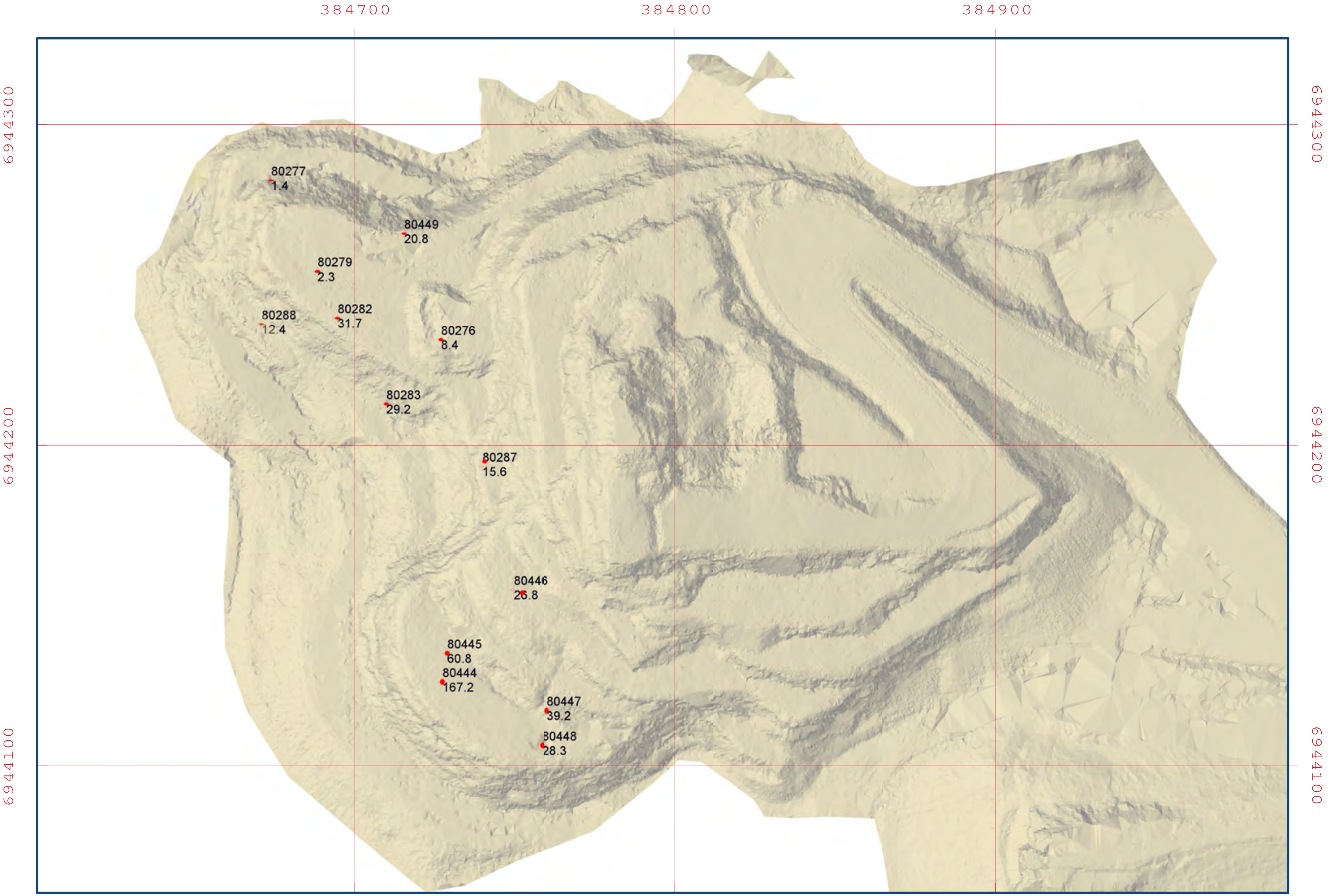
DRAWN BY: MO	DATE: 18-Mar-2015
CHECKED BY:	DRAWING#:
DESIGNED BY:	SCALE: 1:1500

ABA Sample Locations
118 Pit – 889L

CAPSTONE
MINING CORP.
MINTO MINE



ABA Sample Locations
118 Pit - 892L

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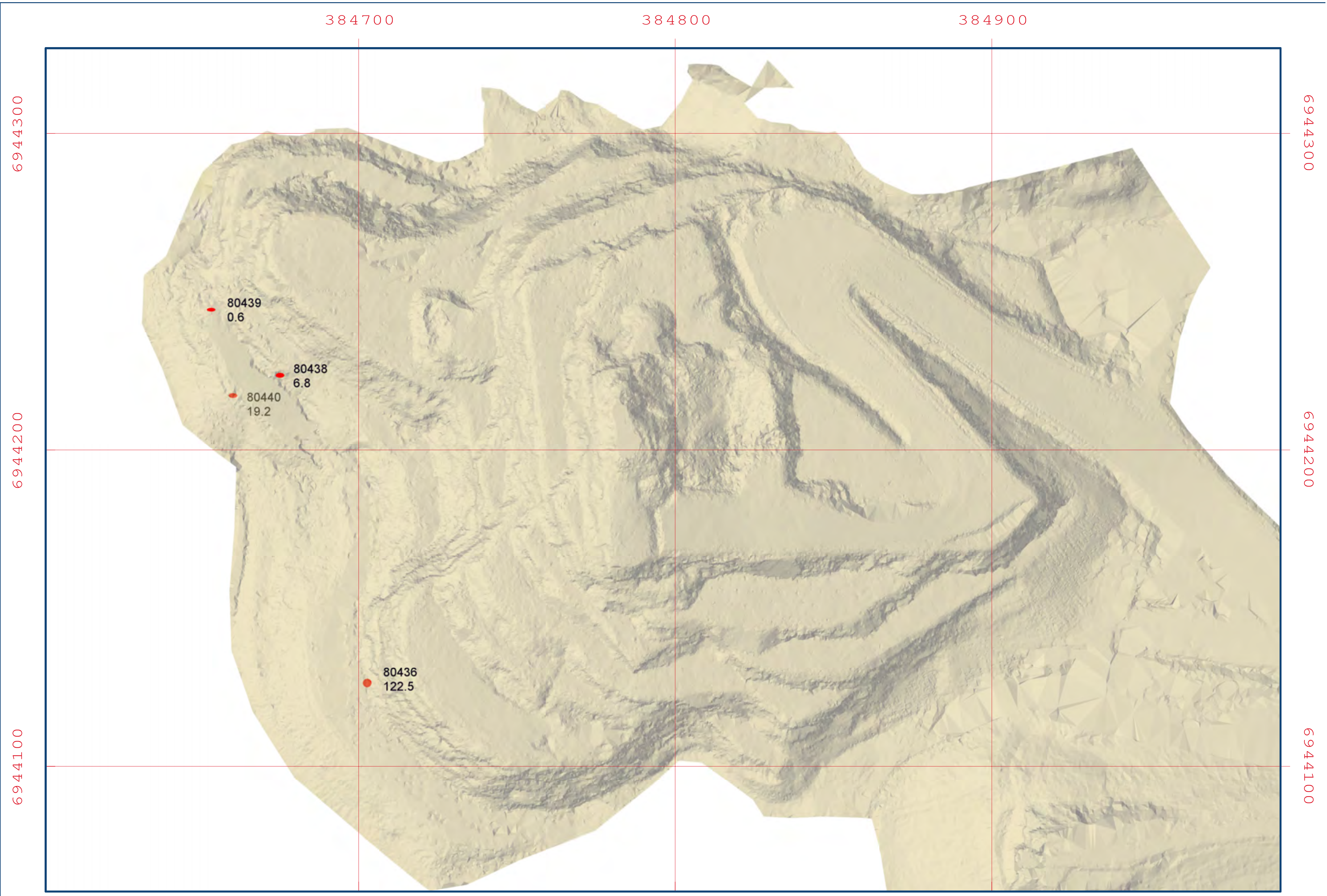
CAPSTONE MINING CORP.
MINTO MINE



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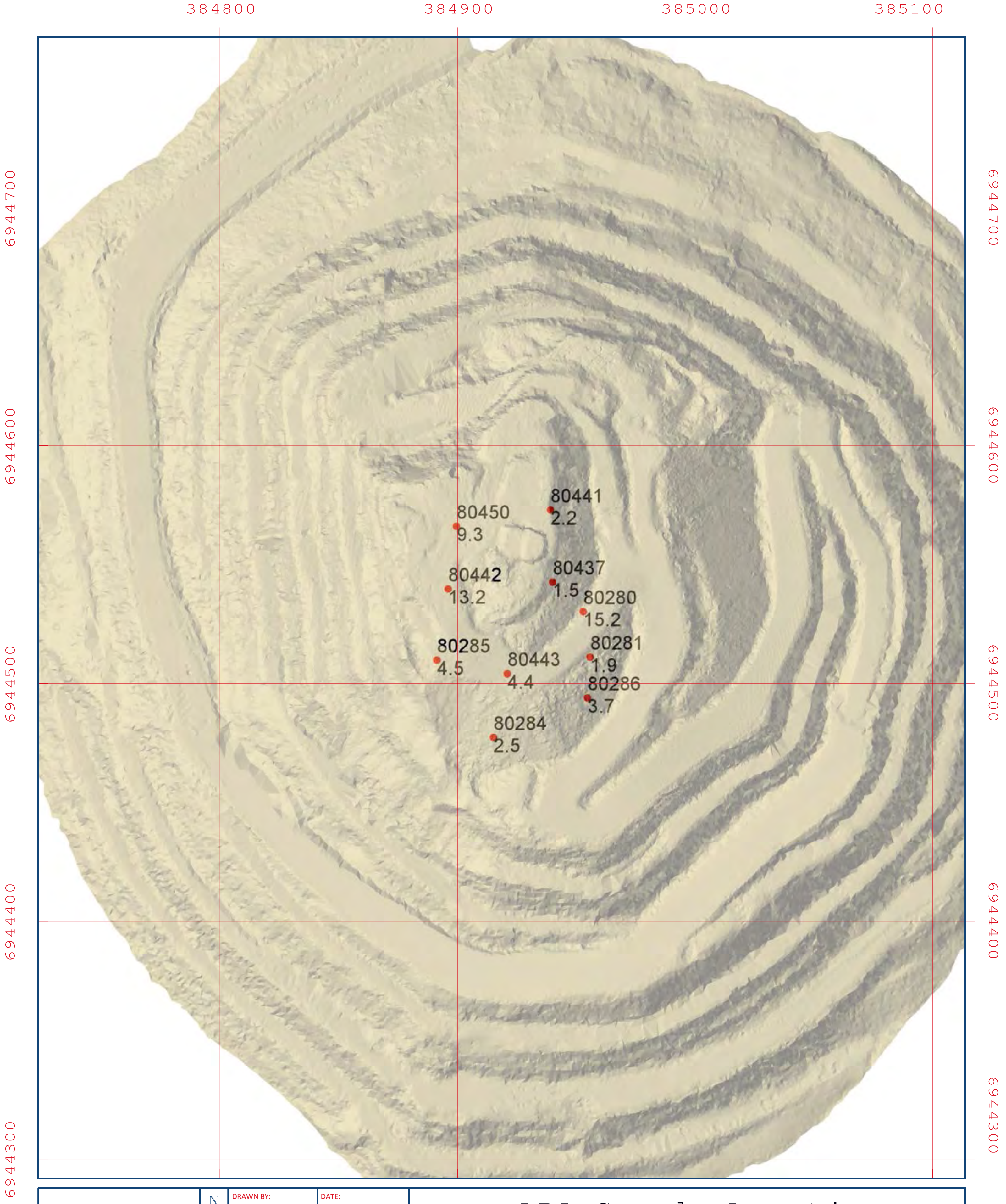
ABA Sample Locations
118 Pit - 898L

CAPSTONE MINING CORP.
MINTO MINE



CAPSTONE MINING CORP.
MINTO MINE

DRAWN BY: MO	DATE: 16-Feb-2015
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ABA Sample Location
Area 2 Pit
08-FEB-2015 Survey

Appendix B: BC Research Method ABA Results for Waste Rock and Overburden in July to December, 2014

Appendix B. Summary Area 2 AND Area 118 Pit ABA Analysis Results from SGS for July to December 2014

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	$CaCO_3$ NP	C(T) %	S(T) %	$S(SO_4)$ %	$S(S^{2-})$ %	AP $CaCO_3$kg / tonne	NP H_2SO_4kg / tonne	NP $CaCO_3$kg / tonne	Net NP	NP:AP Ratio (NP/AP)	Fizz Test
7/2/2014	86079	A118	MGW SAT	8.69	0.69	57.5	0.747	0.538	<0.01	0.538	16.8	56.6	57.8	24.7	3.4	Slight
7/2/2014	86080	A118	MGW NAG	8.81	0.42	35	0.453	0.656	<0.01	0.656	20.5	32.1	32.8	5	1.6	Slight
7/2/2014	86081	A118	HGW SAT	8.43	1.12	93.3	1.17	3.28	0.02	3.26	101.9	60.8	62	-51.4	0.6	Slight
7/2/2014	86082	A118	LGW NAG	8.68	0.13	10.8	0.153	0.014	<0.01	0.014	0.4	17.2	17.5	12.2	40	Slight
7/2/2014	86083	A118	LGW NAG	8.65	0.21	17.5	0.243	0.01	<0.01	0.01	0.3	32.6	33.3	19.5	106.4	Slight
7/2/2014	86084	A118	MGW NAG	8.6	0.06	5	0.119	0.043	<0.01	0.043	1.3	10.8	11	6.5	8.2	None
7/9/2014	86085	A118	LGW NAG	8.52	0.1	8.3	0.13	0.005	<0.01	0.01	0.2	14.5	14.8	14.6	94.4	Slight
7/9/2014	86086	A118	MGW NAG	8.55	0.2	16.7	0.215	0.016	<0.01	0.02	0.5	24.3	24.8	24.3	49.5	Slight
7/9/2014	86087	A118	LGW NAG	8.46	0.18	15	0.211	0.006	<0.01	0.01	0.2	21.1	21.5	21.3	114.7	Slight
7/9/2014	86088	A118	MGW NAG	8.61	0.15	12.5	0.197	0.301	<0.01	0.3	9.4	27.2	27.8	18.3	3	Slight
7/11/2014	86089	A118	LGW NAG	8.83	0.1	8.3	0.132	0.05	<0.01	0.05	1.6	15.2	15.5	13.9	9.9	Slight
7/11/2014	86090	A118	ZGW NAG	8.49	0.14	11.7	0.163	0.008	<0.01	0.01	0.3	17.9	18.3	18	73	Slight
7/11/2014	86091	A118	LGW NAG	8.43	0.22	18.3	0.24	0.007	<0.01	0.01	0.2	24	24.5	24.3	112	Slight
7/15/2014	86092	A118	LGW NAG	8.64	0.28	23.3	0.308	0.015	<0.01	0.02	0.5	28.2	28.8	28.3	61.3	Slight
7/15/2014	86093	A118	MGW NAG	8.57	0.2	16.7	0.221	0.009	<0.01	0.01	0.3	21.3	21.8	21.5	77.3	Slight
7/21/2014	86094	A118	MGW SAT	8.83	0.39	32.5	0.421	0.311	<0.01	0.31	9.7	33.3	34	24.3	3.5	Slight
7/21/2014	86095	A118	MGW NAG	8.79	0.21	17.5	0.226	0.064	<0.01	0.06	2	24	24.5	22.5	12.3	Slight
7/21/2014	86096	A118	ZGW NAG	8.64	0.19	15.8	0.208	0.021	<0.01	0.02	0.7	20.1	20.5	19.8	31.2	Slight
7/30/2014	86097	A118	MGW SAT	7.95	0.78	65	0.816	2.01	<0.01	2.01	62.8	56.8	58	-4.8	0.9	Slight
7/30/2014	86098	A118	LGW NAG	8.87	0.13	10.8	0.17	0.014	0.03	<0.01	<0.3	17.4	17.8	17.8	59.2	Slight
7/30/2014	86099	A118	MGW NAG	8.97	0.63	52.5	0.663	0.461	<0.01	0.46	14.4	56.1	57.3	42.8	4	Slight
7/30/2014	86100	A118	HGW NAG	8.35	0.13	10.8	0.228	0.053	<0.01	0.05	1.7	18.6	19	17.3	11.5	Slight
7/30/2014	87426	A118	LGW NAG	8.61	0.2	16.7	0.221	0.014	<0.01	0.01	0.4	21.6	22	21.6	50.3	Slight
7/30/2014	87427	A118	LGW NAG	8.65	0.26	21.7	0.281	0.047	<0.01	0.05	1.5	24.7	25.3	23.8	17.2	Slight
7/30/2014	87428	A118	MGW NAG	8.76	0.25	20.8	0.256	0.023	<0.01	0.02	0.7	22.1	22.5	21.8	31.3	Slight
8/5/2014	87429	A118	MGW NAG	8.9	0.18	15	0.206	0.028	<0.01	0.028	0.9	21.3	21.8	20.9	24.9	Slight

Appendix B. Summary Area 2 AND Area 118 Pit ABA Analysis Results from SGS for July to December 2014

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	CaCO$_3$ NP	C(T) %	S(T) %	S(SO$_4$) %	S(S^{2-}) %	AP CaCO$_3$kg / tonne	NP H$_2$SO$_4$kg / tonne	NP CaCO$_3$kg / tonne	Net NP	NP:AP Ratio (NP/AP)	Fizz Test
8/5/2014	87430	A118	LGW NAG	8.92	0.15	12.5	0.18	0.013	<0.01	0.013	0.4	17.6	18	17.6	44.3	Slight
8/12/2014	87431	A118	LGW NAG	8.92	0.3	25	0.318	0.025	<0.01	0.025	0.8	28.2	28.8	28	36.8	Slight
8/12/2014	87432	A118	MGW NAG	8.77	0.56	46.7	0.607	0.025	<0.01	0.025	0.8	45.1	46	45.2	58.9	Slight
8/12/2014	87434	A118	HGW NAG	8.93	0.49	40.8	0.542	0.359	<0.01	0.359	11.2	44.3	45.3	34	4	Slight
8/12/2014	87435	A118	HGW SAT	8.8	1	83.3	1.03	0.683	<0.01	0.683	21.3	79.4	81	59.7	3.8	Slight
8/12/2014	87436	A118	LGW NAG	8.81	0.14	11.7	0.178	0.013	<0.01	0.013	0.4	17.9	18.3	17.8	44.9	Slight
8/12/2014	87437	A118	LGW NAG	8.76	0.2	16.7	0.248	0.012	<0.01	0.012	0.4	25.2	25.8	25.4	68.7	Slight
8/15/2014	87438	A118	LGW NAG	9.04	0.13	10.8	0.189	0.02	<0.01	0.02	0.6	19.1	19.5	18.9	31.2	Slight
8/15/2014	87439	A118	MGW SAT	8.83	0.52	43.3	0.574	1.06	<0.01	1.06	33.1	41.9	42.8	9.6	1.3	Slight
8/15/2014	87440	A118	MGW NAG	9.29	0.14	11.7	0.191	0.066	<0.01	0.066	2.1	17.9	18.3	16.2	8.8	Slight
8/19/2014	87441	A118	LGW NAG	8.66	0.15	12.5	0.193	0.012	<0.01	0.01	0.4	19.6	20	19.6	53.3	Slight
8/19/2014	87442	A118	MGW NAG	8.83	0.12	10	0.191	0.02	<0.01	0.02	0.6	15.2	15.5	14.9	24.8	Slight
8/19/2014	87443	A118	LGW NAG	8.47	0.28	23.3	0.335	0.017	<0.01	0.02	0.5	28.7	29.3	28.7	55.1	Slight
8/26/2014	87444	A118	LGW NAG	8.73	0.13	10.8	0.185	0.014	<0.01	0.01	0.4	17.4	17.8	17.3	40.6	Slight
8/26/2014	87445	A118	MGW NAG	8.8	0.47	39.2	0.549	0.067	<0.01	0.07	2.1	49	50	47.9	23.9	Slight
8/26/2014	87446	A118	ZGW NAG	8.63	0.17	14.2	0.209	0.013	<0.01	0.01	0.4	19.4	19.8	19.3	48.6	Slight
8/27/2014	87447	A118	ZGW NAG	8.71	0.16	13.3	0.198	0.02	<0.01	0.02	0.6	18.4	18.8	18.1	30	Slight
8/27/2014	87448	A118	MGW NAG	8.88	0.13	10.8	0.189	0.035	<0.01	0.04	1.1	17.6	18	16.9	16.5	Slight
8/27/2014	87449	A118	MGW NAG	8.95	0.11	9.2	0.138	0.013	<0.01	0.01	0.4	14.5	14.8	14.3	36.3	Slight
8/27/2014	87450	A118	ZGW NAG	8.89	0.1	8.3	0.137	0.012	<0.01	0.01	0.4	13	13.3	12.9	35.3	Slight
8/30/2014	103101	A118	LGW NAG	8.93	0.19	15.8	0.22	0.01	<0.01	0.01	0.3	21.6	22	21.7	70.4	Slight
8/30/2014	103102	A118	ZGW NAG	8.72	0.16	13.3	0.177	0.027	<0.01	0.03	0.8	18.6	19	18.2	22.5	Slight
8/31/2014	103103	A118	MGW NAG	8.89	0.31	25.8	0.333	0.213	<0.01	0.21	6.7	28.4	29	22.3	4.4	Slight
8/31/2014	103104	A118	LGW NAG	8.92	0.28	23.3	0.292	0.088	<0.01	0.09	2.8	30.1	30.8	28	11.2	Slight
8/31/2014	103105	A118	MGW NAG	8.86	0.35	29.2	0.373	0.238	<0.01	0.24	7.4	33.8	34.5	27.1	4.6	Slight
8/31/2014	103106	A118	MGW SAT	8.99	0.38	31.7	0.392	0.324	<0.01	0.32	10.1	31.6	32.3	22.1	3.2	Slight

Appendix B. Summary Area 2 AND Area 118 Pit ABA Analysis Results from SGS for July to December 2014

Sample Date	ABA ID	Sample Source	Waste Type	Paste pH	TIC %	$CaCO_3$ NP	C(T) %	S(T) %	$S(SO_4)$ %	$S(S^{2-})$ %	AP $CaCO_3$kg / tonne	NP H_2SO_4kg / tonne	NP $CaCO_3$kg / tonne	Net NP	NP:AP Ratio (NP/AP)	Fizz Test
9/1/2014	103107	A118	LGW NAG	8.93	0.19	15.8	0.235	0.011	<0.01	0.01	0.3	27.2	27.8	27.4	80.7	Slight
9/1/2014	103108	A118	MGW SAT	8.97	0.4	33.3	0.433	0.394	<0.01	0.39	12.3	29.9	30.5	18.2	2.5	Slight
9/3/2014	103109	A118	LGW NAG	8.91	0.15	12.5	0.179	0.024	<0.01	0.02	0.8	18.4	18.8	18	25	Slight
9/7/2014	103110	A118	MGW SAT	9.27	0.2	16.7	0.231	0.012	<0.01	0.01	0.4	20.6	21	20.6	56	Slight
9/7/2014	103111	A118	MGW SAT	8.98	0.54	45	0.582	0.467	<0.01	0.467	14.6	33.8	34.5	19.9	2.4	Slight
9/7/2014	103112	A118	LGW NAG	9.06	0.23	19.2	0.264	0.012	<0.01	0.012	0.4	23.8	24.3	23.9	64.7	Slight
9/7/2014	103113	A118	ZGW NAG	8.96	0.39	32.5	0.42	0.014	<0.01	0.01	0.4	33.6	34.3	33.8	78.3	Slight
9/15/2014	103114	A118	ZGW NAG	8.97	0.19	15.8	0.232	0.01	<0.01	0.01	0.3	19.6	20	19.7	64	Slight
9/28/2014	103115	A118	LGW NAG	9.43	0.31	25.8	0.408	0.042	<0.01	0.042	1.3	31.6	32.3	30.9	24.6	Slight
10/12/2014	103116	A118	MGW NAG	9.19	0.48	40	0.543	<0.005	<0.01	<0.01	<0.3	45.6	46.5	46.5	155	Slight
12/9/2014	103117	A2P	ZGW NAG	8.52	0.19	15.8	0.222	0.029	<0.01	0.03	0.9	23	23.5	22.6	25.9	Slight
12/21/2014	103118	A2P	LGW NAG	8.4	0.16	13.3	0.2	0.034	<0.01	0.03	1.1	21.8	22.3	21.2	20.9	Slight
12/27/2014	103119	A2P	MGW NAG	8.11	0.22	18.3	0.258	0.108	<0.01	0.11	3.4	25.7	26.3	22.9	7.8	Slight
12/27/2014	103120	A2P	LGW NAG	8.43	0.1	8.3	0.145	0.209	<0.01	0.21	6.5	16.2	16.5	10	2.5	Slight

Appendix C: SGS Raw Lab Results

CLIENT : **Minto Mines**
PROJECT : **Minto Mines**
SGS PROJECT # : **0643**
Test : **BC Research NP and Modified NP Procedures**
Date : **July 30, 2014**

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
86076	14-Jul-14	9.04	0.13	10.8	0.162	<0.005	<0.01	<0.01	<0.3	15.1	18.1	18.5	15.1	61.7	Slight
86077	14-Jul-14	8.77	0.13	10.8	0.141	0.006	<0.01	0.006	0.2	12.8	14.7	15.0	12.6	80.0	Slight
86078	14-Jul-14	8.45	0.18	15.0	0.247	0.127	<0.01	0.127	4.0	20.0	22.1	22.5	16.1	5.7	Slight
86079	14-Jul-14	8.69	0.69	57.5	0.747	0.538	<0.01	0.538	16.8	41.5	56.6	57.8	24.7	3.4	Slight
86080	13-Jul-14	8.81	0.42	35.0	0.453	0.656	<0.01	0.656	20.5	25.5	32.1	32.8	5.0	1.6	Slight
86081	13-Jul-14	8.43	1.12	93.3	1.17	3.28	0.02	3.260	101.9	50.4	60.8	62.0	-51.4	0.6	Slight
86082	14-Jul-14	8.68	0.13	10.8	0.153	0.014	<0.01	0.014	0.4	12.7	17.2	17.5	12.2	40.0	Slight
86083	14-Jul-14	8.65	0.21	17.5	0.243	0.01	<0.01	0.010	0.3	19.8	32.6	33.3	19.5	106.4	Slight
86084	14-Jul-14	8.60	0.06	5.0	0.119	0.043	<0.01	0.043	1.3	7.9	10.8	11.0	6.5	8.2	None
89818	14-Jul-14	9.07	0.27	22.5	0.301	0.016	<0.01	0.016	0.5	20.0	26.5	27.0	19.5	54.0	Slight
89819	14-Jul-14	8.83	0.18	15.0	0.203	0.009	<0.01	0.009	0.3	16.8	20.1	20.5	16.5	72.9	Slight
89820	14-Jul-14	8.64	0.22	18.3	0.255	0.011	<0.01	0.011	0.3	20.1	24.0	24.5	19.8	71.3	Slight
89821	14-Jul-14	8.84	0.11	9.2	0.145	0.01	<0.01	0.010	0.3	13.5	17.4	17.8	13.2	56.8	Slight
89822	14-Jul-14	8.82	0.32	26.7	0.374	0.013	<0.01	0.013	0.4	27.8	35.8	36.5	27.4	89.8	Slight
89823	14-Jul-14	9.32	0.14	11.7	0.182	0.061	<0.01	0.061	1.9	12.2	17.9	18.3	10.3	9.6	Slight
89824	14-Jul-14	9.09	0.09	7.5	0.128	<0.005	<0.01	<0.01	<0.3	10.9	14.5	14.8	10.9	49.2	Slight
89825	14-Jul-14	9.11	0.15	12.5	0.19	0.018	<0.01	0.018	0.6	15.5	19.4	19.8	14.9	35.1	Slight
Duplicates															
86076		8.92	0.13							14.6					Slight
86077					0.144	0.008									
86082							<0.01								
QC															
GTS-2A					1.99	0.342									
PD-1							4.45								
SY-4			0.92												
NBM-1										41.2					Slight
Expected Values			0.95		2.01	0.35	4.27			42.0					Slight
Tolerance +/-			0.06		0.15	0.03	0.3			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT **: Minto Mines**
PROJECT **: Minto Project**
SGS Project # **: 0643**
Test **: Metals by Aqua Regia Digestion with ICP-MS Finish**
Date **: August 12, 2014**

Sample ID	**Ag ppm**	**Al %**	**B ppm**	**Ba ppm**	**Ca %**	**Cr ppm**	**Cu ppm**	**Fe %**	**K %**	**Li ppm**	**Mg %**	**Mn ppm**	**Na %**	**Ni ppm**	**P %**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01	2	0.01	0.5	0.005
86076	0.06	0.82	40	251	0.74	151	48.5	1.95	0.53	5	0.52	484	0.07	7.3	0.069
86077	0.03	0.93	40	272	0.65	128	27.3	2.13	0.59	6	0.56	534	0.06	6.5	0.066
86078	0.16	1.06	50	401	0.91	110	378	3.27	0.72	6	0.53	883	0.04	6.7	0.089
86079	0.64	0.77	40	355	1.41	106	2860	3.02	0.54	3	0.68	522	0.05	5.8	0.082
86080	0.19	1.21	50	571	0.95	92	1740	3.3	1.01	5	0.88	561	0.07	5.3	0.102
86081	0.73	0.85	60	189	1.32	91	4770	6.82	0.57	3	0.96	891	0.05	5.6	0.04
86082	0.11	1	40	298	0.62	120	243	2.36	0.61	6	0.6	587	0.05	5.9	0.069
86083	0.11	0.83	40	304	0.9	131	179	2.5	0.57	5	0.41	614	0.04	7.8	0.07
86084	0.27	0.89	40	351	0.37	133	682	2.52	0.61	5	0.48	614	0.04	8.9	0.071
89818	0.03	0.99	40	477	0.73	114	415	2.5	0.75	5	0.59	564	0.06	6.1	0.075
89819	0.05	0.83	40	316	0.71	140	65.5	2.2	0.54	4	0.45	584	0.05	7	0.065
89820	0.09	0.94	40	254	0.94	134	172	2.23	0.5	6	0.54	607	0.05	6.3	0.073
89821	0.67	1.55	50	673	0.68	111	191	3.41	1.31	8	0.99	806	0.06	7.8	0.118
89822	0.05	1.01	40	473	1.18	127	143	2.42	0.73	5	0.62	679	0.06	6.5	0.076
89823	0.07	1.17	40	564	0.48	118	442	2.51	0.98	5	0.73	437	0.07	6.1	0.068
89824	0.03	0.9	40	496	0.45	139	27.8	2.04	0.72	4	0.51	549	0.06	7.1	0.046
89825	0.19	1.11	50	505	0.66	121	552	2.64	0.9	5	0.65	576	0.06	6	0.074
Duplicates															
86081	0.72	0.85	60	142	1.32	83	4890	6.98	0.58	3	0.98	897	0.05	5.2	0.048
QC															
CH4	2.16	1.89	50	316	0.62	109	2030	5.02	1.52	14	1.29	333	0.07	51.5	0.074
Certified Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18	324	0.06	49.57	0.072
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3	11.5	50.3	12.52	27.4

Sample ID	**S** **%**	**Sr** **ppm**	**Ti** **%**	**V** **ppm**	**Zn** **ppm**	**Zr** **ppm**	**As** **ppm**	**Be** **ppm**	**Bi** **ppm**	**Cd** **ppm**	**Ce** **ppm**	**Co** **ppm**	**Cs** **ppm**	**Ga** **ppm**	**Ge** **ppm**
Method Co	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.5	0.01	1	1	0.5	1	0.1	0.02	0.01	0.05	0.1	0.05	0.1	0.1
86076	<0.01	39.1	0.1	46	51	1.6	<1	0.2	<0.02	0.08	17	5.9	0.33	4.3	<0.1
86077	<0.01	32.3	0.1	51	63	1.3	<1	0.2	<0.02	0.09	21.5	6.8	0.43	5	0.1
86078	0.02	38.5	0.11	80	99	2.4	4	0.4	0.12	0.2	22.5	9.5	0.83	7.1	0.1
86079	0.54	87.4	0.08	84	73	2.8	11	0.3	0.06	0.4	24.2	12.2	0.44	4.2	<0.1
86080	0.61	54.5	0.17	86	80	1.4	2	0.2	<0.02	0.14	8.4	16.5	0.74	6.1	<0.1
86081	3.01	105	0.08	122	113	3.5	8	0.4	0.05	0.45	22.2	44.4	0.61	6.1	0.2
86082	<0.01	39.9	0.09	53	73	1.2	<1	0.2	<0.02	0.1	21.5	7.9	0.44	5.4	0.1
86083	<0.01	38.8	0.08	62	71	1.6	3	0.3	0.02	0.1	21.6	7.4	0.48	4.9	0.1
86084	0.04	28.9	0.1	60	74	2.1	3	0.3	0.17	0.11	20.4	7.9	0.55	4.8	<0.1
89818	0.01	42.2	0.12	58	68	1	3	0.2	<0.02	0.09	29	8.2	0.46	5.2	<0.1
89819	<0.01	42.4	0.08	50	61	1.1	<1	0.2	<0.02	0.05	20.1	6.6	0.43	4.9	<0.1
89820	<0.01	51.2	0.07	52	68	1.2	4	0.3	<0.02	0.08	23.2	7.8	0.42	5.4	0.1
89821	<0.01	30.3	0.2	89	114	1.2	<1	0.2	<0.02	0.05	21.5	10.7	0.6	8.4	0.2
89822	<0.01	49.5	0.12	59	70	1.5	1	0.2	<0.02	0.09	23.5	7.8	0.59	5.3	0.1
89823	0.05	43.1	0.15	64	68	0.9	<1	0.1	<0.02	0.04	53.2	7.9	0.6	6.3	0.1
89824	<0.01	32	0.11	49	51	1	1	0.2	<0.02	0.04	22.9	5.9	0.48	4.4	0.1
89825	0.01	38.7	0.15	63	74	1.2	1	0.2	<0.02	0.06	23.3	7.8	0.57	5.7	0.1
Duplicates															
86081	3.03	105	0.08	122	111	3.4	8	0.4	0.05	0.42	21.5	44.1	0.6	6	0.1
QC															
CH4	0.65	11	0.22	85	214	14.5	8	<0.1	0.58	1.25	29.6	25.1	2.85	9.5	0.3
Certified Va	0.73	9.38	0.21	79.27	189.4	9	8.14	0.11	0.51	1.17	28.18	23.56	2.6	8.72	0.21
Tolerance (	13.4	23.3	23.3	13.2	11.3	17.7	13.1	241.3	19.7	12.1	16.1	11.1	14.8	12.9	127.4

Sample ID	**Hf ppm**	**Hg ppm**	**In ppm**	**La ppm**	**Lu ppm**	**Mo ppm**	**Nb ppm**	**Pb ppm**	**Rb ppm**	**Sb ppm**	**Sc ppm**	**Se ppm**	**Sn ppm**	**Ta ppm**	**Tb ppm**
Method Co	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.01	0.02	0.1	0.01	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05	0.02
86076	0.08	0.02	0.02	8	0.12	7.13	0.42	1.6	21.1	0.06	3.9	<1	0.5	<0.05	0.29
86077	0.07	0.01	0.03	10.1	0.15	6.05	0.35	1.6	24.8	<0.05	4.7	<1	0.6	<0.05	0.31
86078	0.07	0.02	0.07	10.7	0.16	5.34	0.35	3.1	31.9	0.07	6	<1	0.9	<0.05	0.35
86079	0.07	0.02	0.16	11.8	0.15	16.8	0.48	3.5	21.5	<0.05	5.7	2	1.5	<0.05	0.4
86080	<0.05	0.02	0.04	3.5	0.09	10.3	0.42	2.7	39.6	<0.05	3.8	2	1.1	<0.05	0.22
86081	0.09	0.04	0.09	9.8	0.16	28.5	0.36	3.8	25.1	<0.05	6.5	6	1.6	<0.05	0.51
86082	0.05	<0.01	0.03	10.5	0.12	5.87	0.23	1.7	24.4	<0.05	5.7	<1	0.7	<0.05	0.31
86083	0.05	<0.01	0.04	10.2	0.14	6.4	0.25	2.3	24.2	0.12	6.8	<1	0.8	<0.05	0.34
86084	0.06	<0.01	0.05	9.6	0.14	7.15	0.41	2.3	26.3	0.07	7.4	<1	0.8	<0.05	0.36
89818	<0.05	<0.01	0.04	14.1	0.08	5.95	0.51	2.5	29.3	<0.05	7.4	<1	0.8	<0.05	0.27
89819	<0.05	<0.01	0.04	9.3	0.12	6.67	0.34	1.9	22.1	<0.05	6.9	<1	0.8	<0.05	0.33
89820	0.05	<0.01	0.04	10.9	0.14	6.17	0.21	1.9	21	<0.05	5.6	<1	0.7	<0.05	0.38
89821	<0.05	0.02	0.04	10.5	0.11	5.16	0.28	1.3	49.8	<0.05	6.8	<1	0.8	<0.05	0.29
89822	<0.05	0.01	0.04	11.4	0.11	6.43	0.34	2	28.5	<0.05	6	<1	0.9	<0.05	0.29
89823	<0.05	0.03	0.04	27.1	0.06	14.6	0.61	2	38.8	<0.05	6.9	<1	0.7	<0.05	0.26
89824	<0.05	0.01	0.06	10.7	0.11	6.69	0.36	1.2	27.2	<0.05	9.1	<1	0.7	<0.05	0.36
89825	<0.05	0.02	0.05	11.1	0.1	6.75	0.4	2.2	33.9	<0.05	7	<1	0.7	<0.05	0.26
Duplicates															
86081	0.09	0.04	0.09	9.5	0.16	28.8	0.34	3.8	24.6	<0.05	6.5	6	1.6	<0.05	0.5
QC															
CH4	0.38	0.09	0.12	14.7	0.07	3.4	0.22	8.9	63.7	0.4	8.6	2	0.7	<0.05	0.3
Certified Va	0.29	#N/A	0.1	14	#N/A	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3	0.27
Tolerance (	52.8	#N/A	62.1	11.8	#N/A	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7	28.4

Sample ID	**Te ppm**	**Th ppm**	**Tl ppm**	**U ppm**	**W ppm**	**Y ppm**	**Yb ppm**
Method Coc	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.1	0.02	0.05	0.1	0.05	0.1
86076	<0.05	1.5	0.14	0.2	0.5	8.06	0.9
86077	<0.05	1.9	0.17	0.26	0.5	8.91	1
86078	0.09	2.4	0.22	0.23	0.5	11.1	1.1
86079	0.09	4.2	0.17	4.87	0.5	11.6	1
86080	<0.05	0.7	0.43	0.51	0.4	6.59	0.6
86081	0.26	2.1	0.24	1.5	0.2	14.3	1.1
86082	<0.05	2.1	0.15	0.16	<0.1	8.43	0.9
86083	<0.05	2.5	0.16	0.17	0.2	9.77	1
86084	<0.05	2.4	0.18	0.22	0.2	9.83	1
89818	<0.05	5	0.21	0.34	0.4	6.08	0.5
89819	<0.05	2	0.14	0.17	0.3	8.99	0.8
89820	<0.05	2.4	0.13	0.17	<0.1	10.4	1
89821	<0.05	2.2	0.33	0.13	0.6	8.13	0.7
89822	<0.05	3	0.2	0.21	0.4	8.31	0.7
89823	<0.05	8.5	0.3	0.45	1	5.6	0.4
89824	<0.05	3.3	0.19	0.11	0.5	8.56	0.8
89825	<0.05	2.9	0.24	0.14	0.5	6.87	0.7
Duplicates							
86081	0.27	2.2	0.23	1.47	0.3	14	1.1
QC							
CH4	0.51	2.4	0.44	0.33	3	6.08	0.5
Certified Va	0.42	2.2	0.4	0.29	2.15	5.66	#N/A
Tolerance (	39.6	21.2	22.6	52.9	21.6	12.2	#N/A

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS PROJECT # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **July 31, 2014**

Sample ID		**86083**	**NP Contribution**	**89823**	**NP Contribution**
Al	mg/L	65.5		40.2	
Sb	mg/L	< 0.02		< 0.02	
As	mg/L	< 0.01		< 0.01	
Ba	mg/L	0.0695		0.0842	
Be	mg/L	0.0087		0.0054	
Bi	mg/L	0.21		0.24	
B	mg/L	1.57		1.57	
Cd	mg/L	0.006		0.002	
Ca	mg/L	722	18.0	314	7.8
Cr	mg/L	1.70		0.620	
Co	mg/L	0.180		0.066	
Cu	mg/L	6.89		8.34	
Fe	mg/L	87.6		144	
Pb	mg/L	0.025		0.021	
Li	mg/L	< 0.1		< 0.1	
Mg	mg/L	24.1	1.0	37.0	1.5
Mn	mg/L	29.1		7.43	
Mo	mg/L	< 0.01		0.02	
Ni	mg/L	0.362		0.335	
P	mg/L	14.0		0.639	
K	mg/L	60.3	1.5	64.3	1.6
Se	mg/L	0.02		< 0.01	
Si	mg/L	78.5		57.4	
Ag	mg/L	< 0.08		< 0.08	
Na	mg/L	21.5	0.9	24.4	1.1
Sr	mg/L	1.60		1.89	
S	mg/L	991		535	
Tl	mg/L	0.040		0.004	
Sn	mg/L	< 0.02		< 0.02	
Ti	mg/L	0.082		0.010	
U	mg/L	< 0.01		< 0.01	
V	mg/L	0.323		0.161	
Zn	mg/L	0.795		0.524	
Zr	mg/L	0.002		0.004	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv/tonne)			**21.5**		**12.1**

CLIENT : **Minto Mines**
PROJECT : **Minto Mines**
SGS Project # : **0643**
Test : **BC Research NP and Modified NP Procedures**
Date : **August 27, 2014**

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
86085	9-Jul-14	8.52	0.1	8.3	0.13	0.005	<0.01	0.01	0.2	12.8	14.5	14.8	14.6	94.4	Slight
86086	9-Jul-14	8.55	0.2	16.7	0.215	0.016	<0.01	0.02	0.5	20.9	24.3	24.8	24.3	49.5	Slight
86087	9-Jul-14	8.46	0.18	15.0	0.211	0.006	<0.01	0.01	0.2	18.3	21.1	21.5	21.3	114.7	Slight
86088	9-Jul-14	8.61	0.15	12.5	0.197	0.301	<0.01	0.30	9.4	15.4	27.2	27.8	18.3	3.0	Slight
86089	17-Jul-14	8.83	0.1	8.3	0.132	0.05	<0.01	0.05	1.6	12.2	15.2	15.5	13.9	9.9	Slight
86090	17-Jul-14	8.49	0.14	11.7	0.163	0.008	<0.01	0.01	0.3	15.5	17.9	18.3	18.0	73.0	Slight
86091	17-Jul-14	8.43	0.22	18.3	0.24	0.007	<0.01	0.01	0.2	21.0	24.0	24.5	24.3	112.0	Slight
86092	17-Jul-14	8.64	0.28	23.3	0.308	0.015	<0.01	0.02	0.5	24.3	28.2	28.8	28.3	61.3	Slight
86093	17-Jul-14	8.57	0.2	16.7	0.221	0.009	<0.01	0.01	0.3	17.5	21.3	21.8	21.5	77.3	Slight
June Tails Comp.	16-Jul-14	8.46	0.32	26.7	0.33	0.044	<0.01	0.04	1.4	23.3	32.1	32.8	31.4	23.8	Slight
Duplicates															
86085		8.65								12.7					Slight
86092							<0.01								
June Tails Comp.			0.32		0.328	0.044									
QC															
GTS-2A					1.99	0.325									
PD-1							4.25								
SY-4			0.91												
NBM-1										40.2					Slight
Expected Values			0.95		2.01	0.341	4.27			42.0					Slight
Tolerance +/-			0.06		0.15	0.030	0.3			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT **: Minto Mines**
PROJECT **: Minto Project**
SGS Project # **: 0643**
Test **: Metals by Aqua Regia Digestion with ICP-MS Finish**
Date **: August 27, 2014**

Sample ID	**Ag**	**Al**	**B**	**Ba**	**Ca**	**Cr**	**Cu**	**Fe**	**K**	**Li**	**Mg**
	ppm	**%**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**%**	**%**	**ppm**	**%**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01
86085	0.16	1.03	<10	310	0.64	134	62.8	2.33	0.67	6	0.57
86086	0.15	1.41	<10	397	0.95	101	2760	3.09	1.13	8	0.9
86087	0.23	0.98	<10	288	0.87	116	112	2.33	0.63	5	0.54
86088	1.72	1.51	<10	798	0.55	96	>10000	3.32	1.26	7	0.96
86089	0.04	1.23	<10	444	0.62	119	224	2.56	0.92	7	0.72
86090	0.1	1.07	<10	297	0.79	116	69.7	2.44	0.68	6	0.61
86091	0.06	0.85	<10	193	0.99	130	68.5	1.93	0.41	5	0.45
86092	0.06	1.11	<10	371	0.99	110	263	2.42	0.7	6	0.69
86093	0.04	1.05	<10	409	0.77	121	62.9	2.55	0.71	5	0.59
June Tails Comp.	0.46	1.25	<10	222	1.08	100	683	5.38	0.66	8	0.79
Duplicate											
86088	1.67	1.47	<10	794	0.52	100	>10000	3.23	1.22	7	0.93
QC											
CH4	2.05	1.92	<10	303	0.64	111	2000	4.78	1.49	15	1.21
Certified Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3

Sample ID	**Mn**	**Na**	**Ni**	**P**	**S**	**Sr**	**Ti**	**V**	**Zn**	**Zr**	**As**
	ppm	**%**	**ppm**	**%**	**%**	**ppm**	**%**	**ppm**	**ppm**	**ppm**	**ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	2	0.01	0.5	0.005	0.01	0.5	0.01	1	1	0.5	1
86085	575	0.06	7.7	0.064	<0.01	34.3	0.11	55	70	1.3	<1
86086	531	0.05	6.7	0.11	0.02	54.3	0.2	92	66	1.7	3
86087	642	0.05	6.9	0.067	<0.01	48.7	0.1	50	66	1.2	<1
86088	771	0.05	6.7	0.101	0.34	33.6	0.21	91	156	1.7	<1
86089	540	0.07	7.4	0.077	0.07	38.4	0.17	62	70	1.2	<1
86090	628	0.06	6.7	0.07	<0.01	38.1	0.11	55	70	1.3	<1
86091	563	0.05	7	0.055	<0.01	43.7	0.06	41	61	1.1	2
86092	658	0.06	6.5	0.07	0.01	60.9	0.12	56	68	1.2	<1
86093	674	0.05	7.4	0.072	<0.01	45.8	0.11	60	78	1.2	<1
June Tails Comp.	884	0.05	7.6	0.076	0.05	76.7	0.13	80	126	1.5	<1
Duplicate											
86088	753	0.05	7	0.105	0.34	34	0.19	89	157	1.6	<1
QC											
CH4	332	0.06	54.6	0.068	0.79	10.5	0.23	85	208	15.1	11
Certified Values	324	0.06	49.57	0.072	0.73	9.38	0.21	79.27	189.4	9	8.14
Tolerance (%)	11.5	50.3	12.52	27.4	13.4	23.3	23.3	13.2	11.3	17.7	13.1

Sample ID	**Be**	**Bi**	**Cd**	**Ce**	**Co**	**Cs**	**Ga**	**Ge**	**Hf**	**Hg**	**In**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.1	0.02	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01	0.02
86085	0.2	<0.02	0.05	17.6	6	0.34	4.9	<0.1	0.07	<0.01	0.02
86086	0.2	0.11	0.07	29.4	7.2	0.79	7.1	0.1	0.07	<0.01	0.13
86087	0.2	<0.02	0.07	18.5	6.3	0.36	4.5	<0.1	0.06	<0.01	0.03
86088	0.2	0.03	0.11	13.4	9.7	0.7	6.9	<0.1	<0.05	0.01	0.1
86089	0.2	<0.02	0.04	27.3	6.6	0.49	5.7	<0.1	<0.05	<0.01	0.03
86090	0.2	<0.02	0.05	22.3	6.2	0.39	5.1	<0.1	0.06	<0.01	0.03
86091	0.2	<0.02	0.08	19.8	5.3	0.37	4.2	<0.1	<0.05	<0.01	0.02
86092	0.2	<0.02	0.08	23.1	6.6	0.4	5.1	<0.1	<0.05	<0.01	0.03
86093	0.2	<0.02	0.07	24	7	0.43	5.3	<0.1	0.05	<0.01	0.04
June Tails Comp.	0.2	0.18	0.26	14.8	8.1	0.56	9.7	0.1	<0.05	<0.01	0.06
Duplicate											
86088	0.1	0.03	0.09	14	9.3	0.67	6.7	<0.1	<0.05	0.02	0.1
QC											
CH4	0.1	0.78	1.2	27.4	25	2.73	9.6	0.3	0.4	0.06	0.1
Certified Values	0.11	0.51	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A	0.1
Tolerance (%)	241.3	19.7	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A	62.1

Sample ID	La	Lu	Mo	Nb	Pb	Rb	Sb	Sc	Se	Sn	Ta
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.1	0.01	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05
86085	9.4	0.12	5.8	0.24	1.2	27	<0.05	4.3	<1	0.6	<0.05
86086	18.2	0.16	5.36	0.48	2	48.1	<0.05	7.2	<1	1.9	<0.05
86087	10	0.13	5.26	0.23	1.3	25	<0.05	5	<1	0.6	<0.05
86088	7.2	0.08	23.9	0.28	1.9	41.5	<0.05	4.5	2	0.9	<0.05
86089	14.4	0.1	6.23	0.52	1.5	37.2	<0.05	4.8	<1	1	<0.05
86090	12.1	0.13	5.17	0.31	1.5	28.1	<0.05	5.1	<1	0.6	<0.05
86091	10.5	0.14	5.41	0.17	1.7	17.8	<0.05	4.1	<1	0.6	<0.05
86092	12.9	0.1	4.81	0.33	1.8	28.1	<0.05	5.1	<1	0.7	<0.05
86093	13	0.14	5.25	0.18	1.5	28.5	<0.05	6.9	<1	0.7	<0.05
June Tails Comp.	8	0.06	4.89	0.4	2.4	31.1	<0.05	3.8	<1	1	<0.05
Duplicate											
86088	7.6	0.07	22.1	0.27	1.8	39.6	<0.05	4.3	2	0.9	<0.05
QC											
CH4	14.7	0.07	3.07	0.24	8.8	63.9	0.45	8.8	2	0.7	<0.05
Certified Values	14	#N/A	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3
Tolerance (%)	11.8	#N/A	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7

Sample ID	**Tb**	**Te**	**Th**	**Tl**	**U**	**W**	**Y**	**Yb**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.05	0.1	0.02	0.05	0.1	0.05	0.1
86085	0.28	<0.05	1.7	0.17	0.17	0.4	8.02	0.8
86086	0.38	0.05	5.6	0.5	0.19	0.2	10.6	1.1
86087	0.31	<0.05	1.9	0.17	0.18	0.2	8.78	0.9
86088	0.21	0.15	1.1	0.32	0.19	0.4	5.06	0.5
86089	0.3	<0.05	3.3	0.27	0.26	0.3	7.31	0.7
86090	0.3	<0.05	2.4	0.2	0.26	<0.1	8.4	0.9
86091	0.32	<0.05	2.2	0.12	0.22	<0.1	9.42	1
86092	0.29	<0.05	2.9	0.19	0.25	0.2	7.72	0.7
86093	0.39	<0.05	2.5	0.18	0.16	0.2	9.94	1
June Tails Comp.	0.18	0.14	3.6	0.31	0.35	<0.1	4.97	0.4
Duplicate								
86088	0.21	0.13	1.1	0.3	0.18	0.4	5.02	0.5
QC								
CH4	0.31	0.56	2.3	0.48	0.35	2.1	6.2	0.5
Certified Values	0.27	0.42	2.2	0.4	0.29	2.15	5.66	#N/A
Tolerance (%)	28.4	39.6	21.2	22.6	52.9	21.6	12.2	#N/A

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS Project # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **August 27, 2014**

Sample ID		**86085**	**NP Contribution**
Al	mg/L	28.6	
Sb	mg/L	< 0.02	
As	mg/L	0.01	
Ba	mg/L	0.0790	
Be	mg/L	0.0035	
Bi	mg/L	0.12	
B	mg/L	1.07	
Cd	mg/L	0.007	
Ca	mg/L	354	8.8
Cr	mg/L	0.380	
Co	mg/L	0.077	
Cu	mg/L	0.815	
Fe	mg/L	70.6	
Pb	mg/L	0.012	
Li	mg/L	< 0.1	
Mg	mg/L	17.0	0.7
Mn	mg/L	17.6	
Mo	mg/L	< 0.01	
Ni	mg/L	0.316	
P	mg/L	0.050	
K	mg/L	48.8	1.2
Se	mg/L	< 0.01	
Si	mg/L	50.6	
Ag	mg/L	< 0.08	
Na	mg/L	19.7	0.9
Sr	mg/L	1.37	
S	mg/L	454	
Tl	mg/L	0.017	
Sn	mg/L	< 0.02	
Ti	mg/L	0.004	
U	mg/L	< 0.01	
V	mg/L	0.036	
Zn	mg/L	0.290	
Zr	mg/L	0.002	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv./tonne)			**11.6**

CLIENT : **Minto Mines**
PROJECT : **Minto Mines**
SGS PROJECT # : **0643**
Test : **BC Research NP and Modified NP Procedures**
Date : **September 2, 2014**

Sample ID	Sampling Date	Paste pH	TIC %	CaCO3 NP	C(T) %	S(T) %	S(SO4) %	S(S-2) %	AP	NP	NP H2SO4/tonne	NP CaCO3/tonne	Net NP	NP:AP Ratio (NP/AP)	Fizz Test
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
86094	23-Jul-14	8.83	0.39	32.5	0.421	0.311	<0.01	0.31	9.7	23.3	33.3	34.0	24.3	3.5	Slight
86095	23-Jul-14	8.79	0.21	17.5	0.226	0.064	<0.01	0.06	2.0	16.4	24.0	24.5	22.5	12.3	Slight
86096	23-Jul-14	8.64	0.19	15.8	0.208	0.021	<0.01	0.02	0.7	16.7	20.1	20.5	19.8	31.2	Slight
86097	30-Jul-14	7.95	0.78	65.0	0.816	2.01	<0.01	2.01	62.8	43.1	56.8	58.0	-4.8	0.9	Slight
86098	30-Jul-14	8.87	0.13	10.8	0.17	0.014	0.03	<0.01	<0.3	13.9	17.4	17.8	17.8	59.2	Slight
86099	30-Jul-14	8.97	0.63	52.5	0.663	0.461	<0.01	0.46	14.4	35.2	56.1	57.3	42.8	4.0	Slight
86100	30-Jul-14	8.35	0.13	10.8	0.228	0.053	<0.01	0.05	1.7	9.6	18.6	19.0	17.3	11.5	Slight
87426	30-Jul-14	8.61	0.2	16.7	0.221	0.014	<0.01	0.01	0.4	18.9	21.6	22.0	21.6	50.3	Slight
87427	30-Jul-14	8.65	0.26	21.7	0.281	0.047	<0.01	0.05	1.5	20.7	24.7	25.3	23.8	17.2	Slight
87428	30-Jul-14	8.76	0.25	20.8	0.256	0.023	<0.01	0.02	0.7	14.6	22.1	22.5	21.8	31.3	Slight
Duplicates															
86094		8.92			0.421	0.312				22.9					Slight
86097			0.75												
86100							<0.01								
QC															
GTS-2A					1.98	0.344									
PD-1							4.46								
SY-4			0.91												
NBM-1										39.5					Slight
Expected Values			0.95		2.01	0.341	4.27			42.0					Slight
Tolerance +/-			0.06		0.15	0.030	0.3			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS Project # : **0643**
Test : **Metals by Aqua Regia Digestion with ICP-MS Finish**
Date : **September 2, 2014**

Sample ID	**Ag ppm**	**Al %**	**B ppm**	**Ba ppm**	**Ca %**	**Cr ppm**	**Cu ppm**	**Fe %**	**K %**	**Li ppm**	**Mg %**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01
86094	0.52	1.09	30	546	0.83	106	4550	2.72	0.88	4	0.77
86095	0.12	1.13	30	467	0.71	117	956	2.41	0.9	5	0.67
86096	0.03	1.05	30	343	0.84	114	49.7	2.2	0.64	6	0.65
86097	0.2	0.85	20	249	1.52	92	1440	4.08	0.65	4	0.76
86098	0.02	1.28	30	453	0.65	110	54.3	2.54	0.97	6	0.78
86099	0.65	1.51	20	725	1.45	92	>10000	3.46	1.28	6	1.2
86100	1.39	0.76	30	266	0.38	121	6310	2.68	0.5	4	0.39
87426	0.05	0.84	30	263	0.88	130	102	2.09	0.58	4	0.47
87427	0.16	0.9	20	352	0.86	89	1930	2.25	0.66	4	0.6
87428	0.25	0.84	30	320	0.6	115	689	2.1	0.63	4	0.52
Duplicate											
86096	0.02	1.05	30	355	0.84	115	47.9	2.23	0.64	6	0.66
QC											
CH4	1.92	1.88	30	294	0.59	101	2010	4.6	1.44	13	1.19
Certified Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3

CLIENT : Minto Mines
PROJECT : Minto Project
SGS Project # : 0643
Test : Metals by Aqua Regia Digestion with ICP-MS Finish
Date : September 2, 2014

Sample ID	**Mn ppm**	**Na %**	**Ni ppm**	**P %**	**S %**	**Sr ppm**	**Ti %**	**V ppm**	**Zn ppm**	**Zr ppm**	**As ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	2	0.01	0.5	0.005	0.01	0.5	0.01	1	1	0.5	1
86094	470	0.05	7.1	0.083	0.33	56.3	0.14	72	69	1.5	1
86095	610	0.05	7.3	0.078	0.05	38.7	0.14	60	69	1.1	2
86096	648	0.05	6.9	0.071	<0.01	63.2	0.09	46	63	1.3	<1
86097	663	0.04	8	0.054	2.04	65.2	0.1	69	72	1.9	6
86098	608	0.06	7.1	0.072	<0.01	36.3	0.16	59	78	1.1	<1
86099	718	0.05	6.4	0.104	0.5	52.5	0.21	94	87	1.7	<1
86100	540	0.04	9.1	0.058	0.04	35.2	0.08	53	73	2	5
87426	605	0.04	7.6	0.061	<0.01	35.7	0.09	44	64	1.2	1
87427	639	0.04	5.7	0.073	0.05	45.6	0.09	51	82	1.2	<1
87428	539	0.05	6.8	0.06	0.02	37	0.09	47	69	1.2	<1
Duplicate											
86096	653	0.05	7	0.071	0.02	62.3	0.09	48	64	1.3	<1
QC											
CH4	323	0.05	49.2	0.065	0.65	9	0.19	77	200	10.3	7
Certified Values	324	0.06	49.57	0.072	0.73	9.38	0.21	79.27	189.4	9	8.14
Tolerance (%)	11.5	50.3	12.52	27.4	13.4	23.3	23.3	13.2	11.3	17.7	13.1

CLIENT : Minto Mines
PROJECT : Minto Project
SGS Project # : 0643
Test : Metals by Aqua Regia Digestion with ICP-MS Finish
Date : September 2, 2014

Sample ID	**Be ppm**	**Bi ppm**	**Cd ppm**	**Ce ppm**	**Co ppm**	**Cs ppm**	**Ga ppm**	**Ge ppm**	**Hf ppm**	**Hg ppm**	**In ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.1	0.02	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01	0.02
86094	0.2	0.04	0.13	12.6	8.3	0.5	4.9	<0.1	<0.05	<0.01	0.08
86095	0.2	<0.02	0.14	22.8	7	0.67	5.3	<0.1	<0.05	<0.01	0.03
86096	0.3	<0.02	0.07	18.6	6.2	0.37	4.9	<0.1	<0.05	<0.01	<0.02
86097	0.2	0.03	0.32	8.88	28.7	0.47	4	<0.1	<0.05	<0.01	0.04
86098	0.2	<0.02	0.05	13.9	6.8	0.55	5.9	<0.1	<0.05	<0.01	0.02
86099	0.3	0.06	0.14	9.8	9.5	0.67	7	<0.1	<0.05	<0.01	0.17
86100	0.3	0.63	0.2	14.7	6.2	0.41	3.7	<0.1	<0.05	0.01	0.12
87426	0.3	<0.02	0.12	20.4	5.4	0.45	4.1	<0.1	<0.05	<0.01	0.03
87427	0.2	<0.02	0.07	21.8	6.4	0.33	4.4	<0.1	<0.05	<0.01	0.04
87428	0.2	<0.02	0.1	20	6.1	0.33	4	<0.1	<0.05	<0.01	0.04
Duplicate											
86096	0.3	<0.02	0.07	18.9	6.3	0.36	4.9	<0.1	<0.05	<0.01	<0.02
QC											
CH4	0.1	0.54	1.08	29.2	21	2.62	9	0.2	0.21	<0.01	0.1
Certified Values	0.11	0.51	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A	0.1
Tolerance (%)	241.3	19.7	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A	62.1

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS Project # : **0643**
Test : **Metals by Aqua Regia Digestion with ICP-MS Finish**
Date : **September 2, 2014**

Sample ID	**La**	**Lu**	**Mo**	**Nb**	**Pb**	**Rb**	**Sb**	**Sc**	**Se**	**Sn**	**Ta**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.1	0.01	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05
86094	6.6	0.08	19.5	0.86	3.4	36.2	<0.05	5.1	1	1.2	<0.05
86095	12.2	0.08	7.01	0.58	4.3	39.3	0.06	4.9	<1	0.9	<0.05
86096	9.3	0.15	4.85	0.31	4.2	25.9	<0.05	3.7	<1	0.6	<0.05
86097	4.5	0.11	37.6	0.58	4.4	28.7	<0.05	3.7	2	0.6	<0.05
86098	7.5	0.09	4.85	0.36	2.4	41.3	<0.05	3.9	<1	0.6	<0.05
86099	5.2	0.13	32.1	0.53	3.7	51.6	<0.05	5.3	3	1.2	<0.05
86100	8	0.1	5.43	0.77	3.5	23	0.1	4.4	2	0.9	<0.05
87426	10.7	0.14	5.61	0.31	3.7	28	<0.05	4	<1	0.6	<0.05
87427	12.1	0.12	6.67	0.32	2.1	27.8	<0.05	4.8	<1	0.5	<0.05
87428	11	0.1	6.37	0.34	2.3	26.9	<0.05	5.2	<1	0.6	<0.05
Duplicate											
86096	9.2	0.15	4.77	0.3	4.3	25.9	<0.05	3.6	<1	0.5	<0.05
QC											
CH4	15.6	0.06	3	0.31	8.6	66.7	0.37	7.7	2	0.7	<0.05
Certified Values	14	#N/A	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3
Tolerance (%)	11.8	#N/A	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS Project # : **0643**
Test : **Metals by Aqua Regia Digestion with ICP-MS Finish**
Date : **September 2, 2014**

Sample ID	**Tb ppm**	**Te ppm**	**Th ppm**	**Tl ppm**	**U ppm**	**W ppm**	**Y ppm**	**Yb ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.05	0.1	0.02	0.05	0.1	0.05	0.1
86094	0.25	<0.05	0.9	0.24	1.74	0.4	6.8	0.5
86095	0.26	<0.05	2.4	0.26	0.38	0.3	6.63	0.5
86096	0.4	<0.05	1.8	0.16	0.19	0.2	11.3	1
86097	0.27	<0.05	0.6	1.03	0.95	0.3	9.16	0.7
86098	0.19	<0.05	1.2	0.26	0.19	0.5	5.76	0.5
86099	0.35	0.09	0.5	0.37	0.77	0.2	10.6	0.8
86100	0.23	0.22	1.9	0.16	0.38	0.1	6.89	0.6
87426	0.32	<0.05	1.9	0.19	0.22	0.1	9.53	0.9
87427	0.29	<0.05	2.2	0.17	0.17	0.2	8.32	0.7
87428	0.26	<0.05	1.8	0.16	0.13	0.3	7.16	0.6
Duplicate								
86096	0.41	<0.05	1.8	0.16	0.18	0.2	11.2	1
QC								
CH4	0.28	0.4	2.1	0.42	0.28	2.3	5.4	0.4
Certified Values	0.27	0.42	2.2	0.4	0.29	2.15	5.66	#N/A
Tolerance (%)	28.4	39.6	21.2	22.6	52.9	21.6	12.2	#N/A

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS PROJECT # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **September 2, 2014**

Sample ID		**87426**	**NP Contribution**
Al	mg/L	28.5	
Sb	mg/L	< 0.02	
As	mg/L	0.01	
Ba	mg/L	0.0686	
Be	mg/L	0.0043	
Bi	mg/L	0.12	
B	mg/L	1.36	
Cd	mg/L	0.013	
Ca	mg/L	557	13.9
Cr	mg/L	0.650	
Co	mg/L	0.082	
Cu	mg/L	1.90	
Fe	mg/L	67.9	
Pb	mg/L	0.025	
Li	mg/L	< 0.1	
Mg	mg/L	16.5	0.7
Mn	mg/L	21.8	
Mo	mg/L	< 0.01	
Ni	mg/L	0.294	
P	mg/L	0.096	
K	mg/L	56.7	1.5
Se	mg/L	0.02	
Si	mg/L	49.2	
Ag	mg/L	< 0.08	
Na	mg/L	18.4	0.8
Sr	mg/L	1.82	
S	mg/L	628	
Tl	mg/L	0.032	
Sn	mg/L	< 0.02	
Ti	mg/L	0.013	
U	mg/L	< 0.1	
V	mg/L	0.039	
Zn	mg/L	0.567	
Zr	mg/L	0.003	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv./tonne)			**16.8**

CLIENT : **Minto Mines**
PROJECT : **Minto Mines**
SGS PROJECT # : **0643**
Test : **BC Research NP and Modified NP Procedures**
Date : **October 13, 2014**

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
87429	5-Aug-14	8.90	0.18	15.0	0.206	0.028	<0.01	0.028	0.9	17.2	21.3	21.8	20.9	24.9	Slight
87430	5-Aug-14	8.92	0.15	12.5	0.18	0.013	<0.01	0.013	0.4	17.6	17.6	18.0	17.6	44.3	Slight
87431	12-Aug-14	8.92	0.3	25.0	0.318	0.025	<0.01	0.025	0.8	20.0	28.2	28.8	28.0	36.8	Slight
87432	12-Aug-14	8.77	0.56	46.7	0.607	0.025	<0.01	0.025	0.8	34.8	45.1	46.0	45.2	58.9	Slight
87434	12-Aug-14	8.93	0.49	40.8	0.542	0.359	<0.01	0.359	11.2	33.9	44.3	45.3	34.0	4.0	Slight
87435	15-Aug-14	8.80	1	83.3	1.03	0.683	<0.01	0.683	21.3	56.8	79.4	81.0	59.7	3.8	Slight
87436	13-Aug-14	8.81	0.14	11.7	0.178	0.013	<0.01	0.013	0.4	15.8	17.9	18.3	17.8	44.9	Slight
87437	13-Aug-14	8.76	0.2	16.7	0.248	0.012	<0.01	0.012	0.4	18.7	25.2	25.8	25.4	68.7	Slight
87438	15-Aug-14	9.04	0.13	10.8	0.189	0.02	<0.01	0.020	0.6	15.6	19.1	19.5	18.9	31.2	Slight
87439	15-Aug-14	8.83	0.52	43.3	0.574	1.06	<0.01	1.060	33.1	31.4	41.9	42.8	9.6	1.3	Slight
87440	15-Aug-14	9.29	0.14	11.7	0.191	0.066	<0.01	0.066	2.1	15.8	17.9	18.3	16.2	8.8	Slight
July Tails Comp.	July 2014	8.57	0.33	27.5	0.332	0.054	<0.01	0.054	1.7	24.0	31.6	32.3	30.6	19.1	Slight
Duplicates															
87429		8.88								17.0					Slight
87436			0.13												
87438					0.186	0.023	<0.01								
QC															
GTS-2A					1.95	0.339									
PD-1							4.2								
SY-4			0.92												
NBM-1										39.8					Slight
Expected Values			0.95		2.01	0.341	4.27			42.0					Slight
Tolerance +/-			0.06		0.15	0.030	0.3			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT **: Minto Mines**
PROJECT **: Minto Project**
SGS Project # **: 0643**
Test **: Metals by Aqua Regia Digestion with ICP-MS Finish**
Date **: October 13, 2014**

Sample ID	**Ag ppm**	**Al %**	**B ppm**	**Ba ppm**	**Ca %**	**Cr ppm**	**Cu ppm**	**Fe %**	**K %**	**Li ppm**	**Mg %**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01
87429	0.22	0.95	30	326	0.74	146	2640	2.3	0.7	5	0.56
87430	0.2	0.92	30	275	0.78	132	266	2.14	0.57	5	0.56
87431	0.08	0.85	30	320	0.88	119	248	2.12	0.55	4	0.55
87432	0.1	0.87	30	273	1.37	108	771	2.44	0.51	4	0.63
87434	0.34	1	30	416	1.14	116	3540	2.62	0.77	4	0.79
87435	0.43	0.87	30	522	1.66	84	4260	3.39	0.62	4	0.91
87436	0.28	1.03	20	321	0.75	116	186	2.29	0.66	6	0.63
87437	0.19	1.08	30	336	0.96	104	57.7	2.4	0.67	5	0.64
87438	0.06	1.12	30	392	0.74	109	159	2.5	0.75	6	0.69
87439	0.57	1.08	30	515	0.99	96	3180	3.44	0.86	5	0.85
87440	0.19	1.33	30	604	0.66	114	2050	2.79	1.1	5	0.8
July Tails Comp.	0.46	1.15	30	240	1.01	96	811	4.96	0.61	6	0.74
Duplicate											
87436	0.37	1.04	30	317	0.76	112	184	2.29	0.67	6	0.64
QC											
CH4	2.06	1.86	30	301	0.61	103	2060	4.75	1.41	13	1.2
Certified Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3

Sample ID	**Mn** **ppm**	**Na** **%**	**Ni** **ppm**	**P** **%**	**S** **%**	**Sr** **ppm**	**Ti** **%**	**V** **ppm**	**Zn** **ppm**	**Zr** **ppm**	**As** **ppm**	**Be** **ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	2	0.01	0.5	0.005	0.01	0.5	0.01	1	1	0.5	1	0.1
87429	531	0.04	8	0.068	0.02	40.2	0.12	64	64	1.6	3	0.3
87430	576	0.05	7.8	0.074	<0.01	42	0.1	49	69	1.4	<1	0.2
87431	616	0.05	6.8	0.067	0.02	50.1	0.09	46	60	1.3	<1	0.2
87432	862	0.04	6.3	0.079	0.02	80.6	0.07	50	70	1.4	<1	0.3
87434	513	0.05	7.1	0.074	0.35	70.3	0.13	76	63	2	6	0.2
87435	833	0.04	5.8	0.094	0.68	83.4	0.11	89	87	2.8	6	0.2
87436	598	0.05	7	0.074	<0.01	35	0.12	53	75	1.4	<1	0.2
87437	629	0.05	6.7	0.093	<0.01	45.4	0.11	54	82	1.4	<1	0.2
87438	606	0.06	6.9	0.079	0.01	34.1	0.13	56	75	1.5	<1	0.2
87439	591	0.05	6.9	0.083	1.01	49.6	0.15	78	87	2	3	0.2
87440	568	0.06	7.2	0.097	0.05	36.3	0.2	75	78	1.2	<1	0.1
July Tails Comp.	782	0.05	7	0.07	0.05	61	0.12	71	117	1.6	<1	0.2
Duplicate												
87436	602	0.06	7	0.076	<0.01	35.3	0.12	52	78	1.4	<1	0.2
QC												
CH4	327	0.06	49.7	0.067	0.68	9.2	0.22	79	200	12.3	7	<0.1
Certified Values	324	0.06	49.57	0.072	0.73	9.38	0.21	79.27	189.4	9	8.14	0.11
Tolerance (%)	11.5	50.3	12.52	27.4	13.4	23.3	23.3	13.2	11.3	17.7	13.1	241.3

Sample ID	**Bi ppm**	**Cd ppm**	**Ce ppm**	**Co ppm**	**Cs ppm**	**Ga ppm**	**Ge ppm**	**Hf ppm**	**Hg ppm**	**In ppm**	**La ppm**	**Lu ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01	0.02	0.1	0.01
87429	0.07	0.08	20.3	6.3	0.5	5.1	<0.1	0.07	<0.01	0.09	11.3	0.12
87430	<0.02	0.05	19.7	6.3	0.36	4.8	<0.1	0.08	<0.01	0.03	10.8	0.13
87431	0.04	0.07	18.1	6.3	0.44	4.4	<0.1	0.07	<0.01	0.04	9.1	0.15
87432	<0.02	0.13	21.1	8.9	0.51	4.7	<0.1	0.08	<0.01	0.03	9.6	0.22
87434	0.04	0.18	15.4	9.2	0.48	5	<0.1	0.06	<0.01	0.11	7.8	0.12
87435	0.06	0.36	16.6	14	0.48	4.7	<0.1	0.08	0.02	0.11	8.6	0.12
87436	0.03	0.05	18.5	6.7	0.38	5.3	<0.1	0.08	<0.01	0.03	9.9	0.12
87437	<0.02	0.06	22	6.9	0.4	5.4	<0.1	0.08	<0.01	0.03	11.7	0.15
87438	0.03	0.05	23	7.2	0.43	5.7	<0.1	0.08	<0.01	0.03	12.5	0.13
87439	0.09	0.37	13.6	14.5	0.58	5.7	<0.1	0.06	<0.01	0.09	6.9	0.08
87440	0.04	0.03	17.5	7.7	0.64	6.4	<0.1	<0.05	<0.01	0.04	8.9	0.08
July Tails Comp.	0.18	0.3	16.3	8.1	0.53	9.2	<0.1	<0.05	<0.01	0.06	8.7	0.07
Duplicate												
87436	0.02	0.05	18.9	6.7	0.38	5.5	<0.1	0.07	<0.01	0.03	10.2	0.12
QC												
CH4	0.49	1.11	28.9	23.4	2.79	9.7	0.3	0.33	<0.01	0.11	15.5	0.07
Certified Values	0.51	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A	0.1	14	#N/A
Tolerance (%)	19.7	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A	62.1	11.8	#N/A

Sample ID	**Mo ppm**	**Nb ppm**	**Pb ppm**	**Rb ppm**	**Sb ppm**	**Sc ppm**	**Se ppm**	**Sn ppm**	**Ta ppm**	**Tb ppm**	**Te ppm**	**Th ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05	0.02	0.05	0.1
87429	7.66	0.49	2	34.8	0.06	5.7	<1	1.7	<0.05	0.3	0.06	2.7
87430	6.34	0.41	1.5	26.1	<0.05	4.4	<1	1.1	<0.05	0.32	<0.05	2.1
87431	5.39	0.4	1.9	25.8	<0.05	6.3	<1	1.2	<0.05	0.39	<0.05	2
87432	5.01	0.27	1.9	22.3	<0.05	5.8	<1	1.1	<0.05	0.5	<0.05	1.7
87434	33.9	0.52	2.7	34.9	<0.05	6.4	2	1.9	<0.05	0.37	<0.05	2.3
87435	35.2	0.5	5.5	28.7	0.06	5.6	2	1.5	<0.05	0.36	0.09	1.2
87436	5.45	0.37	1.5	30	<0.05	4.5	<1	1	<0.05	0.3	<0.05	1.9
87437	4.87	0.35	1.5	30.1	<0.05	4.9	<1	1.2	<0.05	0.39	<0.05	2.1
87438	5.11	0.55	2.9	32.7	<0.05	5.2	<1	1.2	<0.05	0.33	<0.05	2.6
87439	16.5	0.66	3.2	39.8	<0.05	4.9	2	1.5	<0.05	0.25	0.11	1.8
87440	5.42	0.56	1.9	47.2	<0.05	4.9	<1	1.4	<0.05	0.27	0.08	1.8
July Tails Comp.	5.15	0.55	2.5	31.2	<0.05	3.9	<1	1.5	<0.05	0.2	0.15	3.8
Duplicate												
87436	5.17	0.38	1.5	30.2	<0.05	4.6	<1	1.1	<0.05	0.3	<0.05	1.9
QC												
CH4	2.55	0.31	8.9	71.6	0.57	8.1	2	1.1	<0.05	0.31	0.42	2.3
Certified Values	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3	0.27	0.42	2.2
Tolerance (%)	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7	28.4	39.6	21.2

Sample ID	**Tl ppm**	**U ppm**	**W ppm**	**Y ppm**	**Yb ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.05	0.1	0.05	0.1
87429	0.24	0.16	0.3	8.34	0.8
87430	0.16	0.18	0.3	9.24	0.9
87431	0.16	0.21	0.1	11	1
87432	0.13	0.29	0.2	14.5	1.5
87434	0.24	1.03	0.4	9.89	0.8
87435	0.2	2.3	0.3	10.3	0.8
87436	0.19	0.2	0.5	8.66	0.8
87437	0.18	0.22	0.4	11.1	1
87438	0.2	0.21	0.7	9.1	0.8
87439	0.31	1.77	0.7	7.06	0.5
87440	0.32	0.18	0.6	6.68	0.5
July Tails Comp.	0.27	0.4	<0.1	5.43	0.4
Duplicate					
87436	0.18	0.2	0.5	8.56	0.8
QC					
CH4	0.43	0.31	2.6	6.04	0.4
Certified Values	0.4	0.29	2.15	5.66	#N/A
Tolerance (%)	22.6	52.9	21.6	12.2	#N/A

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS PROJECT # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **October 13, 2014**

Sample ID		**87431**	**NP Contribution**	**87439**	**NP Contribution**
Al	mg/L	38.8		49.2	
Sb	mg/L	< 0.02		< 0.02	
As	mg/L	0.01		0.01	
Ba	mg/L	0.0780		0.0562	
Be	mg/L	0.0093		0.0081	
Bi	mg/L	0.46		0.85	
B	mg/L	1.69		1.23	
Cd	mg/L	0.006		0.025	
Ca	mg/L	610	15.2	722	18.0
Cr	mg/L	0.794		0.674	
Co	mg/L	0.126		0.139	
Cu	mg/L	3.77		32.1	
Fe	mg/L	287		506	
Pb	mg/L	0.051		0.046	
Li	mg/L	< 0.1		< 0.1	
Mg	mg/L	81.8	3.4	193	7.9
Mn	mg/L	26.8		19.4	
Mo	mg/L	< 0.01		< 0.01	
Ni	mg/L	0.322		0.237	
P	mg/L	0.158		0.602	
K	mg/L	47.5	1.2	58.0	1.5
Se	mg/L	< 0.01		< 0.01	
Si	mg/L	60.6		56.6	
Ag	mg/L	< 0.08		< 0.08	
Na	mg/L	19.6	0.9	22.4	1.0
Sr	mg/L	2.93		2.37	
S	mg/L	944		1369	
Tl	mg/L	0.032		0.019	
Sn	mg/L	< 0.02		< 0.02	
Ti	mg/L	0.016		0.025	
U	mg/L	< 0.2		< 0.2	
V	mg/L	0.201		1.16	
Zn	mg/L	1.20		1.83	
Zr	mg/L	0.015		0.020	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv/tonne)			**20.7**		**28.4**

CLIENT : Minto Mines
PROJECT : Minto Mines
SGS PROJECT # : 0643
Test : BC Research NP and Modified NP Procedures
Date : November 3, 2014

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
87441	20-Aug-14	8.66	0.15	12.5	0.193	0.012	<0.01	0.01	0.4	17.5	19.6	20.0	19.6	53.3	Slight
87442	20-Aug-14	8.83	0.12	10.0	0.191	0.02	<0.01	0.02	0.6	15.2	15.2	15.5	14.9	24.8	Slight
87443	20-Aug-14	8.47	0.28	23.3	0.335	0.017	<0.01	0.02	0.5	27.9	28.7	29.3	28.7	55.1	Slight
87444	27-Aug-14	8.73	0.13	10.8	0.185	0.014	<0.01	0.01	0.4	14.9	17.4	17.8	17.3	40.6	Slight
87445	27-Aug-14	8.80	0.47	39.2	0.549	0.067	<0.01	0.07	2.1	39.7	49.0	50.0	47.9	23.9	Slight
87446	27-Aug-14	8.63	0.17	14.2	0.209	0.013	<0.01	0.01	0.4	18.0	19.4	19.8	19.3	48.6	Slight
87447	27-Aug-14	8.71	0.16	13.3	0.198	0.02	<0.01	0.02	0.6	17.1	18.4	18.8	18.1	30.0	Slight
87448	27-Aug-14	8.88	0.13	10.8	0.189	0.035	<0.01	0.04	1.1	14.1	17.6	18.0	16.9	16.5	Slight
87449	27-Aug-14	8.95	0.11	9.2	0.138	0.013	<0.01	0.01	0.4	11.6	14.5	14.8	14.3	36.3	Slight
87450	27-Aug-14	8.89	0.1	8.3	0.137	0.012	<0.01	0.01	0.4	12.7	13.0	13.3	12.9	35.3	Slight
Duplicates															
87441		8.72								17.0					Slight
87443			0.29												
87445					0.551	0.064	<0.01								
QC															
GTS-2A					2.01	0.343									
RTS-3A							0.94								
SY-4			0.92												
NBM-1										39.4					Slight
Expected Values			0.95		2.01	0.341	0.98			42.0					Slight
Tolerance +/-			0.06		0.15	0.030	0.10			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT **: Minto Mines**
PROJECT **: Minto Project**
SGS Project # **: 0643**
Test **: Metals by Aqua Regia Digestion with ICP-MS Finish**
Date **: November 3, 2014**

Sample ID	**Ag ppm**	**Al %**	**B ppm**	**Ba ppm**	**Ca %**	**Cr ppm**	**Cu ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5
87441	0.1	1	<10	276	0.76	129	37.6
87442	0.24	1.15	<10	323	0.65	112	904
87443	0.12	1.1	<10	336	1.24	95	95.2
87444	0.03	0.94	<10	309	0.67	98	42.2
87445	0.34	1.09	<10	401	1.42	98	2480
87446	0.09	0.99	<10	311	0.78	106	47.6
87447	0.9	1.06	10	345	0.78	126	214
87448	0.38	1.11	<10	337	0.55	122	2050
87449	0.12	1.12	<10	341	0.53	127	786
87450	0.06	0.97	<10	281	0.57	125	33.1
Duplicate							
87441	0.09	1.01	<10	280	0.77	128	40.1
QC							
OREAS 901	0.27	0.97	<10	80	0.08	22	1480
Expected Values	0.276	0.992	#N/A	86	0.091	23.0	1440
Tolerance (%)	19.06	12.52	#N/A	24.53	37.47	20.87	10.09

Sample ID	**Fe** **%**	**K** **%**	**Li** **ppm**	**Mg** **%**	**Mn** **ppm**	**Na** **%**	**Ni** **ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	1	0.01	2	0.01	0.5
87441	2.32	0.69	4	0.54	624	0.05	7.4
87442	2.52	0.8	5	0.67	651	0.06	7.3
87443	2.89	0.73	5	0.61	801	0.04	6.7
87444	2.14	0.63	5	0.57	570	0.05	6
87445	2.76	0.84	5	0.79	771	0.04	6.2
87446	2.36	0.67	5	0.54	614	0.04	6
87447	2.33	0.69	5	0.61	634	0.06	6.9
87448	2.62	0.86	5	0.63	588	0.05	7.2
87449	2.58	0.82	5	0.63	740	0.05	7.7
87450	2.1	0.65	5	0.56	578	0.06	7.5
Duplicate							
87441	2.37	0.7	5	0.56	641	0.05	7.4
QC							
OREAS 901	3.72	0.52	3	0.13	296	0.02	34
Expected Values	3.70	0.512	3.1	0.124	300	0.01	34.7
Tolerance (%)	10.68	14.88	98.65	30.16	11.67	#N/A	13.60

Sample ID	**P %**	**S %**	**Sr ppm**	**Ti %**	**V ppm**	**Zn ppm**	**Zr ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.005	0.01	0.5	0.01	1	1	0.5
87441	0.079	<0.01	50.5	0.11	53	80	1.4
87442	0.079	0.01	35.8	0.14	58	75	1.4
87443	0.099	<0.01	75.2	0.12	62	97	1.9
87444	0.07	<0.01	35	0.11	49	75	1.4
87445	0.107	0.07	65.2	0.15	72	84	2
87446	0.068	<0.01	44.5	0.11	52	74	1.4
87447	0.068	0.01	38.5	0.12	55	80	1.4
87448	0.071	0.04	39.7	0.15	68	82	1.4
87449	0.067	<0.01	32.1	0.14	61	96	1.6
87450	0.07	<0.01	32.1	0.11	48	81	1.2
Duplicate							
87441	0.077	<0.01	51	0.11	53	78	1.5
QC							
OREAS 901	0.059	0.04	20.5	<0.01	21	19	31.6
Expected Values	0.059	0.033	21.0	0.01	21	20.2	28.1
Tolerance (%)	31.19	85.76	15.95	#N/A	#N/A	22.38	13.96

Sample ID	**As ppm**	**Be ppm**	**Bi ppm**	**Cd ppm**	**Ce ppm**	**Co ppm**	**Cs ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	1	0.1	0.02	0.01	0.05	0.1	0.05
87441	<1	0.2	0.04	0.04	20.7	6.4	0.41
87442	<1	0.2	0.05	0.06	21.8	6.8	0.48
87443	<1	0.3	0.02	0.06	24	7.5	0.49
87444	<1	0.2	<0.02	0.04	17.9	5.7	0.38
87445	<1	0.2	0.25	0.1	33.4	6.9	0.58
87446	<1	0.2	<0.02	0.06	22.7	6.5	0.41
87447	<1	0.2	<0.02	0.06	22.7	6.3	0.45
87448	<1	0.2	0.05	0.07	25	6.8	0.46
87449	<1	0.2	0.02	0.11	20.5	7.4	0.46
87450	<1	0.2	<0.02	0.05	19.8	5.6	0.35
Duplicate							
87441	<1	0.3	0.04	0.04	22	6.7	0.43
QC							
OREAS 901	63	3.8	4.43	0.04	74.5	62.9	0.86
Expected Values	66	4.49	4.35	0.05	78	73	0.97
Tolerance (%)	13.79	15.57	11.15	#N/A	10.16	10.34	22.89

Sample ID	**Ga ppm**	**Ge ppm**	**Hf ppm**	**Hg ppm**	**In ppm**	**La ppm**	**Lu ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.1	0.1	0.05	0.01	0.02	0.1	0.01
87441	5.4	0.1	0.07	<0.01	0.03	10.5	0.17
87442	5.6	0.1	0.06	<0.01	0.04	11.8	0.12
87443	5.5	0.1	0.1	<0.01	0.04	11.8	0.22
87444	4.6	<0.1	0.07	<0.01	0.03	9.6	0.11
87445	5.6	0.1	0.06	<0.01	0.04	18.4	0.16
87446	5	<0.1	0.07	<0.01	0.04	11.7	0.14
87447	5.2	0.1	0.06	<0.01	0.03	12.3	0.12
87448	5.6	0.1	<0.05	<0.01	0.08	13.9	0.11
87449	5.8	0.1	0.06	<0.01	0.03	10.8	0.12
87450	4.8	0.1	0.05	<0.01	0.03	10.5	0.11
Duplicate							
87441	5.2	<0.1	0.08	<0.01	0.03	11.4	0.17
QC							
OREAS 901	2.8	0.1	0.83	0.02	0.22	36.2	0.24
Expected Values	3.15	0.11	0.8	0.02	0.21	38.1	0.22
Tolerance (%)	17.94	237.27	#N/A	#N/A	33.81	10.66	21.36

Sample ID	**Mo ppm**	**Nb ppm**	**Pb ppm**	**Rb ppm**	**Sb ppm**	**Sc ppm**	**Se ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.05	0.2	0.2	0.05	0.1	1
87441	5.72	0.3	1.3	35.1	<0.05	5.5	<1
87442	6.04	0.37	1.8	38	<0.05	4.6	<1
87443	4.28	0.23	1.5	33.6	<0.05	6.4	<1
87444	4.28	0.41	1.6	28.7	<0.05	4.4	<1
87445	4.92	0.42	2.5	38.2	<0.05	6.5	1
87446	4.64	0.27	1.3	31.8	<0.05	5.6	<1
87447	5.87	0.39	2	30.2	<0.05	4.5	<1
87448	8.13	0.46	1.8	42.7	<0.05	5.3	<1
87449	6.25	0.37	1.4	42	<0.05	3.7	<1
87450	6.16	0.34	1.3	29.7	<0.05	4.2	<1
Duplicate							
87441	5.53	0.3	1.3	34.7	<0.05	5.6	<1
QC							
OREAS 901	2.92	0.08	14.1	24	1.24	5.1	3
Expected Values	3.23	0.1	14.6	23.9	1.47	5.55	2.68
Tolerance (%)	13.87	#N/A	13.42	12.09	18.50	14.50	103.28

Sample ID	**Sn ppm**	**Ta ppm**	**Tb ppm**	**Te ppm**	**Th ppm**	**Tl ppm**	**U ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.3	0.05	0.02	0.05	0.1	0.02	0.05
87441	0.6	<0.05	0.35	<0.05	2.2	0.22	0.24
87442	0.7	<0.05	0.25	<0.05	2.4	0.28	0.29
87443	0.7	<0.05	0.5	<0.05	2.3	0.23	0.22
87444	0.5	<0.05	0.23	<0.05	1.9	0.19	0.26
87445	0.7	<0.05	0.45	0.12	2.5	0.24	0.54
87446	0.5	<0.05	0.32	<0.05	2.6	0.2	0.18
87447	0.8	<0.05	0.28	<0.05	2.7	0.19	0.5
87448	1.4	<0.05	0.26	<0.05	3.2	0.3	0.3
87449	0.8	<0.05	0.26	<0.05	2.6	0.27	0.23
87450	0.5	<0.05	0.25	<0.05	2.1	0.19	0.22
Duplicate							
87441	0.7	<0.05	0.35	<0.05	2.5	0.21	0.25
QC							
OREAS 901	0.4	<0.05	0.75	0.07	9.6	0.38	6.38
Expected Values	0.58	0.02	0.77	0.076	9.13	0.34	5.84
Tolerance (%)	139.31	#N/A	16.49	174.47	12.74	24.71	12.14

Sample ID	**W** **ppm**	**Y** **ppm**	**Yb** **ppm**
Method Code	ICM14B	ICM14B	ICM14B
LOD	0.1	0.05	0.1
87441	0.2	10.7	1.1
87442	0.6	7.35	0.7
87443	0.2	14.4	1.5
87444	0.3	6.94	0.7
87445	<0.1	12.3	1
87446	<0.1	9.07	0.9
87447	0.2	7.9	0.8
87448	0.4	7.4	0.7
87449	0.4	7.97	0.8
87450	0.3	7.07	0.7
Duplicate			
87441	0.2	10.5	1.1
QC			
OREAS 901	0.9	18.2	1.5
Expected Values	1.1	18.8	1.49
Tolerance (%)	#N/A	10.66	26.78

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS PROJECT # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **November 3, 2014**

Sample ID		**87444**	**NP Contribution**
Al	mg/L	27.8	
Sb	mg/L	< 0.02	
As	mg/L	< 0.01	
Ba	mg/L	0.0805	
Be	mg/L	0.0040	
Bi	mg/L	0.17	
B	mg/L	1.39	
Cd	mg/L	0.002	
Ca	mg/L	390	9.7
Cr	mg/L	0.488	
Co	mg/L	0.058	
Cu	mg/L	0.432	
Fe	mg/L	102	
Pb	mg/L	0.015	
Li	mg/L	< 0.1	
Mg	mg/L	24.3	1.0
Mn	mg/L	16.2	
Mo	mg/L	< 0.01	
Ni	mg/L	0.258	
P	mg/L	0.598	
K	mg/L	45.7	1.2
Se	mg/L	< 0.01	
Si	mg/L	52.3	
Ag	mg/L	< 0.08	
Na	mg/L	16.2	0.7
Sr	mg/L	1.64	
S	mg/L	510	
Tl	mg/L	0.016	
Sn	mg/L	< 0.02	
Ti	mg/L	0.023	
U	mg/L	< 0.1	
V	mg/L	0.067	
Zn	mg/L	0.424	
Zr	mg/L	0.003	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv./tonne)			**12.6**

CLIENT : **Minto Mines**
PROJECT : **Minto Mines**
SGS PROJECT # : **0643**
Test : **BC Research NP and Modified NP Procedures** *DRAFT COPY*
Date : **November 21, 2014**

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**	
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek	Vol 1 N
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A	H2SO4
103101	30-Aug-14	8.93	0.19	15.8	0.22	0.01	<0.01	0.01	0.3	15.9	21.6	22.0	21.7	70.4	Slight	4.40
103102	30-Aug-14	8.72	0.16	13.3	0.177	0.027	<0.01	0.03	0.8	15.2	18.6	19.0	18.2	22.5	Slight	3.80
103103	30-Aug-14	8.89	0.31	25.8	0.333	0.213	<0.01	0.21	6.7	20.1	28.4	29.0	22.3	4.4	Slight	5.80
103104	30-Aug-14	8.92	0.28	23.3	0.292	0.088	<0.01	0.09	2.8	21.9	30.1	30.8	28.0	11.2	Slight	6.15
103105	30-Aug-14	8.86	0.35	29.2	0.373	0.238	<0.01	0.24	7.4	23.3	33.8	34.5	27.1	4.6	Slight	6.90
103106	30-Aug-14	8.99	0.38	31.7	0.392	0.324	<0.01	0.32	10.1	23.0	31.6	32.3	22.1	3.2	Slight	6.45
103107	25-Sep-14	8.93	0.19	15.8	0.235	0.011	<0.01	0.01	0.3	18.7	27.2	27.8	27.4	80.7	Slight	5.55
103108	25-Sep-14	8.97	0.4	33.3	0.433	0.394	<0.01	0.39	12.3	21.6	29.9	30.5	18.2	2.5	Slight	6.10
103109	25-Sep-14	8.91	0.15	12.5	0.179	0.024	<0.01	0.02	0.8	13.4	18.4	18.8	18.0	25.0	Slight	3.75
103110	25-Sep-14	9.27	0.2	16.7	0.231	0.012	<0.01	0.01	0.4	14.9	20.6	21.0	20.6	56.0	Slight	4.20
103111	25-Sep-14	8.98	0.54	45.0	0.582	0.467	<0.01	0.47	14.6	24.3	33.8	34.5	19.9	2.4	Slight	6.90
103112	25-Sep-14	9.06	0.23	19.2	0.264	0.012	<0.01	0.01	0.4	17.3	23.8	24.3	23.9	64.7	Slight	4.85
103113	25-Sep-14	8.96	0.39	32.5	0.42	0.014	<0.01	0.01	0.4	24.3	33.6	34.3	33.8	78.3	Slight	6.85
103114	16-Sep-14	8.97	0.19	15.8	0.232	0.01	<0.01	0.01	0.3	16.4	19.6	20.0	19.7	64.0	Slight	4.00
Aug Tails Comp	Aug 2014	8.47	0.38	31.7	0.36	0.047	<0.01	0.05	1.5	22.5	29.9	30.5	29.0	20.8	Slight	6.10
Duplicates																
103101		9.03								15.8					Slight	
103104			0.28		0.294	0.088										
103112							<0.01									
QC																
GTS-2A					1.98	0.344										
PD-1							4.28									
SY-4			0.92													
NBM-1										40.7					Slight	
Expected Values			0.95		2.01	0.341	4.27			42.0					Slight	
Tolerance +/-			0.06		0.15	0.030	0.3			3.0						

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS Project # : **0643**
Test : **Metals by Aqua Regia Digestion with ICP-MS Finish**
Date : **November 21, 2014**

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Sample ID	**Ag**	**Al**	**B**	**Ba**	**Ca**	**Cr**	**Cu**	**Fe**	**K**	**Li**	**Mg**
	ppm	**%**	**ppm**	**ppm**	**%**	**ppm**	**ppm**	**%**	**%**	**ppm**	**%**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01
103101	0.05	1.2	10	410	0.73	125	57	2.57	0.86	5	0.73
103102	0.05	1.03	<10	295	0.68	133	156	2.28	0.69	5	0.58
103103	0.13	1.16	10	365	0.76	120	772	2.88	0.86	5	0.73
103104	0.38	1.08	<10	345	0.87	121	3170	2.54	0.72	5	0.7
103105	0.53	1.23	10	504	0.86	124	3040	2.98	0.93	5	0.82
103106	0.24	1.41	20	667	0.87	121	2630	3.35	1.15	5	0.95
103107	0.16	1.24	<10	438	0.87	116	86	2.59	0.8	6	0.76
103108	0.1	1.17	10	559	0.73	120	531	3.2	0.91	5	0.8
103109	0.1	1.23	<10	362	0.62	105	517	2.77	0.94	6	0.76
103110	0.07	1.31	<10	689	0.64	124	133	2.52	1.07	5	0.76
103111	0.13	1.31	20	273	0.74	114	1340	4.38	1.08	5	0.94
103112	0.02	1.22	<10	428	0.77	116	116	2.58	0.88	5	0.76
103113	0.12	1.32	20	513	0.96	105	164	3.04	1	6	0.88
103114	0.03	1.2	<10	331	0.8	118	84.2	2.6	0.79	5	0.75
Aug Tails Comp	0.43	1.13	<10	212	1	68	767	5.59	0.64	6	0.72
Duplicate											
103103	0.14	1.19	10	371	0.76	120	792	2.98	0.89	5	0.76
QC											
CH4	1.98	1.88	<10	296	0.61	107	2020	4.73	1.44	12	1.22
Certified Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3

Sample ID	**Mn ppm**	**Na %**	**Ni ppm**	**P %**	**S %**	**Sr ppm**	**Ti %**	**V ppm**	**Zn ppm**	**Zr ppm**	**As ppm**	**Be ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	2	0.01	0.5	0.005	0.01	0.5	0.01	1	1	0.5	1	0.1
103101	602	0.06	7.5	0.08	<0.01	45.1	0.14	56	72	1.2	<1	0.2
103102	695	0.06	7.7	0.064	0.03	38.1	0.11	49	94	1.2	<1	0.2
103103	604	0.06	7.4	0.075	0.27	50.7	0.14	63	90	1.5	<1	0.2
103104	639	0.06	6.6	0.076	0.11	52.6	0.12	57	78	1.3	<1	0.2
103105	562	0.06	7.1	0.079	0.29	66.1	0.16	76	78	1.3	2	0.2
103106	593	0.06	7.7	0.096	0.41	53.1	0.19	86	79	1.4	1	0.2
103107	641	0.07	6.8	0.076	<0.01	55.6	0.14	61	75	1.1	<1	0.2
103108	500	0.06	7.1	0.08	0.48	46.3	0.16	71	73	1.3	<1	0.2
103109	688	0.05	6.6	0.079	0.02	31.3	0.16	62	102	1.2	<1	0.2
103110	428	0.07	7.3	0.076	0.01	46.6	0.19	63	65	0.7	<1	0.1
103111	581	0.05	11.4	0.089	0.56	71.4	0.16	84	97	2.3	<1	0.2
103112	587	0.07	7	0.083	0.01	61.3	0.15	58	67	1.2	<1	0.2
103113	742	0.06	6.5	0.088	<0.01	66.8	0.16	70	101	1.3	<1	0.2
103114	663	0.07	6.7	0.078	<0.01	45.6	0.14	59	83	1.3	<1	0.2
Aug Tails Comp	753	0.04	5.6	0.067	0.05	65.6	0.12	72	114	1.4	<1	0.2
Duplicate												
103103	623	0.06	7	0.073	0.26	50.7	0.14	64	91	1.4	<1	0.2
QC												
CH4	314	0.07	52.3	0.069	0.73	10	0.21	81	207	14.2	9	<0.1
Certified Values	324	0.06	49.57	0.072	0.73	9.38	0.21	79.27	189.4	9	8.14	0.11
Tolerance (%)	11.5	50.3	12.52	27.4	13.4	23.3	23.3	13.2	11.3	17.7	13.1	241.3

Sample ID	**Bi ppm**	**Cd ppm**	**Ce ppm**	**Co ppm**	**Cs ppm**	**Ga ppm**	**Ge ppm**	**Hf ppm**	**Hg ppm**	**In ppm**	**La ppm**	**Lu ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01	0.02	0.1	0.01
103101	<0.02	0.04	21.2	6.8	0.41	5.5	<0.1	<0.05	<0.01	<0.02	11.2	0.12
103102	<0.02	0.05	21.1	6	0.35	5.1	<0.1	<0.05	<0.01	0.03	10.3	0.12
103103	<0.02	0.05	21	8.4	0.49	6.1	<0.1	<0.05	0.01	0.07	10.8	0.11
103104	0.04	0.07	19.5	7	0.36	5.2	<0.1	<0.05	<0.01	0.02	10.3	0.11
103105	0.2	0.19	17.5	7.9	0.47	5.9	<0.1	<0.05	<0.01	0.05	9	0.09
103106	0.04	0.13	21	11.2	0.61	6.6	<0.1	<0.05	0.01	0.04	10.8	0.08
103107	<0.02	0.04	17.5	7	0.33	6	<0.1	<0.05	<0.01	<0.02	9.5	0.12
103108	<0.02	0.11	14	10	0.48	5.5	<0.1	<0.05	<0.01	<0.02	7	0.07
103109	0.03	0.06	31.5	7.4	0.56	6	0.1	<0.05	<0.01	<0.02	15.7	0.1
103110	<0.02	0.03	10.9	6.4	0.46	5.7	<0.1	<0.05	<0.01	<0.02	5.6	0.05
103111	0.04	0.08	25.7	10.9	1	7.3	0.1	<0.05	0.03	0.23	12.3	0.14
103112	<0.02	0.04	15.7	7	0.43	5.5	<0.1	<0.05	<0.01	<0.02	7.8	0.11
103113	<0.02	0.05	30.7	8.6	0.5	6.5	0.1	<0.05	<0.01	0.02	14.6	0.12
103114	<0.02	0.04	24.2	7.1	0.36	5.9	0.1	<0.05	<0.01	<0.02	12	0.11
Aug Tails Comp	0.15	0.23	13.4	8.2	0.49	9.7	0.1	<0.05	<0.01	0.03	7	0.06
Duplicate												
103103	<0.02	0.05	21	8.8	0.52	6.3	<0.1	<0.05	0.02	0.08	10.8	0.11
QC												
CH4	0.41	1.12	29.3	23	2.39	8.9	0.3	0.33	<0.01	0.07	13.7	0.07
Certified Values	0.51	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A	0.1	14	#N/A
Tolerance (%)	19.7	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A	62.1	11.8	#N/A

Sample ID	Mo ppm	Nb ppm	Pb ppm	Rb ppm	Sb ppm	Sc ppm	Se ppm	Sn ppm	Ta ppm	Tb ppm	Te ppm	Th ppm
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05	0.02	0.05	0.1
103101	5.83	0.37	1.2	33.5	0.06	5.4	<1	0.5	<0.05	0.24	<0.05	2.2
103102	6.38	0.38	1.7	31	0.05	5.1	<1	0.4	<0.05	0.25	<0.05	2.3
103103	6.34	0.53	2.1	41.5	<0.05	5.7	<1	0.8	<0.05	0.24	<0.05	3.1
103104	6.08	0.34	1.4	27	<0.05	5.7	<1	0.3	<0.05	0.25	<0.05	1.7
103105	9.93	0.46	2.1	39.2	0.06	5.6	2	1.2	<0.05	0.21	<0.05	1.8
103106	7.23	0.47	1.8	49.4	<0.05	6.4	1	0.9	<0.05	0.23	<0.05	2.8
103107	5.15	0.33	1.4	30.5	<0.05	4.5	<1	0.4	<0.05	0.24	<0.05	1.6
103108	5.84	0.42	1.5	36	<0.05	4	<1	0.7	<0.05	0.16	<0.05	1.8
103109	5.23	0.5	2	44.3	<0.05	5.8	<1	0.5	<0.05	0.26	<0.05	3.8
103110	6.17	0.34	1.6	44.2	0.09	2.7	<1	0.4	<0.05	0.1	<0.05	1.1
103111	8.79	0.68	3.1	57.7	<0.05	7.8	<1	1.5	<0.05	0.29	0.09	5.3
103112	4.9	0.42	1.4	33.9	<0.05	5.2	<1	0.4	<0.05	0.26	<0.05	1.5
103113	4.85	0.32	1.5	43.1	<0.05	8.9	<1	0.7	<0.05	0.3	<0.05	3
103114	5.09	0.29	1.4	30	<0.05	5.9	<1	0.4	<0.05	0.23	<0.05	2.3
Aug Tails Comp	3.49	0.4	2.1	30.6	<0.05	4.1	<1	0.6	<0.05	0.13	0.12	2.6
Duplicate												
103103	6.28	0.53	2.1	43.6	<0.05	6.3	<1	0.9	<0.05	0.24	<0.05	3.2
QC												
CH4	2.42	0.21	9	70.6	0.32	8.2	2	0.3	<0.05	0.24	0.37	1.9
Certified Values	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3	0.27	0.42	2.2
Tolerance (%)	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7	28.4	39.6	21.2

Sample ID	**Tl ppm**	**U ppm**	**W ppm**	**Y ppm**	**Yb ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.05	0.1	0.05	0.1
103101	0.17	0.33	0.4	8.97	0.8
103102	0.16	0.19	0.1	8.73	0.8
103103	0.28	0.34	0.2	8.23	0.7
103104	0.13	0.26	0.1	8.73	0.8
103105	0.22	0.88	0.2	7.18	0.6
103106	0.29	0.68	0.3	7.27	0.5
103107	0.15	0.12	0.2	9.05	0.8
103108	0.2	0.65	0.2	5.83	0.5
103109	0.23	0.31	0.4	8.05	0.7
103110	0.23	0.14	0.4	3.59	0.3
103111	0.72	0.66	0.5	9.56	0.9
103112	0.18	0.18	0.2	8.84	0.8
103113	0.2	0.17	0.2	9.96	0.8
103114	0.14	0.18	0.3	8.25	0.7
Aug Tails Comp	0.22	0.25	<0.1	4.68	0.3
Duplicate					
103103	0.29	0.37	0.2	8.2	0.7
QC					
CH4	0.36	0.26	2	6.01	0.5
Certified Values	0.4	0.29	2.15	5.66	#N/A
Tolerance (%)	22.6	52.9	21.6	12.2	#N/A

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS PROJECT # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **November 21, 2014**

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Sample ID		**103104**	**NP Contribution**	**103108**	**NP Contribution**
Al	mg/L	55.8		46.8	
Sb	mg/L	< 0.02		< 0.02	
As	mg/L	< 0.01		0.01	
Ba	mg/L	0.0820		0.0589	
Be	mg/L	0.0082		0.0076	
Bi	mg/L	0.58		0.90	
B	mg/L	2.78		1.30	
Cd	mg/L	0.012		0.008	
Ca	mg/L	557	13.9	486	12.1
Cr	mg/L	0.602		0.782	
Co	mg/L	0.128		0.133	
Cu	mg/L	42.8		6.63	
Fe	mg/L	302		414	
Pb	mg/L	0.029		0.029	
Li	mg/L	< 0.1		< 0.1	
Mg	mg/L	94.3	3.9	125	5.1
Mn	mg/L	24.8		13.5	
Mo	mg/L	< 0.01		0.01	
Ni	mg/L	0.439		0.291	
P	mg/L	0.566		0.018	
K	mg/L	67.6	1.7	62.5	1.6
Se	mg/L	< 0.01		< 0.01	
Si	mg/L	98.8		71.5	
Ag	mg/L	< 0.08		< 0.08	
Na	mg/L	26.5	1.2	20.5	0.9
Sr	mg/L	2.64		2.15	
S	mg/L	972		962	
Tl	mg/L	0.025		0.009	
Sn	mg/L	< 0.02		< 0.02	
Ti	mg/L	0.061		0.024	
U	mg/L	< 0.1		< 0.1	
V	mg/L	0.404		0.706	
Zn	mg/L	1.34		1.13	
Zr	mg/L	0.015		0.012	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv./tonne)			**20.7**		**19.8**

CLIENT **: Minto Mines**
PROJECT **: Minto Mines**
SGS PROJECT # **: 0643**
Test **: BC Research NP and Modified NP Procedures**
Date **: December 10, 2014**

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
103115	30-Sep-14	9.43	0.31	25.8	0.408	0.042	<0.01	0.042	1.3	21.1	31.6	32.3	30.9	24.6	Slight
103116	12-Sep-14	9.19	0.48	40.0	0.543	<0.005	<0.01	<0.01	<0.3	36.9	45.6	46.5	46.5	155.0	Slight
Sept Tails Comp	Sept 2014	8.52	0.32	26.7	0.379	0.05	<0.01	0.05	1.6	27.2	34.8	35.5	33.9	22.7	Slight
Duplicates															
103115		9.40	0.31		0.411	0.058				21.3					
103116							<0.01								
QC															
GTS-2A					1.97	0.342									
PD-1							4.44								
SY-4			0.92												
NBM-1										39.8					Slight
Expected Values			0.95		2.01	0.341	4.27			42.0					Slight
Tolerance +/-			0.06		0.15	0.030	0.3			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT : Minto Mines
PROJECT : Minto Project
SGS Project # : 0643
Test : Metals by Aqua Regia Digestion with ICP-MS Finish
Date : December 10, 2014

Sample ID	**Ag ppm**	**Al %**	**B ppm**	**Ba ppm**	**Ca %**	**Cr ppm**	**Cu ppm**	**Fe %**	**K %**	**Li ppm**	**Mg %**	**Mn ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1	0.01	2
103115	0.1	1.27	10	590	0.71	105	297	3.31	1.06	5	0.83	606
103116	0.11	0.91	20	330	1.23	105	72.8	2.12	0.71	4	0.66	512
Sept Tails Comp	0.39	1.11	20	240	1.11	71	932	4.36	0.65	6	0.71	683
Duplicate												
103115	0.09	1.24	10	589	0.7	99	271	3.24	1.04	6	0.81	596
QC												
CH4	1.83	1.72	20	264	0.55	101	1970	4.47	1.33	13	1.12	303
Certified Values	2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6	1.18	324
Tolerance (%)	10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84	12.3	11.5

Sample ID	**Na** **%**	**Ni** **ppm**	**P** **%**	**S** **%**	**Sr** **ppm**	**Ti** **%**	**V** **ppm**	**Zn** **ppm**	**Zr** **ppm**	**As** **ppm**	**Be** **ppm**	**Bi** **ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.5	0.005	0.01	0.5	0.01	1	1	0.5	1	0.1	0.02
103115	0.06	6.2	0.076	0.05	51.3	0.18	78	94	1.2	1	0.2	<0.02
103116	0.06	5.9	0.06	<0.01	85.5	0.1	50	65	1.3	1	0.2	<0.02
Sept Tails Comp	0.05	5.3	0.07	0.06	82	0.11	67	103	1.5	<1	0.2	0.15
Duplicate												
103115	0.05	5.7	0.072	0.05	50.2	0.18	77	90	1.1	<1	0.2	<0.02
QC												
CH4	0.06	45.8	0.061	0.72	9.5	0.2	71	201	13.1	7	<0.1	0.42
Certified Values	0.06	49.57	0.072	0.73	9.38	0.21	79.27	189.4	9	8.14	0.11	0.51
Tolerance (%)	50.3	12.52	27.4	13.4	23.3	23.3	13.2	11.3	17.7	13.1	241.3	19.7

Sample ID	**Cd ppm**	**Ce ppm**	**Co ppm**	**Cs ppm**	**Ga ppm**	**Ge ppm**	**Hf ppm**	**Hg ppm**	**In ppm**	**La ppm**	**Lu ppm**	**Mo ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01	0.02	0.1	0.01	0.05
103115	0.1	21.5	8	0.54	6.1	<0.1	<0.05	<0.01	0.06	11	0.07	4.8
103116	0.06	27.8	5.2	0.44	4.1	<0.1	<0.05	<0.01	0.03	15.3	0.08	4.9
Sept Tails Comp	0.26	19.7	7	0.54	8.4	0.1	<0.05	<0.01	0.06	10.1	0.07	5.32
Duplicate												
103115	0.08	20.3	7.6	0.54	5.9	<0.1	<0.05	<0.01	0.06	10.3	0.06	4.5
QC												
CH4	1.04	26.4	21	2.45	8.4	0.2	0.31	<0.01	0.09	13.3	0.05	2.61
Certified Values	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A	0.1	14	#N/A	3.05
Tolerance (%)	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A	62.1	11.8	#N/A	14.1

Sample ID	Nb ppm	Pb ppm	Rb ppm	Sb ppm	Sc ppm	Se ppm	Sn ppm	Ta ppm	Tb ppm	Te ppm	Th ppm	Tl ppm
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.2	0.2	0.05	0.1	1	0.3	0.05	0.02	0.05	0.1	0.02
103115	0.65	2.3	44.1	0.1	5.8	<1	0.9	<0.05	0.24	<0.05	3	0.28
103116	0.74	2.9	29.8	<0.05	11.6	<1	0.6	<0.05	0.26	<0.05	3.6	0.18
Sept Tails Comp	0.47	2.2	32.9	<0.05	4.6	<1	1	<0.05	0.22	0.08	3	0.27
Duplicate												
103115	0.67	2	42.6	0.05	5.6	<1	0.8	<0.05	0.22	<0.05	2.9	0.28
QC												
CH4	0.27	7.8	61.9	0.4	8.1	<1	0.5	<0.05	0.25	0.38	1.9	0.37
Certified Values	0.19	8.24	67	0.34	8.53	1.57	0.6	0.3	0.27	0.42	2.2	0.4
Tolerance (%)	75	16.1	10.7	47.3	13.1	169.6	134.5	51.7	28.4	39.6	21.2	22.6

Sample ID	**U ppm**	**W ppm**	**Y ppm**	**Yb ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.1	0.05	0.1
103115	0.23	0.3	6.7	0.5
103116	0.26	0.3	7.44	0.7
Sept Tails Comp	0.42	<0.1	6.64	0.5
Duplicate				
103115	0.21	0.2	6.32	0.5
QC				
CH4	0.28	2	5.44	0.4
Certified Values	0.29	2.15	5.66	#N/A
Tolerance (%)	52.9	21.6	12.2	#N/A

CLIENT : Minto Mines
PROJECT : Minto Mines
SGS PROJECT # : 0643
Test : BC Research NP and Modified NP Procedures
Date : February 4, 2015

Sample ID	**Sampling Date**	**Paste pH**	**TIC %**	**CaCO3 NP**	**C(T) %**	**S(T) %**	**S(SO4) %**	**S(S-2) %**	**AP**	**NP**	**NP H2SO4/tonne**	**NP CaCO3/tonne**	**Net NP**	**NP:AP Ratio (NP/AP)**	**Fizz Test**
Method Code		Sobek	CSB02V	Calc	CSA06V	CSA06V	CSA07V	Calc	Calc	Modified	BC Research	Calc	Calc	Calc	Sobek
LOD		0.2	0.01	#N/A	0.005	0.005	0.01	#N/A	#N/A	0.5	0.5	#N/A	#N/A	#N/A	#N/A
103117	Dec. 9, 2014	8.52	0.19	15.8	0.222	0.029	<0.01	0.03	0.9	19.1	23.0	23.5	22.6	25.9	Slight
103118	Dec. 24, 2014	8.40	0.16	13.3	0.2	0.034	<0.01	0.03	1.1	16.7	21.8	22.3	21.2	20.9	Slight
103119	Jan. 10, 2015	8.11	0.22	18.3	0.258	0.108	<0.01	0.11	3.4	21.2	25.7	26.3	22.9	7.8	Slight
103120	Jan. 10, 2015	8.43	0.1	8.3	0.145	0.209	<0.01	0.21	6.5	13.6	16.2	16.5	10.0	2.5	Slight
103121	Jan. 18, 2015	8.10	0.2	16.7	0.234	0.353	<0.01	0.35	11.0	18.5	24.5	25.0	14.0	2.3	Slight
103122	Jan. 18, 2015	8.35	0.19	15.8	0.243	0.065	<0.01	0.07	2.0	19.2	24.3	24.8	22.7	12.2	Slight
Final Tails	Oct 2014	7.78	0.41	34.2	0.422	0.056	<0.01	0.06	1.8	31.6	40.7	41.5	39.8	23.7	Slight
Final Tails	Nov 2014	7.89	0.32	26.7	0.344	0.065	<0.01	0.07	2.0	25.9	32.1	32.8	30.7	16.1	Slight
Final Tails	Dec 2014	7.90	0.34	28.3	0.366	0.075	<0.01	0.08	2.3	26.8	36.0	36.8	34.4	15.7	Slight
Duplicates															
103117	Dec. 9, 2014	8.38	0.18							18.6					Slight
103119					0.262	0.107									
Final Tails	Dec 2014						<0.01								
GTS-2A					1.97	0.358									
PD-1							4.36								
SY-4			0.89												
NBM-1										39.6					Slight
Expected Values			0.95		2.01	0.341	4.27			42.0					Slight
Tolerance +/-			0.06		0.15	0.030	0.52			3.0					

Note:

AP = Acid potential in tonnes CaCO3 equivalent per 1000 tonnes of material. AP is determined from calculated sulphide sulphur content: S(T) - S(SO4).

NP = Neutralization potential in tonnes CaCO3 equivalent per 1000 tonnes of material.

NET NP = NP - AP

Carbonate NP is calculated from TIC originating from carbonate minerals and is expressed in kg CaCO3/tonne.

CLIENT **: Minto Mines**
PROJECT **: Minto Project**
SGS Project # **: 0643**
Test **: Metals by Aqua Regia Digestion with ICP-MS Finish**
Date **: February 27, 2015**

Sample ID	**Sampling Date**	**Ag ppm**	**Al %**	**B ppm**	**Ba ppm**	**Ca %**	**Cr ppm**	**Cu ppm**	**Fe %**	**K %**	**Li ppm**
Method Code		ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD		0.01	0.01	10	5	0.01	1	0.5	0.01	0.01	1
103117	Dec. 9, 2014	0.06	1.11	20	138	1.17	113	180	2.09	0.3	6
103118	Dec. 24, 2014	0.05	1.01	20	212	0.98	110	70	2.11	0.43	5
103119	Jan. 10, 2015	0.55	1.05	20	113	1.09	95	1380	2.73	0.25	7
103120	Jan. 10, 2015	0.82	1.1	20	189	0.75	100	2780	3.24	0.54	6
103121	Jan. 18, 2015	1.68	1.23	20	194	0.92	100	4570	4.62	0.69	6
103122	Jan. 18, 2015	0.35	1.32	20	329	0.89	106	849	3.22	0.78	7
Final Tails	Oct 2014	0.39	1.24	20	306	1.31	97	1000	3.86	0.71	6
Final Tails	Nov 2014	0.47	1.24	20	298	1.18	96	1020	4.26	0.64	6
Final Tails	Dec 2014	0.4	1.32	10	302	1.19	86	919	3.81	0.66	7
Duplicates											
103118	Dec. 24, 2014	0.05	1.08	20	219	0.95	108	71.8	2.25	0.46	6
CH4		2.12	1.77	20	291	0.62	102	1980	4.62	1.4	11
Expected Values		2.13	1.85	#N/A	293	0.61	103.8	2000	4.79	1.43	12.6
Tolerance (%)		10.9	11.35	#N/A	14.3	14.1	12.4	10.1	10.52	11.74	29.84

Sample ID	**Mg**	**Mn**	**Na**	**Ni**	**P**	**S**	**Sr**	**Ti**	**V**	**Zn**	**Zr**
	%	**ppm**	**%**	**ppm**	**%**	**%**	**ppm**	**%**	**ppm**	**ppm**	**ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.01	2	0.01	0.5	0.005	0.01	0.5	0.01	1	1	0.5
103117	0.64	573	0.09	4.7	0.064	0.01	305	0.09	45	62	0.7
103118	0.64	569	0.08	4.4	0.064	<0.01	63.6	0.11	48	65	0.7
103119	0.62	738	0.04	2.8	0.063	0.1	54.9	0.06	44	78	0.6
103120	0.68	874	0.07	3.1	0.087	0.23	42.4	0.11	61	85	0.7
103121	0.76	1200	0.05	1.3	0.081	0.4	38	0.13	80	103	<0.5
103122	0.81	679	0.06	3.3	0.065	0.06	41.5	0.13	65	103	<0.5
Final Tails	0.79	732	0.06	2.4	0.085	0.04	89.7	0.12	81	105	1.1
Final Tails	0.78	756	0.05	2.7	0.081	0.05	75.6	0.12	83	121	0.9
Final Tails	0.81	749	0.06	3.2	0.08	0.06	87.8	0.12	81	107	1.2
Duplicates											
103118	0.67	607	0.08	5.1	0.067	<0.01	63.4	0.11	49	66	0.7
CH4	1.17	325	0.07	44.5	0.067	0.77	10	0.22	84	198	14.7
Expected Values	1.18	324	0.06	49.57	0.072	0.73	9.38	0.21	79.27	189.4	9
Tolerance (%)	12.3	11.5	50.3	12.52	27.4	13.4	23.3	23.3	13.2	11.3	17.7

Sample ID	**As**	**Be**	**Bi**	**Cd**	**Ce**	**Co**	**Cs**	**Ga**	**Ge**	**Hf**	**Hg**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Method Co	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	1	0.1	0.02	0.01	0.05	0.1	0.05	0.1	0.1	0.05	0.01
103117	3	0.4	0.08	0.07	17.1	5.7	0.25	6.2	0.1	0.06	<0.01
103118	1	0.3	0.04	0.04	21.3	5.6	0.28	5.5	0.1	0.06	<0.01
103119	<1	0.3	0.17	0.18	25.3	5.7	0.31	6.7	0.1	<0.05	<0.01
103120	<1	0.3	0.45	0.23	16.9	6.6	0.7	7.1	0.1	0.06	<0.01
103121	<1	0.3	0.61	0.29	22.9	7.9	0.8	9.3	0.2	0.06	<0.01
103122	<1	0.2	0.14	0.09	33.6	7.6	0.48	8.1	0.1	<0.05	<0.01
Final Tails	<1	0.3	0.21	0.35	21.5	7.6	0.56	8.2	0.1	0.06	<0.01
Final Tails	<1	0.3	0.17	0.36	19.1	7.9	0.49	9.1	0.1	0.06	<0.01
Final Tails	<1	0.3	0.11	0.34	21.6	7.8	0.5	8.6	0.1	0.07	<0.01
Duplicates											
103118	2	0.3	0.04	0.04	22.3	5.8	0.3	5.9	0.1	0.06	<0.01
CH4	8	0.1	0.44	1.19	28.8	23.6	2.68	9.5	0.3	0.44	<0.01
Expected V	8.14	0.11	0.51	1.17	28.18	23.56	2.6	8.72	0.21	0.29	#N/A
Tolerance (	13.1	241.3	19.7	12.1	16.1	11.1	14.8	12.9	127.4	52.8	#N/A

Sample ID	In	La	Lu	Mo	Nb	Pb	Rb	Sb	Sc	Se	Sn
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.02	0.1	0.01	0.05	0.05	0.2	0.2	0.05	0.1	1	0.3
103117	0.02	8.8	0.08	6.19	0.43	5.1	13.9	0.08	3.9	<1	0.4
103118	<0.02	11.3	0.08	4.95	0.45	3.8	19.8	0.05	3.9	<1	0.6
103119	0.03	13.4	0.05	5.61	0.27	4.4	14.3	<0.05	2.6	1	0.4
103120	0.04	9.2	0.07	5.49	0.48	2.8	34.4	<0.05	3	2	0.5
103121	0.06	12.4	0.06	6.35	0.47	3	41.7	<0.05	4.3	3	0.9
103122	0.02	17.5	0.05	4.8	0.35	3	40.5	<0.05	2.6	<1	0.5
Final Tails	0.08	11.1	0.1	7.27	0.46	2.8	34.9	<0.05	5	<1	1.2
Final Tails	0.08	9.9	0.09	7.34	0.45	2.7	31.5	<0.05	4.3	1	1.1
Final Tails	0.08	11.6	0.1	7.53	0.44	2.4	31.4	<0.05	4.6	<1	1.1
Duplicates											
103118	0.02	12	0.08	5.17	0.45	3.8	20.8	<0.05	4.2	<1	0.4
CH4	0.1	14.9	0.07	2.75	0.21	8.2	70.6	0.33	8.6	2	0.6
Expected Values	0.1	14	#N/A	3.05	0.19	8.24	67	0.34	8.53	1.57	0.6
Tolerance (%)	62.1	11.8	#N/A	14.1	75	16.1	10.7	47.3	13.1	169.6	134.5

Sample ID	**Ta**	**Tb**	**Te**	**Th**	**Tl**	**U**	**W**	**Y**	**Yb**
	ppm	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**	**ppm**
Method Code	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B	ICM14B
LOD	0.05	0.02	0.05	0.1	0.02	0.05	0.1	0.05	0.1
103117	<0.05	0.21	<0.05	1.8	0.08	0.25	0.3	5.73	0.6
103118	<0.05	0.21	<0.05	2.5	0.13	0.22	0.3	5.46	0.6
103119	<0.05	0.17	0.13	4.8	0.12	0.48	0.3	3.61	0.3
103120	<0.05	0.19	0.18	3.3	0.38	0.36	0.8	4.89	0.5
103121	<0.05	0.21	0.19	4	0.45	0.36	0.8	4.72	0.4
103122	<0.05	0.2	0.09	3.9	0.26	0.33	0.5	4.24	0.4
Final Tails	<0.05	0.28	0.17	2.7	0.26	0.61	<0.1	8.1	0.7
Final Tails	<0.05	0.24	0.17	2.8	0.22	0.58	<0.1	6.7	0.6
Final Tails	<0.05	0.28	0.15	3	0.23	0.61	<0.1	7.6	0.7
Duplicates									
103118	<0.05	0.21	<0.05	2.7	0.13	0.22	0.3	5.65	0.6
CH4	<0.05	0.29	0.47	2	0.39	0.28	2.3	6	0.5
Expected Values	0.3	0.27	0.42	2.2	0.4	0.29	2.15	5.66	#N/A
Tolerance (%)	51.7	28.4	39.6	21.2	22.6	52.9	21.6	12.2	#N/A

CLIENT : **Minto Mines**
PROJECT : **Minto Project**
SGS PROJECT # : **0643**
Test : **Leachate Analysis by ICP-OES**
Date : **February 27, 2015**

Sample ID		**103118**	**NP Contribution**
Al	mg/L	51.5	
Sb	mg/L	< 0.02	
As	mg/L	0.01	
Ba	mg/L	0.0843	
Be	mg/L	0.0063	
Bi	mg/L	0.26	
B	mg/L	1.32	
Cd	mg/L	0.009	
Ca	mg/L	459	11.5
Cr	mg/L	1.400	
Co	mg/L	0.036	
Cu	mg/L	1.090	
Fe	mg/L	126	
Pb	mg/L	0.016	
Li	mg/L	< 0.1	
Mg	mg/L	28.2	1.2
Mn	mg/L	7.3	
Mo	mg/L	0.02	
Ni	mg/L	0.253	
P	mg/L	0.536	
K	mg/L	35.0	0.9
Se	mg/L	< 0.01	
Si	mg/L	60.3	
Ag	mg/L	< 0.08	
Na	mg/L	24.1	1.0
Sr	mg/L	3.06	
S	mg/L	627	
Tl	mg/L	0.010	
Sn	mg/L	< 0.02	
Ti	mg/L	0.012	
U	mg/L	< 0.1	
V	mg/L	0.114	
Zn	mg/L	0.405	
Zr	mg/L	0.004	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv./tonne)			**14.6**

Appendix D: ICP Results for July to December 2014

Appendix D: Leachate Analysis by ICP-OES

		Sample ID and NP Contribution																	
Sample No.		86083	NP	86085	NP	87426	NP	87431	NP	87439	NP	87444	NP	103104	NP	103108	NP	103118	NP
Al	mg/L	65.5		28.6		28.5		38.8		49.2		27.8		55.8		46.8		51.5	
Sb	mg/L	<0.02		<0.02		<0.02		<0.02		<0.02		<0.02		<0.02		<0.02		<0.02	
As	mg/L	<0.01		0.010		0.010		0.01		0.01		<0.01		<0.01		0.010		0.000	
Ba	mg/L	0.0695		0.079		0.0686		0.078		0.0562		0.0805		0.082		0.0589		0.1000	
Be	mg/L	0.0087		0.0035		0.0043		0.0093		0.0081		0.004		0.0082		0.0076		0	
Bi	mg/L	0.21		0.12		0.12		0.46		0.85		0.17		0.58		0.9		0.3	
B	mg/L	1.57		1.07		1.36		1.69		1.23		1.39		2.78		1.30		1.30	
Cd	mg/L	0.006		0.007		0.013		0.006		0.025		0.002		0.012		0.008		0	
Ca	mg/L	722	18	354	8.8	557	14	610	15.2	722	18.0	390	9.7	557	14	486	12	459	11.5
Cr	mg/L	1.7		0.38		0.65		0.794		0.674		0.488		0.602		0.782		1.4	
Co	mg/L	0.18		0.077		0.082		0.126		0.139		0.058		0.128		0.133		0	
Cu	mg/L	6.89		0.815		1.9		3.77		32.1		0.432		42.8		6.63		1.1	
Fe	mg/L	87.6		70.6		67.9		287		506		102		302		414		126	
Pb	mg/L	0.025		0.012		0.025		0.051		0.046		0.015		0.029		0.029		0	
Li	mg/L	<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.1		<0.1	
Mg	mg/L	24.1	1.0	17	0.7	16.5	0.7	81.8	3.4	193	7.9	24.3	1.0	94.3	3.9	125	5.1	28.2	1.2
Mn	mg/L	29.1		17.6		21.8		26.8		19.4		16.2		24.8		13.5		7.3	
Mo	mg/L	<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01		0.01		0	
Ni	mg/L	0.362		0.316		0.294		0.322		0.237		0.258		0.439		0.291		0.3	
P	mg/L	14		0.05		0.096		0.158		0.602		0.598		0.566		0.018		0.5	
K	mg/L	60.3	1.5	48.8	1.2	56.7	1.5	47.5	1.2	58	1.5	45.7	1.2	67.6	1.7	62.5	1.6	35	0.9
Se	mg/L	0.02		<0.01		0.02		<0.01		<0.01		<0.01		<0.01		<0.01		<0.01	
Si	mg/L	78.5		50.6		49.2		60.6		56.6		52.3		98.8		71.5		60.3	
Ag	mg/L	<0.08		<0.08		<0.08		<0.08		<0.08		<0.08		<0.08		<0.08		<0.08	
Na	mg/L	21.5	0.9	19.7	0.9	18.4	0.8	19.6	0.9	22.4	1.0	16.2	0.7	26.5	1.2	20.5	0.9	24.1	1.0
Sr	mg/L	1.6		1.37		1.82		2.93		2.37		1.64		2.64		2.15		3.1	
S	mg/L	991		454		628		944		1369		510		972		962		627	
Tl	mg/L	0.04		0.017		0.032		0.032		0.019		0.016		0.025		0.009		0	
Sn	mg/L	<0.02		<0.02		<0.02		<0.02		<0.02		<0.02		<0.02		<0.02		<0.02	
Ti	mg/L	0.082		0.004		0.013		0.016		0.025		0.023		0.061		0.024		0	
U	mg/L	<0.01		<0.01		<0.1		<0.2		<0.2		<0.1		<0.1		<0.1		<0.1	
V	mg/L	0.323		0.036		0.039		0.201		1.16		0.067		0.404		0.706		0.1	
Zn	mg/L	0.795		0.29		0.567		1.2		1.83		0.424		1.34		1.13		0.4	
Zr	mg/L	0.002		0.002		0.003		0.015		0.02		0.003		0.015		0.012		0	
NP from Ca, Mg, Na & K (kg CaCO3 Equiv./tonne)		86083	21.4	86085	11.6	87426	16.9	87431	20.7	87439	28.4	87444	12.6	103104	20.7	103108	19.7	103118	14.6

Appendix E: Tailings Results for July to December 2014

Appendix E. Summary Tailings Analysis Results from SGS

Monthly Tails Sample ID	Paste pH	TIC %	CaCO3 NP	C(T) %	S(T) %	S(SO4) %	S(S-2) %	AP	NP H2SO4/tonne	NP CaCO3/tonne	Net NP	NP:AP Ratio (NP/AP)	Fizz Test
July 2014 Tailings	8.57	0.33	27.5	0.332	0.054	<0.01	0.054	1.7	31.6	32.3	30.6	19.1	Slight
August 2014 Tailings	8.47	0.38	31.7	0.36	0.047	<0.01	0.05	1.5	29.9	30.5	29	20.8	Slight
September 2014 Tailings	8.52	0.32	26.7	0.379	0.05	<0.01	0.05	1.6	34.8	35.5	33.9	22.7	Slight
October 2014 Tailings	7.78	0.41	34.2	0.422	0.056	<0.01	0.06	1.8	40.7	41.5	39.8	23.7	Slight
November 2014 Tailings	7.89	0.32	26.7	0.344	0.065	<0.01	0.07	2	32.1	32.8	30.7	16.1	Slight
December 2014 Tailings	7.90	0.34	28.3	0.366	0.075	<0.01	0.08	2.3	36.0	36.8	34.4	15.7	Slight

Appendix P – Minto Mine Constructed Wetland Treatment Research Program

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Forward looking. Lateral thinking.

Minto Mine Constructed Wetland Treatment Research Program – Demonstration Scale

Document – 011_0315_01A

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Table of Contents

1. Introduction and Background

The Minto mine, operated by Capstone, is located 240 km northwest of Whitehorse on the west side of the Yukon River. The Minto property lies within the eastern part of the Dawson Range, with elevations from 700 to 1000 m; the landscape has rounded mountains intersected by broad valleys and drainages that are part of the Yukon River watershed.

The Minto mine has been in commercial operation since October 2007 and the deposits being mined are copper sulphide mineralized zones. Surface and groundwater water quality is a key consideration in the evaluation of potential effects of mining and mineral development projects and changes to water quality parameters have the potential to affect aquatic and human use of water resources. A Reclamation and Closure Plan (RCP) is required under both the Water Licence and the Quartz Mining Licence. The RCP is intended to address the long-term physical and chemical stability of the site and closure of the proposed features and disturbances associated with the mine. As a part of the RCP, a Constructed Wetland Treatment System (CWTS) is being designed, evaluated, and optimized for water treatment at closure through a phased program (Minto Phase V/VI Expansion Project, YOR Project Number 2013-0100).

Once established, wetlands can become self-sustaining ecosystems with plants providing yearly renewal of carbon to fuel microbial activity. As such, they possess the desirable potential to remediate contaminated mine drainage for as long as it is generated. In order for CWTSs to be effective, they must be designed, piloted, optimized, implemented, and maintained in a site-specific manner. A scaled approach for CWTS implementation allows for improvement, optimization, and flexibility for modifications along each step. Phases include: 1) site assessment and information gathering, 2) technology selection and conceptual design, 3) pilot-scale testing and optimization (controlled environment), 4) on-site demonstration-scale confirmation and optimization, and 5) full-scale implementation. Phases 1-3 have been completed (reports 2013-0100-256 and 2013-0100-257 on YESAB registry, and Contango, 2014) and confirmed plant amenability to transplantation and the CWTS design for further on-site testing. During pilot-scale trials, the selected CWTS design achieved 92% removal of copper (mean influent 146 µg/L, outflow 11.3 µg/L) and 41% removal of selenium (mean influent 10.2 µg/L, outflow 6 µg/L) using synthetic influent designed to mimic the worst-case water chemistry of a long-term closure scenario. Phase 4 of the project is now underway, with the on-site demonstration scale CWTS constructed at the Minto Mine during fall 2014. This document reports on the on-site demonstration scale CWTS design, construction, preliminary data, sampling schedule, and the long-term conceptual closure plan.

2. Design

2.1. System layout and dimensions

The demonstration-scale CWTS includes 2 systems in parallel with 2 cells in each series and a final catchment basin that both systems flow into (Figures 1-3). The location of the system in relation to the Minto site is provided in Figure 1. A stable foundation on waste rock fill was selected for the CWTS and a base of residuum (sandy gravel) material was placed in compacted lifts to allow for shaping of the structure to design specifications. The two parallel systems serve as a replicate for data analysis, but as testing progresses, it is also possible that one of the two systems may be subjected to alternate conditions for comparative purposes.

The four planted cells ranged slightly in width and length. The as built sizing of the cells (at soil surface), after soil and amendments were added, ranged from 2.8 m to 3.8 m in width and 8.7 m to 9.8 m in length (Figure 4, Table 1). This was consistent with the submitted design of the cells being 3 to 4 times longer than wide.

The 4 cells and catchment basin were roughed in and large sharp rocks hand picked and removed prior to final grading and survey. The finished surface was lined with an impermeable 4030 Enviro Liner® that was welded together and sandwiched between two layers of 12 ounce geotextile fabric.

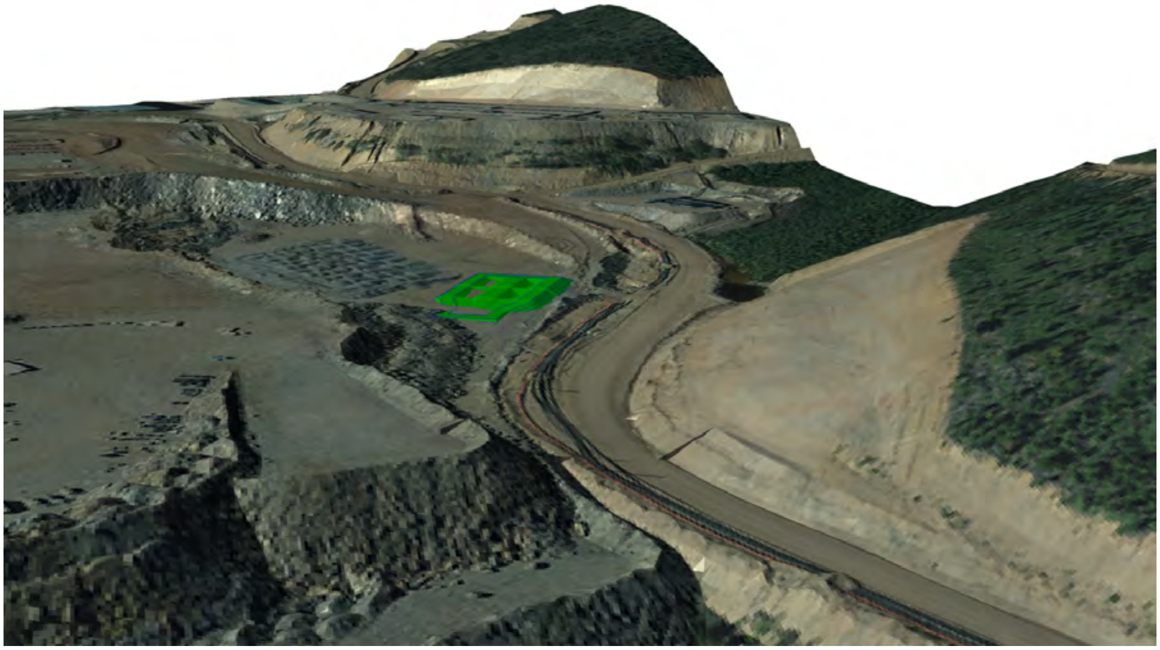

Figure 1. Location of demonstration-scale CWTS at Minto mine.

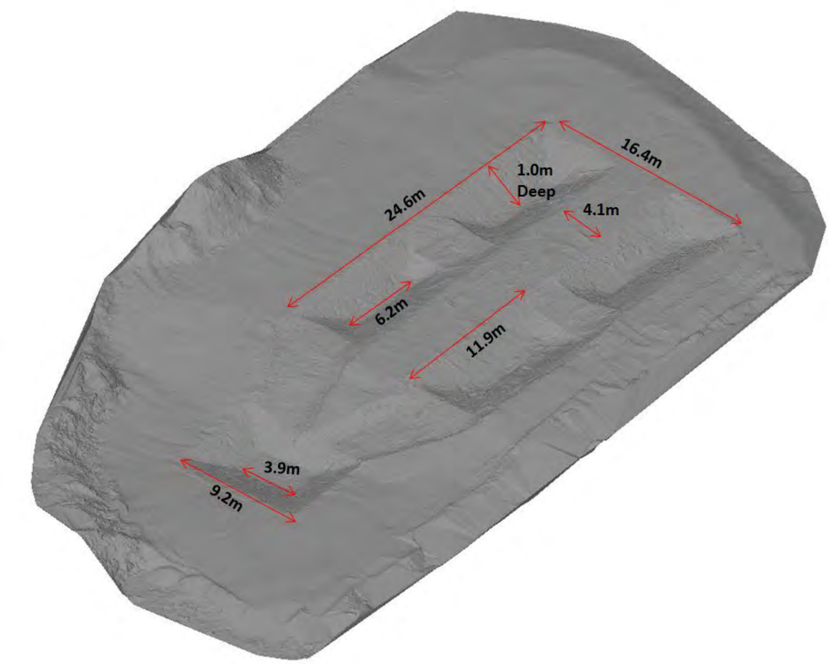

Figure 2. As built schematic of demonstration-scale CWTS.

Figure 3. Demonstration-scale CWTS prior to liner installation.

Table 1. Measurements of demonstration-scale CWTS cells at soil surface and resultant areas of treatment systems.

Measurement		1A	1B	2A	2B
Width (m)	Inflow	3.6	3.8	3.6	2.8
	Outflow	3.3	3.8	3.3	3.6
Length (m)		9.8	9.5	8.7	8.8
Approximate surface area at soil (m^2)		33.8	36.1	30.0	28.2
Total area of System at soil (m^2)		69.9		58.2	

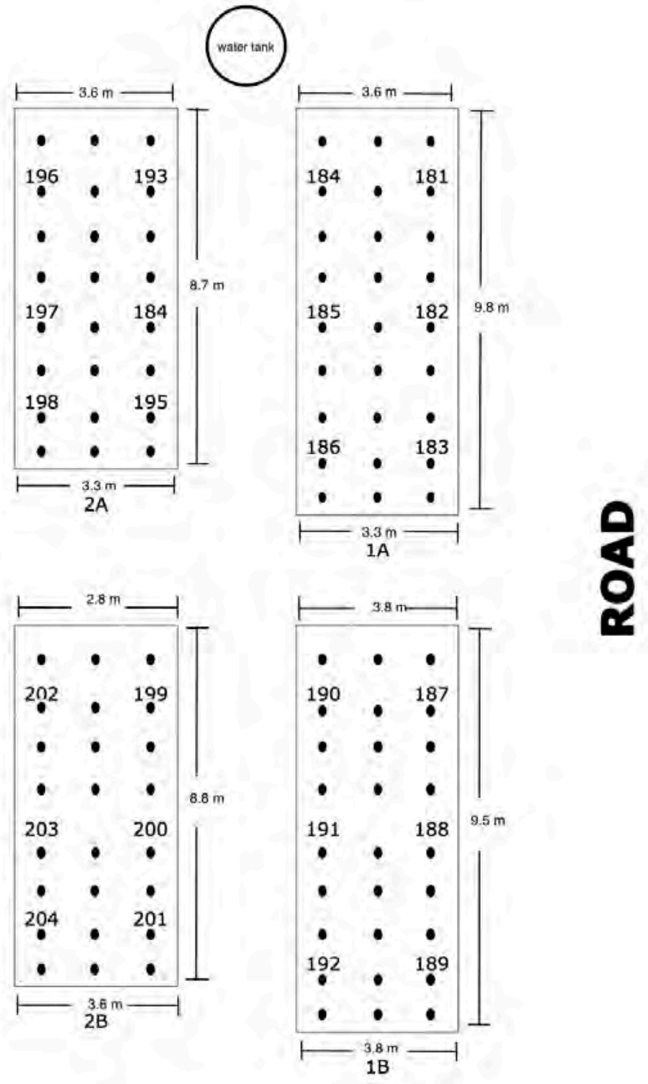

Figure 4. Diagram of demonstration-scale CWTS with dimension measurements at soil surface showing grid (by moss stakes; black dots) and locations of soil redox probes (with identifying numbers; Table 2).

2.2.Soil and Amendments

The recommended soil for the CWTS is sand, with 2-7% by volume as organic material (e.g., woodchips, peat). In the pilot-scale systems, this resulted in a total organic carbon (TOC) content of 0.2-0.6% (the sand itself was at 0.1% TOC prior to adding amendment). In this composition, the sand allows for circulation of water through the root zone of the plants, while the organic matter initiates reductive microbial processes that in future years will be sustained by decaying plant matter. In the case of this demonstration-scale system, the soil added to each of the 4 cells was from a local overburden site. The characteristics of this soil are provided in Appendix A. This borrow site was different than the site that was sampled during the Contango Strategies Ltd. (CSL) assessment in 2013, and also different than that tested in June 2014 (Appendix A, Table A1-A3).

The overburden soil used in the demonstration-scale CWTS was taken from stockpiled material that originated as richly organic soil from stripping of the Area 2 Pit. The calcium, magnesium and sulphate concentrations were higher than those of the pilot-scale tests, but this is not expected to negatively impact the performance of the CWTS. Owing to the general mineralization of the area, the concentration of copper was elevated in all soils tested as potential borrow sources. The synthetic precipitation leaching procedure (SPLP) analysis conducted on the soils used in the demonstration-scale wetland suggested there is between 148-608 µg/L of available copper and 0.35-0.69 µg/L of available selenium in the soil. This should be monitored and taken into consideration with wetland performance, and it may be necessary to investigate other sources of soil with lower copper concentration for final full-scale construction.

It was observed that the soil that was used for the demonstration-scale wetlands was higher in organic content and lower in sand than those used in the pilot-scale testing, or tested during the site assessment or June 2014 pre-construction sampling. This higher organic content was also associated with a more loamy texture. Due to the higher organics content in the soil being used for the demonstration-scale CWTS, there was less organic amendment added (by volume) than was initially planned. As the soil was added by the backhoe (Figure 5), there was 1 standard size straw bale (measuring 36 cm x 46 cm x 102 cm) and 50 rounded standard shovels of a 50:50 mix of spruce and pine wood shavings placed in each of the cells and mixed by hand with shovels and rakes (Figures 6 and 7). There was no biochar added as was proposed in the initial design as this was determined to not be required after the piloting phase at the CSL facilities (Contango, 2014).

The high organic content of this soil may actually be beneficial to the treatment of elements, through both sorption and increased microbial reductive processes. The drawback of using this organic material is that it may not facilitate the circulation of water in the root zone the way sand or gravel would, and it is also more difficult to work with for construction purposes. Specifically, the material used in the demonstration-scale CWTS did not support weight as a sandy soil would. For this reason, the wetland was planted while the soils were somewhat dry (before flooding), as the people planting the wetland would sink into the soil if it were wet. This should be taken into consideration if building the full-scale CWTS for the sake of ease of accessing monitoring points within the wetland, or if any revegetation campaigns are needed. Over time, however, the plant roots and moss will grow and provide greater physical stability to the soils.

Upon inspection, there was too much soil placed in the cells by the mini-backhoe; some of the soil was therefore removed to bring the outflow depth to 20 cm and maintain a level grade in each of the 4 cells to a tolerance of +/- 5 cm in order to provide a uniform water depth. A uniform water depth is necessary to prevent future issues such as channeling of water, open water spots due to plants being unable to grow because of excessive water depth, or conversely, drying out.

Figure 5. Soil being added to demonstration-scale CWTS cells.

Figure 6. Organic soil amendments used in demonstration-scale CWTS. Left, wood shavings 50:50 pine and spruce mixture; Right, straw.

Figure 7. Mixing organic amendments into soil in demonstration-scale CWTS cell 2A.

2.3.Plants

The demonstration-scale CWTS was planted with *Carex aquatilis* (Sedge) and mosses, as was determined by pilot-scale testing as being the best design for this site and application (Contango, 2014). These plant species were harvested for the demonstration scale CWTS from a location that was identified during the August/September 2013 site assessments in the vicinity of the W10 monitoring point (reports 2013-0100-256 and 2013-0100-257 on the YESAB registry). This site had *C. aquatilis* and aquatic mosses growing together as is desired for the CWTS design (Figures 8 and 9). Plant tissues were sent for analytical testing to determine initial concentrations (Appendix A, Table A4).

All 4 cells of the demonstration-scale CWTS were measured and the center of the width marked at both the inflow and outflow ends of each of the cells. The tape measure was then placed on the center axis down the length of each cell to start laying the center grid. The grid was created using wooden gardening stakes (50 cm in height), with aquatic moss tied to one end and inserted into the soil so that the moss was just above the soil (Figure 10; eventually to be submerged in the water). The grid for planting the *C. aquatilis* was created with these stakes, starting on the inflow end of each cell, with stake placement every 1 m progressing to the outflow (Figure 11). The final grid near the outflow of the cell was therefore sometimes less than 1 m of soil, but may look like a greater size due to the overlaying water. This was repeated moving outward from the center line, creating a grid of 1 m square areas for planting *C. aquatilis* to facilitate future monitoring of plant density. Depending on the varying width and length of the cells, along the sides of the length of the cells and the outflow of the cells the grids varied from 1 m squared to smaller than 1 m squared (Table 2).

Table 2. Number of planted grids in each demonstration-scale CWTS cell.

Item	Cell			
	1A	1B	2A	2B
Moss stakes	3*9=27	3*9=27	3*8=24	3*8=24
1 m squares	18	18	16	16
< 1 m squares (perimeter of CWTS cells)	22	22	20	20

Using the 4 stakes marking the edges of the grid, 5 *C. aquatilis* were planted into the soil inside each 1 m by 1 m grids, with one in the middle and 4 others approximately equidistant from the stakes to create an even distribution of 5 sedge per square meter (Figure 12). This placement and grid system was used to ensure even distribution of plants through the demonstration-scale CWTS, with the foresight of future monitoring for plant establishment and density. As the grids at the perimeter of each wetland cell varied and were often smaller than 1 m by 1 m, it was estimated based on the size of the grid how many sedge should be planted to maintain a consistent density of plants.

Figure 8. Harvesting plants from W10 location (top), and transporting back to demonstration-scale CWTS (bottom).

Figure 9. Images of *Carex aquatilis* and aquatic mosses harvested at W10 for planting the demonstration-scale CWTS. Left, aquatic mosses growing at water surface at edge of *C. aquatilis*; top right, underwater photograph of aquatic moss; bottom right, *C. aquatilis* and aquatic mosses growing together.

Figure 10. Example of moss tide to stakes, which then were used to make grid in each demonstration-scale CWTS (Figure 4, 11, 12 and Table2).

Figure 11. Moss stakes placed in demonstration-scale CWTS cell 2A, looking towards cell 2B.

Figure 12. *C. aquatilis* planted within grid of moss stakes in demonstration-scale CWTS cell 2A, and influent perforated pipe being laid in place.

2.4. Water

Water from the W36 area receiving seepage from the toe of the MVFE (Figure 13) was selected for the demonstration-scale CWTS testing as the leachate is similar to that expected upon closure in the Mill Valley Fill Extension (MVFE) area. The chemistry of this water at the time of bringing the demonstration-scale CWTS online (September 18, 2014) is provided in Appendix A, Table A5. A Grundfos CR1S-6 stage pump was selected to maintain the appropriate head of water in the holding tank to provide a range of flows between 0.1-1.1 m^3/hr on a 4-inch line with 30 m of head (Figure 13). The 3,000 Liter holding tank sits above and between the inflow of cells 1A and 2A and is kept at a constant head via pumping from the W36 sump (Figure 14). Overflow water is returned by gravity flow in a pipe to the W36 area. Meanwhile, water within the holding tank is gravity fed through control valves and flow meters prior to entering the parallel treatment cells (Figure 14). The tank was initially rinsed twice with the W36 water before releasing water into the demonstration CWTS because it had originally contained road dust suppressant (Envirobind). Water is constantly pumped from W36 to the tank that has been modified to maintain a constant head (and therefore pressure) to keep flow rate consistent when set using the manual valves. Flow rates are measured using ultra low flow and high accuracy/totalizer meters from GPI (Figure 14).

A flexible 1-inch braided rubber hose with perforations was attached to each of the flow meters and run to the inflow of cells 1A and 2A (Figure 12 and 14). The placement of these perforated hoses was adjusted to promote even flow across the width of the A cells. The system then operates by gravity flow, with Cell 1A and 2A flowing into 1B and 2B, respectively, before flowing into the catchment basin and returning by pipe to W36 (Figure 15).

Sandbags were used at the outflow of each cell to correct for unevenness in grade and prevent channeling to the lowest point. The average height of water in the cells above the soil was approximately 20 cm (Figure 16).

The flow rates for the systems were set to have a 10 day nominal hydraulic retention time (HRT), meaning water entering the wetland takes 10 days to exit. This is referred to as a nominal HRT because it is a calculation based on the size of the wetland and the amount of water entering, and not confirmed empirically using tracing dyes. The HRT was calculated based on the size of the CWTS at the soil, with a 20 cm overlay of water, but not adjusting for pore water because without dense vegetation, the pore spaces in the soil will only have minimal hydraulic relationship to the overlaying water. This HRT is much longer than what is necessary to achieve treatment based on the pilot-scale systems (~3 days), however, this was chosen to facilitate plant establishment and maturation. Because the sizes of the CWTS systems were slightly different, Series 1 (closer to the road) and Series 2 (further from road) were set with inflow rates of 13,928 L/day and 11,635L/day, respectively, both corresponding to an approximate 10 day HRT. As the flow meters record in US gal/min, this corresponds to 2.6 and 2.13 US gal/min.

Figure 13. Water source for demonstration-scale CWTS. Left, Grundfos CR1S-6 stage pump; Right, water source at W36.

Figure 14. Clockwise from left: holding tank, splitting control valve, and flow meters.

Figure 15. Demonstration-scale CWTS immediately after planting and filling with water (August 29, 2014). Top, photograph taken from camp behind kitchen looking down at inflow of CWTS; bottom, photograph taken from outflow holding pond looking towards camp in background.

2.5. Data Collection

Explanatory parameters are quantifiable aspects of a CWTS that can be used to assess the feasibility of treatment for a range of constituents, and therefore 'explain' the performance of a CWTS. These parameters, which often include acidity, alkalinity, conductivity, dissolved oxygen (DO), pH, oxidation reduction potential (ORP), ion balance, available electrons donors (e.g., organic carbon, reduced elements), and temperature, can be used to predict, promote, and/or optimize the ability of the system to treat different constituents.

The relative oxidation-reduction (redox) potential of the soil will be measured using inert electrodes (copper wire probes with platinum tips) permanently installed in the soil of the cells for the duration of the project (Faulkner et al., 1989; Figure 16). To take a reading of the relative redox potential between the soil and water, a reference electrode (Accumet Calomel) is suspended in the water column above the inert electrode and measured in millivolts by a voltmeter. There were 6 platinum tip probes distributed throughout each of the 4 demonstration-scale cells to try and achieve even distribution based on the varying cell sizes. The probes were inserted to cover the epoxy on the end of the probe and secured with flagging tape to the bamboo poles for visibility. The locations of each probe are provided in Figure 4 and Table 3.

Figure 16. Series 2 (cell 2B in foreground, cell 2A in background), showing sandbags used at inflows and outflows between cells.

Table 3. List of location and probe number for inert electrodes permanently installed in the soil of cells. General location also provided in Figure 4.

Stake - Row	Cell 1A	Cell 1B	Stake - Row	Cell 2A	Cell 2B
2nd - Inside	#181	#187	2nd - Inside	#193	#199
5th - Inside	#182	#188	5th - Inside	#194	#200
8th - Inside	#183	#189	7th - Inside	#195	#201
2nd - Outside	#184	#190	2nd - Outside	#196	#202
5th - Outside	#185	#191	5th - Outside	#197	#203
8th - Outside	#186	#192	7th - Outside	#198	#204

Probe numbers 205 to 209 were left as spares, in case of probe failure.

3. Sampling Schedule for 2015

The sampling schedule for 2015 was conceptually developed prior to beginning construction of the demonstration-scale CWTS (Table 4) and the analytical testing refined and summarized in Table 5. Actual dates of sampling will depend on timing of spring thaw and ability to bring the pumps online at the W36 pond to supply water to the demonstration-scale CWTS.

Table 4. Conceptual sampling parameters, locations, and frequencies.

Frequency	Parameter	Location	Sample Type
Weekly	Temperature (by data logger)	All Cells + Inflow to CWTS	Water
	pH		
	Dissolved Oxygen		
	Conductivity		
	ORP		
	Inflow rates/outflow rates (by meter)		
	Regulated Metals (ICP) (Total and dissolved)		
	Relative redox potential	All Cells	Soil
Monthly	Alkalinity	Outflow All cells + Inflow to CWTS	Water
	Hardness		
	Sulfate		
	Chemical Oxygen Demand		
	Total Organic Carbon		
	Ammonia		
	Nitrate/Nitrite		
	Total Kjeldahl Nitrogen		
	Biological Oxygen Demand	Outflow + Inflow of CWTS	
	Total Suspended Solids		

	Stem counts (and height)	All cells	Plant
Seasonally	Available NPKS	All cells	Soil
	Regulated Metals (ICP)		
	Total Organic Carbon		
	Cation Exchange Capacity (CEC)		
	Sodium Adsorption Ratio		
	Conductivity		
	Sequential Leaching		
	MPN for SeIV, NO_3, and sulphate reducing microbes, and total heterotrophs		
	Genetic microbial community profiles		
Twice per year	Detritus depth/accretion measurement	All Cells	Soil
	Regulated Metals (ICP)		Plant
	Available NPK and Sulphur		

Table 5. Summary of analytical sampling types, frequencies and locations

Water samples	
routine package: Ca, Mg, Na, K, Cl, SO_4, NO_3, NO_2, hardness, alkalinity, pH, EC, TDS	Monthly, outflow of each cell and inflow water
Chemical oxygen demand (COD)	Monthly, outflow of each cell and inflow water
Total organic carbon	Monthly, outflow of each cell and inflow water
Ammonia	Monthly, outflow of each cell and inflow water
Total Kjeldahl Nitrogen (TKN)	Monthly, outflow of each cell and inflow water
Total suspended solids	Monthly, outflow of series, and inflow water
Biological Oxygen Demand (BOD)	Monthly, outflow of series, and inflow water
Regulated metals water package (dissolved and total)	Weekly, outflow of each cell and inflow water
In-situ water testing (pH, DO, ORP, Conductivity)	Weekly, all cells and inflow water
Hydrosoil samples	
Relative soil redox	Weekly, all probes (6 per cell)
Cation exchange capacity (CEC)	Seasonally (3x per year), 3 places per cell
SAR, pH, EC, %sat, Ca, Mg, Na, K, Cl, SO4	Seasonally (3x per year), 3 places per cell
Available NPK and sulphur	Seasonally (3x per year), 3 places per cell
Total organic carbon	Seasonally (3x per year), 3 places per cell
Sequential Leaching	Seasonally (3x per year), 3 places per cell
Plant tissue samples	
ICP	2 plant types in triplicate (pre-planting in 2014)
Available NPK and sulphur	2 plant types in triplicate (pre-planting in 2014)
TOC	2 plant types in triplicate (pre-planting in 2014)

4. Long-term conceptual testing plan

A conceptual long-term testing plan has been developed for the demonstration-scale CWTS

(Table 6), which will be refined and adapted based on performance and scientific findings as the trials are conducted. The demonstration-scale wetlands will run for a minimum of 2 more years, until the end of 2016, but ideally longer in order to assess performance under a wider range of conditions. The conditions that could eventually be tested include both natural/environmental and selected influenced pressures, and can be imposed on the systems to mimic peak flow rates or droughts. In 2015 the systems will be allowed to continue to mature, with plants becoming more established and abundant, and microbial communities accordingly acclimating to the targeted conditions. Once plants are well established and showing signs of colonizing through the wetland, the water depth may be increased to 30 cm and the flow rate may also be increased. First, a 5 day HRT (i.e., twice as fast as currently) may be tested, and then fluctuations will be tested based on anticipated seasonal variation.

Table 6. Schedule as per proposed scope of work:

Item		Proposed	Actual
Identify potential location for demonstration scale CWTS (CSL site visit – 1 scientist)		June 1-14 2014	Completed
Engineering and geotechnical (Minto)		June - July 2014	Completed
Construction (Minto)		July 2014	Completed
Planting and bringing system online (CSL site visit – 1 scientist, 1 technologist), coordinate for local students to assist.		August 2014	Completed (no students available, brought 2 technologists)
Monitoring	2014	Acclimation and maturation at constant flow rate of 10 d HRT	Completed
		September - CSL site visit/checkup (1 technologist, 1 scientist)	Did not occur because constructed was last week of August.
	2015	Continued maturation/acclimation. Operation at constant flow rate of 5-10 d HRT	On Schedule
		Spring – CSL site visit/checkup (1 technologist, 1 scientist), includes micro sampling	
		Summer - Increase depth from 10 cm to 20 cm (1 technologist), includes micro sampling	
		Fall – CSL site visit/checkup (1 technologist), includes micro	

		sampling	
	2016	Operation with weekly flow variations based on seasonal variations	
		Spring – CSL site visit/checkup (1 technologist), includes micro sampling	
		Summer - CSL site visit/checkup (1 technologist, 1 scientist), switch to hybrid bioreactor phase if appropriate, includes micro sampling	
		Fall - CSL site visit/checkup (1 technologist), includes micro sampling	
	2017	Hybrid Bioreactor/CWTS phase, late in operation 2016 or 2017, exact timing to be determined based on results from initial operations of the demo scale and results of hybrid CWTS/bioreactor pilot testing. This will involve adding solid organic matter (such as alfalfa hay, straw) to the CWTS cell(s).	
Reporting	2014-2016	Reporting will be performed twice annually, in the form of an interim update and comprehensive (all data to date) report.	On Schedule

5. Closure

We trust the information herein satisfies your present requirements. Should you have any questions, please contact the persons listed below. We appreciate the opportunity to provide the services detailed in this report, and look forward to discussing any comments you may have.

Respectfully submitted,
Contango Strategies Ltd

ALBERTA SOCIETY of Professional Biologists
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6. References

Contango Strategies. Minto Mine Constructed Wetland Treatment Research Program – Pilot Scale Report, November 3, 2014.

Faulkner, S.P., Patrick, W.H. Jr. and Gambrell, R.P. (1989) Field techniques for measuring wetland soil parameters. Soil Science Society of America Journal, Vol. 53, pp. 883-890.

Table A1. Analytical results from initial soil sampled August 28, 2014

Parameter	Units	Rep1	Rep2	Rep3	Rep4	Wood Shavings	Straw	RDL
Calculated Parameters								
Anion Sum	meq/L	5.0	3.1	0.89	0.81	1.0	14	N/A
Cation Sum	meq/L	8.1	6.5	13	5.4	2.2	24	N/A
Cation/EC Ratio	N/A	11	11	10	11	10	9.4	0.10
Ion Balance	N/A	1.6	2.1	15	6.7	2.2	1.7	0.010
Cation exchange capacity	cmol+/Kg	22	20	18	20	<10	50	10
Soluble Parameters								
Soluble Chloride (Cl)	mg/L	41	16	240	26	12	310	5.0
Soluble Conductivity	dS/m	0.72	0.61	1.3	0.51	0.21	2.5	0.020
Soluble (CaCl2) pH	pH	6.46	6.44	6.56	6.47	3.95		N/A
Sodium Adsorption Ratio	N/A	0.55	0.53	2.0	0.65	0.30	0.63	0.10
Soluble Calcium (Ca)	mg/L	110	92	150	71	11	20	1.5
Soluble Magnesium (Mg)	mg/L	14	11	16	8.8	4.0	47	1.0
Soluble Sodium (Na)	mg/L	23	20	97	22	4.6	22	2.5
Soluble Potassium (K)	mg/L	7.6	7.4	8.5	7.1	39	710	1.3
Saturation %	%	47	48	47	44	620	1400	N/A
Soluble Sulphate (SO4)	mg/L	210	180	190	140	<5.0	210	5.0
Nutrients								
Available (NH4F) Nitrogen (N)	mg/kg	8.0	8.1	6.0	5.3	<10	<10	10
Available (NH4F) Phosphorus (P)	mg/kg	5.1	5.7	5.6	3.9	16	200	5.0
Available (NH4OAc) Potassium (K)	mg/kg	55	53	48	61	260	7700	10
Available (CaCl2) Sulphur (S)	mg/kg	29	24	27	24	<20	850	20
Nitrite (N)	mg/L	0.0165	0.0216	0.0156	0.0623	0.0127	<0.50	0.50
Nitrate (N)	mg/L	0.315	0.445	0.332	0.150	0.252	<2.0	2.0
Total Ammonia (N)	mg/L	<0.0050	0.0076	0.0086	0.0090	0.0428	0.067	0.050
Misc. Inorganics								
Fluoride (F)	mg/L	0.220	0.350	0.250	0.210	0.041	0.089	0.010

Parameter	Units	Rep1	Rep2	Rep3	Rep4	Wood Shavings	Straw	RDL
Dissolved Organic Carbon (C)	mg/L	6.55	5.91	4.96	6.85	355	815	50
Total Organic Carbon (C)	%	1.9	1.8	3.1	1.8	48	45	0.10
Alkalinity (Total as CaCO3)	mg/L	33.5	126	36.7	34.8	30.7	304	0.50
Alkalinity (PP as CaCO3)	mg/L	<0.50	13.2	2.49	8.01	<0.50	<0.50	0.50
Bicarbonate (HCO3)	mg/L	40.9	121	38.7	22.9	37.5	371	0.50
Carbonate (CO3)	mg/L	<0.50	15.9	2.99	9.61	<0.50	<0.50	0.50
Hydroxide (OH)	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Physical Properties								
% sand by hydrometer	%	59	60	55	57			
% silt by hydrometer	%	26	25	28	27			
Clay Content	%	15	16	17	16			
Texture	N/A	SANDY LOAM	SANDY LOAM	SANDY LOAM	SANDY LOAM			
Total Dissolved Solids	mg/L	80	200	104	222	692	2360	10
Dissolved Metals by ICPMS								
SPLP Aluminum (Al)	ug/L	6540	3640	4840	34400	145	151	2.5
SPLP Antimony (Sb)	ug/L	0.242	0.208	0.243	0.48	0.042	<0.10	0.10
SPLP Arsenic (As)	ug/L	3.24	2.19	2.67	15.0	0.446	1.57	0.10
SPLP Barium (Ba)	ug/L	141	79.9	102	476	46.8	396	0.10
SPLP Beryllium (Be)	ug/L	0.133	0.091	0.142	0.629	0.015	<0.050	0.050
SPLP Bismuth (Bi)	ug/L	0.0440	0.0240	0.0270	0.193	<0.0050	0.039	0.025
SPLP Boron (B)	ug/L	519	233	90	<250	127	<250	250
SPLP Cadmium (Cd)	ug/L	0.0470	0.0410	0.0740	0.158	0.137	0.484	0.025
SPLP Cesium (Cs)	ug/L	0.347	0.206	0.290	1.42	<0.050	0.29	0.25
SPLP Chromium (Cr)	ug/L	10.7	7.80	6.12	43.1	0.62	0.94	0.50
SPLP Cobalt (Co)	ug/L	2.53	1.44	2.13	10.5	0.106	0.291	0.025
SPLP Copper (Cu)	ug/L	248	148	186	608	11.0	116	0.25
SPLP Iron (Fe)	ug/L	8900	4950	7040	47400	49.4	308	5.0
SPLP Lanthanum (La)	ug/L	5.72	4.16	4.81	17.9	<0.050	0.27	0.25

Parameter	Units	Rep1	Rep2	Rep3	Rep4	Wood Shavings	Straw	RDL
SPLP Lead (Pb)	ug/L	3.00	1.79	2.21	12.4	1.10	14.7	0.025
SPLP Lithium (Li)	ug/L	2.90	1.66	2.00	12.6	1.05	3.5	2.5
SPLP Manganese (Mn)	ug/L	125	76.0	103	372	272	597	0.25
SPLP Molybdenum (Mo)	ug/L	1.75	1.46	1.94	1.86	0.230	2.52	0.25
SPLP Nickel (Ni)	ug/L	5.93	3.76	5.39	26.5	0.693	2.22	0.10
SPLP Phosphorus (P)	ug/L	132	84.6	107	503	416	1460	10
SPLP Rubidium (Rb)	ug/L	7.05	4.56	5.97	27.7	13.7	241	0.25
SPLP Selenium (Se)	ug/L	0.487	0.355	0.360	0.69	<0.040	1.09	0.20
SPLP Silicon (Si)	ug/L	14900	8970	11200	67100	425	24000	500
SPLP Silver (Ag)	ug/L	0.123	0.0950	0.123	0.325	0.0560	0.446	0.025
SPLP Strontium (Sr)	ug/L	14.2	12.7	12.2	35.6	11.3	156	0.25
SPLP Tellurium (Te)	ug/L	<0.020	0.024	0.021	<0.10	<0.020	<0.10	0.10
SPLP Thallium (Tl)	ug/L	0.0500	0.0310	0.0410	0.184	0.0110	0.103	0.010
SPLP Thorium (Th)	ug/L	1.44	1.06	1.25	4.56	0.0140	0.151	0.025
SPLP Tin (Sn)	ug/L	0.32	<0.20	0.22	1.1	<0.20	<1.0	1.0
SPLP Titanium (Ti)	ug/L	237	129	176	1280	1.28	4.7	2.5
SPLP Tungsten (W)	ug/L	0.093	0.080	0.086	0.203	0.054	<0.050	0.050
SPLP Uranium (U)	ug/L	0.176	0.134	0.151	0.865	0.0110	0.057	0.010
SPLP Vanadium (V)	ug/L	22.0	11.9	16.2	92.1	1.24	2.3	1.0
SPLP Zinc (Zn)	ug/L	19.9	13.2	15.4	74.4	16.0	84.5	0.50
SPLP Zirconium (Zr)	ug/L	1.72	1.42	1.49	5.77	0.12	<0.50	0.50
SPLP Calcium (Ca)	ug/L	3040	3290	3090	7240	3960	18000	250
SPLP Magnesium (Mg)	ug/L	1420	954	1110	6150	1670	38300	250
SPLP Potassium (K)	ug/L	1250	1010	1440	5780	14100	499000	250
SPLP Sodium (Na)	ug/L	43900	33900	22100	26900	8550	20500	250
SPLP Mercury (Hg)	ug/L	<0.050	<0.050	<0.050	<0.25	0.096	<0.25	0.25
SPLP Sulphur (S)	ug/L	<10000	<10000	<10000	<50000	<10000	<50000	50000

Table A2. Sequentially extracted ICP-MS analytical results from initial soil sampled August 28, 2014

mg/kg	Extraction 1				Extraction 2				Extraction 3				Extraction 4				Extraction 5				RDL
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4	
Al	-	-	-	-	34	28	30	34	800	640	890	720	920	1500	1300	1300	17000	17000	16000	15000	10
Sb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0
As	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5	6.7	6.7	6.3	2.0
Ba	45	24	39	46	91	51	80	76	120	100	120	110	46	150	63	65	540	620	510	530	5.0
Be	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0
B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.0
Cd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.30
Cr	-	-	-	-	-	-	-	-	-	-	-	-	2.5	6.2	3.4	3.5	21	31	19	19	2.0
Co	-	-	-	-	-	-	-	-	2.6	2.4	2.4	2.2	-	-	-	-	12	11	11	11	1.0
Cu	2.9	4.9	2.8	3.7	93	35	67	120	270	180	240	290	480	380	630	650	1500	960	1400	1300	2.0
Fe	-	-	-	-	-	85	-	-	5000	4400	5300	4700	340	610	440	550	35000	31000	34000	33000	50
Pb	-	-	-	-	-	-	-	-	1.4	1.3	1.5	1.4	-	1.1	0.60	0.74	6.0	8.4	5.3	5.3	0.50
Mn	-	-	-	2.3	140	76	120	130	160	110	150	150	19	21	23	28	750	490	670	700	2.0
Mo	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.9	2.0
Ni	-	-	-	-	-	-	-	-	3.7	5.9	3.7	3.4	-	3.3	-	-	18	28	17	17	2.0
Se	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0
Ag	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50
Ar	14	13	12	14	7.7	7.3	6.9	6.2	-	5.8	-	-	-	-	-	-	48	58	45	47	5.0
Tl	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.22	0.16	0.20	0.20	0.10
U	-	-	-	-	0.19	0.46	0.17	0.15	0.17	0.38	0.17	0.15	-	0.45	0.10	0.11	0.87	2.1	0.78	0.77	0.10
V	-	-	-	-	-	-	-	-	10	12	11	9.3	-	3.8	-	-	80	79	75	74	2.0
Zn	-	-	-	-	-	-	-	-	11	9.1	12	10	-	6.1	5.2	5.5	89	70	83	82	5.0

Table A3. Sequentially extracted ICP-MS analytical results from initial wood shavings and straw amendments sampled August 28, 2014

mg/kg	Wood Shavings					Straw					RDL
	E1	E 2	E3	E4	E5	E1	E2	E3	E4	E5	
Al	-	-	-	-	-	-	-	-	-	35	10
Sb	-	-	-	-	-	-	-	-	-	-	2.0
As	-	-	-	-	-	-	-	-	-	-	2.0
Ba	-	-	-	-	10	-	11	10	-	55	5.0
Be	-	-	-	-	-	-	-	-	-	-	2.0
B	-	-	-	-	-	-	-	-	-	-	5.0
Cd	-	-	-	-	-	-	-	-	-	-	0.30
Cr	-	-	-	-	-	-	-	-	-	-	2.0
Co	-	-	-	-	-	-	-	-	-	-	1.0
Cu	-	-	-	-	-	-	-	-	-	3.5	2.0
Fe	-	-	-	-	-	-	-	-	-	140	50
Pb	-	-	-	-	-	-	-	-	-	2.6	0.50
Mn	21	13	5.4	-	86	3.5	14	7.5	-	70	2.0
Mo	-	-	-	-	-	-	-	-	-	-	2.0
Ni	-	-	-	-	-	-	-	-	-	7.1	2.0
Se	-	-	-	-	-	-	-	-	-	-	2.0
Ag	-	-	-	-	-	-	-	-	-	-	0.50
Ar	-	-	-	-	-	-	-	-	-	13	5.0
Tl	-	-	-	-	-	-	-	-	-	-	0.10
U	-	-	-	-	-	-	-	-	-	-	0.10
V	-	-	-	-	-	-	-	-	-	-	2.0
Zn	-	-	-	-	9.0	-	-	-	-	15	5.0

Table A4. Analytical results from plants sampled August 27, 2014

Parameter	Units	Carex						Moss			RDL
		Roots			Leaves						
		Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	Rep 1	Rep 2	Rep 3	
Nutrients											
Available Nitrogen (N)	mg/kg	<10	<10	<10	<10	<10	<10	<10	<10	<10	10
Available Phosphorus (P)	mg/kg	240	48	91	640	520	810	470	340	150	5.0
Available Potassium (K)	mg/kg	8100	1400	3200	9100	8100	11000	4000	5400	2700	10
Available Sulphur (S)	mg/kg	210	670	700	170	340	530	290	400	220	20
Misc. Inorganics											
Total Organic Carbon (C)	%	39	36	37	38	38	43	43	45	40	0.10
Total Carbon	%	41	37	38	45	40	44	41	45	44	0.20
Inorganics											
Moisture	%	87	88	86	74	77	75	90	94	92	1.0
Metals											
Antimony (Sb)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Arsenic (As)	mg/kg	1.7	1.0	0.4	0.3	0.1	<0.1	0.2	0.1	<0.1	0.1
Barium (Ba)	mg/kg	53.9	34.3	28.2	31.0	23.3	17.9	29.9	22.3	10.5	0.3
Beryllium (Be)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Bismuth (Bi)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Boron (B)	mg/kg	<0.5	0.6	0.8	1.0	0.8	1.1	0.5	<0.5	<0.5	0.5
Cadmium (Cd)	mg/kg	0.02	<0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.01
Calcium (Ca)	mg/kg	973	648	752	1160	944	743	1460	1210	1160	50
Chromium (Cr)	mg/kg	1.4	1.2	0.6	1.3	0.5	0.4	<0.3	<0.3	<0.3	0.3
Cobalt (Co)	mg/kg	1.45	0.864	0.965	0.594	0.333	0.164	0.645	0.464	0.166	0.005
Copper (Cu)	mg/kg	93.7	47.0	15.1	20.5	21.9	6.8	13.8	18.3	11.2	0.5
Iron (Fe)	mg/kg	7870	4540	2560	2080	1140	540	1190	1020	404	3
Lead (Pb)	mg/kg	0.27	0.11	0.11	0.08	0.06	<0.03	0.04	0.04	0.03	0.03
Magnesium (Mg)	mg/kg	910	477	327	653	321	325	293	229	190	100
Manganese (Mn)	mg/kg	98.3	128	151	116	282	141	272	179	27.1	0.3
Molybdenum (Mo)	mg/kg	0.18	0.21	0.15	0.31	0.41	0.17	0.29	0.09	0.25	0.05
Nickel (Ni)	mg/kg	0.87	0.41	0.37	0.32	0.20	0.11	0.36	0.49	0.13	0.05
Phosphorus (P)	mg/kg	<500	<500	<500	<1000	<1000	<1000	<500	<500	<500	500
Potassium (K)	mg/kg	1180	1070	1440	2860	3620	3430	674	363	315	100
Selenium (Se)	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Silver (Ag)	mg/kg	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Sodium (Na)	mg/kg	509	512	508	222	149	180	94	54	<50	50
Strontium (Sr)	mg/kg	5.8	4.4	5.7	5.7	5.4	4.7	10.1	8.2	7.1	0.5
Thallium (Tl)	mg/kg	0.007	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.003
Tin (Sn)	mg/kg	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.3
Titanium (Ti)	mg/kg	109	49	24.3	42	22.8	8.0	6.0	5.9	4.6	0.5
Uranium (U)	mg/kg	0.049	0.025	0.035	0.016	0.016	0.012	0.014	0.015	0.007	0.005
Vanadium (V)	mg/kg	11.8	4.9	3.2	3.5	1.8	0.7	0.7	0.8	0.4	0.3
Zinc (Zn)	mg/kg	12	6	4	7	7	4	5	4	2	2

Table A5. Analytical results from water sampled September 18, 2014

Parameter	Units	CWTS LINE 1	CWTS 1A	CWTS 1B	CWTS LINE 2	CWTS 2A	CWTS 2B	CWTS FINAL	RDL
Elements									
Total Aluminum (Al)	mg/L	0.13	0.031	0.044	0.011	0.021	0.016	0.026	0.0030
Dissolved Aluminum (Al)	mg/L	0.0062	0.0093	0.015	0.0091	0.0097	0.013	0.017	0.0030
Total Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	0.00060
Dissolved Antimony (Sb)	mg/L	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	<0.00060	0.00060
Total Arsenic (As)	mg/L	0.00041	0.00041	0.00044	0.00034	0.00039	0.00038	0.00039	0.00020
Dissolved Arsenic (As)	mg/L	0.00038	0.00038	0.00040	0.00034	0.00034	0.00039	0.00042	0.00020
Total Barium (Ba)	mg/L	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.010
Dissolved Barium (Ba)	mg/L	0.12	0.12	0.13	0.12	0.12	0.13	0.13	0.010
Total Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Dissolved Beryllium (Be)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Total Boron (B)	mg/L	<0.020	<0.020	<0.020	<0.020	0.024	0.020	<0.020	0.020
Dissolved Boron (B)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020
Total Cadmium (Cd)	ug/L	0.048	0.045	0.039	0.046	0.040	0.029	0.021	0.020
Dissolved Cadmium (Cd)	ug/L	0.046	0.036	0.030	0.041	0.038	0.022	<0.020	0.020
Total Calcium (Ca)	mg/L	130	130	130	130	130	130	130	0.30
Dissolved Calcium (Ca)	mg/L	130	120	120	130	120	120	120	0.30
Total Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Dissolved Chromium (Cr)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Total Cobalt (Co)	mg/L	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00030
Dissolved Cobalt (Co)	mg/L	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	<0.00030	0.00030
Total Copper (Cu)	mg/L	0.088	0.047	0.046	0.053	0.047	0.041	0.041	0.00020
Dissolved Copper (Cu)	mg/L	0.046	0.041	0.039	0.047	0.042	0.036	0.034	0.00020
Total Iron (Fe)	mg/L	0.50	0.20	0.20	0.19	0.18	0.15	0.15	0.060
Dissolved Iron (Fe)	mg/L	0.13	0.11	0.12	0.15	0.12	0.10	0.10	0.060
Total Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020
Dissolved Lead (Pb)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020

Parameter	Units	CWTS LINE 1	CWTS 1A	CWTS 1B	CWTS LINE 2	CWTS 2A	CWTS 2B	CWTS FINAL	RDL
Total Lithium (Li)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020
Dissolved Lithium (Li)	mg/L	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	0.020
Total Magnesium (Mg)	mg/L	37	38	37	38	37	37	38	0.20
Dissolved Magnesium (Mg)	mg/L	37	36	37	37	36	36	36	0.20
Total Manganese (Mn)	mg/L	0.26	0.19	0.16	0.26	0.19	0.14	0.094	0.0040
Dissolved Manganese (Mn)	mg/L	0.25	0.18	0.15	0.25	0.20	0.14	0.090	0.0040
Total Molybdenum (Mo)	mg/L	0.0083	0.0082	0.0083	0.0084	0.0083	0.0081	0.0082	0.00020
Dissolved Molybdenum (Mo)	mg/L	0.0079	0.0076	0.0078	0.0077	0.0078	0.0079	0.0076	0.00020
Total Nickel (Ni)	mg/L	0.0013	0.0012	0.0015	0.0012	0.0012	0.0011	0.0012	0.00050
Dissolved Nickel (Ni)	mg/L	0.00075	0.00079	0.00079	0.00072	0.00074	0.00081	0.00068	0.00050
Total Phosphorus (P)	mg/L	0.12	<0.10	<0.10	<0.10	0.14	0.11	<0.10	0.10
Dissolved Phosphorus (P)	mg/L	<0.10	0.13	0.12	<0.10	<0.10	<0.10	<0.10	0.10
Total Potassium (K)	mg/L	4.5	4.5	4.4	4.5	4.5	4.4	4.6	0.30
Dissolved Potassium (K)	mg/L	4.3	4.3	4.4	4.3	4.3	4.3	4.4	0.30
Total Selenium (Se)	mg/L	0.0064	0.0065	0.0064	0.0066	0.0063	0.0063	0.0062	0.00020
Dissolved Selenium (Se)	mg/L	0.0063	0.0061	0.0061	0.0063	0.0061	0.0063	0.0059	0.00020
Total Silicon (Si)	mg/L	7.8	7.2	7.0	7.6	7.2	7.1	7.2	0.10
Dissolved Silicon (Si)	mg/L	7.3	6.9	6.8	7.3	6.9	6.9	6.8	0.10
Total Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010
Dissolved Silver (Ag)	mg/L	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	0.00010
Total Sodium (Na)	mg/L	22	22	22	22	22	22	23	0.50
Dissolved Sodium (Na)	mg/L	22	21	22	22	21	22	22	0.50
Total Strontium (Sr)	mg/L	1.3	1.3	1.3	1.4	1.3	1.3	1.3	0.020
Dissolved Strontium (Sr)	mg/L	1.3	1.3	1.3	1.3	1.3	1.3	1.3	0.020
Total Sulphur (S)	mg/L	44	45	43	44	43	44	44	0.20
Dissolved Sulphur (S)	mg/L	42	41	42	42	41	42	42	0.20
Total Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020
Dissolved Thallium (Tl)	mg/L	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	0.00020

Parameter	Units	CWTS LINE 1	CWTS 1A	CWTS 1B	CWTS LINE 2	CWTS 2A	CWTS 2B	CWTS FINAL	RDL
Total Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Dissolved Tin (Sn)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Total Titanium (Ti)	mg/L	0.014	0.0023	0.0038	<0.0010	0.0021	<0.0010	0.0015	0.0010
Dissolved Titanium (Ti)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Total Uranium (U)	mg/L	0.0031	0.0029	0.0031	0.0031	0.0031	0.0030	0.0031	0.00010
Dissolved Uranium (U)	mg/L	0.0032	0.0032	0.0032	0.0032	0.0032	0.0034	0.0032	0.00010
Total Vanadium (V)	mg/L	0.0011	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Dissolved Vanadium (V)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0010
Total Zinc (Zn)	mg/L	0.075	0.055	0.049	0.071	0.059	0.042	0.029	0.0030
Dissolved Zinc (Zn)	mg/L	0.068	0.049	0.037	0.068	0.052	0.038	0.022	0.0030
Misc.									
Dissolved Nitrite (N)	mg/L	0.016	0.020	0.020	0.016	0.020	0.022	0.026	0.010
Dissolved Nitrate (N)	mg/L	12	12	12	12	12	12	12	0.020
Total Ammonia (N)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.050
Total Nitrogen (N)	mg/L	13	13	13	13	13	13	13	0.050
Biochemical Oxygen Demand	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.0
Total Chemical Oxygen Demand	mg/L	27	28	31	26	41	27	27	5.0
Conductivity	uS/cm	920	920	910	930	920	910	900	1.0
pH	pH	8.27	8.23	8.34	8.20	8.32	8.30	8.44	N/A
Total Organic Carbon (C)	mg/L	9.7	9.3	9.7	9.5	10	11	10	0.50
Total Suspended Solids	mg/L	0.67	1.1	1.3	<0.40	0.53	0.67	0.40	0.40
Alkalinity (PP as CaCO3)	mg/L	<0.50	<0.50	0.90	<0.50	<0.50	<0.50	5.0	0.50
Alkalinity (Total as CaCO3)	mg/L	300	300	300	300	300	300	290	0.50
Bicarbonate (HCO3)	mg/L	360	360	360	370	360	360	350	0.50
Carbonate (CO3)	mg/L	<0.50	<0.50	1.1	<0.50	<0.50	<0.50	6.0	0.50
Hydroxide (OH)	mg/L	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.50
Dissolved Sulphate (SO4)	mg/L	140	140	140	140	140	140	140	1.0
Dissolved Chloride (Cl)	mg/L	22	21	22	21	22	21	21	1.0

Forward looking. Lateral thinking.

Minto Mine Constructed Wetland Treatment Research Program – Pilot Scale

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1. Abbreviations and Definitions

CWTS(s) – Constructed Wetland Treatment System(s).

Dissimilatory reduction – is a process utilized by specific types of bacteria where an electron donor material (e.g. organic carbon) is oxidized, producing energy for the bacteria and reducing another material (e.g. sulphate, or selenium) as part of the microbial metabolism.

DNA (deoxyribonucleic acid) – is the hereditary material in almost all living organisms. This can be used to identify organisms.

DO – Dissolved Oxygen.

Heterotroph – an organism deriving its nutritional requirements from complex organic substances.

Metagenomics – the study of genetic material recovered directly from environmental samples, related to a community rather than an individual organism.

Microbes – microscopic organisms which may be uni- or multi-cellular. This includes algae, bacteria, fungi, viruses, and yeast.

MPN (Most Probable Number) – a statistical value representing the viable population of microbes in a sample through use of dilution and multiple inoculations.

Oxidation – is the loss of electrons or increase in oxidation state by a molecule, atom, or ion. Can be driven by microbes. Process is complementary to chemical reduction.

Redox – Oxidation-reduction potential, measured in millivolts.

Reduction (chemical) – is the gain of electrons or a decrease in oxidation state by a molecule, atom, or ion. Can be catalyzed by microbes. Process is complementary to chemical oxidation.

RRC (Removal Rate Coefficient) - a numerical value, expressed as the variable *k,* representing a first order rate of removal, considering removal extent and the time required for removal.

SeIV broth or agar – laboratory growth medium that contains selenite (SeIV) and indicates reduction of selenite to elemental selenium through a visible colour change.

Species – one of the basic units of biological classification and a taxonomic rank. Rank in the classification of organisms below genus and above strain.

Taxonomy – classification, identification, and naming of organisms.

TSS – Total Suspended Solids.

YTS250 (Yeast, Tryptone, Starch, 250g each) – a type of laboratory growth medium used for environmental microbes.

2. Introduction

Constructed Wetland Treatment Systems (CWTSs) have been proposed as a method for improving the quality of site runoff water in the post-closure period for the Minto Mine (Minto Phase V/VI Expansion Project, YOR Project Number 2013-0100). Once established, wetlands can become self-sustaining ecosystems with the plants providing yearly renewal of carbon to fuel microbial activity. As such, they possess the desirable potential to remediate contaminated mine drainage for as long as it is generated. In order for CWTSs to be effective, however, they must be designed, piloted, optimized, implemented, and maintained in a site-specific manner.

Wetlands provide a natural environment in which unique biogeochemical reactions can occur. CWTSs can be designed to have desirable conditions similar to those in natural wetlands, and should be designed specifically for each site. Having a site-specific approach allows for the appropriate set of operational conditions to be achieved, where complex coupled reactions can take place for treatment of targeted constituents. This can be done with complex and challenging waters, where problematic constituents are transferred or transformed to less bioavailable forms. The benefits of CWTSs include:

- low operational cost,
- low maintenance,
- effective and robust treatment,
- increased effectiveness over time,
- aesthetically pleasing,
- tolerance to changes in flow rate and contaminant load, and
- simultaneous treatment of multiple constituents more effectively than chemical or physical treatment processes.

CWTSs have been used to mitigate risks to aquatic receiving environments from a variety of aqueous contaminants, including copper (Cu) and selenium (Se). The biogeochemical reactions that take place in a wetland environment are many, but there are specific reactions that may decrease the aqueous and more bioavailable concentrations of some contaminants (e.g. Cu, Se), thus lowering risk to the receiving environmental systems by decreasing exposure to contaminants. A process called dissimilatory sulphate reduction can chemically reduce available aqueous sulphate to sulphide through the metabolism of specific bacteria. Once dissimilatory sulphate reduction has occurred, it provides a mechanism to remove dissolved cations such as Cu from water by complexation with the sulphide ion to produce copper sulphide, an insoluble precipitate. Selenium treatment in a CWTS is a similar process, but with slightly different results. The mechanism for Se treatment is more direct, through dissimilatory selenium reduction that is also microbially mediated, often by some of the same bacteria that undergo dissimilatory sulphate reduction. The most common forms of aqueous Se are selenite and selenate, with valence states of IV and VI, respectively. When these are reduced in a wetland to an insoluble state, Se precipitates as elemental Se(0).

In both cases, the Cu and Se precipitates are removed from the water through filtration mechanisms inherent in wetlands and are sequestered into the sediments over time as an accretive process. Accretion is the naturally occurring process of accumulation of wetland sedimentary material (soil, minerals, decaying plant material, etc.) over time. Once an accreting CWTS is established and mature, targeted constituents are sequestered into the sediment and covered over time by newly generated sediments and detritus. This essentially seals away the treated constituents under layers of sediment, rendering them less bioavailable and less susceptible to re-entry into the water column. There is therefore no need to dredge or harvest wetland plants for the Minto site; in fact, this type of activity would disrupt the treatment functions and re-expose the previously sequestered constituents. This process mimics what occurs in naturally created wetlands; therefore, this process is often the best option for long-term, low-maintenance and effective treatment.

3. Background

At the request of Minto Explorations Ltd, Contango Strategies has undertaken a pilot-scale study to inform the design of site-specific passive treatment technologies for the Minto site during post-closure. These pilot-scale trials build upon a site assessment that was conducted and reported on in 2013. The overriding goal of this pilot study is to develop, optimize, and test site-specific pilot-scale CWTSs for post-closure water treatment at the Minto site.

4. Pilot System Operations

4.1. **Design and assembly**

In October 2013 three pilot CWTSs were constructed, each in duplicate, to evaluate the performances of different designs for selenium and copper treatment (Figures 1 and 2). These were planted with either Sedge (*Carex aquatilis*), or Sedge and aquatic moss as follows:

- System 1 and 2: *Carex aquatilis*
- System 3 and 4: *Carex aquatilis* + Moss
- System 5 and 6: *Carex aquatilis* + Moss, with biochar amendment in soil

The pilot CWTS systems were built with two cells per series, each cell having a 41 cm diameter and a height of 57 cm. To establish the plants, soil was filled to a depth of 20 cm at the bottom of each cell, and submerged under 10 cm of tap water. The water depth was changed throughout the pilot testing to evaluate effects on performance, and develop strategies for optimization.

4.1.1. Hydrosoil

Hydrosoil is a specially selected soil blend to aid in achieving the targeted hydraulic conductivity required to meet the CWTS objectives. In this case, the hydrosoil mixture was the same for all pilots; sand amended with 2% woodchips (v/v) and 5% peat, except that the third system design (system 5 and 6) also included a 5% pine biochar amendment. The sand and amendments were tested for initial metal and nutrient contents (Table 5). This specific type of biochar was chosen as an amendment as previous studies conducted by Contango have demonstrated that addition of biochar to the hydrosoil can result in faster establishment and growth of newly planted wetland plants (SETAC Presentation #593, Haakensen 2013). The biochar selected was low in soluble salts, had a high surface area, low metals content, and moderate available organic carbon and phosphorous (Appendix 1). The peat borrow site at the Minto Mine was selected as it provided a sufficient quantity for a full-scale wetland. It was tested for metals content and other relevant parameters such as nutrients (N, P, K), and total organic carbon before use in the pilot CWTS system.

4.1.2. Plants

Two plant species were of interest for the pilot CWTS based on data collected during the August/September 2013 site assessments (reports 2013-0100-256 and 2013-0100-257 on the YESAB registry). *Carex aquatilis* (sedge) was chosen, as it is readily available at the Minto site and was one of the first plants to colonize cleared areas, indicating that it may be a good candidate for quickly establishing the CWTS. Moss was also used in the second and third pilot CWTS designs (systems 3-6), as locations at Minto with shallower water had *Carex* and Moss coexisting. As such, we wanted to assess whether the Moss contributes positively or negatively to treatment, and also whether succession from *Carex* to Moss as the dominant plant can be prevented or enhanced through modification of water depth.

It is well known that Moss has a high uptake rate of cations (such as copper and selenium) and is also a relatively benign sink for these elements (i.e., is not a food source for invertebrates or higher animals and as such does not contribute greatly to bioaccumulation (Haines & Renwick, 2009; Longton, 1997; Suren & Winterbourn, 1991)). This was also confirmed in the site assessment in 2013, which produced data indicating that Moss at the Minto site has a high uptake of elements such as copper, and could therefore be an effective means of removing elements from seepage through uptake. During the September 2013 site visit, Moss and *Carex* were collected from the Minto site and these were subsequently used to vegetate all pilot CWTS in this study. A total of 10-12 *Carex* were planted per cell, with approximately a 250ml volume of Moss (compressed) added to systems 3-6.

4.1.3. Water and Testing Periods

The CWTS(s) were designed for treatment of water that would be present at the Minto site after closure. As such, this water does not yet exist and had to be synthesized as an approximation based on water quality modeling. The worst-case post-closure water chemistry was used based on the month of October, as it had the highest concentrations of key elements for any month with free-flowing water. The synthetic water underwent five iterations of design, testing, and optimization to ensure the composition and method of formulating the water resulted in analytical chemistry that matched the water quality predicted to exist after closure and reclamation of the Minto mine. The final recipe and resultant water chemistry is provided in Tables 1 and 2.

Design of the synthetic water chemistry focused on constituents requiring treatment and elements/compounds that are expected to affect treatment rates or capacity based on previous experience and scientific literature. For the first period (High N) of the pilot-phase work, the predicted maximum worst-case ammonia and nitrate concentrations were used, which reflected residuals of these compounds from blasting. The ammonia concentrations measured on site are lower than would be expected based on the chemical composition of ammonia nitrate used for blasting, suggesting that the ammonia has already undergone oxidation to nitrate prior to the seepage exiting the waste rock pile. Nitrate can affect compounds such as selenium that are removed from water through coupled biogeochemical reactions and dissimilatory reduction, as nitrate has a high affinity for available electrons and is preferentially reduced before other compounds. However, it is known that over time in closure, the concentrations of ammonia and nitrate will decrease dramatically, and this may affect removal rates of other compounds. As such, the pilot-scale CWTSs were subjected to a 6-week trial of synthetic water of the same max worst-case post-closure water quality, but with depleted ammonia and nitrate concentrations to simulate the chemistry expected in long-term closure (Low N period).

It is possible to shift the functionality of a CWTS to stimulate additional microbial dissimilatory selenium reduction and enhance overall treatment of this element. The resultant CWTS would be a hybrid bioreactor-CWTS and is a “passive care” option. This means that the hybrid-CWTS would require more maintenance and operational intervention than a normal CWTS, with periodic dosing of an organic amendment needed (once or a few times annually) in order to achieve the targeted decreased dissolved oxygen and redox levels. However, depending on actual inflow and target outflow concentrations, this approach may be a necessary compromise.

The third and final stage of pilot testing therefore included the addition of an organic carbon amendment (alfalfa hay and straw) to stimulate reducing conditions for improved selenium treatment. Alfalfa hay and straw were chosen as they would provide both short and long-term carbon sources compared to a metered dosing of more available electron donors such as ethanol. This hybrid bioreactor-CWTS period was conducted as an 8-week trial to test how the CWTS functions once converted from conventional CWTS operation to the hybrid configuration. A total of 1.4 g of alfalfa pellets were added per liter of water in each A cell. Straw was added at 10 cm^3 per L to A cells, and 5 cm^3 per L to B cells. The alfalfa pellets and oat straw were tested to ensure suitability for use (Appendix 1). A summary of the periods and timelines is provided in Table 3.

Over the course of the study, a total of 45,000 L of synthetic water (influent) was received by the pilot CWTS (in 41 batches), approximately 1,200 L of synthetic water per week in a pilot CWTS footprint of 1.56 m^2. The system operated with a flow rate of 20 mL/min, resulting in a hydraulic retention time (HRT) ranging from 34 to 94.3 hours, depending on the period of testing and water depth (Table 3).

4.1.4. Routine Monitoring of Explanatory Parameters

Explanatory parameters are characteristics of a specific environment that describe conditions in the context of how these parameters can affect the chemical reactions taking place. These parameters, when within specific ranges of values, can be used to predict and/or promote certain reactions in the aforementioned environment. Accordingly, dissolved oxygen (DO; mg/L and %), temperature (°C), pH, conductivity (µS/cm), specific conductivity (SPC; µS/cm), and oxidation-reduction potential (ORP; mV) were measured on a routine schedule with a YSI Professional Plus handheld unit.

Hydrosoil reduction-oxidation (redox) potential was measured using inert electrodes (copper wire probes with platinum tips) that were permanently installed in the hydrosoil of the cells and remained there for the duration of the project to ensure accurate readings (Faulkner et al., 1989). On testing days, a reference electrode (Accumet Calomel) was suspended in the water column above the inert electrode. The redox potential was then measured in millivolts by a voltmeter.

4.1.5. Flow Rates

Constant flow metering pumps were used to set the flow rate of water into the system. To confirm flow rates, the influent to cell A was collected into a graduated cylinder over a timed period of several minutes allowing a flow rate to be calculated in milliliters per minute (mL/min). Flow rates were measured regularly (at minimum weekly) and adjusted as necessary to within +/-10% of the desired flow, to achieve the desired HRT. The rate of water outflow from a CWTS cell was measured using the same procedure. Outflow rates for a series were typically measured every 2 weeks.

4.1.6. Water sampling

Water samples were collected from the outflow port of each CWTS cell. Care was taken to avoid collecting plant matter, invertebrates, or other debris in the sample. Samples were collected from downstream to upstream to ensure the water sampling did not affect sample collection from the next cell (e.g., disrupting flow rates or suspending solids). All samples were collected according to the schedule in Table 4, with parameters outlined in Table 5.

4.1.7. Stem Counts and Height Measurements

Carex aquatilis stems were counted in each CWTS cell, and 10 stems were randomly chosen in each cell for height measurement. The height of the tallest leaf of each stem was measured to the nearest 0.5 cm from the soil surface to the tip of the leaf. Stem counts and heights were taken monthly during the High N period, as well at the end of the Low N and hybrid bioreactor-CWTS periods (Table 4).

4.1.8. Sediment Sampling

Sediment/hydrosoil samples were collected at key intervals as per Table 4. Sediment was collected by carefully taking a grab sample of a small section of the top 6 cm of hydrosoil in each CWTS cell into a 50 mL centrifuge tube, pouring off any excess water after collection. In addition to the analyses listed in Table 5, sediment was also collected for microbial profiling according to the schedule in Table 4 and as described in Section 4.3.

4.1.9. Plant Sampling

Both *Carex* and Moss were collected for metals analysis at the beginning of the study, as well as at end of the Low N period. This schedule was chosen as it was uncertain if the Moss would survive through the hybrid bioreactor-CWTS period. For sample collection at the end of the Low N period, 4 stems of *Carex* (~15% of total stems) were randomly selected from each cell and trimmed at the surface of the water. An approximate 250 ml volume of compressed Moss was also collected from each cell in series 3-6. Plants from replicate series (e.g., series 1&2, 3&4, 5&6) were combined and sent for metals analysis as a representative sample for each system type. For the final sampling point (i.e., at pilot system takedown) all remaining *Carex* plants in each cell were trimmed at the soil level and rinsed with water prior to sending for metals analysis.

4.1.10. Freeze-Thaw Trial

In addition to routine analysis for metals in plants, a replicate of each plant sample collected at the end of the low N period was used in a freeze-thaw trial to determine if the plants will leach constituents of concern such as Cu and Se after freezing. In this trial, 200 mL of water from the corresponding CWTS cell was added to the plant sample to completely cover the plant material. The samples were frozen at -20°C for 5 days, and then thawed at room temperature (~22°C) overnight. The plant samples were removed and lightly squeezed to return residual water to the container, and the plant tissue was sent for metals analysis to compare with pre-freeze concentrations.

4.1.11. Organic Carbon Leach Test

To determine the constituents that could leach from the alfalfa and straw that were added for organic carbon during the hybrid bioreactor-CWTS period, a leach test was performed. In this test, 2 L of outflow from system 1 was collected and alfalfa and straw were added to mimic the concentrations that were added to the system. The water was tested for total metals 3 weeks after the organic carbon addition to determine if any metals had leached from the alfalfa and straw into the water.

4.2. **Methods for microbial analyses**

4.2.1. Growth-based analyses (MPN)

The most-probable number (MPN) of bacteria was determined for all micro samples. The MPN test allows for an estimation of the number of bacteria that can grow in a specific laboratory medium. The media tested in this project were specific for bacteria that can reduce nitrate, selenite, and sulfate, respectively, as well as the total number of heterotrophic bacteria for comparative purposes (i.e., a growth-permissive test for all bacteria capable of growing on organic carbon as an energy source). MPN tests for sulphate (Active Standard ASTM D4412) were conducted under anaerobic conditions, whereas selenite (Siddique et al., 2006) and nitrate (Nitrate Reduction Test, supplied by Sigma-Aldrich) were tested under aerobic conditions. Total heterotrophs (grown with YTS250 medium; (Lefrançois et al., 2010) were quantified in both aerobic and anaerobic conditions.

In brief, sediment samples were diluted 1:100 with a 0.1% peptone solution. This starting dilution was then used for a serial dilution along a sterile 96-microwell round-bottom plate containing the respective growth media. Sediment dilutions tested in the MPN plate ranged from 1/400 to 1/419,430,400. At minimum, all tests were conducted in duplicate. Wells were incubated at +30°C without light and assessed for visible growth (formation of a bacterial pellet) and/or colour change specific to the type of media after 27 days. A colour change to black or red/orange indicated sulphate or selenite reduction, respectively. Nitrate reduction was tested as per the kit manufacturer's protocol by addition of reagents to differentiate between reduction to nitrite or nitrogen gas. The most probable number of bacteria capable of each metabolism was then calculated as described in the FDA Bacteriological Analytical Manual, Appendix 2: Most Probable Number from Serial Dilutions: (http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm109656.htm). The MPN of organisms in each pilot system was compared over time using the non-parametric Kruskal-Wallis test.

4.2.2. DNA-based analyses

DNA was extracted from all samples using the MO BIO Powersoil Powerlyzer DNA extraction kit, with the addition of phenol during cell lysis as per the manufacturer's alternative protocol. Targeted sequencing was used to identify bacteria present in each sample via polymerase chain reaction (PCR) amplification of the v3/v4 region of the 16S ribosomal RNA gene (Klindworth et al., 2013). Library preparation and sequencing was performed as per the manufacturer's instructions for MiSeq v3 paired-end 300 bp sequencing (Illumina). All raw sequences were filtered to remove low quality reads, and the forward and reverse primers were truncated. Bioinformatics pipelines consisting of internal scripts and selected QIIME scripts (Caporaso et al., 2010; Edgar, 2010) were used to process the reads. Similar sequences were clustered into groups called Operational Taxonomic Units (OTUs) using a 97% identity threshold. Taxonomic classification of the OTU's was performed according to the Greengenes database (DeSantis et al., 2006; McDonald et al., 2012). Non-metric multidimensional-scaling was used to compare microbial communities across samples using the Bray-Curtis dissimilarity metric. The percentage of the microbial community classified as organisms of interest (e.g., sulphate-reducing bacteria) was also compared across samples. The most abundant OTU's were compared to the Cu, Se, and S concentrations in the sediment to calculate the Spearman correlation coefficient and associated p-value.

5. Results and Discussion

5.1.1. Outflow concentrations of copper and selenium

The pilot systems were operated for 37 weeks with three distinct trial periods of High Nitrogen, Low Nitrogen, and Hybrid Bioreactor-CWTS, with the average influent and outflow water chemistry provided in Tables 6, 7, and 8, respectively. The minimum, maximum, and average measurements of selected parameters and copper and selenium concentrations are summarized in Table 9. While copper treatment was relatively stable through both the High N and Low N periods, selenium treatment improved during the High N period (Figure 3), and then stabilized through the Low N period. For both the High N and Low N periods, the systems that were planted with Moss and *Carex* had significantly better copper treatment than Moss only. There was no statistically significant difference found among the three pilot system designs for selenium removal (i.e., Moss or biochar did not show a significant effect on selenium treatment during these periods).

The hybrid bioreactor-CWTS configuration was effective for both copper and selenium treatment. The purpose of the bioreactor-CWTS configuration is to serve as a contingency in case greater treatment is needed than is being achieved by the CWTS at a given point in time (e.g., the influent water quality or outflow objectives change). The tests here show that the CWTS can be repurposed as a hybrid bioreactor-CWTS with improved selenium and copper treatment within the same footprint, and without need for added construction. However, operating the system as a hybrid bioreactor-CWTS would require greater operational maintenance than it would in its original CWTS configuration.

In the case of selenium, the reconfiguration resulted in a statistically significant decrease in outflow concentration compared to that prior to the reconfiguration (Figure 3). This result for selenium was expected based on the design targeting more favourable conditions for selenium reduction, such as lower dissolved oxygen and ORP resulting from the additional electron donors from the microbial decomposition of the alfalfa and straw. In terms of copper, the lowest outflow concentration of the study was measured during the hybrid bioreactor-CWTS phase (7.5µg/L); however, prior to this there was a brief decrease in treatment effectiveness in all systems (Figure 3, June 19th data point). However, even during this brief disruption, 86% of the total copper entering the system was treated.

It is not known whether this brief change in treatment effectiveness was due to a short-term loss of treatment capacity during the transition, or if it might have been caused by a release of copper and other constituents that were sorbed to the moss or other organic matter during the transition. This decrease in treatment effectiveness coincided with low dissolved oxygen and moderately reducing conditions in the water column being attained in all cells (DO < 0.5 mg/L, ORP < -80 mV); however, it was not clear if the additional copper in the outflow was released from the alfalfa and straw that were added, or if constituents were briefly released from the sediment or moss and detritus after the system transitioned into more reducing conditions. As a result, a leach test was conducted on the alfalfa and straw and determined that there was no discernible release of copper from these organic materials. The origins of the decrease in treatment effectiveness could not be determined definitively, with the disturbance being registered during a single sampling point, with a maximum potential disturbance period of 4 weeks.

While the hybrid bioreactor-CWTS configuration improved selenium treatment, and demonstrated the lowest outflow concentration of copper of the entire trial, the short upset of treatment performance during the transition is meaningful in terms of monitoring during site implementation. It should be emphasized that if a transition from a typical CWTS design to a hybrid bioreactor-CWTS style is performed, careful monitoring of the CWTS is required as some elements may have decreased treatment effectiveness for a brief period. During this timeframe, if concentrations of elements exceed regulatory guidelines, water may need to be recycled through the wetland, or a contingency water treatment plan should be put in place for the outflow over the period of treatment disturbance.

5.1.2. Removal Rate Coefficients

An important factor for wetland design is the rate of treatment, also known as the removal rate coefficient (RRC). The RRC is based on treatability of a specific compound and the hydraulic retention time of the system. Once the RRC is known, the equation is rearranged and the RRC can be used to calculate the HRT needed to meet outflow objectives (and accordingly, the size of the wetland). It can also be used to predict the expected outflow concentrations of a specific element in a wetland of the same design based on inflow rates, concentrations, and footprint. RRCs vary with the concentrations of an element, and therefore, a sequential cell approach was used in this pilot study to allow for the RRC to be calculated over a broader range of inflow and outflow concentrations than if the system were only considered as a single treatment unit. Together these can then be used to estimate the size needed for a full-scale CWTS to meet outflow concentration performance objectives for a given influent concentration and flow rate. It should be noted that a RRC is specific to each given constituent respective to a particular wetland design, and can change based on the water chemistry and/or system design. The RRCs presented in this paper are a representative approximation of the Minto Mine site in a closure scenario and accounts for High N, Low N, and the use of a hybrid bioreactor-CWTS operational period (Figure 4, Table 10). When comparing the RRC of different designs of pilot systems in which the retention time and inflow concentrations are the same, a higher RRC indicates increased removal of the constituent. In the equation below, the first order RRC has been reconfigured to calculate *t* (hydraulic retention time), allowing the use of *Ci* (initial concentration), *Cf* (final, desired concentration), and *k* (removal rate constant, RRC) to be used to size the wetlands accordingly.

$$k = \frac{-ln(C_f/C_i)}{t}$$

$$t = \frac{-ln(C_f/C_i)}{k}$$

Equation: Removal rate coefficient (RRC) calculation, and rearranged to solve for HRT

When comparing the copper RRC of cells A and B within a series during the High N period, the RRC of the first cell is very high, while the RRC of the second cell is negligible (Figures 5 and 6). This phenomenon is frequently observed in treatment wetlands, where the treatment rate is faster at higher concentrations than at lower concentrations (Horner et al., 2012; Murray-Gulde et al., 2008; Spacil et al., 2011). As such, increasing the HRT of these systems by adding additional cells to the series would not result in a linear decrease in the final copper outflow concentration.

In contrast, the Low N and hybrid bioreactor-CWTS periods do not have this same degree of difference between copper RRC between cells A and B within a series (Figure 5). This change in cell-to-cell difference of RRC still results in similar or improved outflow concentrations. Generally speaking, the RRC of the first cell in the system has decreased, while that in the second cell has improved. This observation can be attributed to a variety of factors. Based on previous experience, the most likely explanation is that there was an abundance of sorption sites available in all cells at pilot initiation. As the study progressed, the sorption sites became occupied and removal via this mechanism was no longer available. This same phenomenon is also often seen when setting up an on-site demonstration-scale or full-scale treatment wetland. As such, both pilot and demonstration scale studies should be conducted for a sufficiently long period of time so as to realize the actual treatment capacity of the system beyond this initial sorption phase. This phenomenon must also be taken in the context of the duration over which the system must operate within a year, and the knowledge that the reaction front will move downstream within a wetland through this time. Therefore, an increased wetland size might not significantly improve outflow concentrations, but will aid in maintaining treatment performance through the year, so long as the added size does not result in concentration of the elements due to evaporation of the water caused by increased size.

A second possibility is that since the High N conditions coincided with an algal bloom (both visible, but also confirmed by community profiling that there was an abundance of cyanobacteria; Figure 7), the greater concentrations of cyanobacteria and algae during the High N period could have also been responsible for increased sorption and uptake of copper in the A cells. In either case, it is not to say that the B cells were not capable of a high removal rate, but rather that the concentration of copper in the A cell effluent left very little copper available for treatment in the B cell, regardless of capacity for treatment.

It is important to note that the RRCs for copper decreased during the hybrid bioreactor-CWTS period (Figure 4). This can be attributed to the longer HRT created by the increased water depth in this period despite similar outflow concentrations. Through all periods, the outflow concentration of copper for any given system did not vary significantly, indicating that regardless of the cause of the difference in RRC at different points in the system operations (e.g., sorption, algal uptake, increased water depth), the thermodynamic minimum for copper removal has likely been approached within the system, with an average outflow concentration of 18 ± 5 µg/L (Figure 6). That is to say, making the wetland bigger using any of the tested designs would not result in a further significant decrease in outflow copper concentration, but rather, design alterations would need to be made in order to attempt to achieve lower outflow concentrations. During the High and Low N periods when the Moss was actively growing, copper removal rates were greater in systems containing Moss than in systems with only *Carex*. It is likely that as the Moss continues to grow over time and increase in total mass, the RRC would also improve in these systems. Finally, the addition of biochar did not have any significant effect on performance.

Selenium tells a different story than copper in regards to the RRC. Selenium had a fairly similar removal rate in both the A and B cells during the Low N period (Figures 5 and 6). This could be because the selenium treatment is microbially mediated, or because the inflow concentrations are already so low that both the inflow and outflow concentrations of all cells still fall within the same RRC range. A test of the metals composition in the plants and subsequent mass balance of the systems confirmed that the system was operating as designed to target selenium mineralization to the sediment, as plant uptake was responsible for only 1-3% of the total selenium that was removed from the water during the entire course of the study (Figure 10). Based on the RRCs for selenium in the Low and High N periods, an increased HRT is expected to result in a lower outflow concentration of selenium (Figure 6). This could be achieved by increased footprint, or water depth, so long as the depth does not exceed that in which the *Carex* and Moss will grow.

Conversely, the hybrid bioreactor-CWTS time period had a significantly higher RRC for selenium in the A cells compared to the B cells (Figure 5). It should be noted that while the HRT is longer during the hybrid bioreactor-CWTS period than it was during the Low or High N periods due to an increase in water depth, it can be calculated using the RRC from the previous periods that this alone does not account for the degree of improvement in outflow concentration of the bioreactor-CWTS design. If the improvement in outflow concentration could be attributed solely to the increased HRT, the RRC would remain the same. Instead, we observe an improvement of not just the outflow concentration, but also in improvement in the RRC for selenium in all systems when converted to the bioreactor-CWTS configuration. This higher RRC is presumably due to the more favourable conditions that have been targeted for selenium reduction, including lower dissolved oxygen and a lower ORP resulting from the additional electron donors available through the microbial decomposition of alfalfa and straw. Through all time periods, there was no discernible benefit measured by the addition of biochar into the soils of the systems; rather, the systems that were planted with *Carex* and Moss performed similarly regardless of whether biochar had been included in the soil or not.

As would be expected based on the RRC data for systems containing *Carex* and Moss, the final sediment concentrations of copper are higher in the A cells than the B cells, with the B cells being only slightly higher in concentration than the starting levels (Figure 8). The same trend is evident for selenium; however, the starting concentration and concentrations in most of the B cells are below detection limits. It is of note that the copper and selenium sediment concentrations are positively correlated to an increase of sulphur in the sediment, while no discernible change was found in iron concentrations (Figure 8). This correlation is important to understand the long-term stability of copper within the system, as copper is highly stable when mineralized in a sulphide form and maintained under reducing conditions such as those in the wetland soils. In this case, the sulphides are being formed by microbes living in the soil and associated with the plant roots (see black areas in soil and around roots in Figures 14 and 15). This is supported by the finding of an initial increase of sulphate-reducing bacteria in the sediment, followed by stability over time at a most probable number of approximately 10,000-100,000 microbes per gram of sediment that are capable of reducing sulphate to sulphide (Figure 17). In the case of selenium, the correlation with sulphur in sediment is presumably due to the ranges of explanatory parameters found within the system (dissolved oxygen, ORP, soil redox, pH) which are favorable to both microbially-mediated selenium and sulphur reduction, suggesting the sedimentary selenium is likely in an elemental form, or sorbed to organic materials such as biofilms. While, the stability of the copper and selenium mineralizations were not tested in this study, it is planned for testing to be performed during the upcoming on-site demonstration-scale trial by using sequential extractions on the sediment paired with ICP analysis.

5.1.3. Fate and distribution of copper and selenium

Mass balances were calculated for each pilot system to assess the fate and distribution of elements removed from the water during the course of testing (i.e., the full 37 week period). For systems that were planted with *Carex* and Moss, 64-75% of the copper removed from the water was sequestered into the top 6 cm of sediment (Figure 9). In contrast, systems with only *Carex* planted and no Moss had only 33% of the copper ending up in this top sediment fraction (Figure 9). For systems planted with both *Carex* and Moss, 68-83% of the treated selenium was sequestered to this top portion of the sediment, but less than 52% was in the sediment of the system planted with only *Carex* (actual percentage cannot be calculated as the selenium was below the sediment detection level; Figure 10). For both elements, only 1-3% of the total load removed from the water was found in the above water vegetation (*Carex*) at the end of pilot testing.

It was not possible to determine the concentrations of elements in Moss, as the majority did not survive in the hybrid bioreactor-CWTS period conditions. However, in anticipation of this potential issue, samples of Moss were sent for analysis prior to the start of the hybrid bioreactor-CWTS period, allowing for a bioconcentration factor (BCF) to be calculated.

5.1.4. Plant uptake and overall performance

The bioconcentration factor (BCF) is the ratio of the amount of an element taken up into or sorbed onto the surface of a plant, compared to the amount of the element in the water, and is expressed as the ratio of mg of chemical per kg of organism to mg of chemical per liter of water. The amount of an element sorbed onto the surface of a plant was included in the BCF calculation to give a better representation of the amount that would be present in and on a plant in the wetland (i.e., for plant death/degradation as well as consumption perspectives). As would be expected based on samples collected during the site visit in 2013 and supported by scientific literature, we found in this study, and also in the site visit that *Carex* had a much lower BCF than Moss for both selenium and copper (Table 11). This finding is expected, as moss is known to have a high sorption capacity and therefore, high BCF (Aldrich & Feng, 2000; Gstoettner & Fisher, 1997). For some elements, bioconcentration factors within a plant species are higher when the element itself is at a lower concentration. This held true in the pilot systems when comparing cells A and B in a series, as the BCF for copper in *Carex* was significantly higher in B cells (which had lower aqueous concentrations) than in A cells (with higher influent concentrations) for all three pilot system designs tested (Figure 11). However, for selenium, the A cells had a similar BCF as B cells planted with both *Carex* and Moss (not statistically different), but a significantly higher BCF in the A cells planted with only *Carex* (Figure 11).

Selenium bioconcentration in *Carex* in the pilot systems was very low, resulting in average final tissue concentrations of only ~1.9 mg/kg wet weight. The BCF of selenium was greater in the Moss than the *Carex* in the pilot systems (Table 11). However the Moss BCF recorded here is still relatively low overall based on the United States Environmental Protection Agency Toxic Substances Control Act which considers BCF less than 1000 as non-bioaccumulative. It should also be noted that although selenium is generally known to bioaccumulate, Moss is not a food source for higher animals or invertebrates; as such, the selenium in the Moss should not be contributing to bioaccumulating pathways (Haines & Renwick, 2009; Longton, 1997; Suren & Winterbourn, 1991).

It is important to the overall treatment system design to determine if elements may be released by the plants by freezing and thawing in the water, as would occur through natural seasonal progression. A freeze-thaw trial was conducted in which *Carex* and Moss were collected and sent for metals analysis both before and after being submerged in water from the wetland and freezing to -20°C followed by thawing to room temperature. It was promising to find that *Carex* released only a small percentage of the selenium (18-38%) and copper (0-13%) as noted by the decrease in tissue concentrations after freezing and thawing (Figure 12). Moreover, Moss was found to have a significant increase in concentration of these elements after being frozen and thawed (Figure 13). It appears that through the freeze-thaw process, the Moss has an enhanced sorption of these compounds, removing an additional amount from the water.

Based on the pilot system design and plant densities, *Carex* would theoretically release on average 0.14 mg of copper and 0.27 mg of selenium per square meter of wetland area, while Moss would theoretically bind 511 and 11.8 mg/m^2, respectively. This finding is important, as it demonstrates that despite some release of constituents by *Carex* through freeze-thaw, the Moss will provide uptake in excess of what is released by the *Carex* and also assist with treatment during initial spring thaw before biogeochemical processes are at full capacity.

During the pilot CWTS takedown, it was noted that the *Carex* had an extensive root structure throughout the entire hydrosoil (Figures 14 and 15), making it an ideal candidate for construction of stable wetlands on site. Additionally, it should be noted that no significant difference in plant health or growth (i.e., number of stems, plant height, weight, and percent moisture at end of pilot) was found for systems with or without biochar or Moss (Figure 16). Based on the data collected during the pilot-phase testing, we can conclude that the combination of *Carex* and Moss is the ideal CWTS design for long-term and sustainable copper and selenium treatment. In this design the *Carex* provides structure to soil and sediment of the wetland with extensive root structure, additional treatment capacity based on the roots drawing water down into the sediment, renews organic carbon in the sediment and contributes to accretion through detritus decomposition, and aids in the production of sulphate reducing zones (as indicated by black areas in Figure 15). Meanwhile, the Moss provides sorption and uptake of elements even through freeze-thaw events.

5.1.5. Microbially-mediated treatment

In order to fully understand the function of biogeochemical processes such as the mineralization of copper and selenium, it is critical that the microbial populations performing these functions are well characterized and understood. Therefore, the microbial communities populating the sediment of each pilot CWTS cell were analyzed by both genetic and growth-based methods. The genetic method identifies and comparatively quantifies all of the bacteria in a sample without requiring growth, which is very important because a large proportion of environmental organisms will not grow in a laboratory setting. The genetic-based profiling is therefore used to assess which microbes are present and at what abundance, giving an idea of the robustness of the community and allowing for potential function to be inferred. The second method is called the most-probable number (MPN) assay, which is a dilution-based growth method that can determine the number of selenite-reducing, sulphate-reducing, and nitrate-reducing organisms per gram of sediment. The MPN method is therefore a means to evaluate the biogeochemical cycling potential of a sample; however, because the analysis is based on growth in laboratory media, it is presumed that not all organisms are able to grow and that only a partial profile of the microbial community is provided. Both methods allow for comparisons to be made of the microbial populations across samples, treatments, or time series.

With the microbial analyses, we were interested in three key questions:

- How does the microbial community adapt and change with different influent water chemistries and system designs?
- Are microbes that contribute to selenium, copper, or nitrate treatment present in the pilot wetland cells, and if so, are these same organisms present at the Minto site?
- Is selenium or copper treatment mediated by microbes present in the sediment?

As Figure 7 shows, the microbial population adapted rapidly and consistently to the changes in influent chemistry (i.e., High N, Low N), as well as the addition of organic matter. The nMDS plot of Figure 7 can be interpreted simply as samples that cluster together have more similar microbial communities, while those that are farther apart have distinct differences in their populations (such as identity or relative abundance). At the beginning of the pilot system operation, the microbial community had a proportionately high number of *Actinobacteria*, which then transitioned to *Cyanobacteria* during the High N period corresponding to a visible algal bloom. The Low N and hybrid bioreactor-CWTS phases had similar microbial populations, indicating that either the microbes present in the Low N phases were also well suited to the bioreactor-CWTS conditions, or that the community was still in flux at the final sampling, and treatment would have continued to improve over time in the hybrid system as more anaerobic organisms flourished. Overall, Figure 7 shows that as expected, the microbial populations were both adaptive and robust, shifting to respond to changes in the water chemistry and explanatory parameters such as dissolved oxygen and redox.

The results of the MPN testing indicate that the High N period had an abundance of organisms capable of denitrification including the reduction of nitrate to nitrite, and nitrate to N_2 gas (Figure 17). As expected based on the elevated water concentrations of nitrate, the High N period had a large number of organisms present that could reduce nitrate to N_2 gas. Although in decreased abundance, denitrifying bacteria were present through the Low N period and the hybrid bioreactor-CWTS period, despite having much lower nitrogen concentrations during this timeframe. As such, it is anticipated that fluctuations in ammonia and nitrate concentrations over time would be rapidly met with millions of microbes per gram of soil that are able to perform denitrification reactions.

Sulphate-reducing bacteria consistently increased in abundance over time in all system designs, starting out with a most probable number of approximately a thousand per gram of sediment and increasing by two orders of magnitude through the study (Figure 17). This increase is consistent with trends observed in the soil redox measurements becoming more negative over time in this study. The presence and abundance of sulphate-reducing bacteria were positively correlated with final sulphur concentrations in sediment, according to both the genetic and growth-based profiling methods. Several groups of known sulphate-reducing bacteria (e.g., *Desulfobacterium, Desulfosarcina, Desulfotomaculum)* were found to also correlate with copper concentrations in the sediment, suggesting that their presence leads to reduction of sulphate to sulphide, which then binds to copper and precipitates into the sediment. This can also be demonstrated by the black areas surrounding the *Carex* roots and black precipitates on the sediment surface observed during system takedown (Figures 14 and 15). This copper-sulphide mineralization mechanism is ideal for treatment as it provides a non-bioavailable and stable form of copper in the sediment.

We can tell from the genetic sequencing that these same types of sulphate-reducing bacteria were found in samples that were collected during the August 2013 site visit, specifically associated with *Carex* roots and sediment at the W10 location, as well as in the sediment at W15. It is likely that these were brought to the pilot system along with the plant roots as these *Carex* were harvested from the Minto W10 area. This indicates that despite having different sediment and environmental conditions at the site in comparison to the pilot CWTS, these microbes are robust and can be further encouraged to thrive and perform beneficial functions by having the ecological niches that they prefer (e.g., *Carex* roots, low ORP and DO).

The most probable number of selenite-reducing bacteria ranged from hundreds of thousands to tens of millions per gram of soil and was similar between the different system designs, having similar variance through the three testing periods (Figure 17). There was a general increase in selenite-reducing bacteria during the High N and Low N periods, followed by a decrease in their numbers during the hybrid bioreactor-CWTS period similar to denitrifying organisms discussed above. It was not possible to calculate a correlation between the number of selenite-reducing bacteria and the selenium concentration in the sediment due to the generally low levels (i.e., non-detectable) of selenium in the sediment of most cells. An abundance of selenite-reducing organisms in the pilot systems as well as at the Minto site indicates that these organisms are a robust and diverse group, and are present with a latent capacity to perform microbially-mediated selenium treatment given the proper conditions (e.g., electron donors, targeted ORP and DO levels).

The importance of these microbial results is two-fold: first, the treatment of selenium, copper, or nitrate can be mediated and sustained in a very passive manner by microbes if provided the right environment. Second, this necessary environment can be targeted through system design and adjustments in operation as have been done through this study, resulting in stimulation of these microbes in abundance, diversity, and activity.

5.1.6. Range of operational parameters

In order to be able to effectively implement a full-scale passive treatment system such as a CWTS, the targeted explanatory parameters must be predefined. As such, one of the goals of this pilot-scale work was to confirm or optimize the ranges of these parameters from what can be derived from publications and previous experience. These explanatory parameters can then be used to predict the functionality of a wetland and efficacy of treatment. Moreover, well-defined explanatory parameters allow for adaptive management plans to be developed in order to maintain optimal treatment effectiveness and predictability. The pilot systems tested here performed well not only across a variety of water chemistries and induced conditions, but also over a wide range of water pH, DO, ORP and soil redox. Table 9 includes the minimum, maximum and average recorded values of some selected explanatory parameters for the different periods of testing. Most importantly, this table shows that the range of conditions needed for effective copper and selenium treatment were achieved for this site-specific CWTS design, highlighting the robustness and adaptability of the design and providing a range of conditions under which the system will function.

6. Conclusions and Recommendations

When designed and implemented in a strategic and scientifically guided manner, CWTSs can mitigate risks posed by many contaminants. A treatment plan that includes processes that precipitate insoluble species of these constituents for sequestration into the sediments of the wetland are very desirable, as this mechanism captures the contaminant and stores it with stability in the sediments, rather than transferring the contaminant to an indeterminate fate (e.g., plant uptake or volatilization). This study has addressed several important design considerations regarding implementation of a CWTS at the full scale for the treatment of copper and selenium at the Minto Mine. A synopsis of the conclusions and recommendations are:

- An effective and robust pilot-scale CWTS design was demonstrated and optimized using plants from the Minto site and predicted closure water chemistries.

- The pilot-scale CWTSs provided much of the information needed to effectively size full-scale CWTS for treatment at the Minto site, but sizing will also be dependent on other factors (hydrology, available area, and constructability considerations).

- The recommended CWTS design for long-term passive treatment of copper and selenium at the Minto site is a combination of *Carex* and Moss planted in a sand substrate supplemented with woodchips and peat.

- The selected design achieved average outflow concentration of 12 µg Cu/L (average influent 146 µg Cu/L), and 6 µg Se/L (influent 10.2 µg Se/L).

- Conversion of the CWTS to a hybrid bioreactor-CWTS design resulted in the lowest copper (7.5 µg/L) and selenium (1.9 µg/L) concentrations of the study, but was preceded by a brief disruption of treatment capacity. This configuration would require greater maintenance than the basic CWTS, but could be implemented if any changes in influent water quality are predicted or if outflow objectives change.

- If transitioning from the CWTS design to hybrid bioreactor-CWTS, close monitoring of CWTS and potential consideration of contingency treatment is recommended during the transition period, as there may be a brief and temporary disruption in treatment effectiveness.

- The majority of the copper and selenium treated by the system was sequestered to the top 6 cm of sediment, with only a small portion (1-3%) being taken up into the *Carex* (commonly known as sedge).
- After undergoing a freeze-thaw cycle, the *Carex* used in this study released only a small amount of copper and selenium; however, under the same trial the binding and sorption capacity of the Moss increased, resulting in a net removal of copper and selenium from the water through a freeze-thaw cycle.
- Fluctuations in nitrogen levels (as would be expected in early closure due to residue from blasting activities) are responded to by a diverse microbial community with a robust capacity to treat nitrate, but also continue to treat Cu and Se through this transition;
- There were thousands to billions of nitrate, sulphate, and selenium reducing bacteria present per gram of soil in the pilot CWTS, many of which were confirmed through genetic testing to be the same groups of organisms as found at the Minto site.
- It is recommended that the design be tested on-site at Minto with a demonstration-scale CWTS receiving seepage water.

7. Closure

We trust the information herein satisfies your present requirements. Should you have any questions, please contact the persons listed below. We appreciate the opportunity to provide the services detailed in this report, and look forward to discussing any comments you may have.

Respectfully submitted,

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8. References

1. Aldrich, C. and Feng, D. Removal of heavy metals from wastewater effluents by biosorptive flotation. *Minerals Engineering* 13: 1129-1138, 2000.

2. Caporaso, J. G., Kuczynski, J., Stombaugh, J., Bittinger, K., Bushman, F. D., Costello, E. K., Fierer, N., Peña, A. G., Goodrich, J. K., Gordon, J. I., Huttley, G. A., Kelley, S. T., Knights, D., Koenig, J. E., Ley, R. E., Lozupone, C. A., McDonald, D., Muegge, B. D., Pirrung, M., Reeder, J., Sevinsky, J. R., Turnbaugh, P. J., Walters, W. A., Widmann, J., Yatsunenko, T., Zaneveld, J., and Knight, R. QIIME allows analysis of high-throughput community sequencing data. *Nat Methods* 7: 335-6, 2010.

3. DeSantis, T. Z., Hugenholtz, P., Larsen, N., Rojas, M., Brodie, E. L., Keller, K., Huber, T., Dalevi, D., Hu, P., and Andersen, G. L. Greengenes, a chimera-checked 16S rRNA gene database and workbench compatible with ARB. *Appl Environ Microbiol* 72: 5069-72, 2006.

4. Edgar, R. C. Search and clustering orders of magnitude faster than BLAST. *Bioinformatics* 26: 2460-1, 2010.

5. Faulkner, S. P., Patrick Jr., W. H., and Gambrell, R. P. Field techniques for measuring wetland soil parameters.. *Soil Sci. Soc. Am. J.* 53: 883-890, 1989.

6. Gstoettner, E. M. and Fisher, N. S. Accumulation of cadmium, chromium, and zinc by the moss Sphagnum papillosum Lindle. *Water Air Soil Pollut.* 93: 321-330, 1997.

7. Haakensen, M., Terry, M. W., Pittet, V., Castle, J. W., and Rodgers, J. H. Effects of freeze-thaw and biochar on sequestration and localization of elements within oxidizing and reducing pilot constructed wetland. SETAC North America 34th Annual Meeting, Nashville TN, Presentation #59

8.Haines, W. P. and Renwick, J. A. A. Bryophytes as food: comparative consumption and utilization of mosses by a generalist insect herbivore. *Entomologia Experimentalis et Applicata* 133: 296-306, 2009.

9. Horner, J. E., Castle, J. W., Rodgers, J. H., Gulde, C. M., and Myers, J. E. Design and performance of pilot-scale constructed wetland treatment systems for treating oilfield produced water from sub-Saharan Africa. *Water Air Soil Pollut.* 223: 1945-1957, 2012.

10. Klindworth, A., Pruesse, E., Schweer, T., Peplies, J., Quast, C., Horn, M., and Glöckner, F. O. Evaluation of general 16S ribosomal RNA gene PCR primers for classical and next-generation sequencing-based diversity studies. *Nucleic Acids Res* 41: e1, 2013.

11. Lefrançois, E., Quoreshi, A., Khasa, D., Fung, M., Whyte, L. G., Roy, S., and Greer, C. W. Field Performance of alder-Frankia Symbionts for the Reclamation of Oil Sands Sites. *Appl. Soil Ecol.* 46: 183-191, 2010.

12.Longton, E.R. The role of bryophytes and lichens in polar ecosystems. In: Ecology of Arctic Environments, Blackwell Science. Woodin, S.J., and Marquiss, M (eds), 1997.

13. McDonald, D., Price, M. N., Goodrich, J., Nawrocki, E. P., DeSantis, T. Z., Probst, A., Andersen, G. L., Knight, R., and Hugenholtz, P. An improved Greengenes taxonomy with explicit ranks for ecological and evolutionary analyses of bacteria and archaea. *ISME J* 6: 610-8, 2012.

14. Murray-Gulde, C. L., Bridges, W. C., and Rodgers, J. H. Evaluating performance of a constructed wetland treatment system designed to decrease bioavailable copper in a waste stream. *Environ. Geosci.* 15: 21-38, 2008.

15. Siddique, T., Zhang, Y., Okeke, B. C., and Frankenberger, Jr, W. T. Characterization of sediment bacteria involved in selenium reduction. *Bioresour Technol* 97: 1041-9, 2006.

16. Spacil, M. M., Rodgers, J. H., Castle, J. W., and Chao, W. Y. Performance of a pilot-scale constructed wetland treatment system for selenium, arsenic, and low-molecular-weight organics in simulated fresh produced water. *Environ. Geosci.* 18: 145-156, 2011.

17. Suren, A. M. and Winterbourn, M. J. Consumption of aquatic bryophytes by alpine stream invertebrates in New Zealand. *New Zealand Journal of Marine and Freshwater Research* 25: 331-343, 1991.

9. Tables

Table 1: Synthetic water formulation.

Element	Compound	Concentration (mg/L)
Aluminum	$Al_2(SO_4)_3\cdot18H2O$	0.929
Ammonium	NH_4HCO_3	1.00[1]
Arsenic	$Na_2HAsO_4\cdot7H_2O$	0.012
Barium	$BaCl_2\cdot2H_2O$	0.817
Cadmium	$CdCl_2$	0.0005
Calcium	$CaCl_2$	11.68
	$Ca(NO_3)_2\cdot4H_2O$	197.59[1]
Chromium	CrO_3	0.013
Cobalt	$CoCl_2\cdot6H_2O$	0.017
Copper	$CuCl_2\cdot2H_2O$	0.239
Iron	$FeSO_4\cdot7H_2O$	15.29
Lead	$Pb(NO_3)_2$	0.0007
Magnesium	$MgSO_4\cdot7H_2O$	324.77
Manganese	$MnSO_4\cdot H_2O$	8.10
Molybdenum	$Na_2MoO_4\cdot2H_2O$	0.026
Nickel	$NiCl_2\cdot6H_2O$	0.023
Potassium	KNO_3	28.34[1]
	KH_2PO_4	0.298
Selenium	$Na_2SeO_3\cdot5H_2O$	0.032
Silver	$AgNO_3$	0.0005
Sodium	Na_2SO_4	54.14
Strontium	$SrCl_2\cdot6H_2O$	8.73
Vanadium	V_2O_5	0.026
Zinc	$ZnCl_2$	0.056

[1] During Low N and hybrid bioreactor-CWTS periods of testing, NH_4HCO_3 and KNO_3 were not added, and the $Ca(NO_3)_2\cdot4H_2O$ was decreased to 1.976 mg/L

Table 2: Influent chemistry for pilot CWTS.

Element (total)	unit	Influent				
		Targeted	Acclimation Period	High N	Low N	Hybrid bioreactor-CWTS
Aluminum (Al)	mg/L	0.100	0.089	0.085	0.080	0.098
Antimony (Sb)	mg/L	0.00160	0.00060	0.00065	0.00061	0.0006
Arsenic (As)	mg/L	0.0030	0.0031	0.0033	0.0033	0.0037
Barium (Ba)	mg/L	0.500	0.153	0.284	0.192	0.224
Beryllium (Be)	mg/L	0.00078	<0.001	<0.001	<0.001	<0.001
Boron (B)	mg/L	0.315	0.0243	0.0262	0.0239	0.0243
Cadmium (Cd)	µg/L	0.3340	0.011	0.236	0.336	0.392
Calcium (Ca)	mg/L	82	70.33	73.90	40.73	48.22
Chromium (Cr)	mg/L	0.0065	0.0058	0.0064	0.0071	0.0075
Cobalt (Co)	mg/L	0.0039	0.0039	0.0042	0.0043	0.0044
Copper (Cu)	mg/L	0.13	0.14	0.15	0.15	0.18
Iron (Fe)	mg/L	3.1	3.1	3.1	3.2	3.5
Lead (Pb)	mg/L	0.00070	0.00044	0.00067	0.00059	0.00071
Magnesium (Mg)	mg/L	50	49	49	51	53
Manganese (Mn)	mg/L	2.6	2.5	2.5	2.6	2.7
Molybdenum (Mo)	mg/L	0.012	0.013	0.015	0.013	0.013
Nickel (Ni)	mg/L	0.0072	0.0077	0.0087	0.0076	0.0080
Phosphorus (P)	mg/L	0.082-0.27 [1]	0.333	0.236	0.082	0.082
Potassium (K)	mg/L	14	14.3	14.6	3	3
Selenium (Se)	mg/L	0.010	0.010	0.011	0.010	0.011
Sodium (Na)	mg/L	44	40	41	42	43
Strontium (Sr)	mg/L	2.9	2.5	2.5	2.5	2.6
Sulphur (S)	mg/L	85	85	84	86	88
Uranium (U)	mg/L	0.0051	0.0012	0.0012	0.0012	0.0014
Vanadium (V)	mg/L	0.016	0.015	0.013	0.014	0.018
Zinc (Zn)	mg/L	0.032	0.0517	0.037	0.040	0.042
Nutrients						
Total Ammonia (N)	mg/L	0.2-0.5 [2]	0.61	0.50	0.29	0.05
Dissolved Nitrate (N)	mg/L	0.8-28 [2]	29.33	29.67	0.86	0.84
Misc. Inorganics						
pH	pH	7.5-8.0	7.89	8.16	7.96	8.01
Anions						
Alkalinity (Total as $CaCO_3$)	mg/L		107.33	107.00	100	100
Bicarbonate (HCO_3)	mg/L		133.33	130.00	122	130

[1] Phosphorous was not modeled for closure, so the maximum concentration from W15 (2007-2012) was used (0.27mg/L), this was later decreased to 0.082mg/L (95th percentile).
[2] Ammonia and nitrate were not added to the synthetic water for the Low N and hybrid bioreactor-CWTS periods.

Table 3: Pilot CWTS testing periods.

Period	Timeline	# Weeks	Water Depth	HRT (hr) ± Std. Dev.	Description/Purpose
Pre-Influent	Nov 4, 2013 – Dec 12, 2013	6	10 cm	N.D.	Plant establishment
Acclimation	Dec 13, 2013 – Feb 26, 2014	10	10cm	37± 3	Acclimation of system to influent
High N	Feb 27, 2014 – Apr 12, 2014	7	10 cm, 17 cm[1]	37 ± 3 53 ± 3[1]	High ammonia and nitrate in influent (early closure)
Low N	Apr 13, 2014 – May 28, 2014	7	17 cm	53 ± 2.5	Low ammonia and nitrate (long-term closure)
hybrid bioreactor-CWTS	May 29, 2014 – Jul 16, 2014	7	30 cm	87 ± 3	Post alfalfa and straw addition (hybrid bioreactor-CWTS)

[1] 17 cm from March 13 to Apr 12, 2014 to test higher water depth during High N Period. This therefore results in a longer HRT for this timeframe.

Table 4: Monitoring schedule.

Water	
Temperature	Weekly
pH	
Dissolved oxygen	
Regulated metals water package [1]	Bi-weekly
Phosphorus	
Ammonia [2]	
Nitrate	
Flow rate	
Alkalinity [3]	Monthly
Hardness [3]	
Conductivity [3]	
Chemical oxygen demand (COD) [4]	
Total organic carbon [4]	
Total Kjeldahl Nitrogen (TKN) [4]	
Sulphate [3]	
Biological oxygen demand (BOD) [3]	Monthly (outflow only)
Total suspended solids [2]	
Soil	
Eh (redox)	weekly
Available NPK	Initial soil, beginning of influent, end of study
Regulated metals package	
Total organic carbon	Initial soil, end of study
Particle size analysis	
Conductivity	
Cation exchange capacity (CEC)	
Sodium adsorption ratio	
Plant	
Regulated metals	Start and end; Freeze-thaw trial
Stem counts and heights [4]	Monthly
Microbial	
Most probable number (growth-based)	Initial soil; beginning High N period; end Low N period; end of study
Genetic microbial community profiles	

[1] Dissolved metals was tested in addition to total metals for the Low N and hybrid bioreactor-CWTS periods
[2] Not performed during hybrid bioreactor-CWTS period, except at takedown of pilot
[3] Bi-weekly during hybrid bioreactor-CWTS period
[4] Not performed during Low N and hybrid bioreactor-CWTS periods, except at takedown of pilot

Table 5: Summary of water, soil, and plant analyses.

Water	Soil	Plant
ICP-MS Total or Dissolved (Al, Sb, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Li, Mn, Mo, Ni, P, Se, Si, Ag, Sr, Tl, Sn, Ti, U, V, Zn, Ca, Mg, K, Na, S)	ICP-MS (Al, B，Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, P, K, Se, S, Ag, Na, Sr, Tl, Sn, U, V, Zn,)	ICP-MS (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, P, K, Se, Ag, Na, Sr, Tl, Sn, Ti, U, V, Zn)
Routine Water (Alkalinity, HCO_3, Ion Balance, Dissolved ions, Hardness, Nitrate/Nitrite)	Available Nitrogen, Phosphorous, and Potassium (NPK)	
Total Suspended Solids (TSS)	Cation Exchange Capacity (CEC)	
Chemical Oxygen Demand (COD)	Sodium Adsorption Ratio (SAR)	
Biological Oxygen Demand (BOD)	Total Organic Carbon (TOC)	
Total Kjeldahl Nitrogen (TKN)	Electrical Conductivity (EC)	
Total Organic Carbon (TOC)	Texture Analysis (Physical properties)	
Ammonia		

Table 6: Performance of pilot CWTS during High N period.

Elements (Total)	**Unit**	**Influent**	**Outflow Average**		
		Average	*Carex* only	*Carex* + *Sphagnum*	*Carex* + *Sphagnum* + Biochar
Aluminum (Al)	mg/L	0.085	0.012	0.008	0.009
Arsenic (As)	mg/L	0.0033	0.0010	0.0008	0.0007
Barium (Ba)	mg/L	0.284	0.039	0.036	0.040
Boron (B)	mg/L	0.0262	0.025	0.027	0.055
Cadmium (Cd)	µg/L	0.236	0.038	0.023	0.017
Calcium (Ca)	mg/L	73.9	78	78	77
Chromium (Cr)	mg/L	0.0064	0.0024	0.0023	0.0024
Cobalt (Co)	mg/L	0.0042	0.0008	0.0004	0.0003
Copper (Cu)	mg/L	0.150	0.018	0.013	0.012
Iron (Fe)	mg/L	3.10	0.08	0.08	0.08
Magnesium (Mg)	mg/L	49	50	51	51
Manganese (Mn)	mg/L	2.5	1.1	0.37	0.2
Molybdenum (Mo)	mg/L	0.0150	0.0139	0.0130	0.0128
Nickel (Ni)	mg/L	0.0087	0.0042	0.0027	0.0020
Phosphorus (P)	mg/L	0.236	<0.1	<0.1	<0.1
Potassium (K)	mg/L	14.6	14.9	15.3	15.1
Selenium (Se)	mg/L	0.0110	0.0076	0.0073	0.0067
Sodium (Na)	mg/L	41	43	45	42
Strontium (Sr)	mg/L	2.5	2.7	2.7	2.6
Sulphur (S)	mg/L	84	86	87	86
Uranium (U)	mg/L	0.0012	0.0011	0.0011	0.0011
Vanadium (V)	mg/L	0.0130	0.0023	0.0019	0.0017
Zinc (Zn)	mg/L	0.0370	0.0042	0.0044	0.0034
Nutrients					
Total Ammonia (N)	mg/L	0.50	0.05	0.05	0.05
Dissolved Nitrate (N)	mg/L	29.67	29.4	29.4	29.5
Explanatory Parameters					
pH	pH	8.16	7.47	7.61	7.80
DO (mg/L)			5.33	5.16	5.52
Water redox (mV)			154.5	144.2	136.0
Soil Redox (mV)			-148	-191	-220

Table 7: Performance of pilot CWTS during Low N period.

Elements (Total)	**Unit**	**Influent**	**Outflow Average**		
		Average	*Carex* only	*Carex* + Moss	*Carex* + Moss + Biochar
Aluminum (Al)	mg/L	0.080	0.008	0.006	0.007
Arsenic (As)	mg/L	0.0033	0.0007	0.0006	0.0006
Barium (Ba)	mg/L	0.192	0.028	0.027	0.030
Boron (B)	mg/L	0.024	0.023	0.024	0.022
Cadmium (Cd)	µg/L	0.336	0.070	0.027	0.023
Calcium (Ca)	mg/L	41	47	47	47
Chromium (Cr)	mg/L	0.0071	0.0034	0.0029	0.0030
Cobalt (Co)	mg/L	0.0043	0.0006	<0.0003	<0.0003
Copper (Cu)	mg/L	0.150	0.0210	0.0113	0.0125
Copper (Cu) Dissolved	mg/L	0.037	0.0123	0.0086	0.0086
Iron (Fe)	mg/L	3.20	0.16	0.06	0.09
Magnesium (Mg)	mg/L	51	55	55	55
Manganese (Mn)	mg/L	2.6	0.9	0.2	0.2
Molybdenum (Mo)	mg/L	0.0130	0.0110	0.0104	0.0105
Nickel (Ni)	mg/L	0.0076	0.0035	0.0018	0.0015
Phosphorus (P)	mg/L	0.11	<0.10	<0.10	<0.10
Potassium (K)	mg/L	3.0	3.2	3.4	3.4
Selenium (Se)	mg/L	0.0100	0.0061	0.0060	0.0063
Selenium (Se) Dissolved	mg/L	0.0080	0.0052	0.0053	0.0052
Sodium (Na)	mg/L	42	44	44	45
Strontium (Sr)	mg/L	2.5	2.7	2.7	2.7
Sulphur (S)	mg/L	86	93	94	93
Uranium (U)	mg/L	0.0012	0.0009	0.0010	0.0010
Vanadium (V)	mg/L	0.0140	0.0023	0.0016	0.0022
Zinc (Zn)	mg/L	0.0400	0.0082	0.0032	0.0031
Nutrients					
Total Ammonia (N)	mg/L	0.29	<0.05	<0.05	<0.05
Dissolved Nitrate (N)	mg/L	0.86	0.26	0.25	0.25
Explanatory Parameters					
pH	pH	7.96	7.58	7.76	7.61
DO (mg/L)			5.69	6.05	5.42
Water redox (mV)			179	170	205
Soil Redox (mV)			-148	-183	-209

Table 8: Performance of pilot CWTS during hybrid bioreactor-CWTS period.

Elements (Total)	**Unit**	**Influent**	**Outflow Average** [1]		
		Average	*Carex* only	*Carex* + Moss	*Carex* + Moss + Biochar
Aluminum (Al)	mg/L	0.098	0.010	0.013	0.009
Arsenic (As)	mg/L	0.0037	0.001	0.001	0.001
Barium (Ba)	mg/L	0.224	0.061	0.061	0.058
Boron (B)	mg/L	0.024	0.026	0.026	0.025
Cadmium (Cd)	µg/L	0.392	0.057	0.067	0.067
Calcium (Ca)	mg/L	48	49	48	48
Chromium (Cr)	mg/L	0.0075	<0.001	<0.001	<0.001
Cobalt (Co)	mg/L	0.0044	0.003	0.002	0.002
Copper (Cu)	mg/L	0.180	0.021	0.023	0.026
Copper (Cu) Dissolved	mg/L	0.0350	0.0122	0.0134	0.0168
Iron (Fe)	mg/L	3.50	0.41	0.33	0.22
Magnesium (Mg)	mg/L	53	54	54	55
Manganese (Mn)	mg/L	2.7	5.2	5.1	5.7
Molybdenum (Mo)	mg/L	0.013	0.015	0.020	0.021
Nickel (Ni)	mg/L	0.008	0.006	0.006	0.007
Phosphorus (P)	mg/L	0.12	0.11	0.11	0.10
Potassium (K)	mg/L	3.0	6.4	6.1	6.3
Selenium (Se)	mg/L	0.0100	0.0040	0.0040	0.0040
Selenium (Se)	mg/L	0.0119	0.0038	0.0039	0.0041
Sodium (Na)	mg/L	43	44	44	44
Strontium (Sr)	mg/L	2.6	2.6	2.6	2.6
Sulphur (S)	mg/L	88	87	87	87
Uranium (U)	mg/L	0.0014	0.0010	0.0010	0.0010
Vanadium (V)	mg/L	0.018	0.002	0.002	<0.001
Zinc (Zn)	mg/L	0.042	0.007	0.005	0.006
Nutrients					
Total Ammonia (N)	mg/L	0.05	0.06	0.05	0.05
Dissolved Nitrate (N)	mg/L	0.84	0.08	0.06	0.03
Explanatory Parameters					
pH	pH	8.01	7.16	7.20	7.19
DO (mg/L)			1.52	1.73	1.86
Water redox (mV)			-34	-91	-134
Soil Redox (mV)			-197	-218	-226

[1] The average outflow for the hybrid bioreactor-CWTS period includes data from June 19th, when there was a spike in several constituents when the system reached low dissolved oxygen and moderately reducing conditions in the water column.

Table 9: Summary of explanatory parameters and outflow concentrations of copper and selenium

Period	Parameter	Influent	System								
			Carex			*Carex* + Moss			*Carex* + Moss + Biochar		
		Avg	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
High Nitrogen	Copper (µg/L)	146.4	16	20	18	11	16	13	9	14	12
	Selenium (µg/L)	10.2	5.8	9.7	7.6	6.0	9.5	7.3	5.8	8.5	6.7
	pH	8.00	6.99	7.94	7.49	7.19	8.29	7.64	7.39	8.28	7.84
	DO (mg/L)	-	4.08	6.69	5.36	2.59	7.55	5.35	3.50	8.70	5.75
	ORP (mV)	-	82	215	157	104	215	247	84	205	140
	Redox (soil,mV)	-	-229	-51	-144	-273	-177	-190	-301	-135	-218
Low Nitrogen	Copper (µg/L)	145.5	17	32	21	10	13	11.3	11	15	12.5
	Selenium (µg/L)	10.2	5.3	6.7	6.1	5.6	6.5	6.0	5.8	6.9	6.3
	pH	7.96	7.16	8.05	7.54	7.26	8.32	7.71	7.15	8.25	7.60
	DO (mg/L)	-	3.99	7.72	5.61	3.02	9.78	5.73	2.57	9.04	5.21
	ORP (mV)	-	126	220	168	113	188	159	106	374	182
	Redox (soil,mV)	-	-249	-39.5	-150	-246	-88	-185	-264	-123	-211
Hybrid Bioreactor-CWTS	Copper (µg/L)	175.6	7.5	45	21	8.3	44	23	8.3	64	26
	Selenium (µg/L)	11.9	1.9	5.6	4.0	2.5	5.4	4.0	2.8	5.4	4.0
	pH	8.01	6.91	7.62	7.16	6.95	7.82	7.20	6.96	7.71	7.19
	DO (mg/L)	-	0.02	3.23	1.52	0.11	5.61	1.73	0.03	4.71	1.86
	ORP (mV)	-	-175	-79	-129	-212	-101	-150	-195	-30	-134
	Redox (soil,mV)	-	-232	-170	-197	-268	-159	-218	-290	-150	-226

Table 10: Removal rate coefficients for each system and period of testing.

Element	System	Period RRC (hr^{-1})		
		High N	Low N	hybrid bioreactor-CWTS [1]
Copper	*Carex*	0.0465	0.0390	0.0250
	Carex + Moss	0.0519	0.0497	0.0236
	Carex + Moss + Biochar	0.0543	0.0462	0.0242
Selenium	*Carex*	0.0069	0.0103	0.0130
	Carex + Moss	0.0078	0.0102	0.0128
	Carex + Moss + Biochar	0.0095	0.0090	0.0123

[1] The calculation of RRC for the hybrid bioreactor-CWTS period included data from June 19th, when there was a spike in several constituents when the system reached low dissolved oxygen and moderately reducing conditions in the water column.

Table 11: Bioconcentration factor for each plant species at the end of the Low N period.

Plant Species	Copper (L/kg)	Selenium (L/kg)
Carex	23	113
Moss	1390	593

10. Figures

Figure 1: Pilot CWTS layout

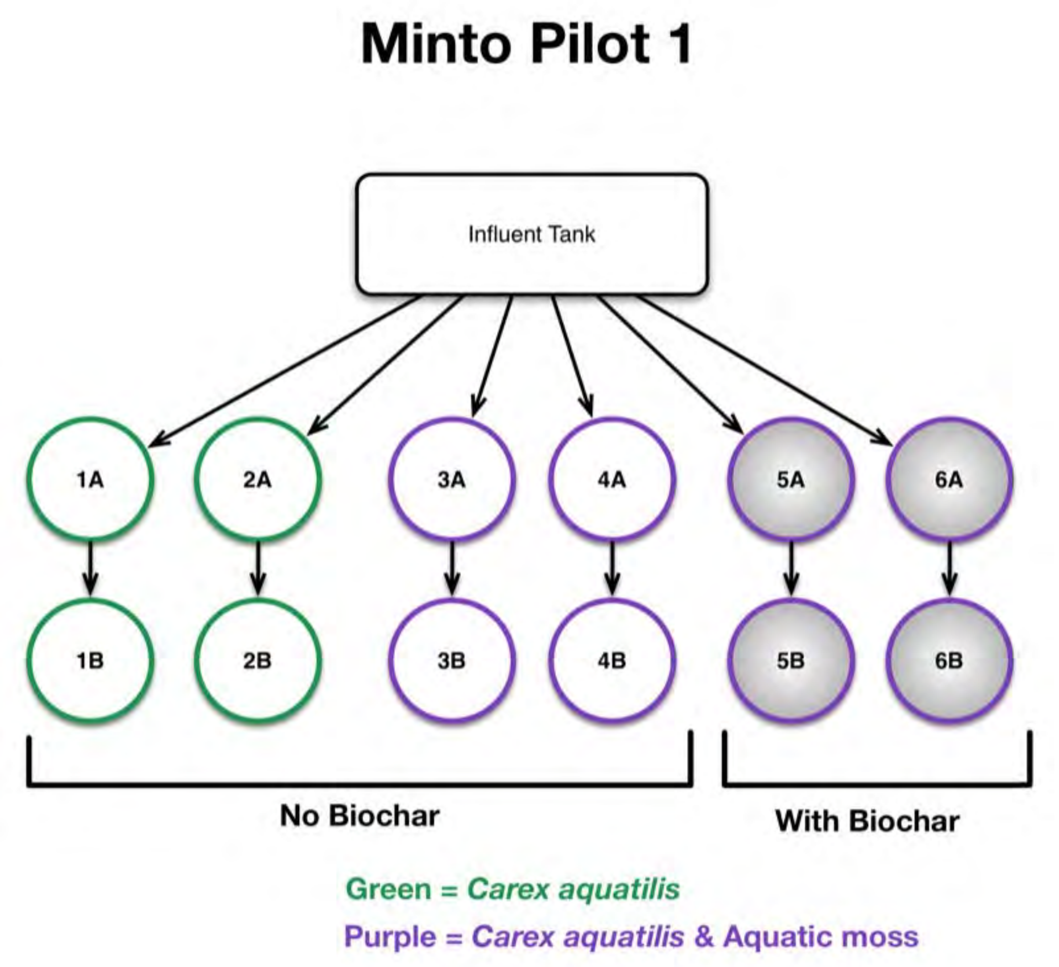


Figure 2: Photographs of pilot CWTS set up. Top is entire system, with 6 series of two cells; bottom is one cell.

Figure 3: Outflow copper and selenium water concentrations over time compared to influent.

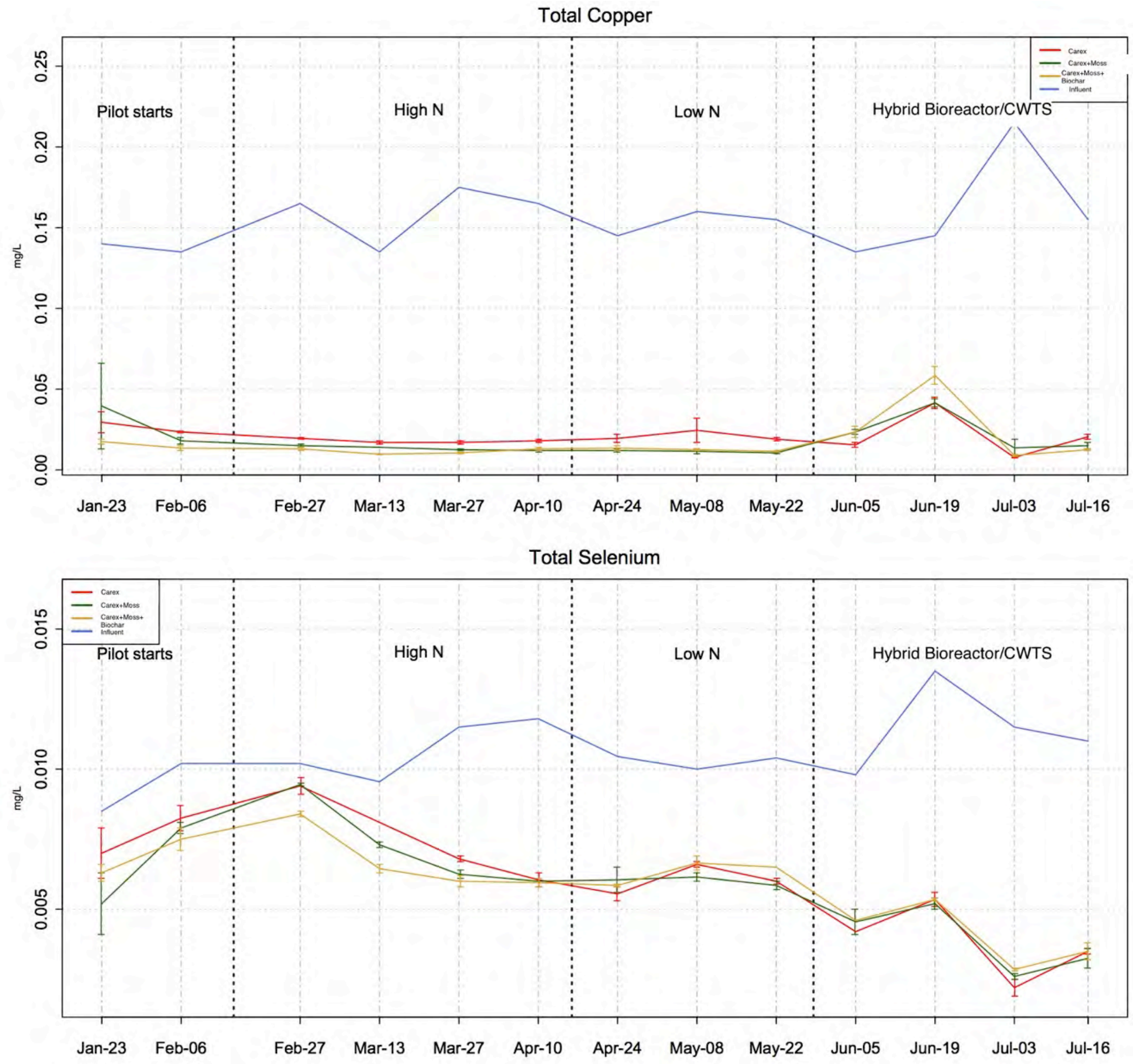


Figure 4: Copper and selenium removal rate coefficients during all periods of testing for the three system designs.

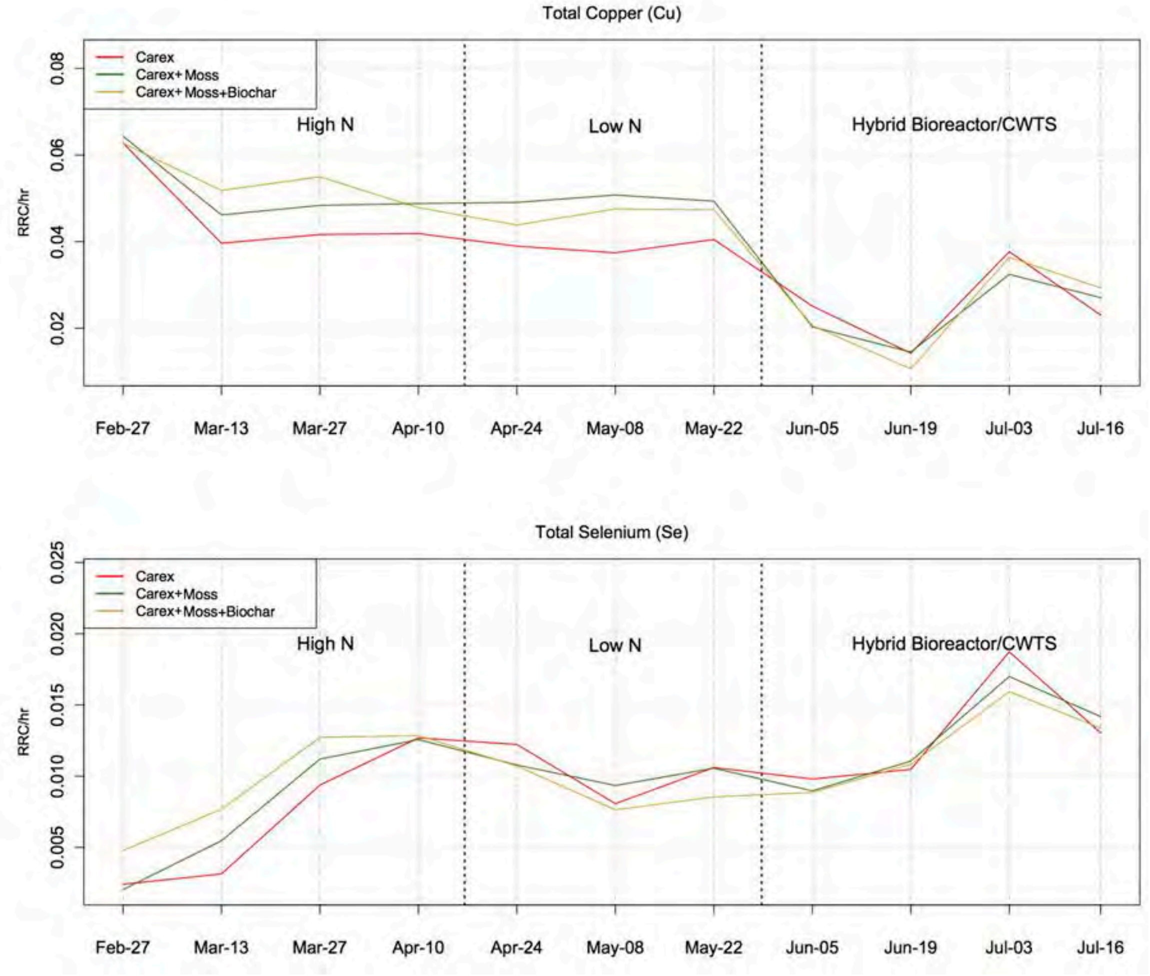


Figure 5: Copper (top) and selenium (bottom) removal rate coefficients for cells A and B in each system design. All three periods of testing are plotted separately (High N = Feb 27-April 12; Low N = April 13-May 28; hybrid bioreactor/CWTS = May 29-July 16). The average RRC is indicated with the bar chart, and error bars show the range. Note that the water depth was changed during the hybrid bioreactor/CWTS phase, which impacts the RRC.

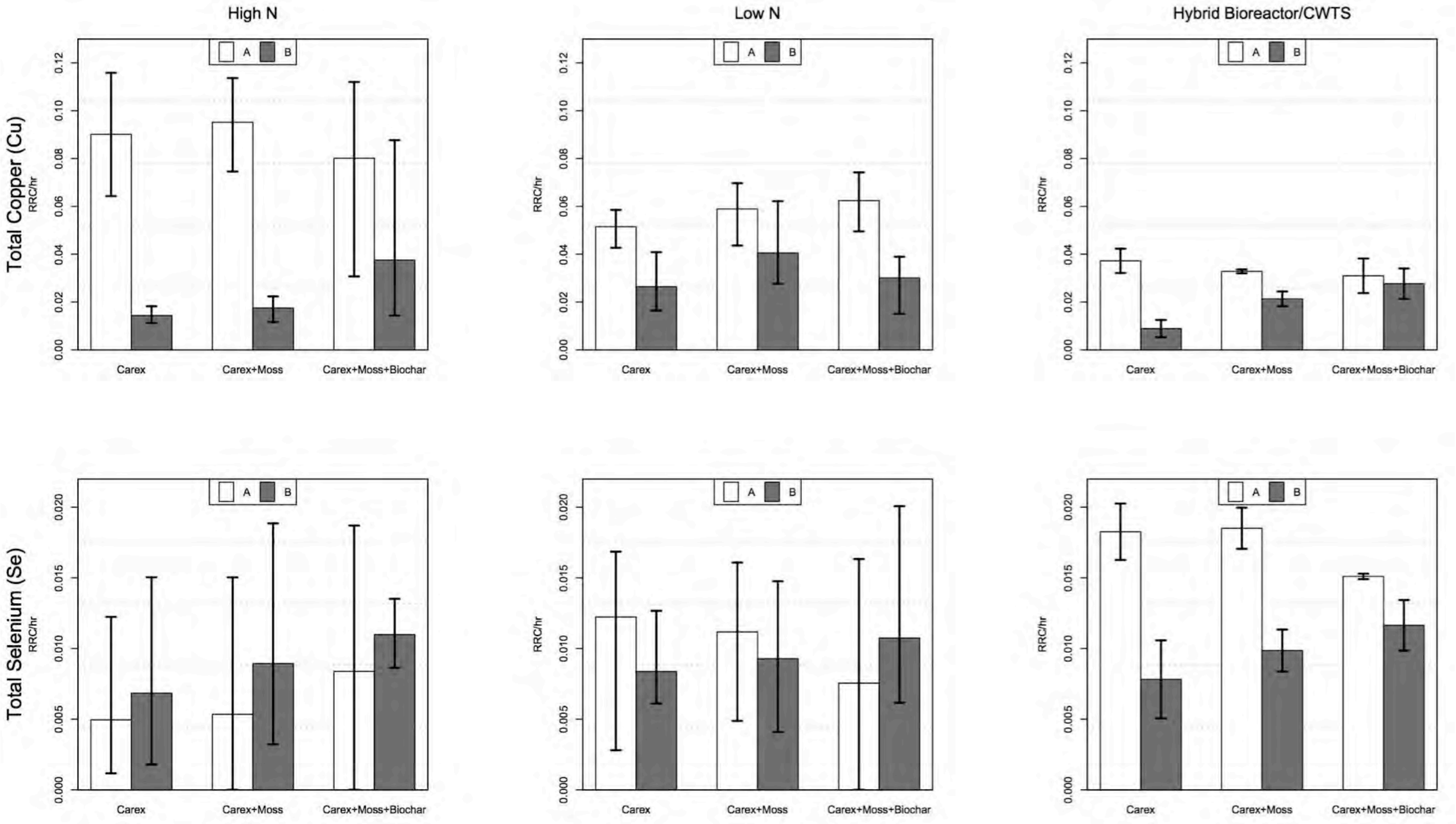


Figure 6: Outflow copper and selenium water concentrations from A and B cells over time compared to influent.

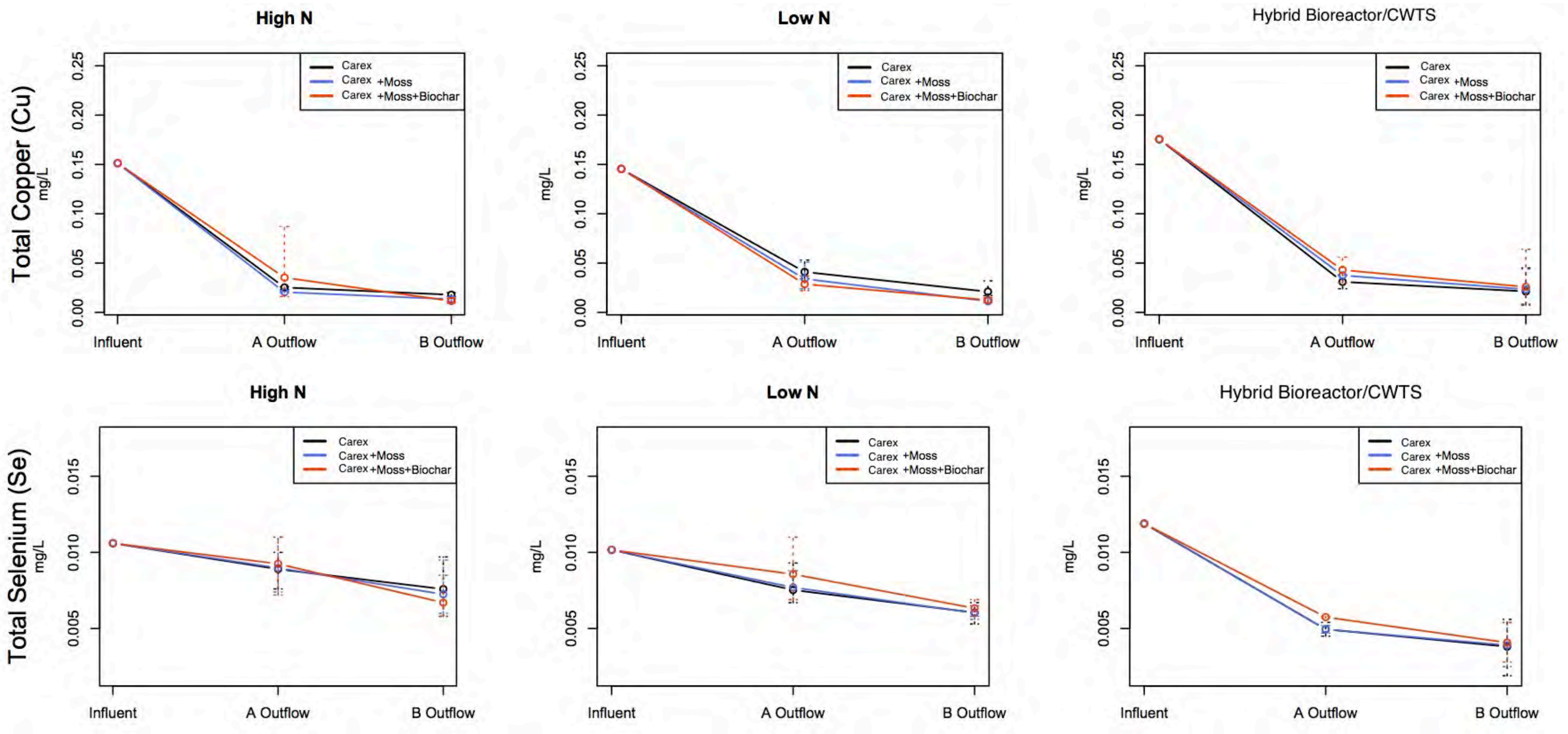


Figure 7: Non-metric multidimensional scaling (nMDS) analysis plot for bacterial community profiles of each pilot system design over time. Results are based on the genetic profiling method. Each time point during testing is shown with a different color, while the system design is indicated with shapes. All points that cluster together indicate similar bacterial communities. At the end of the pilot testing, we also determined the microbial population of the top root mass (orange outline), which was very similar to the microbial population in the sediment. The top 10 bacterial groups are indicated on the plot with dark blue numbers. The distance between a bacterial group label and a sample point depicts how high that group is in that sample.

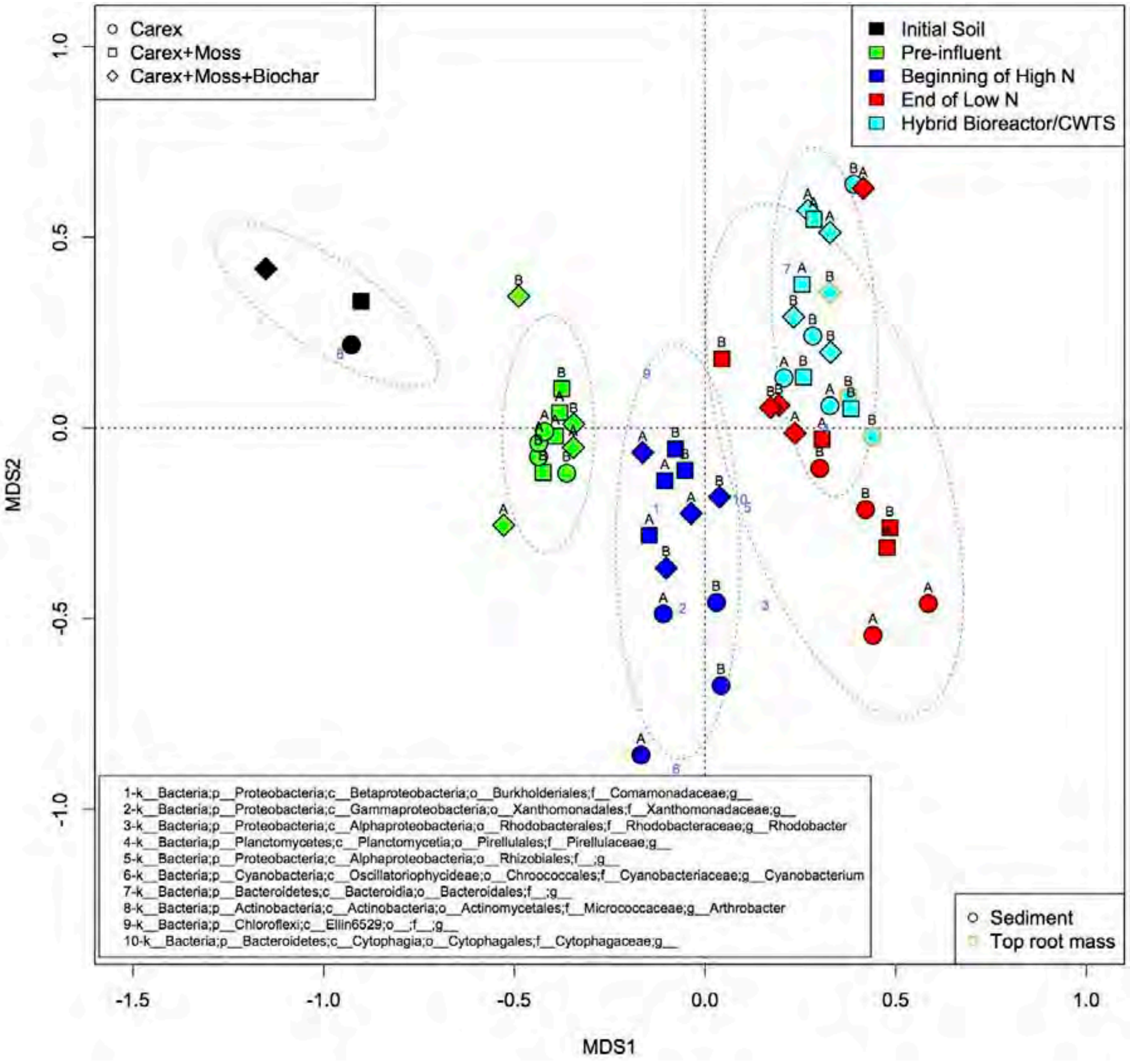
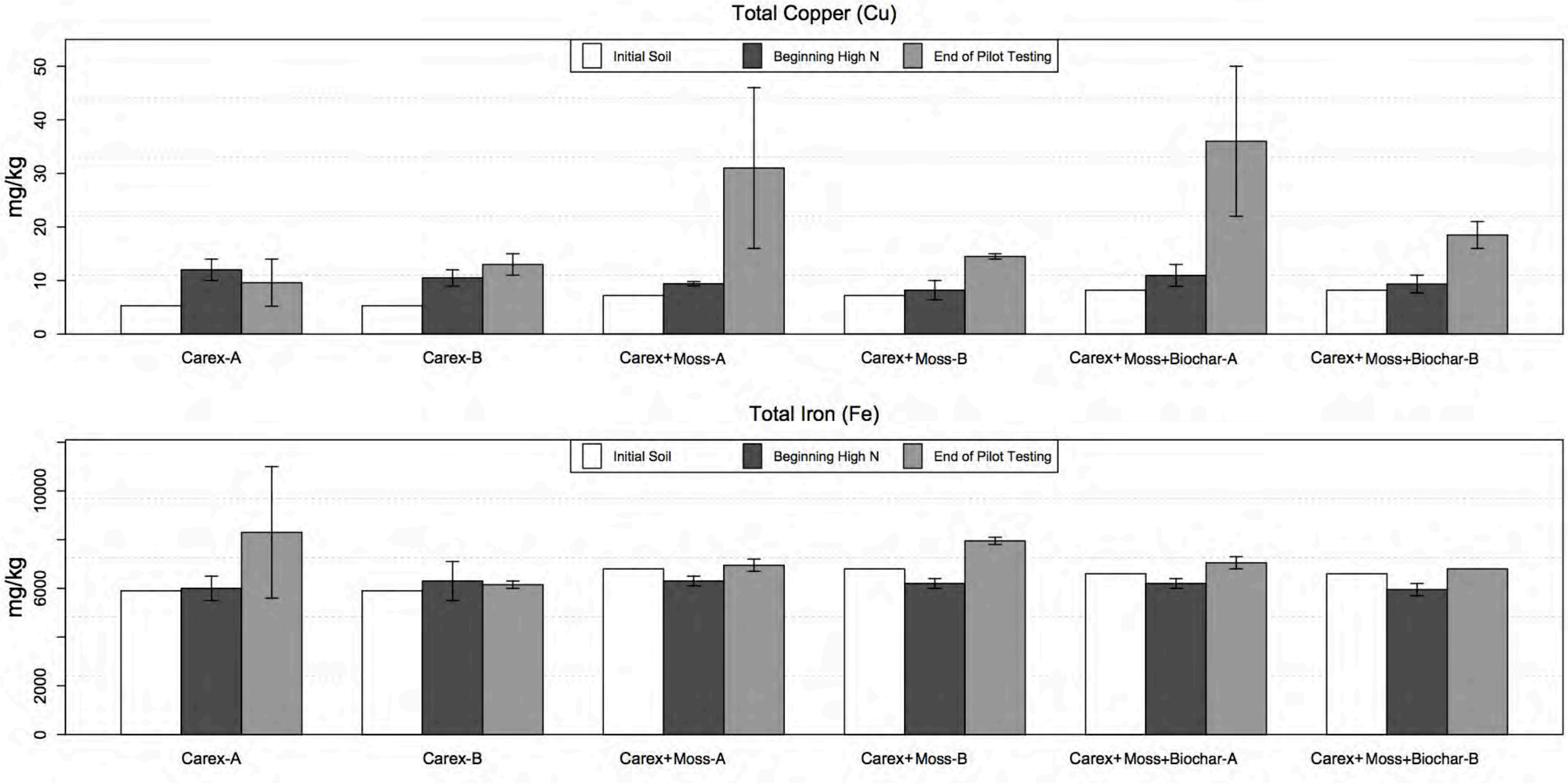
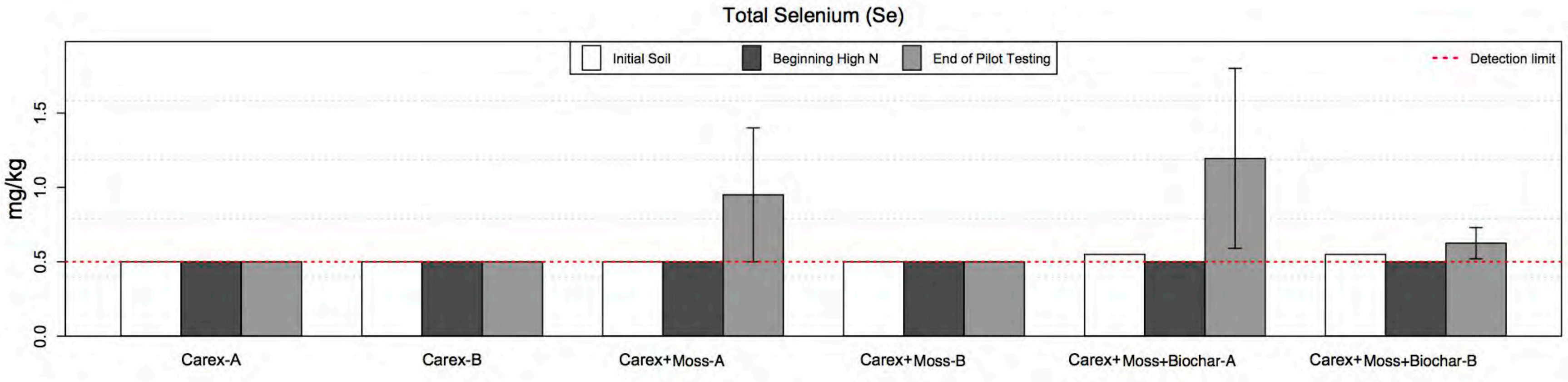


Figure 8: Copper, iron, selenium and sulphur concentrations in sediment throughout the pilot testing. Initial soil is the soil that was used to build the pilot systems, before any water was introduced. A and B cells for system designs are plotted separately, with error bars indicating the maximum and minimum values. The dotted red line indicates the selenium detection limit, as several samples were below this level. Selenium and sulphur plots are on the following page.




Total Selenium (Se)
Initial Soil
Beginning High N
End of Pilot Testing
Detection limit
mg/kg
0.0
0.5
1.0
1.5
Carex-A
Carex-B
Carex+Moss-A
Carex+Moss-B
Carex+Moss+Biochar-A
Carex+Moss+Biochar-B

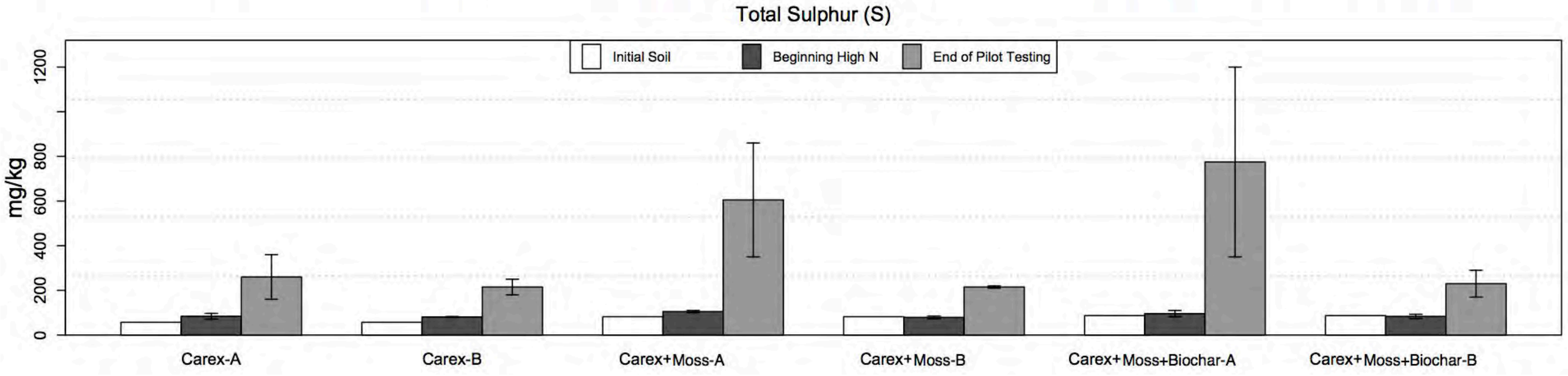

Total Sulphur (S)
Initial Soil
Beginning High N
End of Pilot Testing
mg/kg
0
200
400
600
800
1200
Carex-A
Carex-B
Carex+Moss-A
Carex+Moss-B
Carex+Moss+Biochar-A
Carex+Moss+Biochar-B

Figure 9: Mass balance of copper in the pilot CWTS at the end of testing. The total amount of copper in the top 6 cm of sediment in A and B cells is shown for each system design, as well as the *Carex* in A and B cells. “Other” is the portion that was not analyzed for metals, and therefore cannot be differentiated. Examples of locations in the “Other” category would be plant roots, biofilms, and deeper sediment, as all of these were not analyzed. Additionally, it should be noted that the Moss did not survive the hybrid bioreactor-CWTS period, and therefore was not tested at the end of the pilot testing.

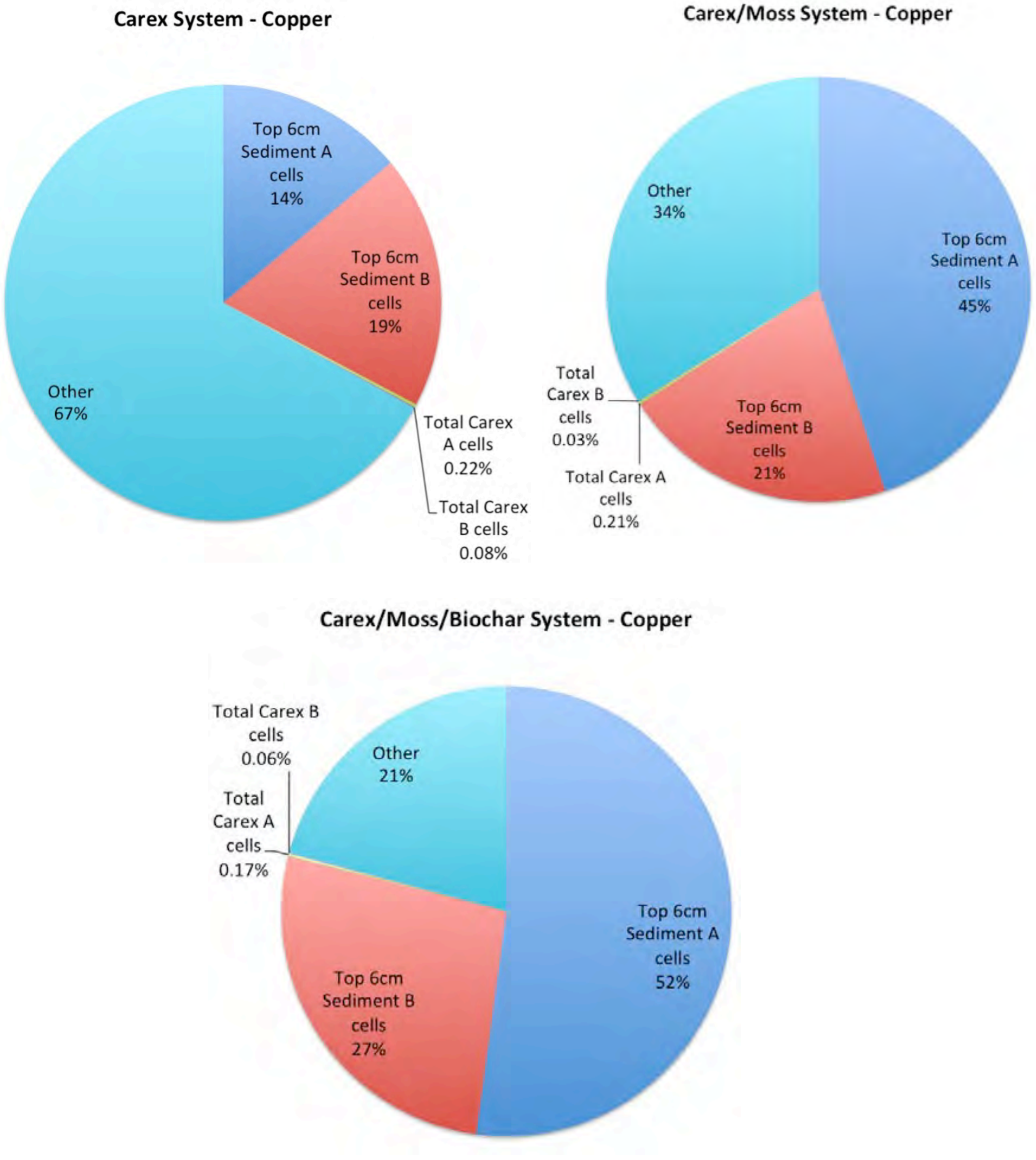


Figure 10: Mass balance of selenium in the pilot CWTS at the end of testing. The total amount of selenium in the top 6 cm of sediment in A and B cells is shown for each system design, as well as the *Carex* in A and B cells. “Other” is the portion that was not analyzed for metals, and therefore cannot be differentiated. Examples of locations in the “Other” category would be plant roots, biofilms, and deeper sediment, as all of these were not analyzed. Additionally, it should be noted that the Moss did not survive the hybrid bioreactor-CWTS period, and therefore was not tested at the end of the pilot testing.

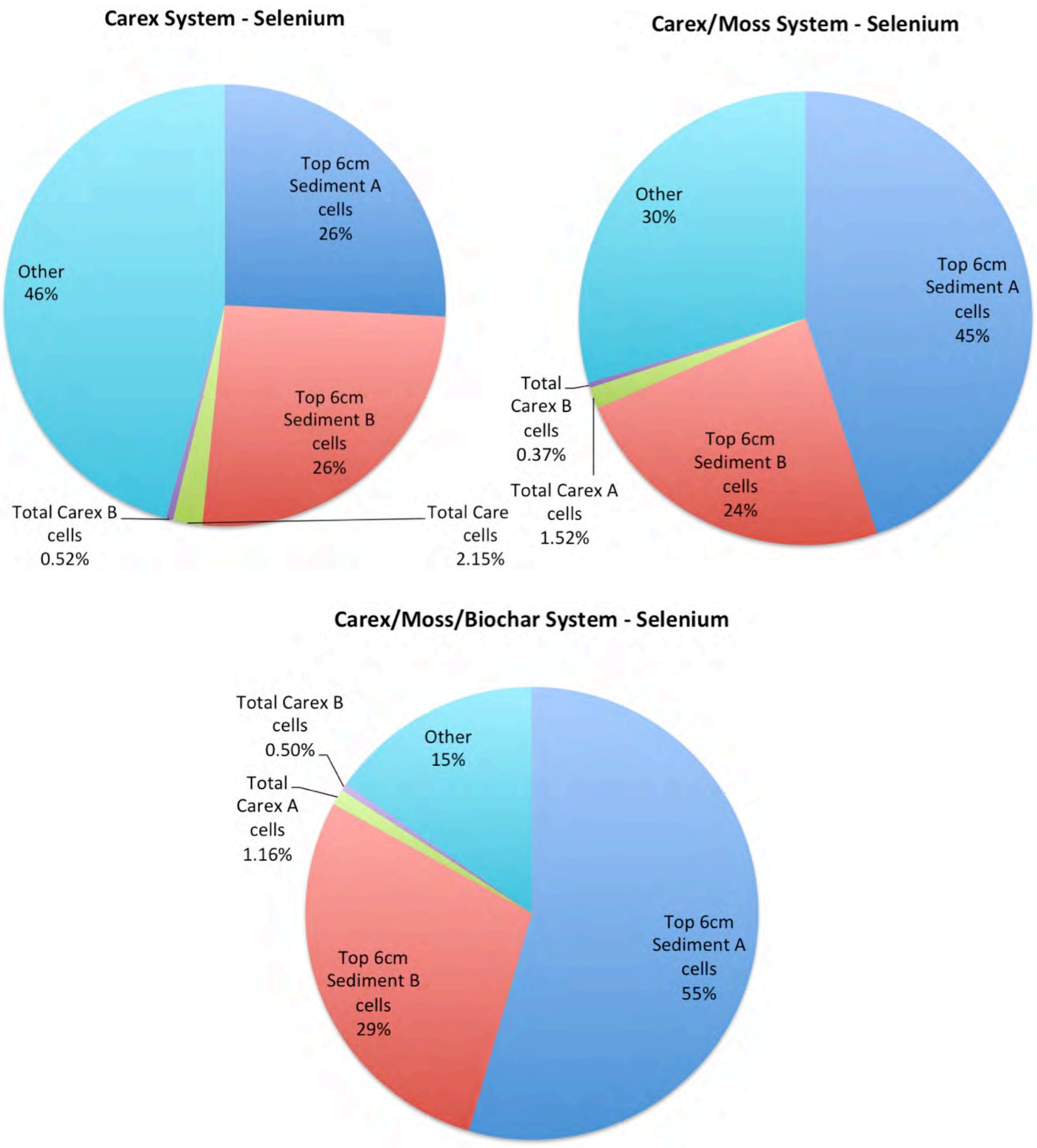


Figure 11: Comparison of bioconcentration factor for copper and selenium in *Carex* in A and B cells from each pilot system design. The p-value is calculated using Friedman test, with significant results shown in red. A significant test means that a difference between the BCF in A and B cells is found (e.g., A cells are always higher than B cells, or vice versa).

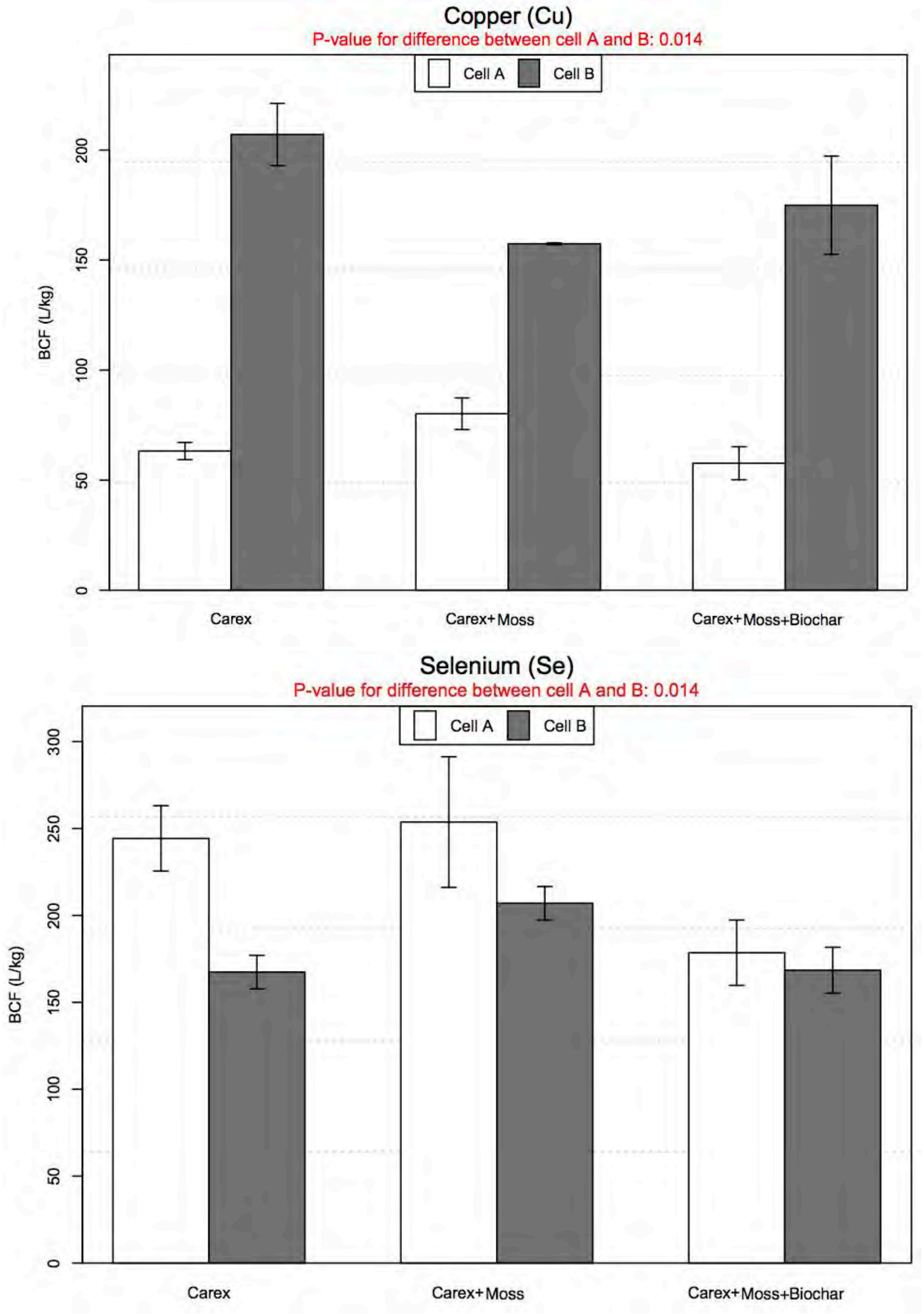


Figure 12: Copper and selenium concentrations in *Carex* before and after the freeze-thaw test, for all three system designs.

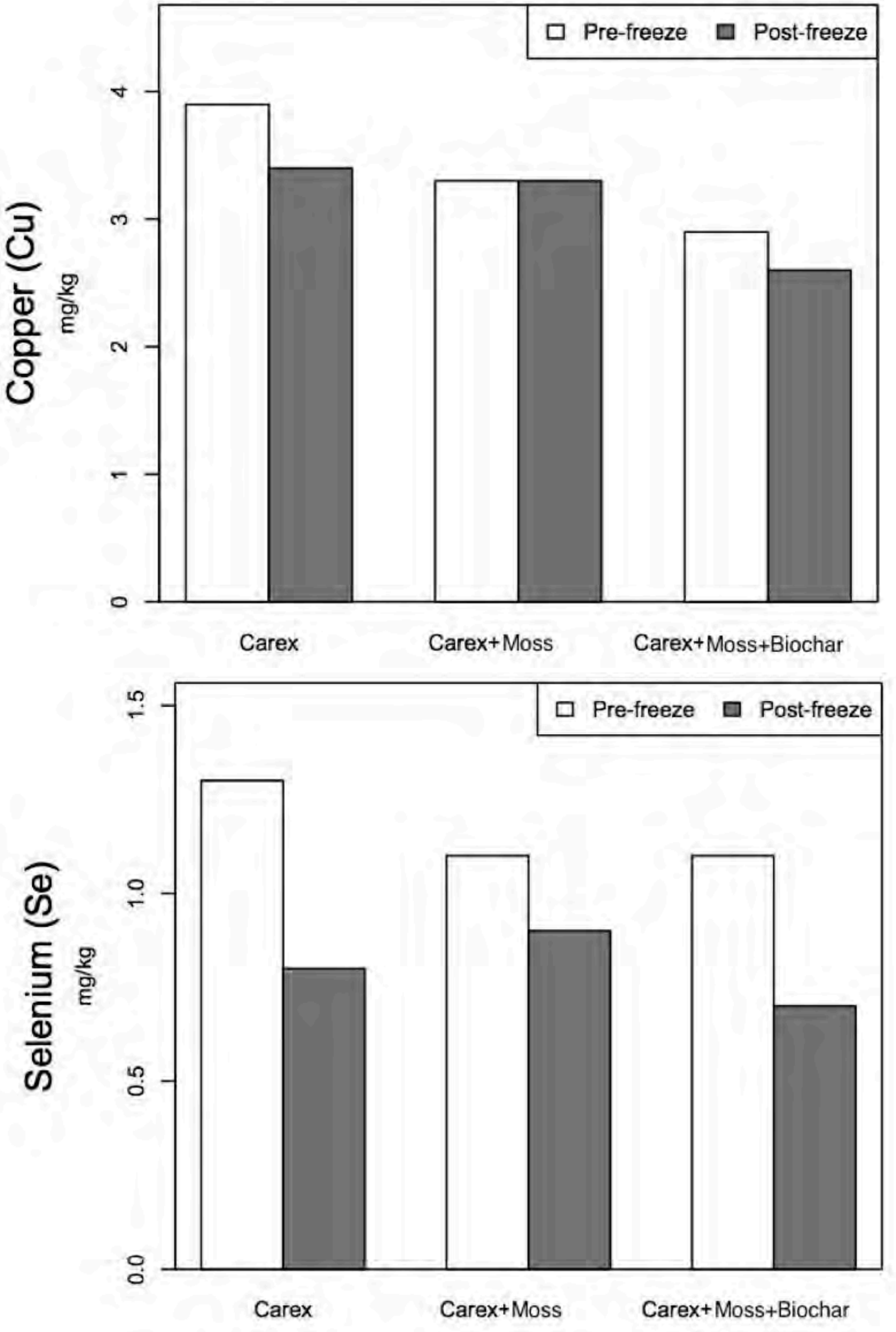


Figure 13: Copper and selenium concentrations in Moss before and after the freeze-thaw test, for the two system designs that had Moss.

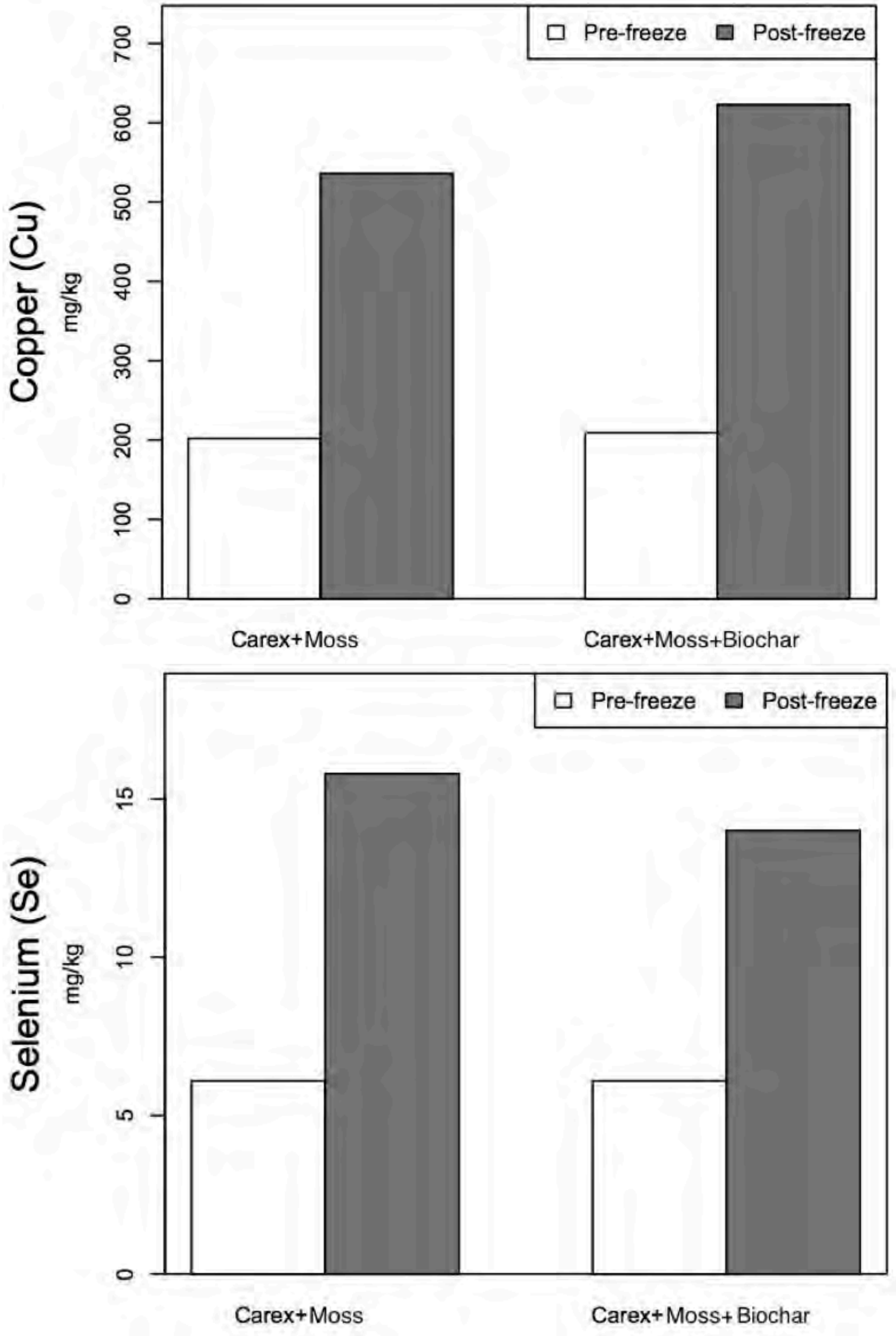


Figure 14: Photograph of *Carex aquatilis* (Sedge) roots at system takedown

Figure 15: Photograph of CWTS cell during takedown of the system. Orange-colored hydrosoil layer is approximately 18 cm, black detritus toproot zone is ~3 cm. Water depth was ~20 cm during the high and low nitrogen periods, and ~30 cm above the sediment during the hybrid bioreactor-CWTS period.

Figure 16: *Carex* stem counts (top) and height (bottom) of each system design, during all periods of testing.

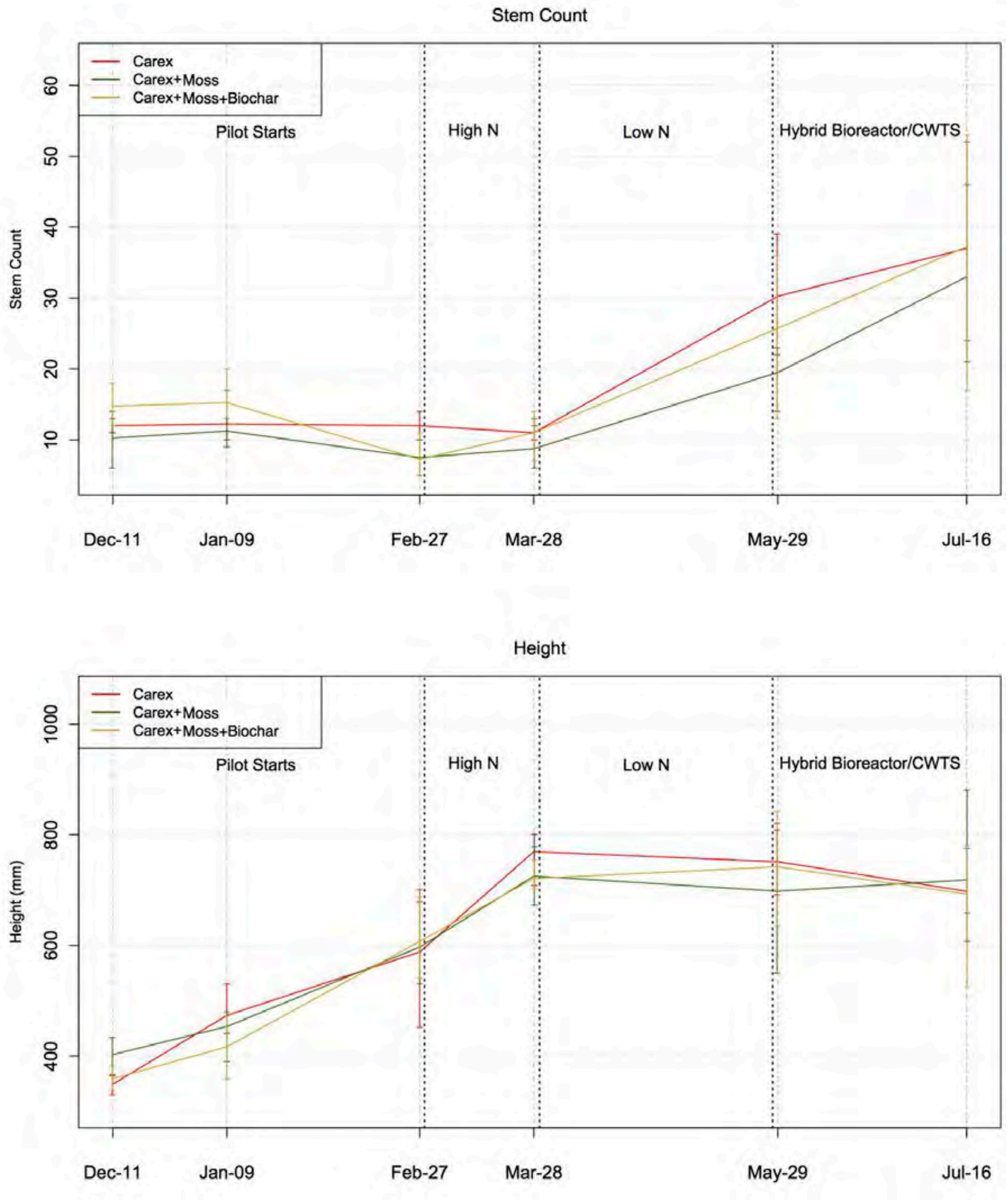
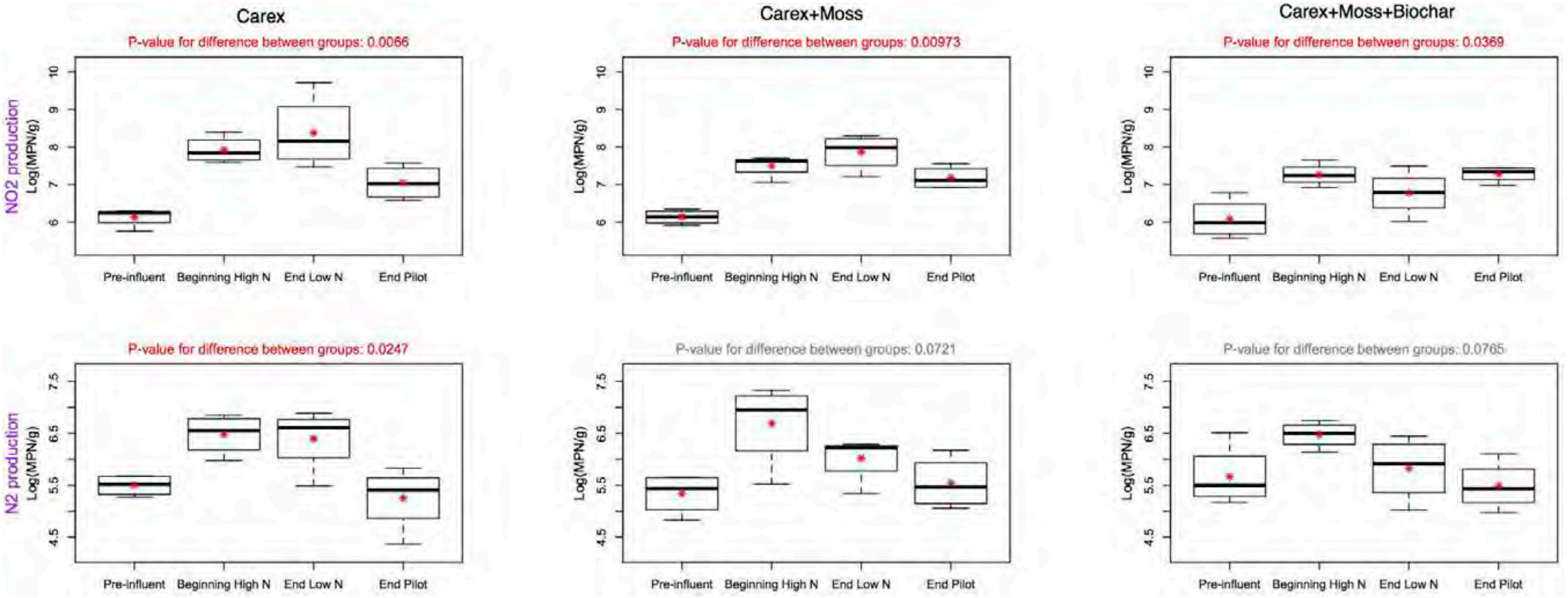
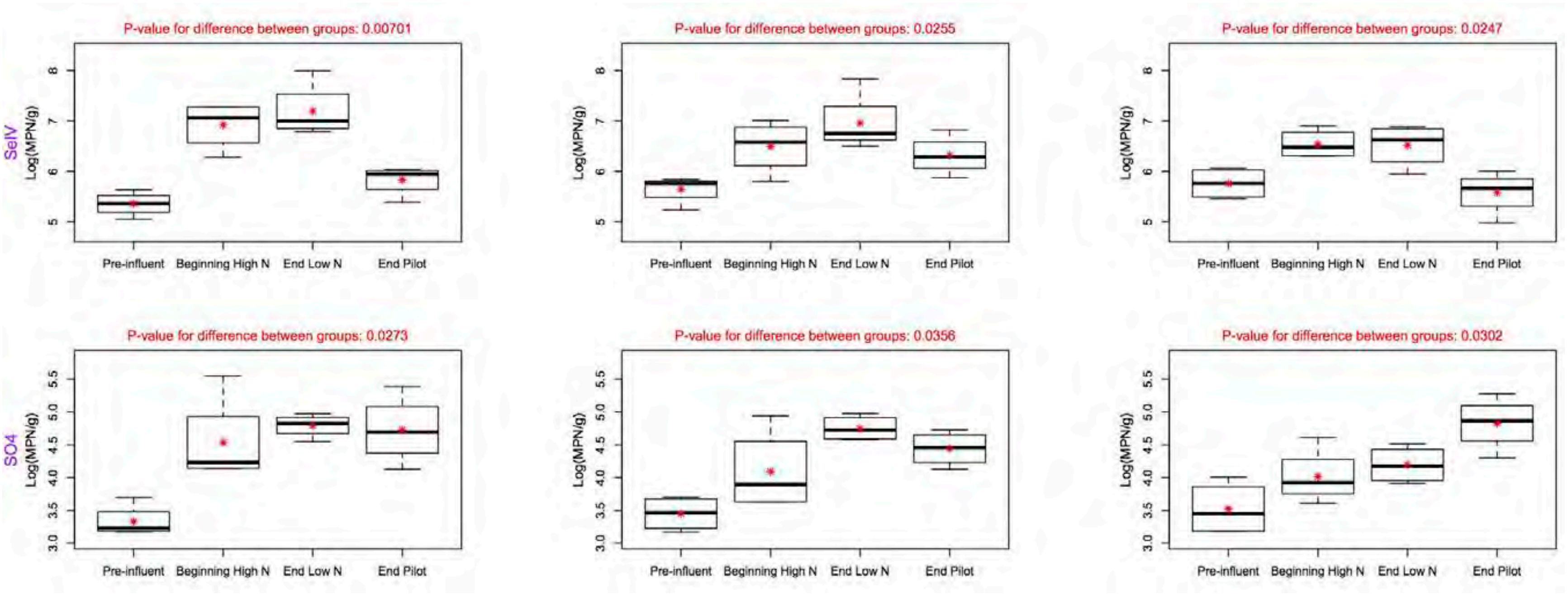


Figure 17: Comparison of the most probable number (MPN) of nitrate-, selenite-, and sulphate-reducing organisms in each system over time. NO_2 production indicates the MPN of organisms that are capable of reducing nitrate to nitrite. N_2 production shows the MPN of organisms that can reduce nitrate to nitrogen gas. The MPN was compared among the four time periods, and a P-value was calculated using the non-parametric Kruskal-Wallis test. The first plot represents systems with just *Carex*, the second plot is systems with *Carex* and Moss, while the third plot is systems with *Carex,* Moss, and biochar. Significant differences (P<0.05) are indicated in red, meaning a significant difference is found between the four testing periods in a given system design. Box plots are used to visualize the results; top and bottom edges of the box show the 25th and 75th percentile, respectively, while the thick black line depicts the median and the red asterisk shows the mean. The upper and lower whiskers provide the maximum and minimum non-outlier values. The remainder of the figure is provided on the following pages.




P-value for difference between groups: 0.00701
P-value for difference between groups: 0.0255
P-value for difference between groups: 0.0247
SeIV
Log(MPN/g)
5
6
7
8
Pre-influent
Beginning High N
End Low N
End Pilot
P-value for difference between groups: 0.0273
P-value for difference between groups: 0.0356
P-value for difference between groups: 0.0302
SO4
Log(MPN/g)
3.0
3.5
4.0
4.5
5.0
5.5
Pre-influent
Beginning High N
End Low N
End Pilot

Appendix 1:
Table 1: Biochar Analytical Results

Parameter	Units	Concentration
Cation exchange capacity	cmol+/kg	11
Total Organic Carbon (C)	%	54
As Received Basis Heat Value	MJ/kg	14.670
Available (NH4F) Nitrogen (N)	mg/kg	<2.0
Available (NH4F) Phosphorus (P)	mg/kg	1.3
Available (NH4OAc) Potassium (K)	mg/kg	1300
Sodium Adsorption Ratio	N/A	1.6
Soluble Calcium (Ca)	mg/L	61
Soluble Magnesium (Mg)	mg/L	1.0
Soluble Sodium (Na)	mg/L	46
Soluble Potassium (K)	mg/L	270
Saturation %	%	220
Soluble Sulphate (SO4)	mg/L	150
Moisture	%	4.6
Total Aluminum (Al)	mg/kg	7800
Total Boron (B)	mg/kg	<2.0
Total Calcium (Ca)	mg/kg	27000
Total Iron (Fe)	mg/kg	10000
Total Lithium (Li)	mg/kg	<10
Total Magnesium (Mg)	mg/kg	7400
Total Manganese (Mn)	mg/kg	250
Total Phosphorus (P)	mg/kg	3100
Total Potassium (K)	mg/kg	7400
Total Sodium (Na)	mg/kg	830
Total Strontium (Sr)	mg/kg	47
Total Sulphur (S)	mg/kg	1200
Total Antimony (Sb)	mg/kg	<1.0
Total Arsenic (As)	mg/kg	2.4
Total Barium (Ba)	mg/kg	77
Total Beryllium (Be)	mg/kg	<0.40
Total Cadmium (Cd)	mg/kg	0.12
Total Chromium (Cr)	mg/kg	13
Total Cobalt (Co)	mg/kg	2.6
Total Copper (Cu)	mg/kg	11
Total Lead (Pb)	mg/kg	3.6
Total Molybdenum (Mo)	mg/kg	0.82
Total Nickel (Ni)	mg/kg	6.4
Total Selenium (Se)	mg/kg	<0.50

Total Silver (Ag)	mg/kg	<1.0
Total Thallium (Tl)	mg/kg	<0.30
Total Tin (Sn)	mg/kg	<1.0
Total Uranium (U)	mg/kg	<1.0
Total Vanadium (V)	mg/kg	19
Total Zinc (Zn)	mg/kg	44
Acenaphthene	mg/kg	0.14
Benzo[a]pyrene equivalency	mg/kg	<0.10
Acenaphthylene	mg/kg	0.072
Acridine	mg/kg	0.020
Anthracene	mg/kg	0.053
Benzo(a)anthracene	mg/kg	0.0081
Benzo(b&j)fluoranthene	mg/kg	0.0056
Benzo(k)fluoranthene	mg/kg	<0.0050
Benzo(g,h,i)perylene	mg/kg	<0.0050
Benzo(c)phenanthrene	mg/kg	<0.0050
Benzo(a)pyrene	mg/kg	<0.0050
Benzo[e]pyrene	mg/kg	<0.0050
Chrysene	mg/kg	0.0095
Dibenz(a,h)anthracene	mg/kg	<0.0050
Fluoranthene	mg/kg	0.24
Fluorene	mg/kg	0.11
Indeno(1,2,3-cd)pyrene	mg/kg	<0.0050
2-Methylnaphthalene	mg/kg	0.13
Naphthalene	mg/kg	0.16
Phenanthrene	mg/kg	0.42
Perylene	mg/kg	<0.0050
Pyrene	mg/kg	0.18
Quinoline	mg/kg	0.028
D10-ANTHRACENE (sur.)	%	82
D12-BENZO(A)PYRENE (sur.)	%	17
D8-ACENAPHTHYLENE (sur.)	%	95
TERPHENYL-D14 (sur.)	%	112

Table 2: Alfalfa Analytical Results

Parameter	Units	Concentration
Available (NH4F) Nitrogen (N)	mg/kg	150
Available (NH4F) Phosphorus (P)	mg/kg	1200
Available (NH4OAc) Potassium (K)	mg/kg	20000
Available (CaCl2) Sulphur (S)	mg/kg	1200
Total Organic Carbon (C)	%	35
Antimony (Sb)	ug/g	<0.05
Arsenic (As)	ug/g	<0.5
Barium (Ba)	ug/g	60.7
Beryllium (Be)	ug/g	<0.05
Bismuth (Bi)	ug/g	<0.05
Boron (B)	ug/g	30.2
Cadmium (Cd)	ug/g	0.09
Calcium (Ca)	ug/g	12100
Chromium (Cr)	ug/g	1.6
Cobalt (Co)	ug/g	0.263
Copper (Cu)	ug/g	8.1
Iron (Fe)	ug/g	532
Lead (Pb)	ug/g	0.54
Magnesium (Mg)	ug/g	3430
Manganese (Mn)	ug/g	62.6
Molybdenum (Mo)	ug/g	1.48
Nickel (Ni)	ug/g	1.24
Phosphorus (P)	ug/g	1810
Potassium (K)	ug/g	18600
Selenium (Se)	ug/g	0.3
Silver (Ag)	ug/g	<0.05
Sodium (Na)	ug/g	451
Strontium (Sr)	ug/g	52.4
Thallium (Tl)	ug/g	0.011
Tin (Sn)	ug/g	<0.3
Titanium (Ti)	ug/g	8.7
Uranium (U)	ug/g	0.113
Vanadium (V)	ug/g	0.8
Zinc (Zn)	ug/g	27

Appendix Q – Post Construction As-Built Report for Reconstruction of the W3 Flume, Minto Mine

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December 17, 2014
Project No: 1CM002.026

Environmental Coordinator
Capstone Mining Corporation, Minto Mine
#13 Calcite Business Centre, 151 Industrial Road
Whitehorse, Yukon Y1A 2V3

Attention: Ryan Herbert

Dear Ryan:

Subject: Post Construction As-Built Report for Reconstruction of the W3 Flume, Minto Mine

1 Introduction

Capstone Mining Corporation's environmental group at Minto Mine, Yukon, retained SRK Consulting (Canada) Inc. (SRK) to provide engineering design and construction supervision services for reconstruction of the fiberglass flume installed at the W3 monitoring station. This letter report provides the project's background and scope including observations made by SRK's engineer during construction. As-built construction drawings that document the completed works were prepared to accompany this as-built report and are located in Attachment A.

An in-channel Palmer-Bowles type fiberglass flume was installed in 2008 by SRK at the W3 water monitoring site on Minto Creek. This type of flume was originally chosen because its design could be easily integrated into the streambed of a creek (minimizing disturbances) and could gauge flows up to the 1-in-200 year event before overtopping. The reinforced fiberglass flume, manufactured by Plasti-Fab of Portland, Oregon, provided service from 2008 to the spring of 2013. During the spring of 2013, erosion at the intake of the flume eroded the backfill placed under and around the sides of the flume.

In response to Minto Mine's need to regain functionality of the W3 flume, SRK proposed a hydraulic intake structure be designed and constructed for the current flume. The upgrade consisted of a compacted fill and geosynthetic foundation, an upstream concrete slab footing, and a wing wall entrance section with upstream and downstream riprap erosion protection. Design objectives included:

- Laminar and low velocity flow condition entering the structure;

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Anchorage 907.677.3520
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Elko 775.753.4151
Fort Collins 970.407.8302
Reno 775.828.6800
Tucson 520.544.3688

Mexico Office:
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Queretaro 52.442.218.1030
Zacatecas 52.492.927.8982

Canadian Offices:
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Sudbury 705.682.3270
Toronto 416.601.1445
Vancouver 604.681.4196
Yellowknife 867.873.8670

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Australia
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North America
South America

- Long-term integrity of the entrance section;
- No excessive backwater or submergence in the structure or in the upstream channel; and
- Reintegrates easily into Minto Mine's field sampling program.

Prior to construction, SRK studied the hydrology of the contributing watershed to analyze the expected discharges of Minto Creek at the W3 sampling location. From this assessment an options analysis was conducted to determine the hydraulic redesign that would regain the functionality of the W3 flume.

2 Hydrological Assessment

The W3 water monitoring site is located downstream of the discharge of a water storage pond and dam. Under normal operating conditions, discharge from the pond into the creek is regulated by a pump system. Contributing to the pond's discharge is a relatively small natural catchment between the dam and flume. Pond discharge and the natural catchment flow reports to the W3 flume.

2.1 Natural Catchment Peak Flow

Peak flow from the natural catchment was calculated using a USGS method developed for estimating peak flow magnitude and frequency at ungauged streams in Alaska and western Yukon (Curran, 2003). This regional analysis is based on gauging station data available from USGS (2003). In the USGS report, Alaska and the western Yukon are divided into seven regions, each defined by a regression equation for each return period (from 2 to 500 years) to estimate peak flows. Each of the equations required meteorological inputs to calculate the geomorphological parameters of the catchment. The Minto site lies within Region 5.

For the peak flow estimation for the W3 flume, the following information was assumed:

- Catchment area = 440,300 m^2;
- Average elevation = 760 m;
- Lake or impoundment area = 0%; and
- Forest cover = 80%.

Using these characteristics of the natural catchment as inputs peak flows were established for the natural catchment reporting to the flume at W3 (Table 1).

Table 1: Peak flow estimates from the natural catchment to the flume at W3

Return Period [year]	Peak Flow [m³/s]
2	0.03
5	0.06
10	0.10
25	0.16
50	0.22
100	0.29
200	0.37
500	0.49

2.2 Peak Flows Estimated for the Flume at W3

Expected peak flows at the W3 flume under normal operating conditions are a summation of the maximum pumping capacity from the water storage pond and the peak flows from the natural catchment that occur downstream of the pond's dam. Based on discussions with Minto personnel, the maximum capacity of the pump system from the pond into Minto Creek could be up to 0.23 m³/s (or 20,000 m³/day). Table 2 presents the range of peak flows for various return periods in Minto Creek including the pond's pump system. For the purpose of this analysis, it was assumed that there will not be a release from the pond's spillway and this flow was not modelled in the analysis. If the pond is full and an extreme precipitation event occurs, the peak flow at the W3 flume would be significantly higher.

Table 2: Peak flow estimates to the W3 flume under normal operating conditions

Return Period [year]	Peak Flow [m³/s]
2	0.26
5	0.29
10	0.33
25	0.39
50	0.45
100	0.52
200	0.60
500	0.73

2.3 Hydrology Assessment Summary

The existing hydraulic structure consisted of an in-channel Palmer-Bowles type flume, made with fiberglass reinforced polyester with a 0.9 m, 60˚ V-notch. This type of flume was originally chosen because it could be installed to minimize streambed disturbances and could accurately gauge flows in the range of 0.0001 to 0.400 m^3/s in a northern climate (SRK 2007). The flume itself was engineered to convey flows up to 0.600 m^3/s. According to the hydrology assessment, 0.600 m^3/s corresponds to a 1-in-200 year event occurring at a time when the mine is discharging at the limits of its capacity.

3 Design Build Overview

SRK produced a set of detailed construction drawings of the proposed upgrades to the W3 flume. In conjunction with the design drawings, SRK provided an onsite engineer who collaborated with Minto staff and contractors for the entirety of the construction process. Milestone events, task completion dates, and communications were summarized in three intermediate construction reports. Intermediate construction reports are included in Attachment B and a construction photo log summary is provided in Attachment C. The following summarizes the major tasks completed during the construction process.

- Diversion construction of Minto Creek to bypass flow around the construction area;
- Excavation of upstream sumps and installation of sump pumps to manage seepage entering the foundation excavation area;
- Excavation and compaction of foundation using a local sandy silt residuum backfill;
- Construction and concrete casting of the formwork for the intake structure base and the internal steel reinforcement following design specifications;
- Casting a flexible membrane into the concrete between base and wing walls;
- Construction of concrete formwork for the intake structure and wing walls following design specifications;
- Casting of concrete into formwork and as backfill into the void space below the flume;
- Removal of concrete formwork and the compaction of sandy silt residuum glacial till behind concrete wing walls;
- Placement of downstream and upstream riprap protection;
- Removal of the Minto Creek diversion pipe;
- Excavation of the emergency overflow diversion; and
- Installation of surface restoration features including willow stakes, modified brush layers, and riprap.

Figure 1 presents a summary of the construction tasks and the duration required for completion. Figures 2 and 3 document the concrete strength and additives that were delivered to site cast. The project was completed as designed, with one modification that will not affect design performance. The constructed width of the upstream channel was narrowed by 1.6 m. This alteration was required to better fit the wing walls into the upstream left creek bank where permafrost was exposed and to limit excavation into competent creek banks.

4 Construction Procedure

4.1 Resources and Equipment

Under SRK's supervision, Pelly Construction conducted the major task of earthwork excavation and riprap placement according to the design drawings. Minto Mine's site services department completed minor excavating tasks including operating the backhoe and mini excavator. Concrete formwork services were provided by A&T Contracting's carpenters and concrete was supplied by Territorial Contracting. All three companies are located in Whitehorse, Yukon.

4.2 Construction Quality Assurance and Quality Control

During site supervision SRK followed the construction design specifications presented on the design drawings. Onsite quality assurance / quality control checks conducted by SRK are listed below.

- Use of adequate elevation control for compacting fill beneath the flume and upstream and downstream excavations for riprap installation and the construction of the concrete base;
- Marked and measured rebar lap lengths, hook diameters, and clearance depths on the rebar cage installation to ensure rebar would not be exposed after the casting is complete;
- Marked and measured the triangular geometry of the headwall-flume opening against the geometry of the fiberglass flume intake opening and flange;
- Inspection of structural cross bracing to ensure stability of formwork during casting; and
- Inspection of the concrete pour to ensure adequate vibration and void consolidation during casting and trowelling of concrete surfaces.

An as-built topographical survey was completed by Minto Mine's surveying department. The survey captured the constructed surface features and geometric alignments of natural slope topography and channel alignments. An as-built site overview of the constructed surfaces is located in Attachment A.

This deliverable, “Post Construction As-Built Report for Reconstruction of the W3 Flume, Minto Mine”, was prepared by SRK Consulting (Canada) Inc.

Stuart McPhee, EIT (BC)
Consultant

Reviewed by:

John Duncan, PEng (BC)
Principal Consultant

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The opinions expressed in this report have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

5 References

Curran, Janet H., Meyer, David F., Tasker, Gary D. USGS. Estimating the magnitude and frequency of peak stream flows for ungagged sites on streams in Alaska and conterminous basins in Canada. Anchorage, Alaska. 2003.

SRK Consulting, 2007. Installation of W3 Replacement Flume on Minto Creek. Report to Minto Mine, November.

Figures

Itemized Schedule and Resource Allocation

Task Item	Desription	Resource	Date	Task Duration [hours]
1.1	Creek By-Pass (Completed Prior to September 20, 2014)	Minto Env.		
1.2	Sandbag Sump	SRK and Minto Env.	20-Sep-14	4
1.3	Mark and Measure Flume for Removal	SRK, Minto Env and Millwright	20-Sep-14	1
1.4	Remove Flume	SRK and Minto Site Services	20-Sep-14	2
1.5	Downstream Excavation for Constructing Erosion Protection	SRK, Minto Env and Pelly	21-Sep-14	1
1.6	Excavation for Flume Structure Foundation	SRK, Minto Env and Pelly	21-Sep-14	1
1.7	Placement and Compaction of Backfill	SRK and Minto Env and Pelly	21-Sep-14	1
1.8	Excavation and Backfill Grading	SRK and Minto Env and Pelly	21-Sep-14	3
1.9	Geotextile Installation	SRK and Minto Env and Pelly	21-Sep-14	0.5
1.10	Downstream Rip Rap Install	SRK and Minto Env and Pelly	21-Sep-14	1
1.11	Temporary Reinstallation of the Flume	SRK and Minto Env, Site Services/ Pelly	23-Sep-14	0.5
1.12	Concrete Formwork and Installation of Steel Reinforcement	SRK and Concrete Contractor	24-Sep-14	6
1.13	Concrete Pour 1	SRK and Concrete Contractor	25-Sep-14	2
1.14	Strip Concrete Forms (Construct forms for Pour 2)	SRK and Concrete Contractor	26-Sep-14	1
1.15	Permanent Installation of Flume	SRK, Minto Env and Pelly	25-Sep-14	0.5
1.16	Concrete Pour 2	SRK and Concrete Contractor	26-Sep-14	1.5
1.17	Backfill Flume with Concrete	SRK and Concrete Contractor	26-Sep-14	1.5
1.18	Strip Concrete Forms	SRK and Concrete Contractor	1-Oct-14	2
1.19	Upstream Rip Rap Install	SRK, Minto Env and Pelly	1-Oct-14	3
1.20	Removal of Minto Creek Diversion Pipe	SRK, Minto Env and Pelly	1-Oct-14	0.5
1.21	Site Restoration and Cleanup	SRK, Minto Env and Pelly	1-Oct-14	2
1.22	Excavation of Overflow Diversion	Minto Env	Completed after October 1, 2014	
1.23	Site As-built Survey	Minto Surveying Technologists	Completed after October 1, 2014)	

srk consulting

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

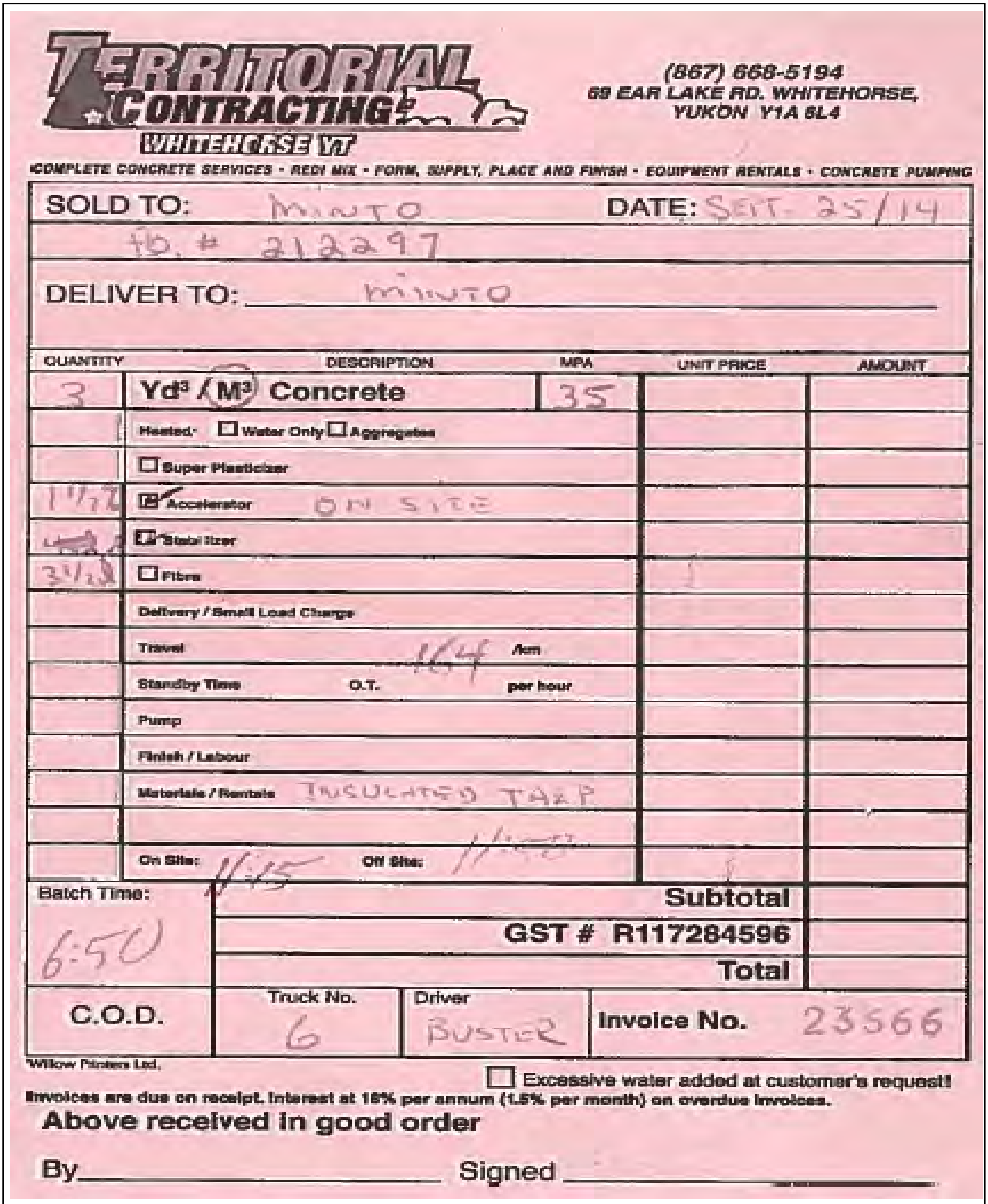
As-built Report – W3 Intake Structure

Construction Schedule

Job No: 1CM002.026
Filename: Figure1_Construction_Schedule.pptx

Minto Mine

Date: December 17, 2014
Approved: SM
Figure: 1



TERRITORIAL CONTRACTING
WHITEHORSE YT

(867) 668-5194
69 EAR LAKE RD. WHITEHORSE,
YUKON Y1A 5L4

COMPLETE CONCRETE SERVICES - REDI MIX - FORM, SUPPLY, PLACE AND FINISH - EQUIPMENT RENTALS - CONCRETE PUMPING

SOLD TO: MINTO DATE: SEPT. 25/14

PO. # 212297

DELIVER TO: MINTO

QUANTITY	DESCRIPTION	MPA	UNIT PRICE	AMOUNT
3	Yd³ / [✓ M³] Concrete	35		
	Heated: ☐ Water Only ☐ Aggregates			
	☐ Super Plasticizer			
1 1/2 L	☑ Accelerator ON SITE			
[illegible]	☑ Stabilizer			
3 1/2 L	☐ Fibre			
	Delivery / Small Load Charge			
	Travel 164 /km			
	Standby Time O.T. per hour			
	Pump			
	Finish / Labour			
	Materials / Rentals INSULATED TARP			
	On Site: 11:15 Off Site: 11:[illegible]			

Batch Time: 6:50

	Subtotal	
	GST # R117284596	
	Total	

C.O.D.	Truck No. 6	Driver BUSTER	Invoice No. 23566

Willow Printers Ltd.

☐ Excessive water added at customer's request!

Invoices are due on receipt. Interest at 18% per annum (1.5% per month) on overdue invoices.

Above received in good order

By____________________ Signed ____________________

srk consulting

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

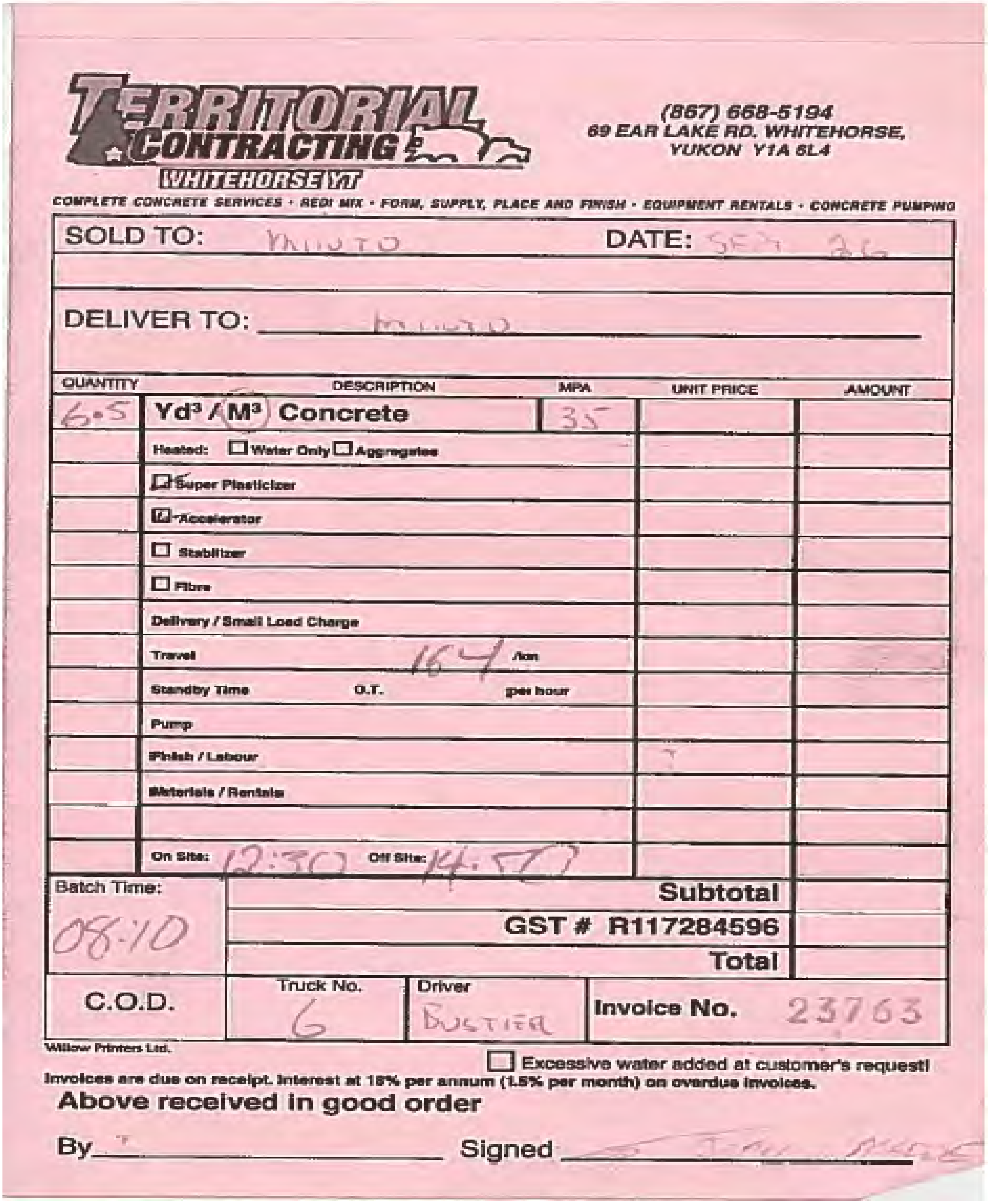
As-built Report – W3 Intake Structure

Concrete Receipt – Pour 1

Job No: 1CM002.026
Filename: Figure2_Concrete_Pour1.pptx

Minto Mine

Date:	Approved:	Figure:
December 17, 2014	SM	2



TERRITORIAL CONTRACTING
WHITEHORSE YT

(867) 668-5194
69 EAR LAKE RD. WHITEHORSE,
YUKON Y1A 6L4

COMPLETE CONCRETE SERVICES • REDI MIX • FORM, SUPPLY, PLACE AND FINISH • EQUIPMENT RENTALS • CONCRETE PUMPING

SOLD TO: MINTO DATE: SEPT 26

DELIVER TO: MINTO

QUANTITY	DESCRIPTION	MPA	UNIT PRICE	AMOUNT
6.5	Yd³ / [✓ M³] Concrete	35		
	Heated: ☐ Water Only ☐ Aggregates			
	☑ Super Plasticizer			
	☑ Accelerator			
	☐ Stabilizer			
	☐ Fibre			
	Delivery / Small Load Charge			
	Travel 164 /km			
	Standby Time O.T. per hour			
	Pump			
	Finish / Labour			
	Materials / Rentals			
	On Site: 12:30 Off Site: 14:50			

Batch Time: 08:10

Subtotal	
GST # R117284596	
Total	

C.O.D.

Truck No. 6

Driver BUSTER

Invoice No. 23763

Willow Printers Ltd.

☐ Excessive water added at customer's request!

Invoices are due on receipt. Interest at 18% per annum (1.5% per month) on overdue invoices.

Above received in good order

By__________ Signed__________

srk consulting

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

As-built Report – W3 Intake Structure

Concrete Receipt – Pour 2

Job No: 1CM002.026
Filename: Figure2_Concrete_Pour1.pptx

Minto Mine

Date: December 17, 2014

Approved: SM

Figure: 3

Attachment A: As-built Construction Drawings

Engineering Drawings for the Minto Mine W3 Flume Assembly

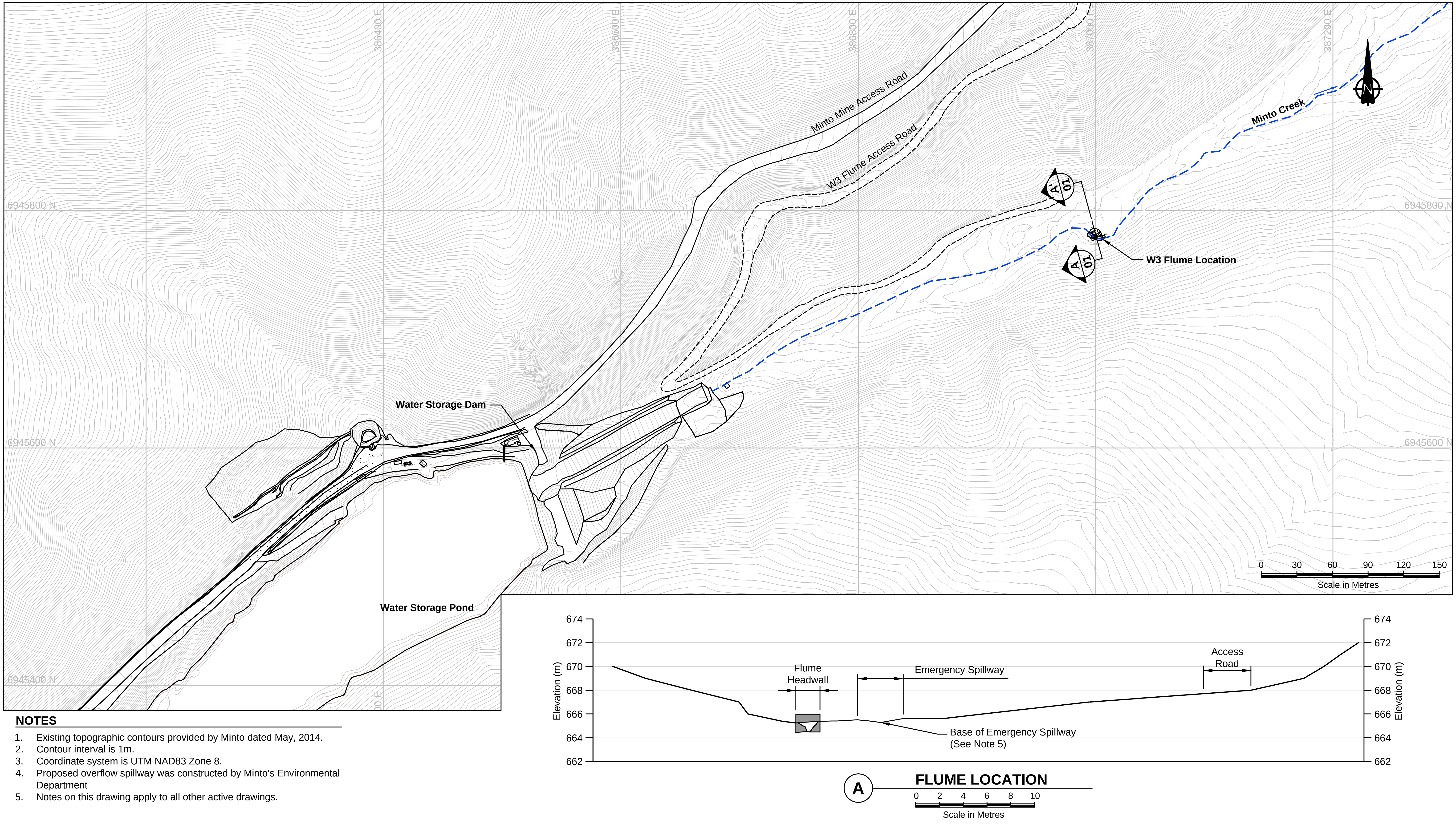
ACTIVE DRAWING STATUS

DWG NUMBER	DRAWING TITLE	REVISION	DATE	STATUS	OLD/REPLACED REVISIONS	
00	Engineering Drawings for the Minto Mine W3 Flume Assembly	AB1	December 17, 2014	As-Built	Rev 1, September 12, 2014	Rev 1, October 7, 2014
01	Site Layout	AB1	December 17, 2014	As-Built	Rev 1, September 12, 2014	AB, November 13, 2014
02	W3 Flume Assembly Plan and Sections	AB1	December 17, 2014	As-Built	Rev 1, September 12, 2014	AB, November 13, 2014
03	Precast Concrete Intake Plan and Sections	AB1	December 17, 2014	As-Built	Rev 2, September 4, 2014	AB, November 13, 2014
04	As-built Flume General Arrangements	AB	December 17, 2014	As-Built		

CAPSTONE
MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

srk consulting

PROJECT NO: 1CM002.026
Revision AB1
December 17, 2014
Drawing 00



A FLUME LOCATION

NOTES

1. Existing topographic contours provided by Minto dated May, 2014.
2. Contour interval is 1m.
3. Coordinate system is UTM NAD83 Zone 8.
4. Proposed overflow spillway was constructed by Minto's Environmental Department
5. Notes on this drawing apply to all other active drawings.

REFERENCE DRAWINGS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REVISIONS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
AB	As-Built	SM	JFD	17Dec14
1	Issued for Construction	LW	JFD	12Sep14
0	Issued for Discussion	LW	JFD	15Aug14

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: VM	DRAWN: NV	REVIEWED: DM
CHECKED: SM	APPROVED: JFD	DATE: Dec. 17, 2014

FILE NAME: 1CM002_018_071_W3 Flume.dwg

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Minto Explorations Ltd.

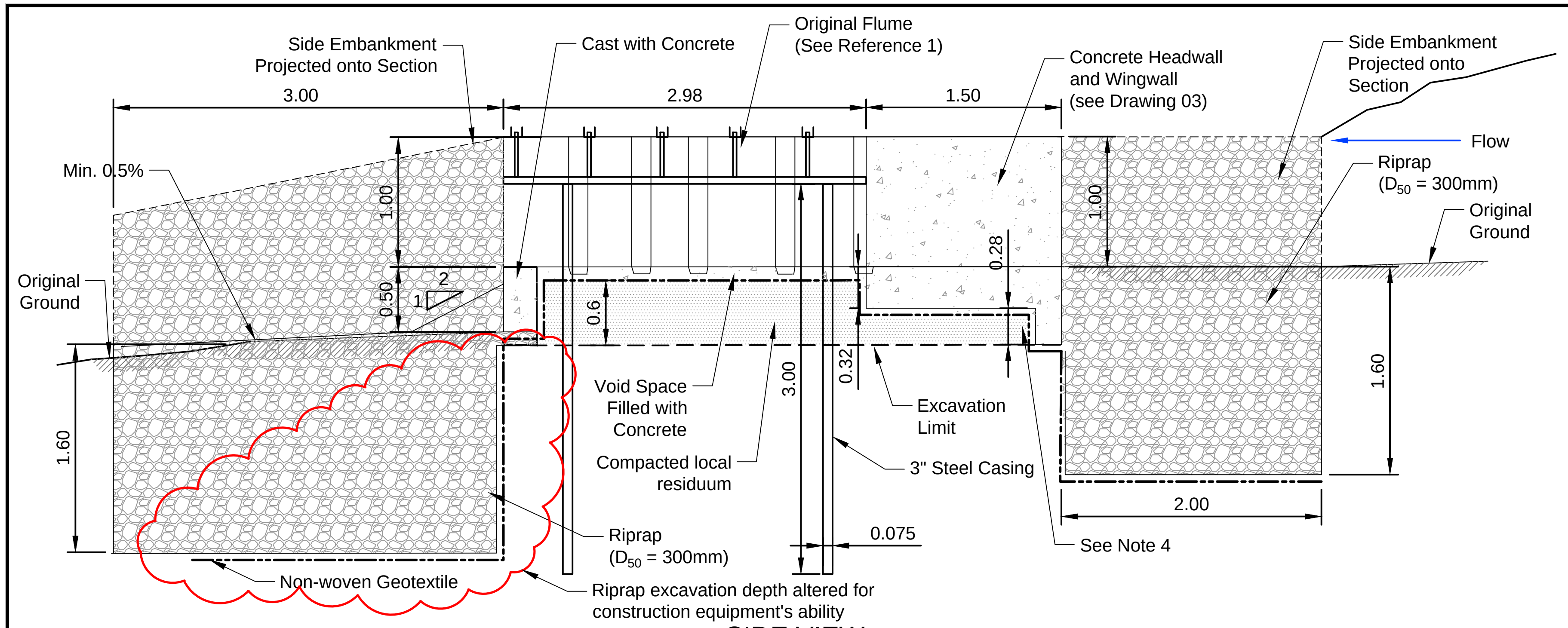
SRK JOB NO.: 1CM002.026

W3 Flume

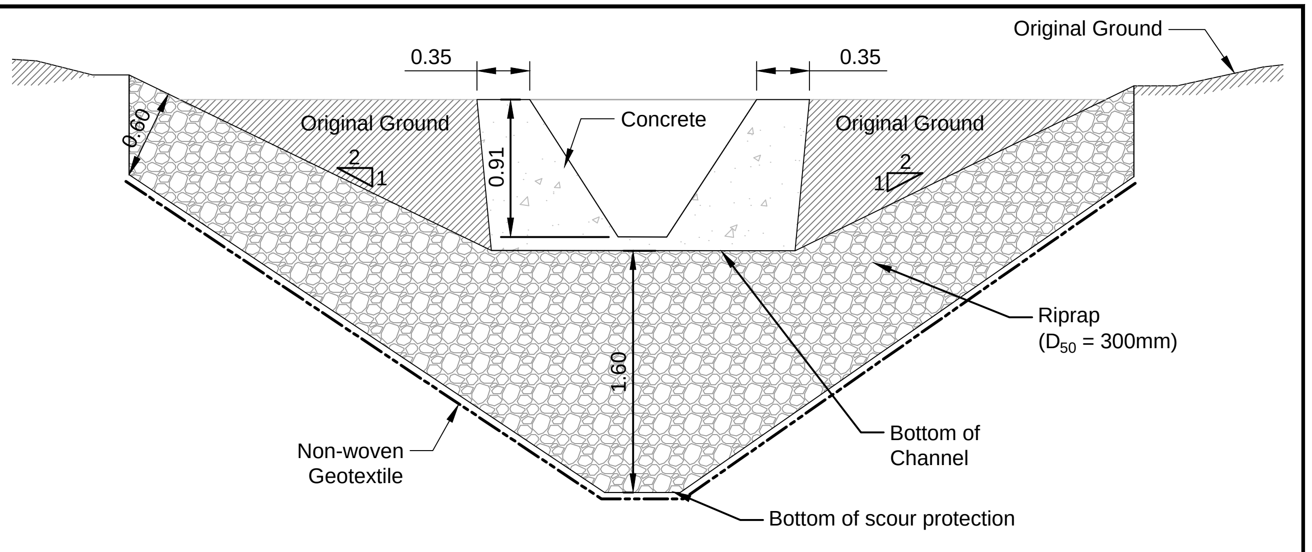
DRAWING TITLE:
Site Layout

DRAWING NO. 01
SHEET 2 OF 5
REVISION NO. AB

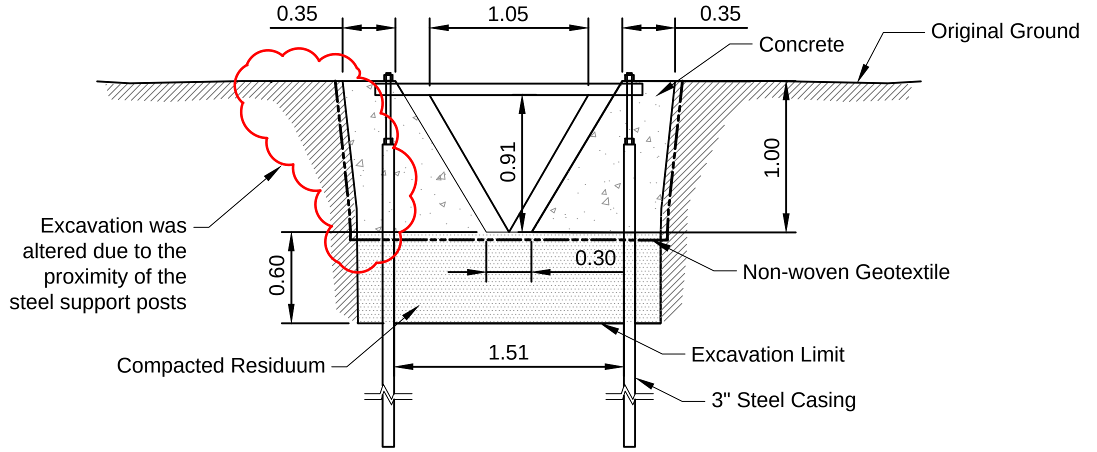
P:\01_SITES\Minto Mine YK Capstone\040.CAD\W3_Flume\Rev 2 - AB 13Nov2014\1CM002_018_071_W3 Flume.dwg



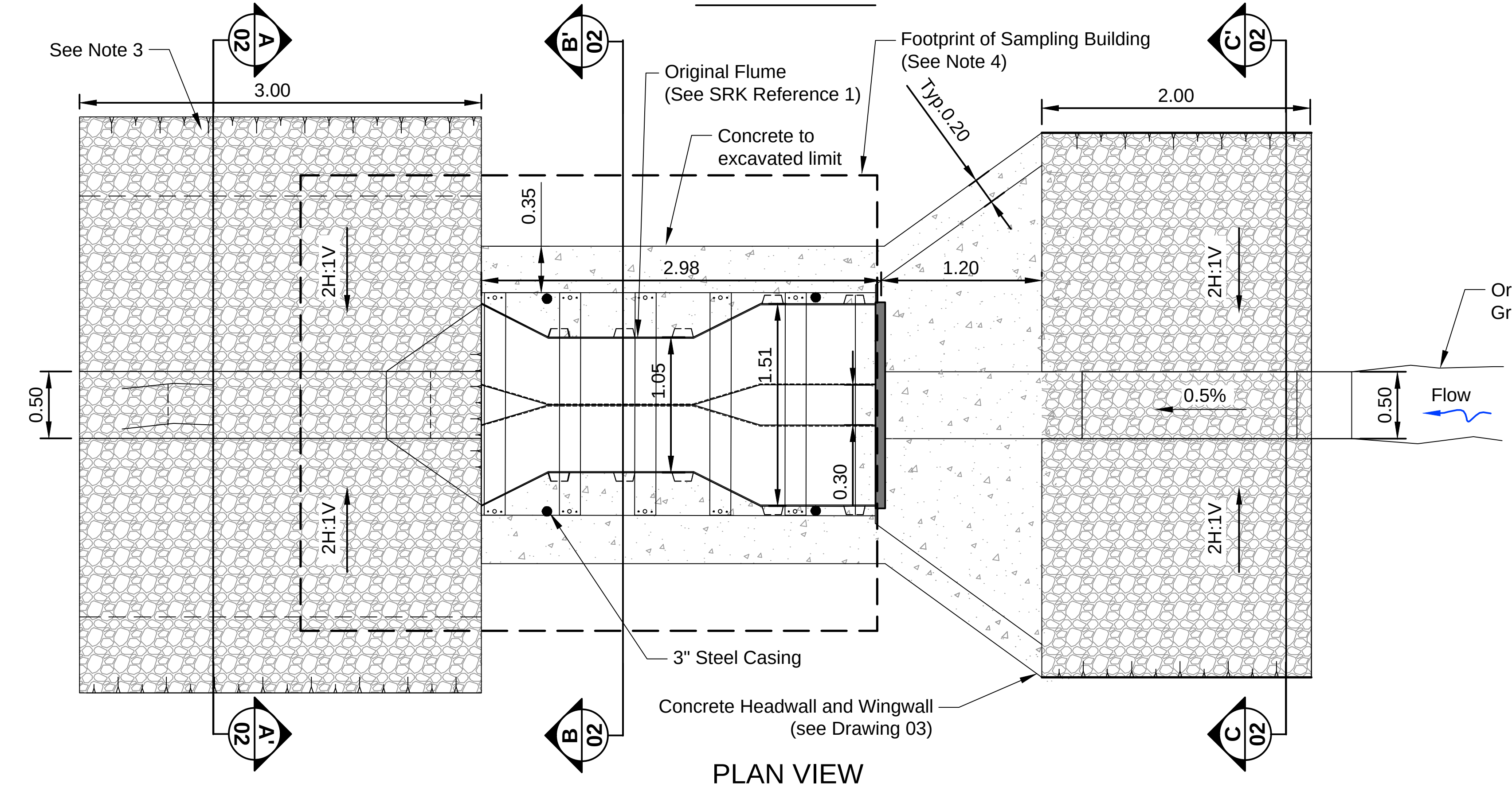
SIDE VIEW



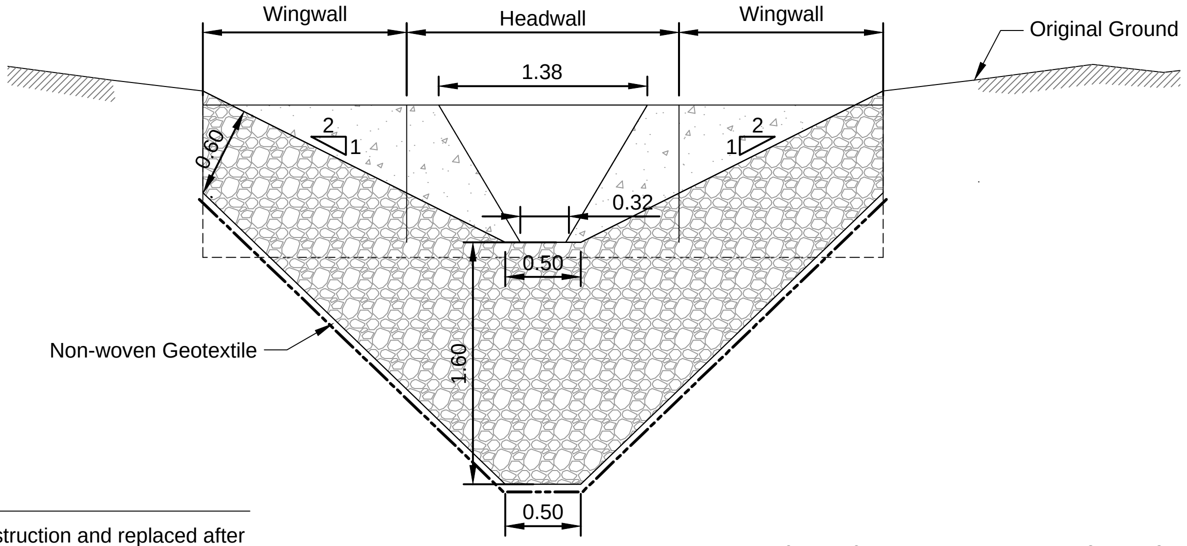
SECTION A - A' - Looking Upstream



SECTION B - B'



PLAN VIEW



SECTION C - C'

0 0.5 1 1.5 2 2.5
Scale in Metres

REFERENCE

1. SRK Consulting Inc. 2008. Installation of W3 Replacement Flume on Minto Creek. Technical memorandum prepared for Accent Consulting. Project No. 2CM022.04. January 16, 2008.

NOTES

1. All dimensions in metres unless noted otherwise.
2. All notes on this drawing apply to all other active drawings.
3. Excavation limits were determined in the field during construction.
4. The sampling building was removed prior to construction and replaced after construction of the intake structure by Minto's environmental department.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
AB1	As-Built	SM	JFD	17Dec14
1	Issued for Construction	LW	JFD	12Sep14
0	Issued for Discussion	LW	JFD	15Aug14

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

srk consulting

DESIGN: VM	DRAWN: NV	REVIEWED: DM
CHECKED: SM	APPROVED: JFD	DATE: Dec. 17, 2014

FILE NAME: 1CM002.026_W3_Flume_metric.dwg

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Minto Explorations Ltd.

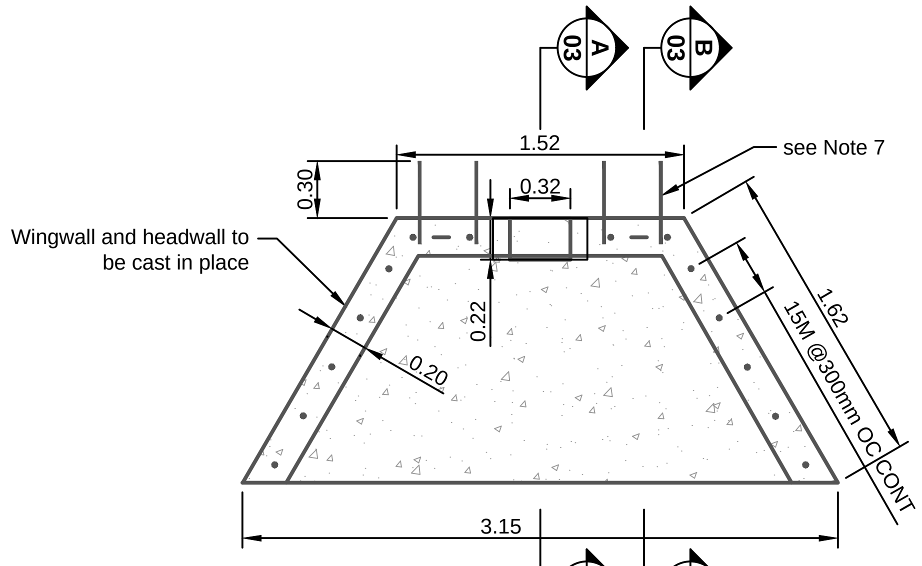
SRK JOB NO.: 1CM002.026

W3 Flume

DRAWING TITLE:
W3 Flume Assembly
Plan and Sections

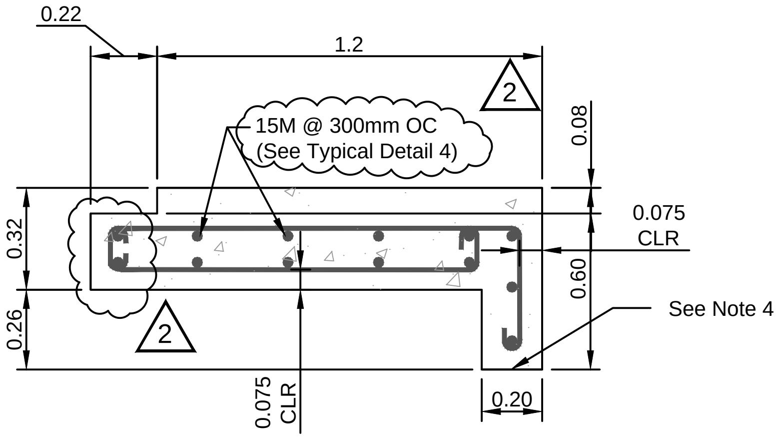
DRAWING NO. 02
SHEET 3 OF 5
REVISION NO. AB1

P:\01_SITES\Minto Mine YK Capstone\040CAD\W3_Flume\Rev 2 - AB 13Nov2014\1CM002.026_W3_Flume_metric.dwg



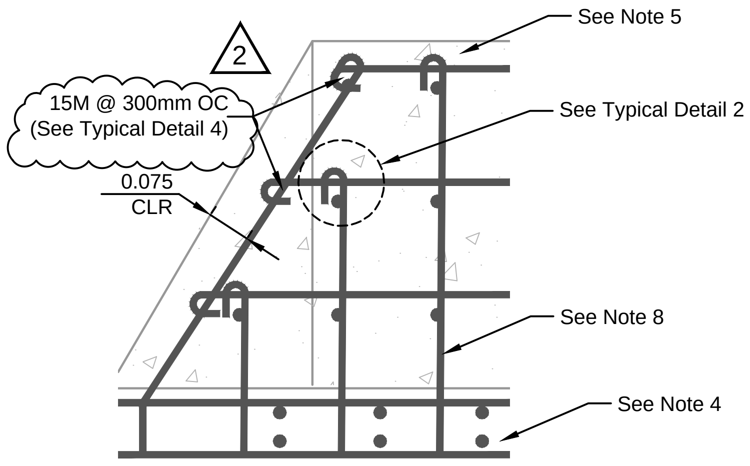
PLAN VIEW

0 0.2 0.4 0.6 0.8 1
Scale in Metres



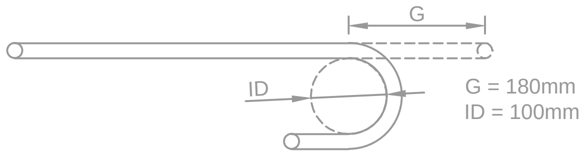
A SECTION A - A'
TYPICAL REBAR LAYOUT

0 0.2 0.4 0.6 0.8 1.0
Scale in Metres



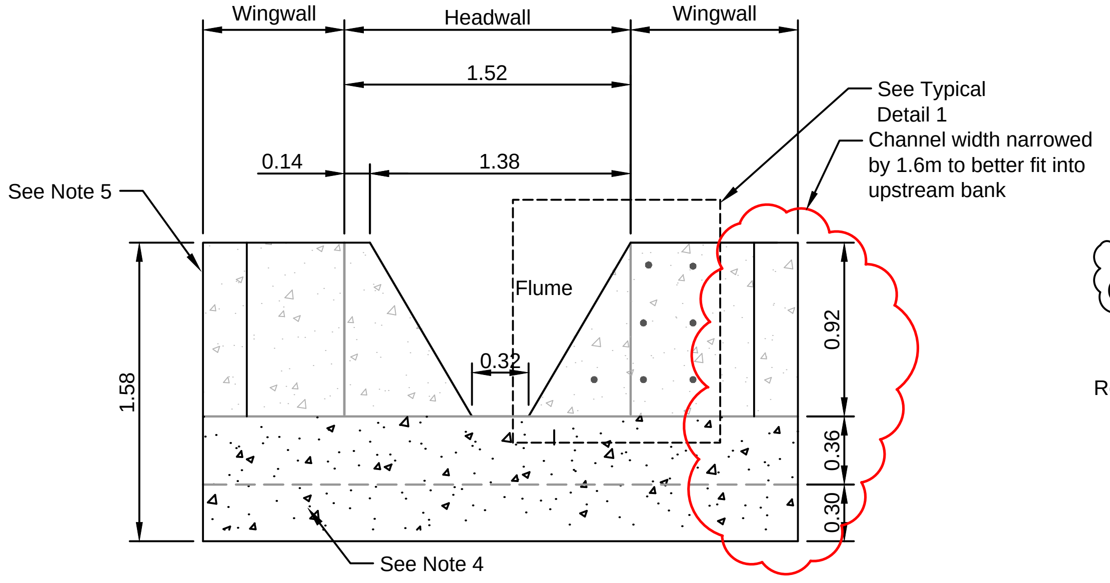
1 DETAIL 1
REBAR LAYOUT AROUND FLUME

0 0.2 0.4 0.6 0.8 1
Scale in Metres



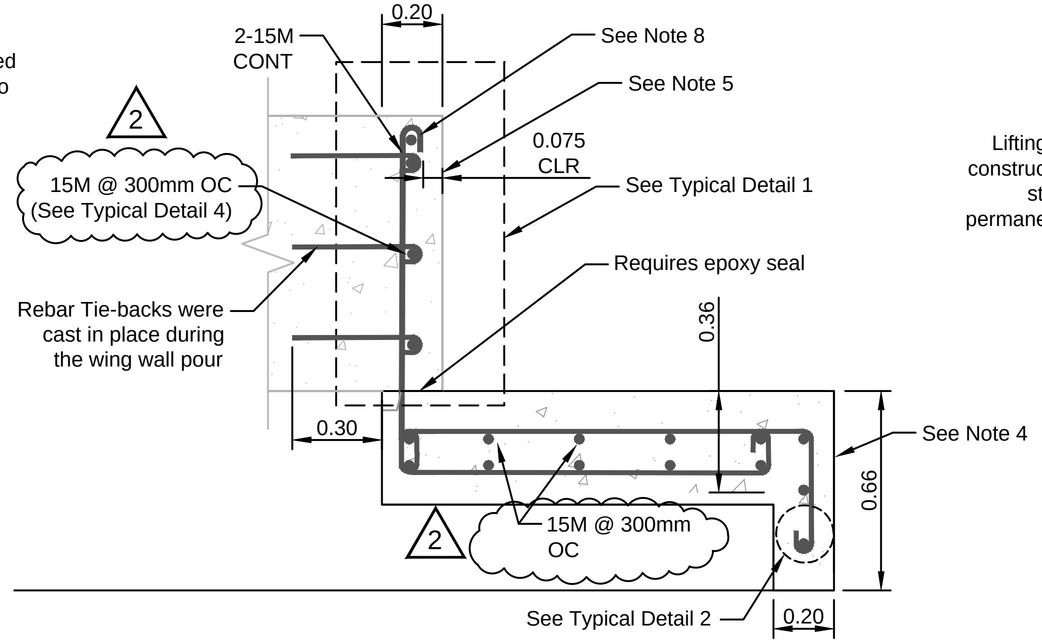
2 DETAIL 2
TYPICAL HOOK LENGTH: 180°

not to scale



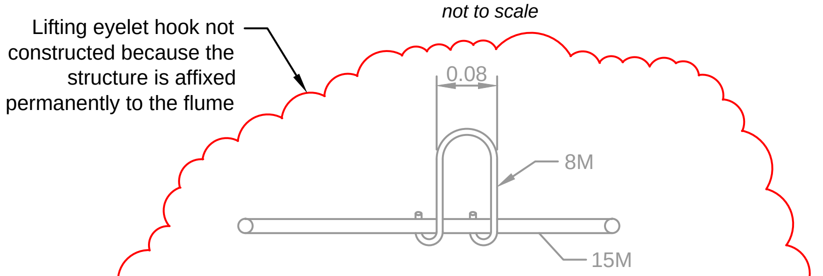
FRONT VIEW - Looking Downstream

0 0.2 0.4 0.6 0.8 1
Scale in Metres



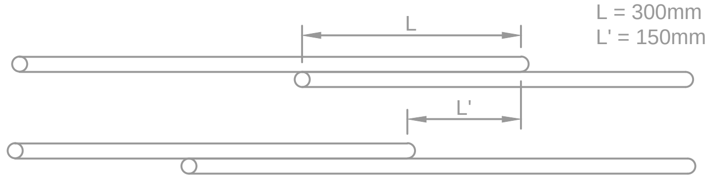
B SECTION B - B'
TYPICAL REBAR LAYOUT

0 0.2 0.4 0.6 0.8 1.0
Scale in Metres



3 DETAIL 3
TYPICAL EYELET HOOK

not to scale



4 DETAIL 4
TYPICAL REBAR LAP LENGTH

not to scale

NOTES

1. All dimensions in metres unless noted otherwise.
2. All concrete steel reinforcement used during construction was standard 15M non coated rebar.
3. All constructed rebar tie-backs between the wing walls and flume backfill area were cast as a single pour.
4. All vertical rebar was case into the base, wing walls, and headwall at 300 mm spacing OC.
5. Delivered concrete was batched to have a strength of 35 MPa. The compressive strength was not verified.
6. All Notes on this drawing apply to all active drawings.

NO.	DESCRIPTION	CHK'D	APP'D	DATE
AB1	As-Built	SM	JFD	17Dec14
2	Minor Edits	LW	JFD	04Sep14
1	Issued for Construction	LW	JFD	18Aug14
0	Issued for Discussion	LW	JFD	15Aug14

REVISIONS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REFERENCE DRAWINGS

PROFESSIONAL ENGINEERS STAMP

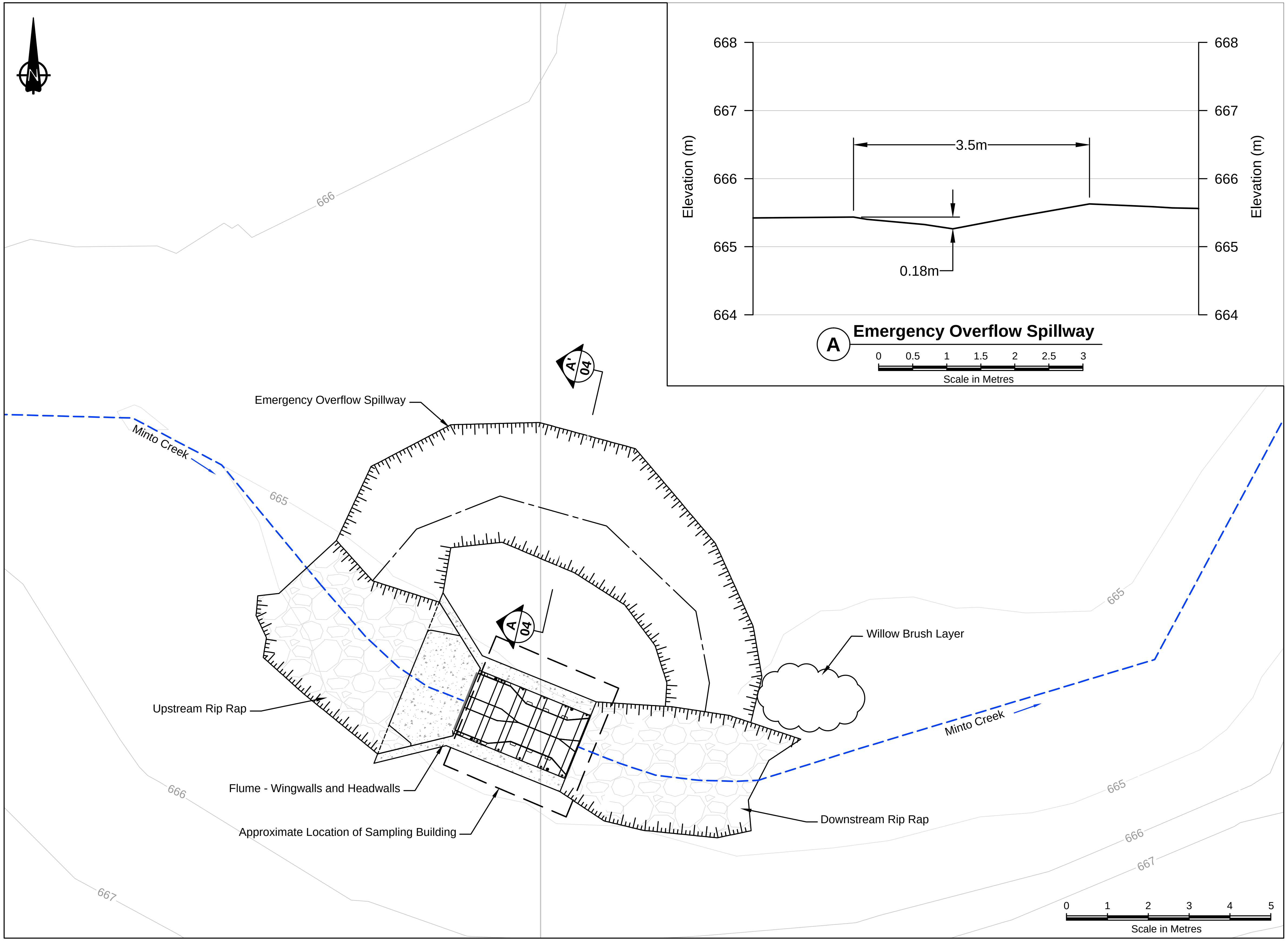
srk consulting

DESIGN: LW
DRAWN: NV
REVIEWED: DM
CHECKED: SM
APPROVED: JFD
DATE: Dec. 17, 2014
FILE NAME: 1CM002.026_W3_Flume_metric Precast.dwg

CAPSTONE MINING CORP.
MINTO MINE
Minto Explorations Ltd.
SRK JOB NO.: 1CM002.026

W3 Flume
DRAWING TITLE:
Concrete Intake
Plan and Sections
DRAWING NO.: 03
SHEET 4 OF 5
REVISION NO. AB1

\\van-svr0\Projects\01_SITES\Minto\1CM002.026_W3_Flume\040_AutoCAD\W3 Flume\Rev 2 - Minor Edits\1CM002.026_W3_Flume_metric Precast.dwg



NOTES

1. Existing topographic contours provided by Minto dated May, 2014.
2. Existing topographic contour interval is 1m.
3. Coordinate system is UTM NAD83 Zone 8.
4. Notes on this drawing apply to all other active drawings.
5. As-built survey provided by Minto site surveying staff.

P:\01_SITES\Minto Mine YK Capstone\!040.CAD\W3_Flume\Rev 2 - AB 13Nov2014\1CM002_018_071_W3 Flume.dwg

REFERENCE DRAWINGS

DRAWING NO.	DRAWING TITLE	DRAWING NO.	DRAWING TITLE

REVISIONS

NO.	DESCRIPTION	CHK'D	APP'D	DATE
AB	As-Built	SM	JFD	17Dec14

PROFESSIONAL ENGINEERS STAMP

srk consulting

CAPSTONE MINING CORP.
MINTO MINE
OPERATED BY MINTO EXPLORATIONS LTD.

Minto Explorations Ltd.

DESIGN: VM
DRAWN: TAH
REVIEWED:
CHECKED:
APPROVED:
DATE: Dec. 17, 2014
FILE NAME: 1CM002_018_071_W3 Flume.dwg
SRK JOB NO.: 1CM002.026

W3 Flume

DRAWING TITLE:
As-built Flume
General Arrangements

DRAWING NO. 04
SHEET 5 OF 5
REVISION NO. AB

Attachment B: Interim Construction Report

SRK Consulting (Canada) Inc.
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vancouver@srk.com
www.srk.com

INTERMEDIATE REPORT #01 – MINTO W3 FLUME CONSTRUCTION

Prepared by:	Stu McPhee	**Date:**	2014.09.21
		Project #:	1CM002.026
Role	**Company**	**Responsible Person – Position**	
Client and Client's Representative	Capstone Mining Corporation		
	Minto	Ryan Herbert – Environmental Coordinator	
Contractor	Pelly Construction and Minto Site Services	Steven Kromhout – Project Manager Mike Davison – Construction Site Manager	
Design Engineer	SRK Consulting (Canada) Inc.	Lowell Wade – Lead Design Engineer John Duncan – Project Principal	
Distribution List:	SRK: Stu McPhee, John Duncan, Samantha Barns, Lowell Wade Minto: Ryan Herbert		
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SITE PERSONNEL

SRK	Stuart McPhee

WEATHER (Carmacks Yukon):

Temperature (°C)	6 AM: -1	12 PM: 5	6 PM: 6
Conditions	Fog (AM) overcast and intermittent rain turning to rain by 6 PM		

Source: http://weather.gc.ca/trends_table/pages/xck_metric_e.html

HEALTH, SAFETY AND ENVIRONMENT

- Stuart McPhee attended the daily toolbox meeting.

ACTIVITY SUMMARY

Task	Description
1.1	**Creek-By-Pass:** • Minto environmental department constructed a creek by-pass by installing a 300m plastic pipe approximately 25 m upstream of the flume that routed flow around the W3 Flume.
1.2	**Sand Bad Sump:** • A seepage collection sump was constructed upstream of the designed erosion protection. Sump was constructed from sandbags and plastic geomembrane, a submersible sump was installed to dewater seepage.
1.3	**Mark and Measure Flume for Removal:** • The steel support structure of the flume consisted of 12 threaded ready rod posts to which the flume is lowered onto and leveled and secured. The flume was secured using a double nut on the underside of the flume to maintain the flume level and a single nut on the topside securing the structure. There is no need to remove the double nut because if left as is the flume will be reinstalled back to its original position after construction. • A laser level was set up onto a local survey datum to determine control elevations of the flume, compacted backfill, concrete intake structure and excavations for rip rap excavation.
1.4	**Remove Flume:** • The flume was removed using two lifting straps and a JLG zoom boom. • The flume was set down on two wooden pallets and inspected by SRK for cracks and damage. None was documented.

1.5	**Downstream Excavation for Constructing Erosion Protection:** • CAT 325 excavator constructed the excavation limits and slopes of the erosion barrier. • To prevent the creek water discharging from the diversion pipe from backwatering into the excavation an earthen berm was constructed across the channel. • Electric sump pumps were installed to remove sediment laden water within the excavation.
1.6	**Excavation for Flume Structure Foundation:** • A small Kabota excavator was used to excavate between the steel support structures as per the design specifications.
1.7	**Placement and Compaction of Backfill:** • Residium (sandy silt) backfill was placed between the steel structure and compacted using a small plate tamper. The elevation of the compacted grade is 30 mm below final grade. After a mocking up the flume and concrete forms the compacted grade will be increased to final grade.
1.8	**Excavation and Backfill Grading:** • The 325 CAT excavator was used to grade and cut slopes prior to installing geotextile.
1.9	**Geotextile Installation:** • A medium weight non-woven geotextile was installed on the final excavated and graded slope downstream of the flume.
1.10	**Downstream Rip Rap Placement:** • 50% complete rip rap placement. • Additional rock needed on site.
#	**Remainder of Tasks to be completed during the week of September 22-27, 2014**

COMMENTS, CONCERNS AND CORRESPONDENCE

GENERAL: N/A

SCHEDULE TRACKING

Itemized Schedule and Resource Allocation (Green Complete)				Duration (Hours)	
Task Item	**Description**	**Resource**	**Date**	**Planned**	**Actual**
1.1	Creek By-Pass	Minto Env.	Completed		
1.2	Sandbag Sump	SRK and Minto Env.	Saturday AM	4	4
1.3	Mark and Measure Flume for Removal	SRK, Minto Env and Millwright	Saturday AM	2	1
1.4	Remove Flume	SRK and Minto Site Services	Saturday PM	1	2
1.5	Downstream Excavation for Constructing Erosion Protection	SRK, Minto Env and Pelly	Sunday AM	1	1
1.6	Excavation for Flume Structure Foundation	SRK, Minto Env and Pelly	Sunday AM	1	1
1.7	Placement and Compaction of Backfill	SRK and Minto Env and Pelly	Sunday PM	1	1
1.8	Excavation and Backfill Grading	SRK and Minto Env and Pelly	Sunday PM	2	3
1.9	Geotextile Installation	SRK and Minto Env and Pelly	Sunday PM	1	0.5
1.10	Downstream Rip Rap Placement	SRK and Minto Env and Pelly	Sunday PM	2	1
1.11	Temporary Reinstallation of the Flume	SRK and Minto Env, Site Services/Pelly	Sunday PM	1	
1.12	Concrete Formwork and Installation of Steel Reinforcement	SRK and Concrete Contractor	Tuesday AM	10	
1.13	Concrete Pour 1	SRK and Concrete Contractor	Wednesday AM	5	
1.14	Strip Concrete Forms (Construct forms for Pour 2)	SRK and Concrete Contractor	Thursday PM	4	
1.15	Permanent Installation of Flume	SRK, Minto Env and Pelly	Thursday PM	2	
1.16	Concrete Pour 2	SRK and Concrete Contractor	Friday AM	2	
1.17	Backfill Flume with Concrete	SRK and Concrete Contractor	Friday AM	2	
1.18	Strip Concrete Forms	SRK and Concrete Contractor	Saturday AM	2	
1.19	Upstream Rip Rap Install	SRK or Minto Env and Pelly	Saturday PM	2	

Photo 1: Flume prior to removal

Photo 2: Flume removal

Photo 3: Flume's steel support structure. (Looking Downstream)

Photo 4: Sump pump discharging into creek bypass

Photo 5: Initial excavation with Kabota mini excavator. (Looking Downstream)

Photo 6: Dewatering seepage in the excavation. (Looking Downstream)

Photo 7: Downstream rip rap placement. (Looking Downstream)

Photo 8: Compaction of backfill to 30mm below final grade.

Photo 9: Intermediate backfill compaction and erosion barrier construction (Looking Upstream)

SRK Consulting (Canada) Inc.
2200–1066 West Hastings Street Vancouver, BC

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vancouver@srk.com
www.srk.com

INTERMEDIATE REPORT #02 – MINTO W3 FLUME CONSTRUCTION

Prepared by:	Stu McPhee	**Date:** 2014.09.26 **Project #:** 1CM002.026
Role	**Company**	**Responsible Person – Position**
Client and Client's Representative	Capstone Mining Corporation	
	Minto	Ryan Herbert – Environmental Coordinator
Contractor	Pelly Construction and Minto Site Services	
Design Engineer	SRK Consulting (Canada) Inc.	Lowell Wade – Lead Design Engineer John Duncan – Project Principal
Distribution List:	SRK: Stu McPhee, John Duncan, Samantha Barns, Lowell Wade Minto: Ryan Herbert	
This Construction Report is produced as an internal communication document between SRK site and head office staff. Any distribution of this report outside of SRK is done as a courtesy, and the information contained in this report are for information only to those external parties.		

SITE PERSONNEL

SRK	Stuart McPhee

WEATHER (Carmacks Yukon):

Temperature (°C)	6 AM: -7	12 PM: 5	6 PM: 6
Conditions	Cold and clear mornings with light frost and sunny afternoons.		

Source: http://weather.gc.ca/trends_table/pages/xck_metric_e.html

HEALTH, SAFETY AND ENVIRONMENT

- Stuart McPhee attended the daily toolbox meeting.

ACTIVITY SUMMARY

Task	Description
1.11	**Reinstallation of the Flume (Tuesday September 23rd):** • Minto Site Services provided a JLG forklift to reinstall the flume to the existing supports. • Reinstallation was uncomplicated and fit to backfill specifications. • This flume fitting will be the permanent installation to accommodate formwork around the upstream intake.
1.12	**Concrete Formwork and Steel Reinforcement (Wednesday September 24th):** • A&T Contracting Ltd. from Whitehorse, Yukon formed and tied rebar into the intake structure base. • Rebar hooks were pre bent offsite to the design specification. • The upstream length of the concrete base was increased from 1.5 m to 1.85 m to allow the wood forms to fit into the prepared excavation around a problematic boulder and seep.
1.13	**Concrete Pour 1 (Thursday September 25th):** • At 12:30 pm Territorial Contracting from Whitehorse, Yukon supplied 3 m^3 of 35 MPa premixed concrete with 3.5 L of stabilizer and 1.5% accelerator. **Figure 1** Concrete Receipt • The concrete base was covered with an insulated tarp and a diesel powered Frost Fighter was used to heat the slab overnight. Unexpectantly, the Frost Fighter quit working between 10pm and 12am when temperatures dropped below freezing. Night-shift millwrights were not able to get it started.

	• At 8:00 am Friday morning the slab was inspected and didn't display any signs of freezing and the Frost Fighter was restarted. • It was decided by SRK and A&T Contracting to proceed with forming the wing walls for a pour at 12:30 – 1:00 pm.
1.14	**Strip Concrete Forms from Base Pour and Construct Forms for Wing Walls (September 26th):** • Form work was stripped from the base section to fit formwork for the wing walls. • When forms were stripped it was discovered that the curing concrete was softer than expected.
1.15	**Permeant Installation of Flume (Tuesday September 23rd):** • Task completed during fitting of base formwork.
1.16	**Concrete Pour 2 (Friday September 26th):** • Wing walls and flume backfill was completed at 3:30 pm. • There were no major issues during the pour. • The formwork and fresh concrete was covered with insulated tarps and heat applied from a Frost Fighter.

COMMENTS, CONCERNS AND CORRESPONDENCE

SCHEDULE PUSH:

- Tasks 1.18 (Stripping Forms) and 1.19 Upstream Rip-Rap placement are pushed to Wednesday October 1st to allow concrete to reach an acceptable hardness.

TASK ADDITION:

- Task 1.20 includes the removal of the creek diversion pipe during the construction of the emergency spillway and site regrading. Task to be completed during 1.19 Rip-Rap placement.

SCHEDULE AND CURING TIME DISCUSSIONS WITH MINTO:

- Task 1.14: After discussions with concrete contractors and John Duncan (SRK) it was decided that forming of the wing walls could continue; following the addition of concrete to the wing wall forms the entire structure would be covered with insulated tarps until Wednesday October 1st. During the night when temperatures dropped below freezing heat will be applied to the tarp enclosure with a Frost Fighter.

SCHEDULE TRACKING

Itemized Schedule and Resource Allocation (Green Complete)				Duration (Hours)	
Task Item	**Description**	**Resource**	**Date**	**Planned**	**Actual**
1.1	Creek By-Pass	Minto Env.	Completed		
1.2	Sandbag Sump	SRK and Minto Env.	Saturday AM	4	4
1.3	Mark and Measure Flume for Removal	SRK, Minto Env and Millwright	Saturday AM	2	1
1.4	Remove Flume	SRK and Minto Site Services	Saturday PM	1	2
1.5	Downstream Excavation for Constructing Erosion Protection	SRK, Minto Env and Pelly	Sunday AM	1	1
1.6	Excavation for Flume Structure Foundation	SRK, Minto Env and Pelly	Sunday AM	1	1
1.7	Placement and Compaction of Backfill	SRK and Minto Env and Pelly	Sunday PM	1	1
1.8	Excavation and Backfill Grading	SRK and Minto Env and Pelly	Sunday PM	2	3
1.9	Geotextile Installation	SRK and Minto Env and Pelly	Sunday PM	1	0.5
1.10	Downstream Rip Rap Placement	SRK and Minto Env and Pelly	Sunday PM	2	1
1.11	Temporary Reinstallation of the Flume	SRK and Minto Env, Site Services/Pelly	Tuesday AM	1	0.5
1.12	Concrete Formwork and Installation of Steel Reinforcement	SRK and Concrete Contractor	Wednesday PM	10	6
1.13	Concrete Pour 1	SRK and Concrete Contractor	Thursday AM	5	2
1.14	Strip Concrete Forms (Construct forms for Pour 2)	SRK and Concrete Contractor	Friday PM	4	1
1.15	Permanent Installation of Flume	SRK, Minto Env and Pelly	Wednesday AM	2	0.5
1.16	Concrete Pour 2	SRK and Concrete Contractor	Friday AM	2	1.5
1.17	Backfill Flume with Concrete	SRK and Concrete Contractor	Friday AM	2	1.5
1.18	Strip Concrete Forms	SRK and Concrete Contractor	Wednesday AM	2	
1.19	Upstream Rip Rap Install	SRK and Minto Env and Pelly	Wednesday AM	2	
1.20	Removal of Creek diversion pipe	SRK and Minto Env and Pelly	Wednesday PM	3	
1.21	Site Restoration and Cleanup	SRK and Minto Env and Pelly	Wednesday PM	2	

Photo 1: Intake structure base concrete forms and rebar cage prior to pour

Photo 2: Intake structure base concrete pour.

Photo 3: Concrete surface trowelled smooth

Photo 4: Downstream concrete forms for backfill pour.

Photo 5: Flexible membrane that seals between the base and wing walls.

Photo 6: Flexible membrane that seals between the base and wing walls.

Photo 7: Base cut off wall concrete finish forms removed.

Photo 8: Wing wall form sill plates.

Photo 9: Wing wall forms before crossing bracing.

Photo 10: Intermediate wing wall forms before crossing bracing.

Photo 11: Wing wall concrete forms.

Photo 12: Wing wall cross-bracing

Photo 13: Wing wall concrete pour

Photo 14: Tarp enclosure and Frost Fighter.

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INTERMEDIATE REPORT #03 – MINTO W3 FLUME CONSTRUCTION

Prepared by:	Stu McPhee	**Date:** 2014.10.01 **Project #:** 1CM002.026
Role	**Company**	**Responsible Person – Position**
Client and Client's Representative	Capstone Mining Corporation Minto	 Ryan Herbert – Environmental Coordinator
Contractor	Pelly Construction and Minto Site Services	
Design Engineer	SRK Consulting (Canada) Inc.	Lowell Wade – Lead Design Engineer John Duncan – Project Principal
Distribution List:	SRK: Stu McPhee, John Duncan, Samantha Barns, Lowell Wade Minto: Ryan Herbert	
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SITE PERSONNEL

SRK	Stuart McPhee

WEATHER (Carmacks Yukon):

Temperature (°C)	6 AM: -7	12 PM: 0	6 PM: 1
Conditions	Cold and clear mornings with light frost and sunny afternoons.		

Source: http://weather.gc.ca/trends_table/pages/xck_metric_e.html

HEALTH, SAFETY AND ENVIRONMENT

- Stuart McPhee attended the daily toolbox meeting.

ACTIVITY SUMMARY

Task	Description
1.18	**Strip Concrete Forms (Wednesday October 1st):** • SRK and Minto's Environmental stripped the concrete forms. • The upstream sump pumps were removed and a nonwoven geotextile was placed in preparation for riprap placement.
1.19	**Upstream Riprap Installation (Wednesday October 1st):** • Pelly Contracting installed the upstream riprap as per design specifications. • Additional riprap was installed downstream to finish grade.
1.20	**Remove the Creek Diversion Pipe (Wednesday October 1st):** • Pelly Construction removed the creek diversion pipe and backfilled. • Riprap was placed into Mino creek at the diversion pipe location (both upstream and downstream).
1.21	**Site Restoration and Cleanup (Wednesday October 1st):** • Pelly, SRK and Minto installed a modified brush layer from willow and cottonwood stakes into the downstream creek bank to stabilize and revegetate.

COMMENTS, CONCERNS AND CORRESPONDENCE

TASK ADDITION:

- Minto’s Environmental Staff will construct the overflow spillway after the sampling building is replaced. The overflow spillway will be constructed following SRK’s advice.

SCHEDULE TRACKING

Itemized Schedule and Resource Allocation (Green Complete)				**Duration (Hours)**	
Task Item	**Description**	**Resource**	**Date**	**Planned**	**Actual**
1.1	Creek By-Pass	Minto Env.	Completed		
1.2	Sandbag Sump	SRK and Minto Env.	Saturday, 20th AM	4	4
1.3	Mark and Measure Flume for Removal	SRK, Minto Env and Millwright	Saturday, 20th AM	2	1
1.4	Remove Flume	SRK and Minto Site Services	Saturday, 20th AM	1	2
1.5	Downstream Excavation for Constructing Erosion Protection	SRK, Minto Env and Pelly	Sunday, 21st AM	1	1
1.6	Excavation for Flume Structure Foundation	SRK, Minto Env and Pelly	Sunday, 21st AM	1	1
1.7	Placement and Compaction of Backfill	SRK and Minto Env and Pelly	Sunday, 21st AM	1	1
1.8	Excavation and Backfill Grading	SRK and Minto Env and Pelly	Sunday, 21st AM	2	3
1.9	Geotextile Installation	SRK and Minto Env and Pelly	Sunday, 21st AM	1	0.5
1.10	Downstream Rip Rap Placement	SRK and Minto Env and Pelly	Sunday, 21st AM	2	1
1.11	Temporary Reinstallation of the Flume	SRK and Minto Env, Site Services/Pelly	Tuesday, 23rd AM	1	0.5
1.12	Concrete Formwork and Installation of Steel Reinforcement	SRK and Concrete Contractor	Wednesday, 24th PM	10	6
1.13	Concrete Pour 1	SRK and Concrete Contractor	Thursday, 25th AM	5	2
1.14	Strip Concrete Forms (Construct forms for Pour 2)	SRK and Concrete Contractor	Friday, 26th PM	4	1
1.15	Permanent Installation of Flume	SRK, Minto Env and Pelly	Wednesday, 24th AM	2	0.5
1.16	Concrete Pour 2	SRK and Concrete Contractor	Friday, 26th PM	2	1.5
1.17	Backfill Flume with Concrete	SRK and Concrete Contractor	Friday, 26th PM	2	1.5
1.18	Strip Concrete Forms	SRK and Concrete Contractor	Wednesday, 1st AM	2	2
1.19	Upstream Rip Rap Install	SRK and Minto Env and Pelly	Wednesday, 1st AM	2	3
1.20	Removal of Creek diversion pipe	SRK and Minto Env and Pelly	Wednesday, 1st PM	3	0.5
1.21	Site Restoration and Cleanup	SRK and Minto Env and Pelly	Wednesday, 1st PM	2	2

Photo 1: Final concrete intake structure

Photo 2: Upstream wing wall profile

Photo 3: Final profile of concrete intake structure.

Photo 4: Flow entering flume

Photo 5: Flow exiting flume

Photo 6: Upstream riprap left bank

Photo 7: Upstream riprap right bank

Photo 8: Willow cutting modified brush layer.

Photo 9: Riprap protection at former diversion pipe intake.

Photo 10: Riprap protection at former diversion pipe discharge

Attachment C: Photo Log

Photo 1: Minto Creek diversion pipe intake

Photo 2: Minto Creek diversion pipe discharge

Photo 3: Intake of W3 Flume before construction

Photo 4: Discharge of W3 Flume before construction

Photo 5: Removal of W3 Flume

Photo 6: Condition of foundation backfill between steel support structure

Photo 7: Flume support structure before excavation

Photo 8: Flume support structure after excavation

Photo 9: Initial placement of downstream riprap.

Photo 10: Compacting backfill between steel support structures.

Photo 11: Excavation flooded due to generator failure.

Photo 12: Upstream excavation prior to base backfill compaction

Photo 13: Leveled and compacted base backfill

Photo 14: Geotextile installation beneath flume.


Photo 15: Steel reinforcement and wooden formwork for base concrete section.

Photo 16: Sump pump dewatering the upstream formwork and excavation area.

Photo 17: Concrete deployment and vibration into base formwork.

Photo 18: Finished troweled surface on base section.

Photo 19: Concrete deployment and vibration into wing wall formwork.

Photo 20: Formwork cross bracing.

Photo 21: Frost Fighter diesel heater and insulated tarps set up to heat concrete as it cures.

Photo 22: Insulated tarp covering exposed permafrost bank from heated concrete intake structure.

Photo 23: Final intake structure entrance section.

Photo 24: Wing wall entrance section incorporated with riprap.