2018 Environmental Audit
Minto Mine

Prepared for:
Capstone Mining Corp.
Suite 2100 – 510 West Georgia Street,
Vancouver, BC, V6B 0M3

Prepared by
Lorax Environmental Services Ltd.
2289 Burrard Street
Vancouver, BC, V6J 3H9
Canada

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1. Introduction

1.1 Background

Capstone Mining Corp. (Capstone) retained Lorax Environmental Services Ltd. (Lorax) to undertake the 2018 Environmental Audit (the Audit) in accordance with the requirements of Quartz Mining License QML-0001 for the Minto Mine (Minto). The 2018 Approved Audit Scope (Appendix A), approved by Yukon Energy, Mines and Resources (EMR), comprises two specific environmental protection plans (EPPs) for the Minto Mine (Yukon); the Operational Adaptive Management Plan (OAMP) and the Environmental Monitoring Surveillance and Reporting Plan (EMSRP). The focus of the audit relates to compliance, implementation adequacy and reporting adequacy of monthly and annual reports submitted versus the noted EPPs. Lorax requested BGC Engineering Inc. (BGC) to act as sub-consultant for this review on three select aspects reviewed further in Section 1.2.

For the 2018 environmental audit, the following review assumptions were confirmed through discussion with Minto:

- The audit period under review herein covered "last 2 calendar years" noted in the work scope provided by Minto and hence, 2016 and 2017 were covered; no auditing of 2018 reports was done.
- These EPPs were submitted for two different regulatory aspects; the Quartz Mining Licence (QML) and the Water Use Licence (WUL). Approvals for these EPPs, where provided by the associated agencies, were provided on different dates. To that constraint, it was assumed that EPP approvals were provided on the dates noted by the QML submission, as opposed to the WUL. Further details on the relevant approval dates and associated approved reports are provided under each section.

Knight Piésold (KP, 2016) undertook the previous 2015 Environmental Audit for Minto that covered the period from December 18, 2014, until June 30, 2016. Though their review period overlaps with that of the 2018 Audit review period described herein, the scopes and focuses of the 2015 and the 2018 Audits differed substantially. As such, and as the approved audit scope did not reference the previous audit, this document stands alone without further reference to KP (2016).

1.2 Audit Execution

In accordance with the Approved Audit Scope, the review documented herein was undertaken by the following personnel, with support from Jennifer Owen, M.Sc. (Lorax):

- Mr. Justin Bourne, M.Eng, P.Eng. – Audit Lead and Hydrogeologist;
- Mr. Timo Kirchner, M.Sc. - Environmental Geoscientist – geochemistry;
- Mr. Scott Jackson, M.Sc., P.Geo. – Hydrologist, and;
- Mr. Jim Cassie, M.Sc., P.Eng. – Geotechnical Engineer (BGC Engineering Inc. sub-contract)

None of the audit team members noted above had prior involvement with the Minto Mine prior to being engaged for this scope.

BGC, as subconsultant to Lorax, was responsible for the following select aspects of the 2018 environmental audit:

1. Physical stability program.
2. Erosion and sedimentation monitoring program.
3. Progressive reclamation effectiveness monitoring program.

It should be noted that these three aspects are covered under the two noted EPPs with the physical monitoring plan and sediment and erosion control plan having their own stand-alone plan in separate appendices or reports. BGC's findings are presented as part of this document.

1.3 Approach

The following general steps were taken to conduct the Audit:

- Check monitoring activities at all sites against EMSRP for frequency, methods, conformance with relevant SOPs;
- Review data quality control/quality assurance procedures;
- Check EMSRP data reporting in monthly and annual reports;
- Confirm OAMP thresholds are being monitored appropriately, and;
- Confirm OAMP responses match what is outlined in OAMP and are reported appropriately in the annual reports.

2. Site Visit

To compliment the review of noted EPPs, monthly and annual reports and associated inspection reports, Lorax and BGC staff undertook a site visit to Minto Mine from July 31 to August 2, 2018. Respective company attendees were Justin Bourne, P.Eng., and Jim Cassie, P.Eng. After the required site orientation, the two noted staff were given a general site tour on the afternoon of July 31 by Deborah Flemming, Environmental Coordinator for Minto Mine. The next day, Mr. Cassie met with the mine's two geotechnical engineers, Lesley Sandve, P.Eng., and Ian Litaveez, P.Eng., to discuss various aspects of the Physical Monitoring Plan (PMP). During that same day, Mr. Bourne met with Ms. Flemming and Emilie Bouchard (Site Environmental Hydrologist) to discuss additional details regarding water quality, sampling, geochemical sampling and groundwater wells. Mr. Bourne also met with Mr. Doug McIlveen (Chief Geologist) regarding waste rock sampling and tracking. Later that day and the morning of August 2, Messrs. Cassie and Bourne also met with the Ryan Herbert, Environmental Manager for Minto Mine.

The primary objectives of the site visit were as follows:

- Provide an understanding of the site layout and spatial relationships of the various structures and monitoring locations;
- Meet and discuss EPPs and specific plan aspects with site staff to discuss environmental management processes including data collection, management and review work flow;
- Confirm environmental audit work scope details with Minto Mine staff; and,
- Identify and collect additional plans, reports and documentation not provided initially before the site visit.

As such, the site visit was meant to provide additional context and detail to the review of the noted plans and reports. No other documentation or photos resulting from the site visit are provided herein.

The discussion with Ms. Sandve and Mr. Liaveez at site focused on select aspects of the PMP but generally focused on the data collection, processing, review and notifications of inspection observations and instrumentation data. Based on those discussions, the following work flow was outlined:

1. Site observations and photos and instrumentation readings are collected by Minto Mine geotechnical engineers (some are engineers-in-training whilst others are

professional members) and mine technicians on forms for various structures and either forms or digital methods for instrumentation data.

Following collection and initial processing for instrumentation data, if no issues relative to Specific Performance Thresholds (SPTs) are noted, the observation and/or data collection sheets are filed.

If any issues are identified regarding SPTs, the following are notified:

a. Geotechnical engineering consultant - SRK Consulting (Canada) Inc.

b. Chief Engineer

c. Mine Manager.

Following notification and consultation, specific responses including additional or complementary monitoring, are implemented and documented as action items.

Mr. Bourne discussed general logistics and internal quality assurance/quality control protocols within the Minto Environmental Department with Ms. Bouchard. She described a well-thought out system including a whiteboard laying out monitoring requirements each week with space for sign-off and approval for each site, providing a visual status for all staff of progress at any given time. Ms. Bouchard indicated that photographs of the whiteboard are taken and archived each week prior to erasing. Field data are similarly collected on standardized forms, then entered into the electronic database by the collector, then double-checked against the hard copy by another staff member. Upon confirmation of accurate transcription, both staff members sign the field data sheet, which is then filed away for future reference.

Ms. Bouchard also described the (apparently significant) efforts she has undertaken with respect to the hydrometric monitoring program since commencing with Minto in 2016. While Minto staff were previously collecting hydrometric data in accordance with EMSRP locations and frequency, the data were all sent to a consultant for processing at a later date. As a result of this physical and temporal disconnect, there were often data quality issues that could not be addressed by the time they were discovered. Ms. Bouchard did a comprehensive review of the locations of each location for required hydrometric monitoring and identified the best stream reach for each. She also ensured that staff gauges were appropriately installed, revised SOPs and ensured staff were trained in appropriate hydrometric measurement methods for the conditions at each location (e.g. selecting a minimum number of velocity measurements for narrow reaches rather than an arbitrary spacing between measurements). While the present Audit did not comprise hydrometric data prior to Ms. Bouchard's involvement, the present methods and training at Minto appear to be above average for a typical mine site.

Ms. Flemming showed Mr. Bourne the EQWin database that Minto uses for managing their environmental data. Lorax notes that this database is widely used in the industry by industry and consultants alike, and has been found to be reliable and generally accepted. Following cursory review while on-site, Minto's database seemed to be logically constructed and organized. Minto further uses a software package for compliance called LOCUS; this package has been populated with the requirements from the EMSRP, QML, WUL, MMER, and others. It allows responsible parties to be assigned, reminded, and notified about tasks to be completed. Overdue tasks can escalated to supervisors for follow-up. For example, the weekly monitoring whiteboard photograph (and upload) is a task that has been scheduled in LOCUS. Following AMP SPT triggers, LOCUS can be updated to include extra samples/duplicates, for example, as required by the AMP. These can have an indefinite status or pre-defined stop date. Lorax notes that this level of compliance tracking is uncommon in the mining industry, and in this regard Minto appears to be a leader amongst its peers.

Mr. McIlveen described the procedure using composite intervals from blast hole cones to determine waste rock classification. Minto uses both NP/AP ratio and %S cutoffs to classify waste. Loads are trucked from origin to destination using truck count sheets, which are compiled into a spreadsheet and reconciled on a monthly basis against mine and dump surveys. Waste rock dumps are also sampled at 25 m intervals on a monthly basis to confirm appropriate placement.

Following from the site visit, Ms. Flemming provided a timeline summary of plan approvals (by both QML and WUL agencies) that was used to guide the compliance audit within the individual plans. In addition, Ms. Sandve forwarded select examples of the physical stability inspection forms to Mr. Cassie, which Minto Mine site staff use for their geotechnical inspection documentation. Finally, Ms. Flemming forwarded some Dry Stack Tailings Storage Facility (DSTSF) inspections files for 2016 and 2017 in November 2018.

3. Environmental Monitoring Surveillance and Reporting Plan

The specific tasks defined in the Approved Audit Scope (Appendix A) to be addressed for the EMSRP are:

1. Compliance with monitoring requirements for the following:
    a. water (surface, groundwater and seepage);
    b. geochemical (ABA, waste rock verification, low grade and oxide ore metals leaching characterization);
    c. physical stability
2. Are the monitoring programs adequately implemented to meet the objectives and intent of the plan? (Are the sampling methods adequately being followed, *etc*).
3. Is the reporting of the EMSRP adequately implemented to meet the objectives and intent of the plan?

Each of the above is discussed in the subsections below, which are further subdivided by technical discipline for clarity.

Per the Approved Audit Scope, a review was conducted of the implementation of the Environmental Monitoring, Surveillance and Reporting Plan (EMSRP) over the 2016 to 2017 period. Three versions of the EMSRP were relevant during this period, and the audit compared the monitoring activities conducted in each month to the EMSRP version that was relevant for the month in question, as presented in Table 3-1.

Table 3-1:
EMSRP Version History

Revision Number	Issue Date	Description and Revisions Made	Effective Period
2015-01	December 2015	Revisions made as per requirements of WUL QZ14-031	Dec. 2015 - Jan. 2016
2016-01	February 2016	Revisions made as per EMRSP comments from the Yukon Government and Selkirk First Nation	Feb. 2016 - Jun. 2016
2016-02	July 2016	Revisions made as per direction from Yukon Water Board letter April 26, 2016	Jul. 2016 – Dec. 2017

3.1 Surface Water Quality Monitoring

3.1.1 Documents Reviewed

The following documents were reviewed to complete the audit scope for the Surface Water Quality Monitoring Program:

- All monthly reports from Jan. 2016 to Dec. 2017;
- 2016 and 2017 Annual Reports;
    - Appendix H – Minto and McGinty Creek 2016 Surface Hydrology Update;
    - Appendix F – Minto and McGinty Creek 2017 Surface Hydrology Update;
- EMSRP (versions 2015-01, 2016-01 and 2016-02);
    - Appendix 1 – Minto Mine Surface Water Quality Monitoring Standard Operating Procedures (July 2015)

The results of the Surface Water Quality Monitoring Program are reported in both the monthly and annual reports. In 2016 and 2017, the water quality results were compared to the WUL effluent quality standards at stations W16, W16A, W17, W50 and WTP/RO. Results were compared to the WUL water quality objectives at the W2 station are when W35 and W15 are frozen, and at the W50 station when W35 and W15 are not frozen.

3.1.2 Compliance with EMSRP

To fulfill the first component of the approved audit scope (Section 1.2), the following items were checked for each station:

- Sampling frequency in conformance with schedule in the relevant EMSRP;
- Sample types in conformance with scheduled sample types in EMSRP (*i.e.*, field parameters [FP], internal analytical suite [IAS] and external analytical suite [EAS]), and;
- If samples not collected according to the relevant EMSRP, a rationale for such was provided in Table 5-2 of the Annual Reports.

The full record of this exercise is provided in Table 3-2 (2016) and Table 3-3 (2017).

Section 5.1 of the 2016 and 2017 Annual Reports outlines the currently active monitoring network, and the monitoring conformance with the EMSRP for the year in question (Table 5-2 of the Annual Report). In 2016, almost all stations were sampled according to the schedule, with the exceptions listed in Table 3-4. In most cases, rationale for a missed sample was provided in either the monthly or annual reports, and these do not include

missed samples due to frozen or dry conditions, or where access issues were noted. Thus, the sites and samples listed in Table 3-4 constitute instances where sampling was missed, either due to human error (which were reported), or where rationale for the departure from the EMSRP schedule was not provided. In total, of the hundreds of samples listed in the EMSRP over the course of 2016 and 2017, only five were missed. In 2016, one was due to unsafe pit wall conditions, and no rationale was provided for the other missed sample from station UG1. In 2017, the three missed samples were due to human error.

3.1.3 **Water Quality QA/QC**

The required ratio of quality control (QC) water quality samples to actual monitoring samples (1:10, specified in the Minto Mine SWQ SOP) was exceeded in 2016 (15.3% of all collected samples were for QC) and 2017 (22.1%).

3.1.4 **Monitoring Program Implementation**

The surface water quality monitoring program appears to be implemented according to the guidelines and SOPs presented in the EMSRP.

3.1.5 **Reporting Adequacy**

The reporting for the surface water quality monitoring program was reviewed for 2016 and 2017 to ensure that it met the objectives and intent of the EMSRP. Overall, the reporting of data collected under the Surface Water Surveillance Program is robust and adequately summarized the data collected, with reference to the appropriate Effluent Quality Standards (EQS) and Water Quality Objectives (WQOs) as specified in the WUL. However, some deviations and omissions were noted, as follows:

- Table 5-4 and Table 5-6 in the 2016 and 2017 Annual Reports in the 2016 Report do not include the standards for dissolved silver (WQO = 0.0001 mg/L at W2, or EQS = 0.0003 mg/L at W50).
- The 2016 Annual Report does not provide the DOC concentration at W2 or W50, on which the dissolved copper WQO or EQS is based on (*e.g.*, 0.02 mg/L when DOC @ W2 > 10 mg/L and 0.013 mg/L when DOC @ W2 ≤ 10 mg/L). Given that the WQO provided in these tables is 0.013 mg/L, it is assumed that DOC concentrations remained below 10 mg/L, but this is not stated explicitly, and it would be useful to do so. Note that the two DOC dependent copper thresholds are provided in Table 5-5 of the 2017 Annual Report, but not in Table 5-7.

- Water quality plots, including the relevant EQSs were not provided for the W50 station in the 2016 Annual Report, but were provided in 2017. It is recommended that this is continued in all future reporting for ease of reference.

In summary, the Annual Reports contain the appropriate information and data summaries as required by the EMSRP, and the WUL, with several exceptions as noted above.

Table 3-2:
EMSRP Surface Water Quality Monitoring Compliance Table – 2016

EMSRP Version	Field Parameters Frequency	External Analytical Suite	Internal Suite	2015-01	2016-01					2016-02					
Site				Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16
W2	W/Wd	W/Wd	Wd	frozen	frozen	FP=1w, EAS=1w, IAS=0	FP=4w, EAS=4w, IAS=4Wd	FP=11w, EAS=4w, IAS=5Wd	FP=8w, EAS=5w, IAS=5Wd	FP=6w, EAS=4w, IAS=5Wd	FP=8w, EAS=6w, IAS=4Wd	FP=4w, EAS=4w, IAS=2Wd	FP=6w, EAS=6w, IAS=5Wd	FP=1w, EAS=1w, IAS=0	frozen
W3	W/Wd	W/Wd	Wd	FP=5w, EAS=5w, IAS=0	FP=4w, EAS=4w, IAS=0	FP=5w, EAS=5w, IAS=0	FP=23w, EAS=4w, IAS=22Wd	FP=32w, EAS=6w, IAS=30Wd	FP=30w, EAS=5w, IAS=29Wd	FP=27w, EAS=4w, IAS=24Wd	FP=32w, EAS=6w, IAS=32Wd	FP=30w, EAS=4w, IAS=30Wd	FP=26w, EAS=6w, IAS=24Wd	FP=5w, EAS=5w, IAS=5Wd	FP=5w, EAS=4w, IAS=3Wd
W4	Q	Q	-	x	x	FP=1Q, EAS=1Q	x	x	FP=2Q, EAS=1Q	x	FP=1Q, EAS=1Q	x	FP=1Q, EAS=1Q	x	x
W5	Q	Q	-	x	x	unsafe access	x	x	FP=1Q, EAS=1Q	x	FP=1Q, EAS=1Q	x	FP=1Q, EAS=1Q	x	x
W6	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
W7	M	M	-	FP=1m, EAS=1m	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=2m	FP=2m, EAS=2m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=2m	FP=1m, EAS=1m	frozen
W8	W	W	W	inaccessible	inaccessible	inaccessible	dry	dry	dry	dry	dry	dry	dry	dry	dry
W8A	W	W	W	inaccessible	inaccessible	inaccessible	dry	dry	FP=2w, EAS=2w, IAS=2w, dry in early June	FP=4w, EAS=4w, IAS=3w	FP=3w, EAS=4w, IAS=4w	FP=5w, EAS=5w, IAS=5w	FP=5w, EAS=5w, IAS=4w	FP=4w, EAS=5w, IAS=5w	FP=5w, EAS=4w, IAS=3w
W10	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=1m
W12	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=1m
W12A	Wd	Wd	-	x	x	x	x	x	x	No discharge	No discharge	No discharge	No discharge	No discharge	No discharge
W14	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W15	M	M	Wd	FP=1m, EAS=1m	frozen	frozen	FP=27m, EAS=1m, IAS=27Wd	FP=31m, EAS=2m, IAS=30Wd	FP=29m, EAS=1m, IAS=29Wd	FP=25m, EAS=2m, IAS=24Wd	FP=31m, EAS=3m, IAS=31Wd	FP=30m, EAS=1m, IAS=30Wd	FP=4m, EAS=1m, IAS=2Wd	FP=1m, EAS=1m, IAS=0	FP=1m, EAS=1m, IAS=0
W16	Mnf/Wd	Mnf/Wd	Wnf	FP=2Mnf/Wd, EAS=1Mnf/Wd, IAS=5Wnf	FP=4Wd, EAS=1Mnf, IAS=4Wnf	FP=4Wd, EAS=1Mnf, IAS=4Wnf	FP=9Mnf/Wd, EAS=2Mnf/Wd, IAS=9Wnf	FP=4Wd, EAS=3Mnf/Wd, IAS=4Wnf	FP=4Wd, EAS=3Mnf/Wd, IAS=4Wnf	FP=4Wd, EAS=4Mnf/Wd, IAS=4Wnf	FP=5Wd, EAS=5Mnf/Wd, IAS=4Wnf	FP=4Wd, EAS=4Mnf/Wd, IAS=4Wnf	FP=5Wd, EAS=4Mnf/Wd, IAS=4Wnf	FP=2Wd, EAS=1Mnf, IAS=2Wnf	FP=1Mnf/Wd, EAS=1Mnf, IAS=0Wnf
W16A	Wd	Wd	Wd	no discharge	no discharge	no discharge	FP=24Wd, EAS=5Wd, IAS=23Wd	FP=20Wd, EAS=4Wd, IAS=19Wd	FP=25Wd, EAS=4Wd, IAS=24Wd	FP=25Wd, EAS=4Wd, IAS=24Wd	FP=31Wd, EAS=6Wd, IAS=31Wd	FP=29Wd, EAS=4Wd, IAS=29Wd	FP=24Wd, EAS=4Wd, IAS=23Wd	No discharge	No discharge
W17	W/Wd	W/Wd	Wd	FP=5w, EAS=5w, IAS=0	FP=4w, EAS=4w, IAS=0	FP=5w, EAS=5w, IAS=0	FP=17w, EAS=4w, IAS=16Wd	FP=4w, EAS=4w, IAS=0	FP=4w, EAS=4w, IAS=1Wd	FP=5w, EAS=5w, IAS=0	FP=5w, EAS=5w, IAS=0	FP=4w, EAS=4w, IAS=0	FP=4w, EAS=4w, IAS=1Wd	FP=5w, EAS=5w, IAS=1Wd	FP=4w, EAS=4w, IAS=0
W30	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=0, EAS=1m	FP=0, EAS=1m
W33	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen	frozen
W35	M	M	Wd	frozen	frozen	frozen	FP=28m, EAS=1m, IAS=28Wd	FP=30m, EAS=1m, IAS=30Wd	FP=27m, EAS=1m, IAS=27Wd	FP=10m, EAS=1m, IAS=10Wd	FP=31m, EAS=2m, IAS=31Wd	FP=30m, EAS=1m, IAS=30Wd	FP=2m, EAS=0, IAS=2Wd, frozen later in month	frozen	frozen
W36	M	M	-	FP=1m, EAS=1m	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W37	M	M	-	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W45	M	M	-	FP=1m, EAS=1m	inaccessible	inaccessible	FP=1m, EAS=1m	FP=2m, EAS=2m	FP=1m, EAS=1m	FP=0m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W46	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W47	M	M	-	dry	dry	dry	unsafe	unsafe	unsafe	unsafe	unsafe	FP=1m, EAS=1m	frozen	frozen	frozen

EMSRP Version	Field Parameters Frequency	External Analytical Suite	Internal Suite	2015-01	2016-01					2016-02					
Site				**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**	**Oct-16**	**Nov-16**	**Dec-16**
W50	M/Wd	M/Wd	Wd	dry	dry	dry	FP=5Wd, EAS=5Wd, IAS=3Wd	FP=50Wd, EAS=4Wd, IAS=5Wd	FP=5Wd, EAS=3Wd, IAS=4Wd	FP=4Wd, EAS=4Wd, IAS=4Wd	FP=6Wd, EAS=5Wd, IAS=5Wd	FP=6Wd, EAS=6Wd, IAS=5Wd	FP=16Wd, EAS=4Wd, IAS=16Wd	dry	dry
MC-1	M/Wd	M/Wd	-	FP=1m, EAS=1m, frozen afterwards	frozen	frozen	FP=5Wd, EAS=5Wd	FP=6Wd, EAS=5Wd, IAS=2	FP=4Wd, EAS=4Wd	FP=5Wd, EAS=5Wd	FP=5Wd, EAS=5Wd	FP=4Wd, EAS=4Wd	FP=4Wd, EAS=4Wd	FP=3Wd, EAS=3Wd	frozen
WTP	Wd	Wd	Wd	no treated water	no treated water	FP=2Wd, EAS=2Wd, IAS=0	FP=1Wd, EAS=0, IAS=1Wd	No discharge to Minto Creek	No discharge to Minto Creek	No discharge to Minto Creek	No discharge to Minto Creek	No discharge to Minto Creek	No discharge to Minto Creek	No discharge to Minto Creek	No discharge to Minto Creek
RO	Wd	Wd	Wd	no treated water	no treated water	No treated water	FP=14Wd, EAS=2Wd, IAS=14Wd	FP=14Wd, EAS=2Wd, IAS=15Wd	FP=13Wd, EAS=2Wd, IAS=14Wd	FP=10Wd, EAS=2Wd, IAS=10Wd	FP=5Wd, EAS=2Wd, IAS=5Wd	FP=26Wd, EAS=4Wd, IAS=27Wd	FP=9Wd, EAS=1Wd, IAS=9Wd	No discharge	No discharge
W51	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W52	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W53	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W54	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W55	M	M	-	dry	dry	dry	FP=1m, EAS=1m	FP=1m, EAS=1m	dry	dry	dry	dry	dry	dry	frozen
W62	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=1m, IAS=1	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
C4	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
C10	M	M	-	frozen	frozen	frozen	dry	FP=1m, EAS=1m	dry	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen	frozen
MN	M	M	-	dry	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	inaccessible/unsafe	not storing water
MN-0.2	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen
MN-0.5	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
MN-1.5	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen	frozen
MN-2.5	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
MN-4.5	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
UG 1	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=2m	FP=1m, EAS=1m	FP=0m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=2m	FP=1m, EAS=1m	FP=2m, EAS=1m
UG 2	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 3	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 4	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established

Notes:
In 2015-01, W12A was not included as a station as W12 and W12A are water equivalent to one another
W12A is only included in the 2016-02 version of the EMSRP (marked with an x prior to this)
Highlighted cells indicate months where the EMSRP requirements may not have been met
Blank cells - no explanation given in monthly reports but site is not indicated as sampled in the WQ tracking spreadsheets
FP = Field Parameters
EAS = External Analytical Suite
IAS = Internal Analytical Suite
W: Weekly
Wd: Weekly while discharging
Wnf: Weekly, when not frozen
M: Monthly
Mnf: Monthly, when not frozen
Q: Quarterly

Table 3-3:
EMSRP Surface Water Quality Monitoring Compliance Table – 2017

EMSRP Version	Field Parameters Frequency	External Analytical Suite	Internal Suite	2016-02											
Site				**Jan-17**	**Feb-17**	**Mar-17**	**Apr-17**	**May-17**	**Jun-17**	**Jul-17**	**Aug-17**	**Sep-17**	**Oct-17**	**Nov-17**	**Dec-17**
W2	W/Wd	W/Wd	Wd	frozen	frozen	frozen	FP=6w, EAS=6w, IAS=3Wd	FP=8w, EAS=8w, IAS=6Wd	FP=4w, EAS=4w, IAS=4Wd	FP=5w, EAS=4w, IAS=3Wd	FP=7w, EAS=6w, IAS=3Wd	FP=4w, EAS=4w, IAS=4Wd	FP=6w, EAS=6w, IAS=1Wd	frozen	frozen
W3	W/Wd	W/Wd	Wd	FP=5w, EAS=5w, IAS=5Wd	FP=4w, EAS=4w, IAS=4Wd	FP=4w, EAS=4w, IAS=3Wd	FP=5w, EAS=5w, IAS=4Wd	FP=30w, EAS=5w, IAS=30Wd	FP=30w, EAS=4w, IAS=30Wd	FP=20w, EAS=5w, IAS=19Wd	FP=12w, EAS=6w, IAS=11Wd	FP=4w, EAS=4w, IAS=3Wd	FP=6w, EAS=6w, IAS=3Wd	FP=4w, EAS=4w, IAS=2Wd	FP=4w, EAS=4w, IAS=0Wd
W4	Q	Q	-	x	x	FP=1Q, EAS=1Q	frozen	x	FP=2Q, EAS=1Q	FP=1Q	x	FP=1Q	FP=1Q, EAS=1Q	x	x
W5	Q	Q	-	x	x	frozen	frozen	x	FP=1Q, EAS=1Q	x	x	x	FP=1Q, EAS=1Q	x	x
W6	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen
W7	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W8	W	W	W	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	dry	destroyed
W8A	W	W	W	FP=4w, EAS=5w, IAS=5w	FP=4w, EAS=4w, IAS=4w	FP=3w, EAS=3w, IAS=3w	FP=4w, EAS=4w, IAS=4w	dry	FP=3w, EAS=3w, IAS=3w	FP=5w, EAS=5w, IAS=5w	FP=4w, EAS=4w, IAS=4w	FP=4w, EAS=4w, IAS=4w	FP=5w, EAS=5w, IAS=3w	FP=5w, EAS=5w, IAS=5w	FP=2w, EAS=2w, IAS=2w
W10	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=0m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W12	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=5m, EAS=1m, IAS=4	FP=10m, EAS=1m, IAS=9	FP=6m, EAS=1m, IAS=5	FP=3m, EAS=1m, IAS=2	FP=5m, EAS=1m, IAS=2	FP=4m, EAS=1m, IAS=4
W12A	Wd	Wd	-	No discharge	No discharge	No discharge	Not active	Not active	Not active	Not active	Not active	Not active	Not active	Not active	Not active
W14	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W15	M	M	Wd	FP=1m, EAS=1m	FP=1m, EAS=1m, IAS=0	frozen	FP=11m, EAS=3m, IAS=11Wd	FP=31m, EAS=6m, IAS=31Wd	FP=12m, EAS=1m, IAS=12Wd	FP=10m, EAS=1m, IAS=9Wd	FP=25m, EAS=1m, IAS=25Wd	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W16	Mnf/Wd	Mnf/Wd	Wnf	FP=1Mnf, EAS=1Mnf, IAS=0Wnf	FP=1Mnf, EAS=1Mnf, IAS=0Wnf	FP=1Mnf, EAS=1Mnf, IAS=0Wnf	FP=5Wd, EAS=5Wd, IAS=5Wnf	FP=5Wd, EAS=6Wd, IAS=4Wnf	FP=4Wd, EAS=4Wd, IAS=4Wnf	FP=15Wd, EAS=5Wd, IAS=15Wnf	FP=26Wd, EAS=6Wd, IAS=24Wnf	FP=17Wd, EAS=4Wd, IAS=16Wnf	FP=3Wd, EAS=2Wd, IAS=2Wnf	FP=2Mnf/Wd, EAS=1Mnf/Wd, IAS=2Wnf	FP=1Mnf, EAS=1Mnf, IAS=0Wnf
W16A	Wd	Wd	Wd	No discharge	No discharge	No discharge	No discharge	FP=29Wd, EAS=5Wd, IAS=29Wd	FP=26Wd, EAS=4Wd, IAS=25Wd	FP=8Wd, EAS=2Wd, IAS=8Wd	FP=5Wd, EAS=5Wd, IAS=5Wd	No discharge	No discharge	No discharge	No discharge
W17	W/Wd	W/Wd	Wd	FP=5w, EAS=5w	FP=3w, EAS=4w	FP=4w, EAS=4w, IAS=0	FP=4w, EAS=4w, IAS=0	FP=5w, EAS=5w, IAS=1Wd	FP=4w, EAS=4w, IAS=0	FP=5w, EAS=5w, IAS=0	FP=5w, EAS=5w, IAS=0	FP=4w, EAS=4w, IAS=0	FP=5w, EAS=5w, IAS=0	FP=4w, EAS=4w	FP=4w, EAS=4w
W30	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
W33	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	destroyed
W35	M	M	Wd	frozen	frozen	frozen	FP=11m, EAS=3m, IAS=11Wd	FP=29m, EAS=5m, IAS=29Wd	FP=14m, EAS=1m, IAS=14Wd	FP=2m, EAS=1m, IAS=1Wd	FP=7m, EAS=1m, IAS=6Wd	FP=9m, EAS=1m, IAS=9Wd	FP=1m, EAS=1m, IAS=0	frozen	frozen
W36	M	M	-	not established	not established	not established	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W37	M	M	-	not established	not established	not established	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W45	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	inaccessible - unsafe	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	pump removed, no sample	FP=1m, EAS=1m	FP=1m, EAS=1m
W46	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m

EMSRP Version	Field Parameters Frequency	External Analytical Suite	Internal Suite	2016-02											
Site				Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
W47	M	M	-	closed	closed	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned
W50	M/Wd	M/Wd	Wd	frozen	dry	dry	dry	FP=5Wd, EAS=5Wd, IAS=5Wd	FP=4Wd, EAS=4Wd, IAS=3Wd	FP=2Wd, EAS=2Wd, IAS=2Wd	FP=1Wd, EAS=1Wd, IAS=1Wd	dry	dry	dry	frozen
MC-1	M/Wd	M/Wd	-	frozen	frozen	frozen	FP=4Wd, EAS=4Wd	FP=5Wd, EAS=5Wd	FP=4Wd, EAS=4Wd	FP=4Wd, EAS=4Wd	FP=5Wd, EAS=5Wd	FP=4Wd, EAS=4Wd	FP=5Wd, EAS=5Wd	FP=1Wd, EAS=1Wd, then frozen	frozen
WTP	Wd	Wd	Wd	No discharge	No discharge	No discharge	No discharge	No discharge	No discharge	No discharge	No discharge	No discharge	Not active	Not active	No discharge
RO	Wd	Wd	Wd	No discharge	No discharge	No discharge	FP=16Wd, EAS=4Wd, IAS=16Wd	FP=27Wd, EAS=3Wd, IAS=27Wd	FP=9Wd, EAS=2Wd, IAS=9Wd	No discharge	No discharge	No discharge	Not active	Not active	No discharge
W51	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	FP=1m, EAS=1m	FP=1m, EAS=1m	closed - unsafe	closed - unsafe
W52	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W53	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W54	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W55	M	M	-	dry	dry	dry	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	dry	dry	dry	frozen	frozen
W62	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=2m, EAS=2m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
C4	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen
C10	M	M	-	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	dry	dry	dry	dry
MN	M	M	-	closed due to safety	closed due to safety	closed due to safety	inaccessible - unsafe	inaccessible - unsafe	inaccessible - unsafe	inaccessible - unsafe	inaccessible - unsafe	inaccessible - unsafe	FP=1m, EAS=1m	frozen	closed due to safety
MN-0.2	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen
MN-0.5	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
MN-1.5	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen	frozen
MN-2.5	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
MN-4.5	M	M	-	frozen	frozen	frozen	frozen	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	frozen
UG 1	M	M	-	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m	FP=1m, EAS=1m
UG 2	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 3	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 4	M	M	-	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established

Notes:
In 2015-01, W12A was not included as a station as W12 and W12A are water equivalent to one another
W12A is only included in the 2016-02 version of the EMSRP (marked with an x prior to this)
Highlighted cells indicate months where the EMSRP requirements may not have been met
Blank cells - no explanation given in monthly reports but site is not indicated as sampled in the WQ tracking spreadsheets

FP = Field Parameters EAS = External Analytical Suite IAS = Internal Analytical Suite
W: Weekly Wd: Weekly while discharging Wnf: Weekly, when not frozen
M: Monthly Mnf: Monthly, when not frozen Q: Quarterly

Table 3-4:
Summary of surface water quality sampling departures from EMSRP schedule without rationale provided in 2016 and 2017.

Year	Site	Month(s)	Sampling Missed	Reason/Notes
2016	W45	July	FP	site unsafe due to pit wall geotechnical issue
	UG1	Jul.	FP	No reason provided
2017	W5	Nov.	Not sampled	Human error – monthly report states that this station was sampled on schedule
	W10	Oct.	FP	Report states that field parameters were missed due to human error
	W17	Feb.	FP=3w, EAS=4w	Field parameters missed due to human error

Notes:
[1]Table 5-2 in 2017 Annual Report states that this station was sampled according to the schedule
Gray shading indicates station where WQ results are compared to WUL effluent quality standards
IAS = Internal Analytical Suite
EAS = External Analytical Suite
FP = Field parameters

3.2 Surface Water Flow Monitoring

The following documents were reviewed to complete the audit scope for the Surface Water Flow Monitoring Program:

- All monthly reports from Jan. 2016 to Dec. 2017;
- 2016 and 2017 Annual Reports;
    - Appendix H – Minto and McGinty Creek 2016 Surface Hydrology Update;
    - Appendix F – Minto and McGinty Creek 2017 Surface Hydrology Update;
- EMSRP (versions 2015-01, 2016-01 and 2016-02);
    - Appendix 2 – Minto Mine Surface Water Hydrology Standard Operating Procedures (Oct. 2012)

3.2.1 **Monitoring Program Implementation**

Section 9.3.1 in the EMSRPs reviewed as part of this audit outlines the QA/QC of hydrology data at a high level. More detailed information on the implementation of the surface water hydrology monitoring program is provided in Appendix 2 of the EMSRP (*Minto Mine Surface Water Hydrology Standard Operating Procedures*; Oct. 2012).

The procedures described are consistent with industry best practices, including conducting two sets of measurements at selected stations to confirm the accuracy of the flow measurements. Lorax supports the recommendation that annual levelling surveys be conducted, as this is a critical component of the stage-discharge curve development,

particularly in areas subject to frost heave conditions. Lorax suggests that this survey be conducted following the spring freshet, to determine the degree of vertical staff gauge movement from year to year.

The data collected by the flow monitoring program appears to be of high quality, as determined from the rating curves and time-series plots presented in the Annual Report appendices for 2016 and 2017. One exception to this statement is the method by which some of the rating curves are calculated. For example, at station W3 (2017 Annual Report; Appendix F; Figure 3), a polynomial equation is fit to the data. The reviewer notes that this does not conform to the standard rating curve formulation, which is that of a power law equation. Note that the polynomial curve trends upwards below stage values of 0.5 m, which is contrary to the actual stage:discharge relationship, and contrary to open channel hydraulic principles. This will result in overestimates of low flows when this curve is applied to the corrected water level record. The rating curve is calculated according to the correct hydraulic principles for MC1, W1 and MN-4.5. Lorax recommends that Minto discuss the methods used to derive the rating curve equations for future streamflow record updates with the Qualified Professional tasked with this work.

Aside from the rating curve equations, there are no significant gaps identified in the existing flow monitoring SOP, and all flow data appears to be collected according to industry best practices.

3.2.2 **Reporting Adequacy**

The annual conveyance volumes provided in the Annual Reports were checked for consistency against the total volumes conveyed between water management features, as described in the text (*e.g.*, Section 8.2.1 and 8.2.2 in the 2016 Annual Report). In addition, Section 6 of the monthly reports were examined to verify the information contained in the Annual Reports and infill gaps where necessary. The complete results of this audit are contained in Table 3-5 (2016) and Table 3-6 (2017).

The noted departures from the scheduled flow measurements presented in the EMSRP are summarized in Table 3-7. The 2016 Annual Report states that the RO discharged to Minto Creek from September 9th to October 9th, 2016, however multiple water quality samples were taken from this station (presumably while discharging) from April to September of this year. Further, there is flow data available for April, May, September and October, but none is reported for June to August. Table 6.2 in the monthly report for August indicates that discharge from the RO to Minto Creek was zero for the month. This apparent discrepancy arose because the monthly reports provided flow volumes from the WTP to the WSP, but this water was passed through the RO first. The reports did not make this distinction, and thus it is flagged for future refinement in the reporting procedures.

In total, nine instances were identified in 2016 (n=7) and 2017 (n=2) where flow measurements were missed due to human error (n=6), or the rationale was not adequately reported.

Recommendations:

- Provide a complete list of all possible water conveyances in the summary table in the monthly reports (*e.g.*, Table 6-3, June 2016), and when no flow values are presented, insert a note providing the reason (*e.g.*, frozen, dry, instrument out of commission, no transfer).
- The *WSP Discharge vs. Maximum Allowable* figures in the monthly reports would benefit from a y-axis label.

Table 3-5:
EMSRP Surface Water Flow Monitoring Compliance Table – 2016

EMSRP Version	Flow	2015-01	2016-01					2016-02					
Site		**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**	**Oct-16**	**Nov-16**	**Dec-16**
W1	C	frozen	frozen	frozen, flow collected in last week	flow beginning Apr 5	✓	✓	✓	✓	✓	✓	✓	frozen
W3	C	✓*	✓*	flume backed up	✓	✓	✓	✓	✓	✓	✓	✓	✓
W6	M	frozen	frozen	frozen	Insufficient flow	✓	✓	Insufficient flow	✓	✓	✓	frozen	frozen
W7	C	no flow/inaccessible**	frozen	frozen	No data	✓	✓	✓	✓	✓	✓	No data	frozen
W12A	Wd	no discharge	✓	✓	✓	✓	✓	No discharge	✓	✓	✓	No discharge	No discharge
W15	C	no flow**	frozen	frozen	✓	✓	✓	✓	✓	□	frozen Oct. 10	No discharge	frozen
W16A	Wd	no discharge	no discharge	✓	✓	✓	✓	✓	✓	✓	✓	No discharge	No discharge
W17	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
W30	M	no flow**	no flow**	✓	No water	No water	No water	No water	No water	No water	No water	No water	No water
W33	M	frozen	frozen	frozen	Missed - human error	✓	Missed - human error	Missed - human error	Missed - human error	✓	frozen	frozen	frozen
W35	C	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen Oct. 10	frozen	frozen
W36	C	✓	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W37	M	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W45	Cdw	✓	inaccessible	inaccessible	✓	✓	✓	✓	✓	✓	✓	✓	✓
W46	M	frozen	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen
W47	Cdw	dry	dry	dry	unsafe	unsafe	unsafe	No water storage	No water storage	No water storage	No water storage	frozen	frozen
W50	M/Wd	dry	dry	dry	✓	✓	✓	✓	✓	✓	✓	dry	dry
MC-1	C	frozen after 1st week	frozen	frozen	✓	✓	✓	✓	✓	✓	✓	frozen	frozen
WTP	Wd	no treated water	no treated water	March 21 onwards	✓	✓	✓	✓	✓	✓	✓	No discharge	No discharge
RO	Wd	no treated water	no treated water	Discharge beginning Mar 21	✓	✓	✓	✓	No discharge	✓	✓	No discharge	No discharge
W51	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W52	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W53	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W54	C	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W55	M	dry	dry	dry	Insufficient flow	Insufficient flow	dry	dry	dry	dry	dry	dry	frozen
W62	C	not established	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
C4	M	frozen	frozen	frozen	✓	✓	✓	Insufficient flow	✓	✓	✓	no flow recorded	frozen
C10	M	frozen	frozen	frozen	dry	X	dry	✓	✓	✓	frozen	frozen	frozen
MN	Cdw	dry	No flow data	□	✓	✓	✓	✓	✓	✓	X	inaccessible/unsafe	not storing water
MN-0.2	M	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	X	frozen	frozen
MN-0.5	M	frozen	frozen	frozen	No data	No data	✓	✓	✓	✓	✓	no flow recorded	X
MN-1.5	C	frozen	frozen	frozen	No data	No data	✓	✓	✓	✓	frozen	frozen	frozen
MN-2.5	C	frozen	frozen	frozen	No data	No data	✓	✓	✓	✓	✓	X	frozen
MN-4.5	C	frozen	frozen	frozen	No data	No data	✓	✓	✓	✓	✓	no flow recorded	frozen
UG 1	Cdw	□	□	□	✓	✓	✓	✓	✓	✓	✓	✓	✓
UG 2	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 3	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 4	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established

Notes:
*ice caused backing up of flume, flow measurements may not be accurate
**no flow due to ice buildup
✓ = Flow data was collected
X = Flow data was not collected, and reason not provided
C: Continuously
M: Monthly
Wd: Weekly while discharging
Cdw: Continuous when dewatering

Table 3-6:
EMSRP Surface Water Flow Monitoring Compliance Table – 2017

EMSRP Version	Flow	2016-02											
Site		**Jan-17**	**Feb-17**	**Mar-17**	**Apr-17**	**May-17**	**Jun-17**	**Jul-17**	**Aug-17**	**Sep-17**	**Oct-17**	**Nov-17**	**Dec-17**
W1	C	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	✓	frozen	frozen
W3	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
W6	M	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen	frozen
W7	C	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen	frozen
W12A	Wd	✓	✓	No discharge	✓	Not active	✓	✓	✓	✓	✓	✓	Not active
W15	C	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	✓	frozen	frozen
W16A	Wd	No discharge	No discharge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
W17	C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
W30	M	frozen	frozen	frozen	frozen	No water	No water	No water	No water	No water	No water	No water	No water
W33	M	frozen	frozen	frozen	no flow	no flow	Missed - human error	✓	✓	no flow	no flow	frozen	destroyed
W35	C	not established	not established	not established	□	□	✓	✓	✓	No discharge	No discharge	frozen	frozen
W36	C	not established	not established	not established	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W37	M	not established	not established	not established	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed	destroyed
W45	Cdw	✓	✓	✓	✓	✓	✓	✓	✓	✓	pump removed, no flow data	✓	✓
W46	M	frozen	frozen	frozen	frozen	no flow	no flow	✓	✓	✓	✓	frozen	frozen
W47	Cdw	closed	closed	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned	decommissioned
W50	M/Wd	frozen	dry	dry	dry	✓	✓	✓	✓	dry	No discharge	frozen	frozen
MC-1	C	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen	frozen
WTP	Wd	No discharge	No discharge	No discharge	✓	No discharge	✓	No discharge	No discharge	No discharge	Not active	Not active	No discharge
RO	Wd	No discharge	No discharge	No discharge	✓	✓	✓	No discharge	No discharge	No discharge	Not active	Not active	No discharge
W51	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	closed - unsafe	closed - unsafe
W52	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W53	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W54	C	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
W55	M	dry	dry	dry	dry	Insufficient flow	Insufficient flow	X	dry	dry	dry	frozen	frozen
W62	C	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
C4	M	frozen	frozen	frozen	no flow	✓	✓	✓	✓	✓	✓	frozen	frozen
C10	M	frozen	frozen	frozen	no flow	✓	✓	✓	✓	dry	dry	dry	dry
MN	Cdw	closed due to safety	closed due to safety	closed due to safety	inaccessible - unsafe	inaccessible - unsafe	inaccessible - unsafe	inaccessible - unsafe	✓	inaccessible - unsafe	inaccessible - unsafe	frozen	closed due to safety
MN-0.2	M	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	frozen	frozen	frozen
MN-0.5	M	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen	frozen
MN-1.5	C	frozen	frozen	frozen	frozen	✓	✓	Insufficient flow	✓	✓	frozen	frozen	frozen
MN-2.5	C	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen	frozen
MN-4.5	C	frozen	frozen	frozen	frozen	✓	✓	✓	✓	✓	✓	frozen	frozen
UG 1	Cdw	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UG 2	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 3	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established
UG 4	Cdw	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established	not established

Notes:
*ice caused backing up of flume, flow measurements may not be accurate
**no flow due to ice buildup
✓ = Flow data was collected
X = Flow data was not collected, and reason not provided
C: Continuously
M: Monthly
Wd: Weekly while discharging
Cdw Continuous when dewatering

Table 3-7:
Summary of flow measurement departures from EMSRP schedule without rationale provided in 2016 and 2017.

Year	Site	Month(s)	Sampling Missed	Reason/Notes
2016	W33	Apr, Jun-Aug.	Flow	Missed due to human error
	RO	Jun-Jul	Flow	Reported in monthly report as WTP to WSP (all water from WTP was transferred through the RO and report didn't make the distinction.
	C10	May	Flow	Missed due to human error
2017	W33	June	Flow	Missed due to human error
	W55	July	Flow	No reason provided

Notes:
[1]Table 5-2 in 2017 Annual Report states that this station was sampled according to the schedule
Gray shading indicates station where WQ results are compared to WUL effluent quality standards (EQS)

3.3 Meteorology Monitoring

The climate record from site is generally complete, with the exception of two gaps. The first occurred between July 15-20th, 2016. The gap is evident from the plots, where these 5 days are interpolated linearly. The reason for this gap is not provided. The second gap was the result of a loss of power to the station, from Jan. 25th - Feb. 16th, 2017, and is mentioned in the 2017 Annual Report.

Plots of all climate parameters are presented in both the monthly (except relative humidity) and annual reports.

The snow survey data is presented in the annual reports (*e.g.*, Appendix E – 2017 Water Balance and Water Quality Model Summary for the Minto Mine), but only as an average of the three stations. While the reporting meets the requirements of the EMSRP, it would be more consistent with the reporting for other monitoring programs if these data (specifically snow depth, water equivalent and density) were presented for each station, and for each survey period in the main body of the report.

3.3.1 **Meteorology Monitoring Program Implementation**

This Audit finds that the Meteorology Monitoring Program appears to be implemented according to the guidelines and SOPs presented in the EMSRP.

3.3.2 Meteorology Monitoring Program Reporting

The reporting for the Meteorology Monitoring Program was reviewed for 2016 and 2017 to ensure that it met the objectives and intent of the EMSRP. This Audit concludes that the reporting for this Program meets the objectives laid out in the EMSRP

3.4 Groundwater

3.4.1 Documents Reviewed

The following documents were reviewed to complete the audit scope for the Groundwater Monitoring Program:

- All monthly reports from Jan. 2016 to Dec. 2017;
- 2016 Annual Report;
    - Appendix C – Environmental Tracer Study – Status Update
    - Appendix D – Groundwater Quality Monitoring Program Laboratory Results
    - Appendix J – 2016 AMP Groundwater SRK Memo
- 2017 Annual Report;
    - Appendix C – Groundwater Quality Monitoring Program Laboratory Results;
    - Appendix H – 2017 AMP Groundwater SRK Memo
- EMSRP 2015-01, 2016-01 and 2016-02);
    - Appendix 1: Minto Mine Groundwater Monitoring Plan (2015-01)
- EMSRP 2016-01
    - Appendix 3: Minto Mine Groundwater Monitoring Plan
- EMSRP 2016-02
    - Appendix 3: Minto Mine Groundwater Monitoring Plan

The results of the Groundwater Monitoring Program are reported in both the monthly and annual reports. The results are detailed further below.

3.4.2 Compliance with EMSRP

To fulfill the first component of the approved audit scope (Section 1.2), the following items were checked for each station:

- Sampling frequency in conformance with schedule in the relevant EMSRP;
- Sample types in conformance with scheduled sample types in EMSRP (*i.e.*, field parameters [FP], internal analytical suite [IAS] and external analytical suite [EAS]), and;
- If samples not collected according to the relevant EMSRP, a rationale for such was provided in Table 6-1 of the Annual Reports.

The full record of this exercise is provided in Table 3-8. This review concludes that all required sampling was completed (or satisfactorily justified otherwise) in accordance with the EMSRP. Frozen or dry conditions are duly reported in the monthly reports.

It should be noted that EMSRP version 2016-02 (issued July 2016) required quarterly monitoring from new groundwater monitoring wells that were constructed in July 2017 and sampled thereafter. These multilevel Westbay monitoring wells are often constrained by the supplier's availability of specialized equipment and personnel and requires significant logistical coordination. As such, the installation timeline for these new wells is not considered unreasonable.

3.4.3 **Groundwater Quality QA/QC**

The required ratio of quality control (QC) water quality samples to actual monitoring samples (1:10, specified in the Minto Mine SWQ SOP) was not met in 2016 (4.5% of all collected samples for QC). Minto indicates in the 2016 Annual Report that they employ compliance management system software to track programs and actions that meet license requirements. As a corrective measure, Minto reported that the compliance system was reportedly updated to ensure that environmental staff complete the required field duplicates. The groundwater sample QA/QC ratio was exceeded in 2017 (18.2%).

3.4.4 **Monitoring Program Implementation**

The groundwater quality monitoring program appears to be implemented according to the guidelines and SOPs presented in the EMSRP. Discussions with site staff during the site visit provide the reviewer confidence that samplers have been well-trained and follow Minto SOPs.

3.4.5 **Reporting Adequacy**

The reporting for the groundwater monitoring program was reviewed for 2016 and 2017 to ensure that it met the objectives and intent of the EMSRP. The reviewers encountered one clerical error whereby the analytical results for five multilevel Westbay wells (MW12-05, MW17-08, MW17-10, MW17-11, and MW17-12 were not included in Appendix C of the

2017 Annual Report. These results were, however, included in Appendix C of the Monthly Report for August 2017. Upon request, Minto confirmed that the omission of these laboratory reports was simply a clerical error, and that the summary tables presented in the 2017 Annual Report do include all data for 2017.

Table 3-8:
EMSRP Groundwater Monitoring Compliance Table

EMSRP Version		2015-01	2016-01					2016-02																	
Site	**Westbay Zone Depth**	**Jan-16**	**Feb-16**	**Mar-16**	**Apr-16**	**May-16**	**Jun-16**	**Jul-16**	**Aug-16**	**Sep-16**	**Oct-16**	**Nov-16**	**Dec-16**	**Jan-17**	**Feb-17**	**Mar-17**	**Apr-17**	**May-17**	**Jun-17**	**Jul-17**	**Aug-17**	**Sep-17**	**Oct-17**	**Nov-17**	**Dec-17**
Operational																									
MW09-01	Zone 1 (44 mbgs)	-	-	-	-	-	-	-	-	dry	dry	-	dry	-	dry	-	-	dry	-	-	dry	-	-	replaced by 17-10	-
	Zone 2 (34 mbgs)	-	-	-	-	-	-	-	-	dry	dry	-	dry	-	dry	-	-	dry	-	-	dry	-	-	replaced by 17-10	-
	Zone 3 (26 mbgs)	-	-	-	-	-	-	-	-	dry	dry	-	dry	-	dry	-	-	dry	-	-	dry	-	-	replaced by 17-10	-
MW12-DP1	n/a	-	-	-	-	frozen	-	-	-	dry	dry	-	-	-	frozen	-	-	frozen	-	-	destroyed	-	-	frozen	-
MW12-DP2	n/a	-	-	-	-	dry	-	-	-	dry	dry	-	-	-	frozen	-	-	frozen	-	-	-	-	-	frozen	-
MW12-DP3	n/a	-	-	-	-	dry	-	-	-	dry	dry	-	-	-	frozen	-	-	frozen	-	-	-	-	-	frozen	-
MW12-06	Zone 1 (142 mbgs) - WL only	-	-	-	-	-	-	-	-	-	sampled	-	sampled	-	-	-	sampled	-	-	-	sampled	-	-	sampled	re-sampled
	Zone 2 (123 mbgs)	-	-	-	-	sampled 2x	-	-	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-	sampled	-	-	sampled	re-sampled
	Zone 3 (93 mbgs) - WL only	-	-	-	-	-	-	-	-	sampled	sampled	-	sampled	-	-	-	sampled	-	-	-	sampled	-	-	sampled	re-sampled
	Zone 4 (66 mbgs)	-	-	-	-	sampled 2x	-	-	-	glycol contamination	glycol contamination	-	sampled	-	sampled	-	sampled	-	-	-	sampled	-	-	sampled	re-sampled
	Zone 5 (35 mbgs) - WL only	-	-	-	-	-	-	-	-	sampled	sampled	-	sampled	-	-	-	sampled	-	-	-	sampled	-	-	sampled	re-sampled
	Zone 6 (18 mbgs)	-	-	-	-	sampled 2x	-	-	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-	sampled	-	-	sampled	re-sampled
MW15-09	TBD (Zones not defined)	-	-	-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW12-07	Zone 1 (115 mbgs)	-	sampled	-	-	sampled 2x	-	-	-	sampled	sampled	-	sampled	sampled	sampled	sampled	sampled	sampled	sampled	sampled	sampled	-	sampled	sampled	-
	Zone 2 (88 mbgs)	-	sampled	-	-	sampled 2x	-	-	-	sampled	sampled	-	sampled	sampled	sampled	sampled	sampled	sampled	sampled	sampled	sampled	-	sampled	sampled	-
	Zone 3 (66 mbgs) - WL only	-	-	-	-	-	-	-	-	-	-	-	sampled	-	-	-	-	-	-	-	-	-	-	-	-
MP-1	TBD	x	-	-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW12-05	Zone 1 (132 mbgs)	-	-	-	-	sampled 2x	-	sampled	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
	Zone 2 (110 mbgs)	-	-	-	-	sampled	-	sampled	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
	Zone 3 (94 mbgs)	-	-	-	-	sampled 2x	-	sampled	-	sampler stopped working	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
	Zone 4 (69 mbgs)	-	-	-	-	sampled	-	sampled	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
	Zone 5 (52 mbgs)	-	-	-	-	sampled 2x	-	-	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
	Zone 6 (26 mbgs)	-	-	-	-	sampled	-	sampled	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
	Zone 7 (15 mbgs)	-	-	-	-	sampled 2x	-	sampled	-	sampled	sampled	-	sampled	-	sampled	-	sampled	-	-	-		-	-	sampled	-
MW09-03	Zone 1 (38 mbgs)	-	-	-	-	sampled	sampled	-	-	sampled	sampled	-	sampled	-	sampled	sampled	sampled	sampled	sampled	sampled	sampled	-	sampled	sampled	sampled
	Zone 2 (24 mbgs)	-	-	-	-	sampled	sampled	-	-	sampled	-	-	sampled	-	sampled	sampled	sampled	sampled	sampled	sampled	sampled	-	sampled	sampled	sampled
	Zone 3 (11 mbgs)	-	-	-	-	-	-	-	-	dry	dry	-	-	-	dry	dry	dry	dry	dry	dry	dry	-	dry	dry	dry
MW15-08	TBD (Zones not defined)	-	-	-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
A2P-1	TBD	x	-	-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW11-01A	n/a	-	x	x	x	x	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MW17-08	Zone 1 (44.7 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 2 (34.1 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 3 (23.4 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 4 (8.2 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-

EMSRP Version		2015-01	2016-01					2016-02																
Site	Westbay Zone Depth	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sep-16	Oct-16	Nov-16	Dec-16	Jan-17	Feb-17	Mar-17	Apr-17	May-17	Jun-17	Jul-17	Aug-17	Sep-17	Oct-17	Nov-17	Dec-17
MW17-09	Zone 1 (57.2 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction	sampled	-	-	frozen	-
MW17-10	Zone 1 (85.5 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 2 (75 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 3 (61 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 4 (53.5 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction	-	-	-	dry	-
MW17-11	Zone 1 (96.9 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 2 (75.5 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 3 (58.8 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 4 (40.5 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 5 (16.1 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction	dry	-	-	sampled	-
MW17-12	Zone 1 (143.4 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 2 (129.6 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 3 (111.4 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 4 (91.5 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 5 (80.9 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 6 (70.2 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 7 (50.4 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
	Zone 8 (35.2 mbgs)	x	x	x	x	x	x	-	-	-	-	-	-	-	not established	-	not established	-	-	under construction		-	-	sampled	-
Baseline																									
MW11-02	n/a	-	-	-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW11-03	n/a	-	-	-	-	-	-	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
MW11-04	n/a	-	-	-	-	sampled	-	x	x	sampled	x	x	sampled	x	x	sampled	x	sampled	x	x	x	x	x	x	x
Notes:																									
Westbay zones not defined in 2015-01 EMSRP																									
x = not included in EMSRP																									
Sampling frequency for MW09-03 increased to monthly in May 2017 as per AMP																									
MW12-07 is sampled monthly for internal monitoring, beginning in June 2017																									
Blue shading indicates wells with no results in annual report but that were indicated as sampled in the monthly reports																									

3.5 Geochemistry

3.5.1 **Documents and Background Information Reviewed**

The following documents were reviewed to complete the audit scope for the Geochemistry Monitoring Program:

- EMSRP (v. 2015-01 to 2018-01)
- Waste Rock and Overburden Management Plan (WROMP)
- All monthly reports from Jan. 2016 to Dec. 2017;
- 2016 Annual Reportm;
    - Appendix P – Waste Rock Verification Program Results
    - Appendix Q – ABA Report
- 2017 Annual Report;
    - Appendix N – Waste Rock Verification Program Results
    - Appendix O – ABA Report 2017 GMP Annual Report

To evaluate the implementation of the Geochemistry Monitoring Program, various information requests were made in addition to the above documents. The following additional information were reviewed:

- Sampling
    - Frequency
    - Sampling Standard Operating Procedures (SOPs)
- Analytical
    - Chains of Custody (COCs)
    - Raw data
    - Minto geochemical databases
    - QA/QC measures
    - On-site lab SOPs
- Implementation
    - Load count sheets
    - Segregation of construction rock

Initial review indicated potential discrepancies between external and internal laboratory results for NP/AP ratio. Upon discussion with Minto, it was discovered that there is no direct comparison of the values between internal and external NP/AP values as the analysis methods used are quite different. The external laboratory uses sulfide sulfur and modified

Sobek NP to calculate NP/AP whereas the Minto internal lab uses total sulfur and total carbon to calculate NP/AP.

3.5.2 **Compliance with EMSRP**

The geochemical monitoring program is intended identify and minimize the potential for metal leaching and acid rock drainage (ML/ARD) from waste rock, overburden and tailings material generated during mine operations. For the time period of 2016-2017, the geochemical monitoring program comprised two main components:

1. The Acid Base Accounting (ABA) Program, which provides for monitoring of overburden and waste rock derived from the underground and open pit mining operations, and tailings from milling;
2. The Waste Rock Management Verification Program.

As a requirement under Water Licence QZ14-031, the geochemical monitoring program was to be updated to include a metal leaching characterization from low-grade ore and oxide ore. To address this, Minto constructed two large-scale leach test piles containing Blue Ore and POX material. The test piles were completed in October 2017, and therefore no leachate data had been collected during 2016 and 2017. As such, results from this monitoring component are not included in this audit.

The compliance of the geochemical monitoring program with commitments made in the EMSRP was assessed as part of this audit and an overview of the outcome is presented in Table 3-9. Information sources utilized for this exercise included the 2016 and 2017 annual reports, which in the EMSRP are outlined as the only document requiring the documentation of geochemical monitoring results.

Discrepancies were noted between the EMSRP commitments and sampling frequencies reported in the annual reports for both the ABA and waste rock verification program (shaded orange in Table 3-9). Upon request for clarification with Minto, the following explanations were provided:

1. Discrepancy: Open Pit Waste Rock & Overburden – only every 7 blast holes (2016 and 2017)

   Explanation: ABA (blast hole) sampling was not conducted in areas that are known primarily contain ore material which is thought to be the reason for a lower sampling frequency than required for waste rock blocks.

   Response: Resolved

2. Discrepancy: Tailings – Samples are only available for January through September 2016

   Explanation: Tailings samples for the months of October through December 2016 were in fact collected and submitted for analysis. Miscommunication by the laboratory was made responsible for this discrepancy. The tailings lab reports were reviewed and validated for this audit.

   Response: Resolved

3. Discrepancy: Waste Rock Verification – Samples missing October through December 2016

   Explanation: The lack of sampling after August in 2016 coincides with the end of North pit mining. Material was not being added to the stockpiles after that point.

   Response: Resolved

4. Discrepancy: Waste Rock Verification – Samples missing for December 2017

   Explanation: The lack of available site staff was made responsible for the missing monthly waste rock verification sample.

   Response: Unresolved – Additional resources should be made available to satisfy the EMSRP sampling requirements.

Table 3-9:
Overview of EMSRP requirements and compliance pertaining to the geochemical monitoring program

Program Component	Material type	Year	Sample Quantity	Sampling Frequency	
				Required	Conducted
ABA Program	Open Pit Waste Rock & Overburden	2016	203	1 per every 4-5 blast holes	~ Every 7 blast holes
		2017	265		~ Every 7 blast holes
	Underground Waste Rock	2016	10	1 per every 50 m of development	1 per every 50 m of development
		2017	19		1 per every 50 m of development
	Tailings	2016	9	Monthly (12)	January - September
		2017	15		January - December
Waste Rock Verification	Waste Rock	2016	183	Monthly, along crest of active dump	January - August
		2017	119		January - November

Notes: Orange-shaded sampling frequencies do not meet the requirements specified in the EMSRP, while sampling frequencies shaded in green do meet such requirements.

3.5.3 Monitoring Program Implementation

With the exception of the missing December 2017 waste rock verification sample noted above, the geochemistry monitoring program appears to be generally implemented according to the guidelines and SOPs presented in the EMSRP.

3.5.4 Reporting Adequacy

Reporting requirements outlined in the EMSRP relating to the Minto geochemistry monitoring program constitute the discussion of analytical results of the three major monitoring components (ABA, tailings, waste rock verification) as part of the WUL and QML Annual Report. For the ABA monitoring program in particular, the following additional reporting conditions were outlined:

- Comparison between new and historical data (including discussion), and
- Comparison of NP/AP and sulphide sulphur (log NP/AP versus log percent sulphide sulphur graph).

Upon review of the 2016 and 2017 Annual Reports, it was concluded that these reporting requirements are met.

3.6 Physical Monitoring Program

3.6.1 Approved Plans

The PMP is generally located as a short summary section and a more-detailed associated appendix within the EMSRP. Based on the timeline approval schedule provided by Ms. Flemming, Table 3-10 outlines the relevant plans and associated approval dates relative to the QML were provided, along with relevant compliance dates for the reports (assuming they were valid when approved).

Table 3-10:
Relevant PMPs and compliance dates.

Plan Title and Date	QML Approval Date (after Minto Mine)	Relevant Compliance Dates
PMP May 2014	Dec. 2014	Jan. 2016 to Nov. 2016
PMP 2016-1, Dec. 2016	Dec. 2016	Dec. 2016 to Dec. 2017

Another version of the PMP was submitted in November 2017 but no QML approval was noted. As such, this report and its conditions were not reviewed herein. Only the two noted plans in Table 3-1 were used for compliance assessment herein.

3.6.2 **Objectives and Plan Requirements**

The objective of the PMP is to monitor the performance of key mine infrastructure and workings that requires monitoring. The program consists of two main components; instrumentation to measure in-situ ground conditions and deformations and regular visual geotechnical inspections of surface conditions. The following report requirements and content were noted within PMP 2014:

- Table 1 outlines 12 structures in total to be monitored with 9 that have instrumentation to be read.
- Table 1 outlines instrumentation includes survey hubs, slope inclinometers, thermistors, and piezometers while pit walls have wall-specific survey prisms and radar surveys are note in the plan.
- Table 4 lists inspection frequency for the noted structures
- Table 5 notes 13 inclinometers and associated frequencies, which range from bi-weekly to quarterly
- Table 6 notes 37 survey hubs to be monitored from weekly to monthly
- Table 7 outlines 23 thermistors to be monitored from monthly to quarterly
- Table 8 outlines 18 piezometers to be monitored monthly
- Table 9 notes that processing and reporting of data to be provided in weekly, monthly, quarterly, semi-annual and annual report, based on specific report requirements
- Appendix A provides a map of all site instrumentation
- Appendix B provides information and manuals on data collection and input.

Even though pit-wall prisms and radar are mentioned in Table 1, no further information on these instruments is detailed in the PMP.

The content within PMP 2016-1 is similar but with updated information regarding number of structures and specific instruments to be read.

3.6.3 **Reviewed Reports and Compliance**

In order to undertake a compliance audit, the following reports were reviewed relative to the two main aspects of the physical monitoring program, visual inspections and instrumentation readings:

- Minto Explorations Ltd. Minto Mine, Water Licence QZ14-031, Monthly Report.
- January 2016 to December 2017. Includes relevant appendix labelled Physical Monitoring Program Data for each month.
- Minto Explorations Ltd. Minto Mine

- Water Licence QZ14-031, Quartz Mining Licence QML-0001, 2016 Annual Report, March 2017.
- Water Licence QZ14-031, Quartz Mining Licence QML-0001, 2017 Annual Report, March 2018.
- Minto Explorations Ltd. Minto Mine
- 2016 Q3 Geotechnical Inspection, November 2016.
- Fall 2017 Geotechnical Inspection, November 2017.
- SRK Consulting (Canada) Inc.
- 2016 Geotechnical Annual Review, Minto Mine, YT, November 2016.
- 2017 Geotechnical Annual Review, Minto Mine, YT, August 2017.
- Minto Explorations, DSTSF Inspection files (Excel) for 2016 and 2017.

These reports were compared to the requirements (structure/instrument and related frequency) outlined in the two noted PMP's in Table 3-1. It should be noted that BGC did not review weekly inspection reports or any underground or pit geotechnical reports within this audit scope. In addition, BGC did not review any Operations, Maintenance and Surveillance (OMS) Manuals that may exist for specific structures (*e.g.*, Water Storage Dam).

Based on the inspection requirements outlined in the reports in Table 3-1, a compliance table of structure/area, proposed schedule/frequency and actual inspections was prepared. Inspection compliance within the time period of January 2016 until November 2016 was high (inspection done or reason why not done provided) with only one missing inspection of the Reclamation Overburden Dump in September 2016. In the later compliance period from December 2016 until December 2017, inspection compliance was good with the following exceptions:

- Ice rich overburden dump was not inspected in September 2017
- Area 1 Pit and associated tailings area was to be inspected quarterly but only one inspection was recorded in September 2017
- The Mill Valley Fill Extension (MVFE) and the Mill Valley Fill Extension 2 Collection Sump (MVFE2CS) were noted under the DSTSF inspection files but no inspection for December 2017 was found.
- Minto Access Road was to be inspected annually but no inspections were documented.

It is possible that these inspections were done by documentation under the title of other structures and areas or there were reasons why these inspections were not done, but these explicit explanations were not provided.

Instrumentation compliance was also reviewed through the preparation of another compliance table versus the requirements noted in Table 3-1. A summary of the compliance results, based on the various instrumentation types, follows:

Inclinometers:

2016:

- There were several (DSI-14 through DSI-21, SDI-1, SDI-5) that were included in the May 2014 PMP but did not have readings and no associated explanations were provided
- There was a discrepancy in the required frequency for MDI-2 and SDI-3 (PMP states monthly, but these were done quarterly)

2017: done at correct frequency or provided an explanation

Survey hubs:

2016:

- There were several (A211, DSSH-23, DSSH-25, M74, SWD03A, WSP2) that were included in the May 2014 PMP but did not have readings and no associated explanations were provided
- M73 through M81 were not read at the frequency specified in the May 2014 PMP (read monthly instead of semi-weekly)
- M82 through M87 were not required by the 2014 PMP but were included

2017:

- A215 through A218 are required in the Dec 2016 PMP but were not read in 2017 and no reason was provided for missing these
- No readings were done for DSSH-17 from September 2017 onwards with no explanation
- No readings were done for M87 from August 2017 onwards with no explanation
- No readings were done for SWD10 or SWD11 prior to July 2017 (these may not have been installed until this time)

Thermistors:

2016:

- No reason was provided for not reading MW11-02/MW11-03 in the second half of the year (quarterly readings were required by the 2014 PMP)

- A2T-1, DST-10 through DST-15, SDT-1 through SDT-4 were not read at the frequency stated in the 2014 PMP (monthly required, done quarterly)

2017: done at correct frequency or provided an explanation

Piezometers:

2016/2017: done at correct frequency or provided an explanation

- Except for DSP-6A (not included with negative reading noted as reason).

Based on the instrumentation compliance table, approximately 7% of the required readings were not undertaken or noted in the monthly reports. As such, the mine site has a high compliance rate of approximately 93% for required instrumentation readings.

3.6.4 Monitoring Program Adequacy

The objective of this section is to assess if the monitoring programs were adequately implemented to meet the objectives and intent of the PMP, which are to monitor (visually and with instrumentation) key structures and work areas and respond if any stability issues noted. To that end, the following comments are provided regarding the PMP:

- A detailed plan for inspection and instrumentation readings exists with a noted monitoring frequency and the monitoring schedule is stored on X Drive as noted by the PMP. Generally, the Mine Site is in compliance with the plan requirements during 2016 and 2017.
- The plan includes observation of surface features along with collection of subsurface instrumentation data which cover the necessary aspects of deformations (near surface and internal), pore pressures and ground thermal regime (important for permafrost areas).
- The plan is updated, generally on an annual basis, to reflect important operational and instrumentation changes.
- A map of all instruments is provided in Appendix A so that all monitoring personnel can find necessary instrumentation. Coordinates for all instruments are provided in the tables in the PMP.
- Appendix B contains data collection and input manuals for inclinometers, thermistors, and vibrating wire piezometers, along with file directory locations to store the data. This documentation would assist in the collection of accurate and repeatable data.
- The PMP notes that data collection equipment is returned to manufacturers as per their recommended calibration schedule. BGC did not audit their calibration certificates.

No survey hub specific data collection manual was provided to BGC, but it assumed that site surveyors experienced in coordinate surveys are used to collect and process the field data. BGC did not audit their data collection or processing.

Structure observation forms for recording observations and photos are used by site staff and select examples were provided to BGC. These forms provide a consistent basis for observations documentation and change identification by different staff members.

The work flow from collection to processing to review was audited during the site visit, compared to the written plan and appears adequate to indicate and address concerns if noted. Concerns are raised up to more senior staff including possibly the external geotechnical engineering consultant.

Two complementary parties, the Minto Mine geotechnical staff (on site every day) and the geotechnical engineering consultant (on site at least annually), are involved in the collection of site observations, the reviews of instrumentation monitoring data and in the assessment of SPTs. This two-party system provides a range of local experience as compared to larger experience base for the external consultant.

It is assumed that the geotechnical engineer consultant (SRK) is intimately familiar with the subsurface conditions, design and performance of the noted structures, since they have undertaken these inspections since 2012. An audit of SRK's experience relative to the main structures was not undertaken. Generally, it appears that a Minto Mine geotechnical engineer accompanies the SRK engineer during the June inspection visit, which is good for two-way communication and knowledge transfer.

Based on these noted aspects, it is considered that the monitoring plan is adequately implemented to meet the objectives and intent of the PMP. Two possible improvements are noted as follows:

1. The geotechnical engineering consultant is sometimes referred to as the "Geotechnical Engineer", the "Design Engineer" and the "Engineer of Record" (EOR), which is not currently a legal dam safety term in the Yukon (although it has legal status in BC). Within Section 4 Roles and Responsibilities of the PMP though, the nomenclature, roles and responsibilities of the geotechnical engineering external consultant should be noted and defined. After that, consistent nomenclature should be used in all follow up documents and plans.

2. Ensuring physical stability of various structures should be related to the risk (hazard likelihood by the potential consequences) category for each structure with high risk structures having more inspection/monitoring, while low risk structures would have less inspection/monitoring. No such risk assessment or related structure hazard

ratings were reviewed to BGC but it recommended that SRK and Minto Mine confirm that they have used such a basis to assess the priority and frequency of the structures, instruments and frequencies within their proposed PMPs.

3.6.5 **Reporting Adequacy**

The objective of this section is to assess if the reporting was adequately implemented to meet the objectives and intent of the PMP. To that end, the following section overviews the content of the main reports produced relative to physical monitoring.

Minto Mine provides monthly reports to satisfy Water Licence Requirements, as noted earlier. Within those reports, one specific appendix by Minto Mine staff addresses Physical Monitoring Program data and generally includes the following content:

- Summary of instruments read that month and those potentially missed that month (*e.g.*, frozen).
- Brief summary of instrumentation results (*e.g.*, movement rate, equivalent water elevation).
- Brief summary of visual inspection observations and related mitigations if required. Further detail generally noted under separate weekly reports (which were not audited by BGC).
- Summary of any exceedances of SPTs, broken down by Category 1 and Category 2 structures (explained later in more detail). A summary of technical response, including contact and discussion with Engineer of Record and summary of current conditions are also provided.
- Appendices within the report provide instrumentation plots for data collected that month.
- These appendix reports are signed by the mine site geotechnical engineer and chief mine engineer (usually including both EIT and P.Eng. designations).

All 24 monthly reports were provided and reviewed within the compliance interval. These reports are satisfactory in their content and related assessments relative to observations, instrumentation results and specific performance thresholds. Suggested improvements for these reports would include the following:

- The map of instrument locations could show A and B directions for inclinometers.
- Simplified ground conditions logs could be noted on inclinometers (*e.g.*, fill material contact with native subgrade) plots which provide context for movement depths.
- Specific water elevation threshold levels could be placed directly on piezometer plots.

- BGC does not know if SRK receives these monthly reports (and reviews them) or if SRK only responds after contact by Minto Mine staff, if an issue were noted. Assuming that SRK reviews them, the former approach is better over the latter.

The SRK annual geotechnical inspection reports document the geotechnical inspection of numerous site structures, generally in June of the year, after thaw of the seasonal frost has occurred at site. The report covers approximately 15 structures or areas and include dams, dry stack tailings facility (DSTF) and related fills, dumps, ditches, pits, stockpiles and other miscellaneous structures and areas. During their review, SRK reviews the previous year's reports, instrumentation data and monitoring guidance documents to guide their inspection. Table 5.1 in their report summarizes recommendations including a priority classification of low, medium and high. Appendix A contains a photographic summary and associated inspection commentary for each major structure. Instrumentation summary plots and locations are provided within the various other appendices.

The SRK inspection reports were comprehensive in their treatment of instrumentation and inspection results for the noted major structures. Suggested areas of improvement for these reports includes the following:

- SRK explicitly acknowledge that SPT exceedances (from previous site Monthly Reports) were observed, reviewed and addressed within their annual review. This issue closure may in fact happen currently, but the documentation in the annual report is not explicit on these details.
- SRK provides high priority recommendations in Table 5.1 but for example, June observations and subsequent recommendations are not specifically documented until the August or November report submission. This documentation delay may have implications in terms of action implementation delay at site. It is possible that this information transfer occurs directly after the site visit in a close out meeting between SRK and Minto Mine staff. Therefore, it is suggested that SRK provide a site memorandum within one week of their site inspection visit to Minto Mine that documents high priority action items and allow for more rapid work planning, implementation and mitigation to occur. This site memorandum should be attached as an appendix within SRK's annual report.
- Table 5.1 provides SRK's recommended action items for the next 0.5 to 3 years. There is no documentation within the current SRK reports that addresses if the recommendations were undertaken or if they are under assessment (although a follow up response is noted in the Minto Mine reports reviewed later). As a documentation method, it is suggested that SRK document the progress on all action items noted on the previous year's report.

- A summary of climatic conditions over past year could also be useful to explain surface observations, including but not limited to, erosion and cracking for example.

Minto Mine Fall or Q3 geotechnical inspection reports, before the onset of winter freezing conditions, are shorter in content than the same year SRK June inspection reports and address the following aspects:

- Geotechnical inspection of approximately same structures and areas as SRK reports, except that Area 118/2 underground and Mill Valley Fill Extension 2 Collection Sump are explicitly noted.
- Section 2 provides a summary of Q2 (June) inspection recommendations from SRK and the mine site responses. The responses appear comprehensive in nature but do not appear complete. For example, SRK's medium priority recommendation for the Mill Valley Fill Extension from 2016 does not appear to be noted or addressed in the table in Section 2.
- Section 3 provides a tabular summary of recommended action items and target dates, assumed for completion.
- Appendix A provides some geotechnical inspection forms (observations, data review and actions/recommendations), associated photos and occasional plots of relevant instrumentation data. In some cases, the inspection summary sheets note that SRK was consulted on a particular issue and the issue was addressed.

The reports are basic in their content but are adequate to address the reporting intent. Suggested improvements in these reports would be as follows:

- Ensure that recommendations from the June report (by SRK) are noted in complete extent within the Fall report (by Minto Mine staff).
- Action items priorities have different basis between the SRK approach (low to high) and the Minto Mine staff (target dates) and the priority basis should be made consistent. In fact, one table of action items should be kept at all times with both SRK and Minto Mine reports commenting on the tracking and responses with both parties using the same table and priority basis.
- Instead of the basic inspection forms with limited text and photo content, more detailed dam, dump, pit slope, ditch and structure area inspection forms (with check off boxes and associated text description areas) could be used to better detail observations in the appendix summary sheets. This would facilitate better understanding of the conditions and changes observed, potentially both by site staff, SRK and external stakeholders.

The Minto Mine Annual Reports contain a wide range of content relative to the Water Licence and Quartz Mining Licence including site activities and proposed mining activities for the next year. Section 6.4 covers vibrating wire piezometer results (over several years) while Section 6.5 covers ground temperature cables over several years (with simplified ground conditions shown on the plots). Section 9 specifically covers the PMP including survey hub and inclinometer plots and discussion, along with Engineer's Physical Inspection summary. Table 9-1 provides a summary of annual inspection recommendations and associated actions, including dates for implementation. Section 10.6 covers the Physical Monitoring Program Adaptive Monitoring Program (AMP) summary, including a review of both Category 1 and 2 Specific Monitoring Thresholds, if exceeded and the associated response. Appendix I provides an update PMP basically noting instruments added, removed and/or replaced. These year-end reports are generally a compilation and synthesis of all work and assessments done in the past calendar year.

In summary, the reporting of the PMP is adequately implemented to meet the objectives of the plan. Several suggestions were provided to enhance consistency and ensure no actions are missed between the two involved parties, SRK and Minto Mine staff, which are responsible for its implementation.

3.7 Erosion and Sedimentation Monitoring Program

3.7.1 Approved Plans

The Sediment and Erosion Control Plan (SECP) is a requirement of the QML that requires generally "a plan that describes methods and techniques for protecting undisturbed lands, minimizing mining footprints and reducing erosion of soils due to land disturbance and weathering by wind and water" to prevent impacts to Minto Creek. Based on the reports and timeline approval schedule provided by Ms. Flemming, Table 3-11 outlines the relevant plans and associated approval dates relative to the SECP, along with relevant compliance dates for the reports (assuming they were valid when approved).

Table 3-11:
Relevant SECP and EMSRPs and compliance dates.

Plan Title and Date	Plan Length	QML Approval Date (after Minto Mine)	Relevant Compliance Dates
2014 SECP April 2014	9 pages	Not provided	January 2016 to February 2016
EMSRP December 2015	SECP covered in Section 7.3. No content in appendices.	March 2016	March 2016 to November 2016
EMSRP 2016-2 July 2016	SECP covered in Section 7.3. No content in appendices.	December 2016	December 2016 to December 2017

Only the three noted plans in Table 3-11 were used for compliance assessment herein.

3.7.2 Objectives and Plan Requirements

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 SECP by Minto Mine provides the following components:

- Monitoring strategies with specific activities and frequency noted in Table 2-1 therein as follows
    - Visual inspections – as needed following heavy rains and during freshet
    - Water quality monitoring for total suspended solids (TSS) – at four stations W2, W3, W17 and W50 weekly and during heavy runoff periods
    - Physical inspections of surface facilities – numerous structures (dam, pond, dumps, DSTF, *etc.*) in May/June and September of each year.
- Reviews sediment sources
- Review of potential erosion and sediment control measures.

As such, this plan has noted activities that are linked with water quality monitoring and physical stability monitoring plans.

The 2015 EMSRP Plan, Section 7.3 reiterates similar monitoring commitments with the following two changes from the 2014 SECP.

- Water quality monitoring for total suspended solids (TSS) – at three stations W2, W17 and W50 weekly and during heavy runoff periods
- Physical inspections of surface facilities – numerous structures (dam, pond, dumps, DSTF, *etc.*) in May/June of each year; monitoring in September is not noted.

This report notes that the Erosion and Sedimentation Monitoring Program should be reported in the Annual Report (Terrestrial Environment Monitoring Program) provided relative to the QML. The 2016-2 EMSRP Plan, Section 7.3 is consistent with these noted requirements as above.

3.7.3 Reviewed Reports and Compliance

In order to check compliance, the Minto Mine Annual Reports for 2016 and 2017 were reviewed relative to two of the three main activities; visual inspections and water quality monitoring. Physical monitoring compliance was assessed in Section 3.3.1 and those results are not reviewed again herein. It should be noted that there is an inconsistency between the requirements of the PMP, which requires May/June and September inspections for noted structures but the requirements of the SECP in Section 4.2 noted physical

inspections in May/June only. The following compliance observations were noted for the two reports.

- 2016 Report: Section 14.2 outlines the 2016 activities and the associated results. No specific observations were provided and the section concludes with "There were no significant issues for 2016.". Section 5.2 reviews surface water quality stations with Table 5-2 measuring conformance summary for the stations, while other sections review water quality results as follows:
    - W2 was frozen for Q1 and Q2 but sampled for remainder of the year. The Water Quality Objectives (WQO's) including TSS criteria were met within period of April 3 to October 10.
    - W3 results were noted in Table 5-9, including TSS results.
    - No results from W17 are provided (even though Table 5-2 notes "sampled as per schedule"), which are required as noted in Section 4.2.
    - W50 was dry and only samples of seepage were monitored. The Effluent Quality Standards (EQS) including TSS standards for W50 was met within the period of April 3 to October 10.
- 2017 Report: Section 14.2 again summarizes the 2017 activities. No specific observations were provided and the section again concludes with "There were no significant issues for 2017.". Section 5.2 reviews surface water quality stations with Table 5-2 provides a conformance summary for the stations, while other sections review water quality results as follows:
    - The WQ's including TSS criteria for Station W2 were met within period of April 11 to October 3.
    - W3 results were noted in Table 5-5, including TSS results.
    - No results from W17 are provided but the text noted that no water was discharged into Minto Creek. As a result, it does not provide any results but explains why results were not provided.
    - The EQS including TSS standards for W50 were met for the period of May 2 to August 1 (when water was encountered).

In summary, no specific visual inspection observations were provided in the report the general comment "no significant issues were noted" was provided. It should also be noted that visual inspections were to follow heavy rains and freshet, which are neither defined or noted as climatic conditions within the reports. The water quality monitoring for TSS were generally compliant, based on generalized water quality statements within the necessary

requirements but some W17 results were missing with no explanation as to why they were missing.

3.7.4 Monitoring Program Adequacy

The SECP is considered inadequate as some of the main tenets of the plan have not been defined or followed to guide the required activities. Significant improvement in its implementation could be achieved by the following activities:

- Define "heavy rain" events with actual criteria (amounts and associated return periods) appropriate for Minto Mine, such as 1 in 10-year 24-hour rainfall, for example.
- Define "freshet" event for the Minto Mine, based on snowmelt dates and hydrological stations flow data.
- As noted in the SECP, visual inspections should be undertaken and documented by Minto Mine staff following these noted events.
- Specific TSS monitoring should follow these trigger events, as well as weekly monitoring, at Stations W2, W17 and W50 as noted in the SECP.
- Implement sediment and erosion control mitigation measures if elevated TSS values are measured in lower Minto Creek.

3.7.5 Reporting Adequacy

The SECP reporting (Section 14.2), as viewed from the 2016 and 2017 Annual Reports, is considered inadequate. The SECP reporting could be improved by the following additions:

- Note when "heavy rain" and "freshet" events occurred during the past year under consideration.
- Note visual inspections that occurred following heavy rains and freshet events in the Monthly and Annual Reports.
- Link back observations from the Physical Inspection Program to heavy rain and freshet events.
- Note when specific TSS monitoring occurred at Stations W2, W17 and W50 following trigger events and if any elevated values occurred and for what duration.
- If any high TSS events were noted, outline what sediment and erosion controls measures were implemented for mitigation and on what structures or areas. Report if mitigation measures lowered TSS level.

The SECP has not been updated since 2014 and it should be for future years, especially now that some reclamation covers have been partially placed proximal to Minto Creek areas. The covers may generate sediment during construction and adjustments to water stations for monitoring may be necessary.

3.8 Progressive Reclamation Effectiveness Monitoring Program

3.8.1 Approved Plans

The Progressive Reclamation Effectiveness Monitoring Program (PREMP) is outlined within the various EMSRPs, which have been submitted and approved as outlined in Table 3-12.

Table 3-12:
Relevant EMSRPs and PREMP and compliance dates.

Plan Title and Date	QML Approval Date (after Minto Mine)	Relevant Compliance Dates
EMSRP 2014-1 June 2014	December 2014	January 2016 to February 2016
EMSRP 2015-1 December 2015	March 2016	March 2016 to November 2016
EMSRP 2016-2 July 2016	December 2016	December 2016 to December 2017

Only the three noted plans in Table 3-12 were used for the assessment herein.

3.8.2 Objectives and Plan Requirements

The PREMP is a requirement of the EMSRP and is required to "monitor the effectiveness of progressive reclamation and post closure reclamation" at the Minto Mine. The objective of the program is to identify and evaluate reclamation and remediation technologies that are considered both promising and feasible for incorporation into the evolving mine Reclamation and Closure Plan (RCP). Section 8 of EMSRP 2014 notes that reclamation research at the Minto Mine has focused primarily on key closure methods proposed for the site including soil covers, vegetation, and semi-passive water treatment. The section notes that Best Management Practices (BMP's) from various guidance documents are to be used as the basis of identifying optimal reclamation approaches. Table 10-2 notes that the PREMP is to be reported in the Annual Report prepared by Minto Mine. No other requirements or commitments relative to the PREMP are noted therein.

The text in Section 8 of EMSRP 2015 and EMSRP 2016 are basically the same as the 2014 version. The requirements noted therein are relatively general in nature and without any necessary specific monitoring as is noted in the other two aspects reviewed herein.

3.8.3 **Reviewed Reports and Compliance**

In order to check compliance, the Minto Mine Annual Reports (for Water Licence and Quartz Mining Licence purposes) for 2016 and 2017 were reviewed relative to the general requirements noted in Section 5.2. It should be noted that BGC did not review any aspect or text within the RCP for the mine.

Section 16 of the 2016 Annual Report outlines reclamation activities and research that occurred in that year. The first two sections outline 2016 reclamation activities (and associated photos) that occurred at site (recontouring and Mill Valley Fill Extension 2) while Section 16.3 outlined reclamation research including work undertaken and related findings specifically focused on passive water treatment. Section 16.4 outlined expected 2017 reclamation activities. Appendix T provides a 2016 detailed report on constructed wetlands water treatment program by Contango Strategies Ltd. on the demonstration scale project. The demonstration-scaled system confirms that a passive water treatment system can be used to successfully improve mine-impacted waters.

Section 16 of the 2017 Annual Report has a similar content. Section 16.1 outlined the 2017 recontouring and overburden activities, which included placement of cover material from the stripping of Area 2 Stage 3 onto targeted facilities including DSTSF and associated MVFE, along with Southwest Dump. Tables 16-1 and 16-2 outlined reclamation research focused on the constructed wetlands including work undertaken and related key findings (ties objectives to purpose to key findings). Appendix Q provides a detailed report on constructed wetlands water treatment program which notes again “ongoing monitoring of the system in future years will be used to optimize performance and inform the designs for the full-scale constructed wetland treatment system”. The last section outlined expected 2018 reclamation activities which focuses on cover placement, recontouring work, seeding of soil covers and passive water treatment research.

Based on this review and content in the two Annual Reports, compliance has been achieved regarding the relatively general requirements noted in the EMSRP’s. Reclamation research and activities were reviewed, generally focused on passive water treatment methods, but recontouring, cover placement and seeding activities were also noted.

3.8.4 **Monitoring Program Adequacy**

The objective of this section is to assess if the PREMP is adequately implemented to meet the objectives and intent of the program, which is to identify and evaluate reclamation and remediation technologies that are considered both promising and feasible for incorporation into the Mine RCP. To that end, Section 16 in the Annual Repots addresses both progressive reclamation activities (*e.g.*, cover placement) and reclamation research topics

(*e.g.*, passive water treatment). As such, the current implementation of the PREMP is adequate to achieve the objectives and intent but the following improvements are suggested:

- Where progressive reclamation activities (*e.g.*, cover placement and revegetation) are undertaken, it would be useful to keep track of the year to year progress in terms of areas covered versus total area required, volumes of materials placed, types of materials placed, production rates for placement, revegetation approaches and seed mixtures, *etc*. The progress tracking would be useful relative to the concept of progressive closure.
- In addition to progress tracking and materials used, it would be useful to see if the progressive reclamation measures are meeting their design intent/objectives in terms of performance monitoring (*e.g.*, infiltration rates, erosion, revegetation types and biomass, resultant water quality). If the measures are meeting their design intent during operations, then they may be relied upon for closure measures. If the reclamation measures are not meeting design intent, then either the measures need to be altered or redesigned or the design intent of the measures needs to be changed within the closure plan.
- Where reclamation research activities are outlined, they should be compared to BMP's in noted references to see if alignment occurs. In addition, research activities should be extrapolated to see if the noted methods/activities are feasible inclusion in the final RCP.
- The RCP should be consulted for either high cost or high risk closure activities (*e.g.*, water treatment for some specific parameter to some low discharge level). Given the importance of these activities to the final RCP, progressive or research activities related to these two areas should be included within the Section 16 summary. This connection with the end objective (enhancing the closure plan) should be considered with the information provided in the PREMP.

The main objective of the PREMP is to de-risk the final RCP for the mine and this aspect should be demonstrated through progressive reclamation activities and reclamation research prior to closure.

3.8.5 **Reporting Adequacy**

The current reporting in the Annual Reports is adequate to meet the objectives and intent of the PREMP. However, as noted under Section 5.3.2, some improvements to the implementation aspects would significantly improve the report's ability to assess if progressive reclamation activities and research have the ability to de-risk the final RCP, which is the real outcome from this program.

4. Operational Adaptive Management Plan

An Adaptive Management Plan (AMP) is required by the Yukon Government's Decision Document (Yukon, 2014) that was issued following the YESAA review of Minto's Phase V/VI project proposal. Minto must update the AMP with additional information included in the QML and WUL. The primary purpose of an AMP is to address uncertainty in the predicted conditions within the mine site and the downstream receiving environment. An AMP seeks to identify a range of possible outcomes that have not been predicted to occur, and then outline the responses that will be undertaken to mitigate potential negative impacts resulting from these unexpected situations. The existing operational management plans (including the Environmental Surveillance Monitoring Plan) are in place to address the expected conditions, and in the case of the EMSRP, to implement a monitoring network that is capable of capturing any unexpected conditions. Thus, the AMP is in place only to deal with those conditions not covered by the existing suite of operational management and monitoring plans.

As this audit scope covers the years of 2016 and 2017, the version history presented here only includes the OAMP versions relevant for this period.

Per the Approved Audit Scope, a review was conducted of the implementation of the Operations Adaptive Management Plan (OAMP) over the 2016 to 2017 period. Four versions of the OAMP were relevant during this period, and the audit compared the monitoring activities conducted in each month to the OAMP version that was relevant for the month in question, as presented in Table 4-1:

Table 4-1:
OAMP Version History

Revision Number	Issue Date	Description and Revisions Made	Effective Period
2015-01	December 2015	Revisions made as per requirements of WUL QZ14-031 and QML-0001	Dec. 2015 – Apr. 2016
2016-01	March 2016	Revisions made as per AMP comments from the Yukon Government, Selkirk First Nation and QML-0001 conditions	Mar. 2016 – Mar. 2017
2017-01	January 2017	Revisions made as per Yukon Water Board and Yukon Government review comments.	Jan. 2017 - Mar. 2017
2017-02	April 2017	Revisions made as per Yukon Water Board and Yukon Government review comments.	Apr. 2017 – Dec. 2017

While the AMP specifies specific performance thresholds for further action, due to the nature of adaptive management, the AMP does not provide specific detailed descriptions of responses to a given situation. Rather, the AMP provides a list of potential responses that can guide the path forward.

The AMP is comprised of three primary, and four secondary components:

- Water quality;
    - Surface water quality in Minto Creek
    - Surface water quality in McGinty Creek
    - Groundwater quality in Minto Creek
    - Groundwater quality in McGinty Creek
- Water Management, and;
- Physical Stability

The specific indicators, performance thresholds and responses for each of the components listed above are outlined in detail in Table 2-1 (Minto Creek), Table 2-3 (McGinty Creek). The Specific Performance Thresholds (SPTs) are provided in Table 2-2 for Minto Creek and Table 2-4 (McGinty Creek) in the OAMP v.2017-02.

The specific performance thresholds are ties to three sets of values for the parameters of concern: the site-specific water quality objectives (WQOs), expected case water quality predictions for W2 (Operational Period) and worst-case water quality predictions for W2 (Operational Period). The specific response thresholds are provided below, for each component (Table 4-2). These response thresholds are current as of April 2017 (OAMP v.2017-2).

Table 4-2:
OAMP Components and Specific Response Thresholds

Component	Station	Specific Response Thresholds
Surface water quality – Minto Creek	W2	Five (5) specific response thresholds in total, based upon: 1. Exceedance of Operational Phase Expected Case maximum predictions (dissolved). Does not apply to As, Fe, Pb, Mo, Ni, Ag, Zn) 2. Two consecutive exccedances of Operational Phase Expected Case maximum predictions (dissolved), where mine loading was determined to be responsible for the first exceedance. Does not apply to As, Fe, Pb, Mo, Ni, Ag, Zn)

		3. Single exceedance of Operational Phase maximum Worst-Case predictions (dissolved) or exceedance of WQO 4. Two consectutive exccedances of Operational Phase Worst-Case maximum predictions (dissolved), where mine loading was determined to be responsible for the first exceedance. WQO or PNEC exceeded in 2 consecutive samples where evaluation confirmed mine loading responsible for first exceedance.
Surface water quality – McGinty Creek	MN-4.5	Three (3) specific response thresholds in total, based upon the baseline data collected from 2009-2015. These were used to calculate the 95th percentile, used as the maximum WQO (individual data point evaluator [IDPE]). The 95th percentile of the annual median monthly data was calculated to generate the central tendency evaluator (CTE): • WQOs - 85th percentile of baseline data (2009-2015) 1. Exceedance of 85th percentile baseline in two consecutive samples 2. Exceedance of the WQO (grab vs. IDPE, or 12-month moving average vs. CTE) Exceedance of the WQO (as defined above) in two consecutive samples where evaluation confirmed mine loading responsible for first exceedance
Groundwater Quality – Minto Creek	MW12-05 and MW12-06	Specific Performance Thresholds (SPTs) are defined for each of the Effluent Quality Standards (EQS) parameters identified in Clause 9 (a), Table 1 of Water Use Licence QZ14-031, with the exception of pH, oil and grease, iron and nitrite. Additionally, although it is not specified in Clause 9(a), sulphate has been included in the SPTs. Three SPTs have been defined for the Minto Creek watershed. Rationale for development of the SPTs is as follows: 1. SPT-1 corresponds to a trend-based assessment designed to flag a potential rapid increase in groundwater loadings that has not yet exceeded concentration-based thresholds. The assessment is structured to determine if an indicator has increased significantly compared to the last sampling event. 2. SPT-2 generally corresponds to the Effluent Quality Standard (EQS) concentrations defined in Clause 9 (a), Table 1 of Water Use License QZ14-031 (with four exceptions (Cr-D, Cu-D, Ni-D and sulphate) as indicated in the notes to Table 2-6). The EQS are

		defined for surface water discharge, and the mine is not permitted to discharge water that exceeds any EQS guidelines to surface water. As SPT-2 applies to groundwater (not surface water) concentrations in single zone, this is a highly conservative threshold. 3. SPT-3 generally corresponds to the estimated concentrations in groundwater that would be necessary to cause exceedance of the Water Quality Objectives in lower Minto Creek, at W2, under long term steady state conditions (exceptions are listed in the notes to Table 2-6). These concentrations were determined by conducting a mass loading calculation to determine the groundwater concentrations that would be necessary to cause exceedance of WQOs in lower Minto Creek during low flow periods where all streamflow is derived from groundwater discharge. The mass loading calculation was structured to represent a low-flow period when all surface flows in lower Minto Creek originate from groundwater discharge to the creek.
Groundwater Quality – McGinty Creek	MW09-03 MW17-08 (to be reviewed by a QP)	Specific Performance Thresholds (SPTs) are defined for each of the Effluent Quality Standards (EQS) parameters identified in Clause 9 (a), Table 1 of Water Use Licence QZ14-031, with the exception of pH, oil and grease, iron and nitrite. Additionally, although it is not specified in Clause 9(a), sulphate has been included in the SPTs. Two Specific Performance Thresholds have been defined for McGinty Creek watershed groundwater. Rationale for development of the two specific performance thresholds is as follows: 1. SPT-1 is triggered by three consecutive exceedances of the 75th percentile background level in a single monitoring port. The specification of three consecutive exceedances is intended to avoid triggering the AMP unnecessarily, but to ensure that any sustained increase from baseline conditions receives appropriate scrutiny. 2. SPT-2 is triggered by three consecutive exceedances of the 95th percentile background level in a single monitoring port.
Water Management		The water inventory in the Main Pit Tailings Management Facility or the Area 2 Pit Management Facility exceeds target inventory, defined as:

		1. Water inventory target is exceeded for a period of three months. The water storage capacity still exceeds 1,000,000 m^3. 2. The water storage capacity is less than 1,000,000 m^3. The water storage capacity is less than 500,000 m^3.

The key changes to the OAMP thresholds and responses between the plan versions were as follows:

Station W2

- In 2016, pH and bioassays were added to the table
- No changes from 2016 to 2017

Station MN-4.5

- In 2016, pH was added to the table
- In 2017, the specific response threshold was changed from the 95th percentile to:
    - SPT1 – 85th Percentile
    - SPT2 (Individual Data Point Evaluator) – 95th Percentile
    - SPT3 (Central Tendency Evaluator) – 95th Percentile for the annual medians

Minto Creek Groundwater (v.2017-01)

- Addition of potential incorporation of the new background groundwater well into future AMPs;
- Addition of a statement regarding the plan for additional well being installed in 2017;
- Reorganization of specific performance thresholds,
- Correction regarding reference errors;
- Addition of the frequency of AMP assessments;
- Addition of examples of actions that may arise from recommendations;
- Addition of timing of notification, review, evaluation and action for all threshold in Table 2-6;
- Addition of trend analysis into the response evaluation for threshold 1-3 of Table 2-6, and;
- Changes to the dissolved nickel thresholds.

McGinty Creek Groundwater (v.2017-01)

- Addition of the frequency of AMP assessments;
- Addition of examples of actions that may arise from recommendations;
- Addition of timing of notification, review, evaluation and action for all threshold in Table 2-6;

- Corrected Table 2-9 reference error;
- Addition of trend analysis into the response evaluation for threshold 1-2 of Table 2-8.

The specific tasks defined in the Approved Audit Scope (Appendix A) to be addressed for the OAMP are:

1. Are the specific performance thresholds being monitored as required as per the OAMP for Minto Creek groundwater, McGinty Creek groundwater, Minto Creek surface water, McGinty Creek surface water, physical stability and water management?
2. Are Minto's responses to threshold exceedances adequately implemented to meet the objectives and intent of the plan? (timing of identification, appropriate level of effort put into responses, *etc*.)
3. Is the reporting of the AMP occurrences adequately implemented such that the reliability and integrity of information relating to reporting meets the objectives of the AMP. (appropriate trend analysis application, appropriate level of effort into evaluation and action implementation)

Each of the above is discussed for each technical discipline in the subsections below.

4.1 Surface Water Quality

As part of this audit scope, a review was conducted of the Specific Performance Threshold exceedances for each component in Minto Creek and McGinty Creek, in 2016 and 2017, as documented in the respective annual reports. Following this review, the following conclusions were reached for each of the three audit objectives listed in Section 4:

1. Are the specific performance thresholds being monitored as required as per the OAMP for Minto Creek groundwater, McGinty Creek groundwater, Minto Creek surface water, McGinty Creek surface water, physical stability and water management?
    a. The specific performance thresholds for surface water quality are being adequately monitored in both Minto Creek and McGinty Creek.
2. Are Minto's responses to threshold exceedances adequately implemented to meet the objectives and intent of the plan? (timing of identification, appropriate level of effort put into responses, *etc.*).
    a. Yes – issues identified with the responses to specific threshold exceedances for surface water quality in Minto and McGinty Creeks.

3. Is the reporting of the AMP occurrences adequately implemented such that the reliability and integrity of information relating to reporting meets the objectives of the AMP? This includes appropriate trend analysis application, appropriate level of effort into evaluation and action implementation, *etc.*

    a. Yes. However, while several SPT exceedances were noted in the annual reports, no additional information was provided on the subsequent follow-up responses. This was the case in 2016 for selenium, which exceeded the expected case value at W2, but no mention was made of this in the 2016 Annual Report. In 2017, no details were provided on follow-up responses to the exceedance of the SPT1 for aluminum (April 30th) or ammonia (June 13th) at W2, or copper (May 26th), molybdenum (Oct. 21st) and nickel (SPT2; May 26th) at MN-4.5.

A detailed summary of the exceedances, responses and follow-up reporting is provided below.

2016

Minto Creek (W2)

- Aluminum and chromium on April 12th
    - Exceeded expected case
    - Compared values to W3 and determined mine loadings were not the cause
    - No further action was taken
- Molybdenum on May 25th
    - Exceeded worst case
    - Investigated – AMP1 – Molybdenum Investigation
    - Response was continuation of monitoring and no further action taken unless the concentrations increase to values equal to half the CCME value
- Zinc on Sept. 6th
    - Exceeded worst case
    - Investigated results – did a retest (lower value) also the duplicate sample was below detection limit
    - Stated that its not a true exceedance, no further action
- Nitrates on Oct. 18th, 23rd and 24th
    - Exceeded expected case

- Triggered AMP Specific Threshold 1, Specific Threshold 2 and initiated AMP response plan
- Increased discharge from WSP around this time, developed specific recommendations for discharge during frozen periods, did not exceed worst case and returned to below expected case values in Nov. 1st and 11th samples

- Selenium is above the expected case value but is not included in the AMP section

McGinty Creek (MN-4.5)

- No adaptive management thresholds were exceeded, and thus no responses were required in 2016

2017

Minto Creek (W2)

- Arsenic on May 24th, June 6th and June 13th
  - 3 out of 37 samples exceeded threshold concentration, during discharge period
  - Conducted a trend analysis over a 2-year period
  - Determined the source is not mine related
  - No further investigation
- Copper on April 18th, April 30th and May 1st
  - 3 out of 37 samples exceeded threshold concentration, prior to discharge period
  - Compared values to W3, lower values were measured at this station
  - No indication of mine loading, elevated values did not continue during discharge period
  - No further investigation
- Molybdenum on May 24th and 31st, June 13th, 20th and 27th, July 11th and 27th, and Aug. 1st
  - 8 out of 37 samples exceeded threshold concentration, during discharge period
  - Conducted investigation – AMP1 – Molybdenum Investigation
  - Continued monitoring but no further action unless values increase to half the CCME guideline
- Aluminum on April 30th
  - Triggered exceedance threshold SPT1
  - No details of further action provided in annual report

- Ammonia on June 13th
    - Triggered exceedance threshold SPT1
    - Occurred during a period of high precipitation
    - No details of further action provided in annual report

McGinty Creek (MN-4.5)

- Copper on May 26th
    - Triggered exceedance threshold SPT1
    - No details of further action provided in annual report
- Molybdenum on Oct. 21st
    - Triggered exceedance threshold SPT1
    - No details of further action provided in annual report
- Nickel on May 26th
    - Triggered exceedance threshold SPT2
    - No details of further action provided in annual report
- Nitrate on May 26th, Sept. 16th, Oct. 21st and Nov. 10th
    - Triggered exceedance threshold SPT3 (12-month average CTE)
    - Monthly samples were below all thresholds, exceed for November
    - Compared to MN-1.5 results and determined nitrate source is not mine related
    - Does not trigger SPT3
- Selenium on June 24th, July 7th, Sept. 16th, Oct. 21st and Nov. 10th
    - 12-month average CTE was above SPT3
    - Compared to MN-1.5 results and determined Se source is not mine related
    - No further investigation
- TSS on May 26th
    - Triggered exceedance threshold SPT1
    - Single event likely due to freshet conditions

4.2 Groundwater Quality

As part of this audit scope, a review was conducted of the Specific Performance Threshold exceedances for groundwater quality in Minto Creek and McGinty Creek, in 2016 and

2017, as documented in the respective annual reports. Following this review, the following conclusions were reached for each of the three audit objectives listed in Section 4:

1. Are the specific performance thresholds being monitored as required as per the OAMP for Minto Creek groundwater, McGinty Creek groundwater, Minto Creek surface water, McGinty Creek surface water, physical stability and water management?
    a. The specific performance thresholds for groundwater quality are being adequately monitored in both the Minto Creek and McGinty Creek watersheds.
2. Are Minto's responses to threshold exceedances adequately implemented to meet the objectives and intent of the plan? (timing of identification, appropriate level of effort put into responses, *etc.*).
    a. Yes – SRK was retained as a Qualified Professional in 2016 and 2017 to review SPT exceedances and provide recommendations. These recommendations were reasonable based on the data available. Also, SRK (2017) notes that SPT exceedance is not widespread; most wells (~70%) did not exceed OAMP SPTs in 2017. This suggests that the thresholds are not unnecessarily conservative.
3. Is the reporting of the AMP occurrences adequately implemented such that the reliability and integrity of information relating to reporting meets the objectives of the AMP? This includes appropriate trend analysis application, appropriate level of effort into evaluation and action implementation, *etc.*
    a. Yes. However, while recommendations were made by SRK following their review of groundwater AMP SPT exceedances in 2016, the resulting follow-up actions were not documented in the 2017 Annual Report or associated 2017 SRK review memo.

A detailed summary of the exceedances, responses and follow-up reporting is provided in the appendix of the Annual Reports (2016 Appendix J, 2017 Appendix H).

4.3 Geochemistry

The OAMP does not specify operational management requirements relating to the geochemical monitoring program and hence, this document is not considered further as part of the geochemistry audit.

4.4 Physical Monitoring Program

4.4.1 Specific Performance Thresholds and Monitoring Adequacy

During the compliance review noted in Section 3.3.1, SPTs were tracked across the two compliance periods. Initially, no SPTs were noted in the monthly reports from January to March 2016 which is not in compliance with the SPTs noted in OAMP 2014 (Tables 2-6 and 2-7). Five SPTs were tracked from April 2016 until October 2016 but these were not broken down into two categories as outlined in OAMP 2014 (Tables 2-6 and 2-7). Beginning in the November 2016 Monthly Report, the SPTs were broken down in two required categories; Category 1 structures on ice-rich subgrades and Category 2 structures on other subgrades. These SPTs address the following aspects:

- Category 1 (ice-rich periglacial foundations)
    - SPT 1 – observation of unusual occurrence including significant seismic event
    - SPT 2 – accelerating deformations in survey hub or inclinometer
    - SPT 3 – elevated pore pressures in specific piezometers or above zero temperatures at 2 m below ground surface
    - SPT 4 – higher elevated pore pressures in specific piezometers
    - SPT 5 – accelerating deformations in three consecutive survey hub or inclinometer readings
- Category 2 (all remaining waste dumps and the Main Dam)
    - SPT 1 – observation of unusual occurrence including significant seismic event
    - SPT 2 – survey hub cumulative displacements or increased pore pressures in piezometers
    - SPT 3 – significant survey hub cumulative displacements or significantly increased pore pressures in piezometers.

As such, the noted SPTs were monitored during 2016 and 2017 but some were not noted at all during the first three months of 2016 and then only five SPTs, as opposed to eight total SPTs, were monitored during the period from April to October 2016. Beginning in November 2016, all eight SPTs were monitored in compliance with the noted requirements.

4.4.2 Response to Exceedances and Related Reporting

If any SPTs are exceeded during monitoring, then some form of response is necessary and Specific Responses are outlined in two tables in the various OAMPs including notification, review, evaluation and possible actions (*e.g.*, surface inspection, increase in reading frequency, interact and follow directions from Geotechnical Engineer). As such, the

OAMP tables provide guidance on next steps to follow in case of exceedances, including the involvement of the external geotechnical engineering consultant.

Section 2.7 within the reviewed Monthly Reports captures the SPT number, location/instrument where SPT was exceeded and the response undertaken by the mine site staff. Based on a review of these responses, which vary by type and amount of exceedance, the responses appear adequate to address the exceedances noted. The responses included contacting the "design engineer" or "engineer of record", increasing frequency of readings, installing additional instrumentation. The timing of the responses is difficult to gauge since little information is generally provided for each SPT. Generally, an SPT "initiation date" is provided in the text description under the Response column, with some responses having a more detailed chronology and explanation of related response actions.

In terms of reporting SPT exceedances, the text description under the Response column is generally brief and hence, assessment of information reliability and integrity is difficult to judge. In order to improve this aspect, and make the response more detailed and transparent, it is suggested that the Response column be broken into the four sub-response categories noted previously, and the following questions be answered:

1. Notifications – when was the SPT initially noted, who was notified and on what dates?
2. Review – what background or associated data was reviewed, by whom and on what dates?
3. Evaluations – what evaluations or assessments were undertaken, by whom and on what dates?
4. Actions undertaken – what actions were undertaken at site, by whom and on what dates?

This more detailed response in the Monthly Reports would create transparency and accountability related to chronology of notifications and actions (time duration), what parties were involved and the rational for actions taken. When a SPT is no longer active, and no active actions are underway, a closure date for the SPT should also be noted in the Monthly Report. This detailed response documentation would enhance information reliability and integrity in the future.

4.5 Erosion and Sedimentation Monitoring Program

According to Table 3-2, three OAMPs were in effect during the period of this audit review. It should be noted that there is no specific section in the OAMPs that pertains specifically to sediment and erosion control. Section 2.1 provides an adaptive management plan for

surface water quality in Minto Creek where Station W50 is considered the main control point on Minto Creek (this station also noted under EMSRP). Station W2 is a monitoring point near the Yukon River but beyond the control on Minto Mine (other water quality influences by Station W2). Within the AMP, Station W2 is the main monitored station reflective of potentially changing water quality on lower Minto Creek. It should be noted though, that TTS (as required under SECP's requirements) is not listed in the water quality parameters required under Specific Indicators. Based on this review, the following comments are provided relative to the OAMP's:

- No section in the OAMP's cover specific SECP aspects including visual inspections or TSS values within lower Minto Creek.
- Even based on a review of W2 water quality requirements, there are no SPTs noted for TSS
- The third aspect of the program, physical stability inspections, has been addressed with Section 3.4.

Given this lack of topic specific description, results or SPTs, it is not possible to comment further on adequacy, responses to threshold exceedances or information reliability and integrity. It is therefore suggested that the main water quality aspect of the SECP, TSS in the noted water stations, could be assessed specifically within future versions of the OAMP.

4.6 Progressive Reclamation Effectiveness Monitoring Program

No aspects or content regarding the PREMP is provided within AMP 2016 or 2017. Section 1.4 notes "Though some covers are anticipated to be placed as part of progressive reclamation, they are not an operational feature and therefore have not been included in this AMP." This comment therefore provides some context for this content exclusion from the AMP's.

4.7 Water Management

As the water storage capacity in the Main Pit Tailings Management Facility and the Area 2 Pit Tailings Management Facility exceeded 1,000,000 m^3 during both 2016 and 2017 such, no responses from the adaptive management plan were necessary.

5. Summary and Recommendations

Overall, both the EMSRP and OAMP appear to be generally well-implemented. Monitoring SOPs are comprehensive, and from the available information provided to Lorax, appear to be followed closely. The OAMP is well structured, and the specific responses are implemented appropriately and according to the plan in almost all cases where an STP exceedance has been noted. There are several exceptions to this general summary however, and recommendations are provided below to further improve the implementation and reporting of both the EMSRP and OAMP:

- Tracking of flow and water quality monitoring is generally very good, but several apparent gaps were noted. Lorax recommends providing summary tables like those presented in Table 3-2 and Table 3-3 for surface water quality and Table 3-5 and Table 3-6 for flow monitoring. This will allow mine management and other stakeholders to quickly assess the monitoring programs compliance with the EMSRP for a given year.
- Provide a complete list of all possible water conveyances in the summary table in the monthly reports (*e.g.*, Table 6-3, June 2016 monthly report), and when no flow values are presented, insert a note providing the reason (*e.g.*, frozen, dry, instrument out of commission, no transfer).
- The various submitted reports, PMP's, SECP's, EMSRP's and OAMP's, which are inter-related, have different submission dates and generally different approval dates (from different regulatory agencies) from each other makes determining the proposed monitoring requirements (structures, instruments, frequencies) very difficult and likely confusing for all parties. It should be assumed or made clear that updated plans prepared in December of one year are to be implemented and followed in January of the following year, even if regulatory approval has not been received. This would, of course, simplify the monitoring requirements for each calendar year.

6. Closure

We trust that this information meets your present requirements. Please contact us should you have any questions or comments.

Regards,

LORAX ENVIRONMENTAL SERVICES LTD.

Original Signed By:

Timo Kirchner, M.Sc., P.Geo.
Environmental Geoscientist
Geochemistry
Lorax Environmental Services Ltd.

Original Signed By:

Scott Jackson, M.Sc., P.Geo.
Hydrologist
Meteorology & Surface Water
Lorax Environmental Services Ltd.

Original Signed By:

James W. Cassie, M.Sc., P.Eng.
Principal Geotechnical Engineer
Geotechnical & Physical Stability
BGC Engineering Inc.

Original Signed By:

Justin Bourne, M.Eng., P.Eng.
Senior Hydrogeological Engineer
Hydrogeology
Lorax Environmental Services Ltd.t

References

Capstone. 2015a. Minto Mine Environmental Monitoring, Surveillance and Reporting Plan. V.2015-01. Prepared by: Minto Explorations Ltd., Minto Mine. December 2015.

Capstone. 2016a. Minto Mine Environmental Monitoring, Surveillance and Reporting Plan. V.2016-01. Prepared by: Minto Explorations Ltd., Minto Mine. February 2016.

Capstone. 2016b. Environmental Monitoring, Surveillance and Reporting Plan. V.2016-02. Prepared by: Minto Explorations Ltd., Minto Mine. July 2016.

Capstone. 2015b. Minto Mine Operations Adaptive Management Plan. V.2015-01. Prepared by: Minto Explorations Ltd., Minto Mine. December 2015.

Capstone. 2016c. Minto Mine Operations Adaptive Management Plan. V.2016-01. Prepared by: Minto Explorations Ltd., Minto Mine. May 2016.

Capstone. 2017-1. Minto Mine Operations Adaptive Management Plan. V.2017-01. Prepared by: Minto Explorations Ltd., Minto Mine. January 2017.

Capstone. 2017-2. Minto Mine Operations Adaptive Management Plan. V.2017-02. Prepared by: Minto Explorations Ltd., Minto Mine. April 2017.

Knight Piésold Ltd., 2016. Minto Mine, QML – 0001 Environmental Audit 2015. Report for Capstone Mining Corp., VA101-365/5-1, Rev. 1, October 28, 2016.

Maidment, D. R. 1993. Handbook of Hydrology. Maidment (editor). McGraw Hill.

Minto Exploration Ltd., 2016. Minto Mine Environmental Monitoring, Surveillance and Reporting Plan (2016-02).

Resource Inventory Standards Committee. 2009. Manual of Standard Operating Procedures for Hydrometric Surveys in British Columbia - Version 1.0. Prepared by Ministry of Environment, Science and Information Branch for the Resources Information Standards Committee. 222 p.

Appendix A: Approved Audit Scope

capstone
MINTO MINE

PO Box 11
Whitehorse Central PO
Whitehorse, YT, Y1A 5X9, Canada
Tel: 604-759-0860 Fax: 604-759-0861

2018 Environmental Audit Scope

Introduction

Environmental audits are systematic, documented processes that are often used to assess a facility's compliance with relevant legislative and regulatory requirements. Within that context, they are also used to evaluate the effectiveness of a project's environmental management system and its ability to identify risks and therefore allow for the development of mitigation measures to address these risks which ultimately leads to continual improvement of a project. Minto is committed to continual improvement and the process of reviewing, revising and improving our Environmental Management System.

Objective

To audit how Minto Explorations Ltd. is implementing two critical environmental protection plans. Primarily focusing on the following:

a. compliance with the approved plans;
b. are the plans being implemented in a timely and thorough manner that is consistent with plan objectives and intent; and
c. the reliability and integrity of information relating to environmental reporting and compliance (is the information being reported, thorough, complete and is follow up conducted until resolution of situation).

Approved Audit Scope

Minto Mine – Operational Adaptive Management Plan

Conduct a review of the implementation of the Operational Adaptive Management Plan over the last 2 years with a specific focus on the following:

1. Are the specific performance thresholds being monitored as required as per the OAMP for Minto Creek groundwater, McGinty Creek groundwater, Minto Creek surface water, McGinty Creek surface water, physical stability and water management?
2. Are Minto's responses to threshold exceedances adequately implemented to meet the objectives and intent of the plan? (timing of identification, appropriate level of effort put into responses, etc.)
3. Is the reporting of the AMP occurrences adequately implemented such that the reliability and integrity of information relating to reporting meets the objectives of the AMP. (appropriate trend analysis application, appropriate level of effort into evaluation and action implementation)

Minto Mine – Environmental Monitoring Surveillance and Reporting Plan

Conduct a review of the implementation of the Environmental Monitoring, Surveillance and Reporting Plan over the last 2 years with a specific focus on the following:

1. Compliance with monitoring requirements for the following:
    a. water (surface, groundwater and seepage);
    b. geochemical (ABA, waste rock verification, low grade and oxide ore metals leaching characterization);

c. physical stability

2. Are the monitoring programs adequately implemented to meet the objectives and intent of the plan? (Are the sampling methods adequately being followed, etc).
3. Is the reporting of the EMSRP adequately implemented to meet the objectives and intent of the plan?

Documentation to Review

1. Minto Mine - Operational Adaptive Management Plan 2016-01, 2017-01, 2017-02
2. Minto Mine – Environmental Monitoring, Surveillance and Reporting Plan 2016-01
3. Monthly Reports (2016, 2017, 2018)
4. Annual Reports (2016, 2017)
5. External Notifications (Government and SFN)
6. Summary of requests from Minto Explorations Ltd. to qualified professional (QP) as a request for recommendation based on threshold exceedances.
7. QP responses to threshold exceedances

Audit Execution

Minto proposes that this audit will be completed by a team of technical professionals. The primary/lead auditor(s) will be Lorax Environmental Services with a sub-consultant used for the review of the physical stability portions of the audit. The team will consist of the following professionals:

Mr. Justin Bourne, M.Eng, P.Eng. – Audit Lead and Hydrogeologist,
Mr. Timo Kirchner, M.Sc. - Environmental Geoscientist - geochemistry,
Mr. Scott Jackson, M.Sc., P.Geo. – Hydrologist, and
Mr. Jim Cassie, M.Sc., P.Eng. – Geotechnical Engineer (BGC Engineering Inc. sub-contract)

The Lorax team members proposed have had no prior involvement with the Minto mine.

The licence requirement is for the audit to be completed by September 1st.

Reporting

The findings of the audit will be documented in an Audit report by Lorax and Minto Explorations will submit the report to the Ministry by October 31st, 2018.